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A

DICTIONARY

OF

ARTS AND SCIENCES.

BY G. GREGORY, D.D.

DOCTOR IN PHILOSOPHY AND THE ARTS, AND HONORARY MEMBER OF THE IMPERIAL UNIVERSITY OF WILNA; MEMBER OF THE MANCHESTER AND NEWCASTLE LITERARY AND PHILOSOPHICAL SOCIETIES; HONORARY MEMBER OF THE BOARD OF AGRICULTURE; DOMESTIC CHAPLAIN TO THE LORD BISHOP OF LLANDAFF; AUTHOR OF ESSAYS HISTORICAL AND MORAL, THE ECONOMY OF NATURE,

&c. &c.

IN TWO VOLUMES.

VOL. I.

LONDON:

PRINTED FOR RICHARD PHILLIPS,

NO. 6, BRIDGE-STREET, BLACKFRIARS:

AND SOLD BY ALL BOOKSELLERS AND DEALERS IN BOOKS IN THE UNITED KINGDOM.

1806.

T. Gillet, Printer, Wild-Court, Lincoln's-Inn-Fields.

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ADVERTISEMENT

TO THE FIRST VOLUME.

IT is long since the Editor of this Work conceived that a Dictionary of Arts and Sciences in a compendious form, sufficiently copious without being prolix, accurate but not diffuse, divested of all superfluous matter, compressing rather than copying what had been done by others, and exhibiting a clear but concise view of the present state of the various branches of human knowledge, was not only a most desirable object to the English reader, but an object perfectly practicable. He considered that a Dictionary is properly a work of reference and not of detail; and that those who wish to become adepts in any one art or science, will scarcely study it exclusively from an Encyclopædia.

The progress of the work has fully convinced him that he was not mistaken in his opinion. One half of the publication, according to the usual division of books of this nature, is now before the Public, and the reader will perceive that every science of real importance is given as completely as in more bulky publications, and in some instances even more at large. It is therefore with some degree of additional confidence that the Editor now re-states to the Public the following as the advantages which will result from the present new Dictionary of Arts and Sciences.

First, It will exhibit a compendium of all human knowledge, the more luminous because cleared of all extraneous matter; rather practical than speculative; and in which particular attention will be paid to the most useful branches.

Second, It will be of a convenient and comparatively portable size, calculated to lie on the table of every studious person as a book of constant reference.

Third, It will be printed so as to correspond with the quarto edition of Dr. Johnson's Dictionary; and the possessors of both works will thus have in four quarto volumes, and at a moderate expence, all the literary aid which the English student or reader can possibly require.

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ERRATA.

In some of the Copies the following Corrections are necessary:—

Page 7, Art. Acarus, *for* fig. 1—3 *read* fig. 2—3.
43, Art. Alca, *for* fig. 8 *read* fig. 10.
44, Art. Alcedo, *for* fig. 9 and 10 *read* fig. 8 and 9.
70, Art. Ampelis, *for* fig. 15 and 16 *read* fig. 14 and 16.
74, Art. Anacardium, *for* fig. 14 *read* fig. 17.
75, Art. Anarrhicas, *for* fig. 15 *read* fig. 16.
ib. Art. Anas, *for* fig. 16 and 17 *read* fig. 18 and 19.
152, Middle column at bottom, *for* $3^2 \times 3 = 4107$, *read* $\overline{37}^2 \times 3 = 4107$.

The references to the Anatomical Plate and Arteries will be found after the Index to the article Anatomy. See the end of the volume.

In a few of the copies, the references to the figures of the first Plate in Chemistry were unfortunately omitted by the writing Engraver, but the descriptions are so clear, that it is hoped little inconvenience will occur through the neglect.

TO THE RIGHT HONOURABLE

THOMAS, LORD ERSKINE,

BARON ERSKINE OF RESTORMEL CASTLE, IN THE COUNTY OF CORNWALL,

LORD HIGH CHANCELLOR OF GREAT BRITAIN,

&c. &c. &c.

MY LORD,

THOUGH a Dedication is in general an expression of gratitude from an Author to his Patron, or of friendship from one literary character to another, yet I cannot but be of opinion, that there should be some accord between the character of the Work and that of the Patron to whom it is presented.

In this point of view the world will see the propriety of a Work which professes to treat of the Sciences and the Arts in general, being inscribed to a Nobleman who unites in himself more various, as well as more splendid talents, more general knowledge,and more diversified taste, than any other public character of the present age; who, deservedly filling the chair of Bacon, possesses the same excursive and expanded genius; but whose public duties, being more onerous than they were in the time of that great man, alone preclude him from gratifying and enlightening the Public by researches out of the line of his profession.

If a private sentiment might be indulged on such an occasion, the Editor would add, that your Lordship's unremitted zeal for true Religion, and your tried and disinterested Patriotism, must for ever endear the name of ERSKINE toevery friend of liberty, piety, and active virtue.

That your Lordship may long continue to serve your country, and promote the best interests of humanity, in the arduous situation to which the Divine Providence has been pleased to call you, is the fervent prayer of,

My Lord,

Your Lordship's

Ever faithful humble servant,

G. GREGORY.

West Ham, Jan. 20, 1807.

PREFACE.

FROM the time of Chambers, Dictionaries of Arts and Sciences have been increasing in magnitude, without (it is to be feared) a proportionable increase of utility. The authors appear to have regarded it as a kind of sacrilege to retrench, while they have equally thought it their duty to add every thing that came within their reach. Hence not only obsolete terms, but obsolete sciences, as magic, alchemy, and astrology, have been retained even in works of high character, and otherwise of distinguished merit. Hence, that which was new even in the living sciences, has been combined with what had been long since exploded: a practice calculated not only to confuse but to mislead.

It was upon this view of the subject it occurred to the editor of this work, that in framing a new Dictionary, selection was a more urgent duty than accumulation; that perspicuity, not less than convenience, would be consulted by reducing the size; and that whatever is practically useful in science and in art might be compressed within a smaller compass than had been commonly imagined. However deficient he may have been in the execution of his plan, he has the satisfaction to say, that in this idea he was not deceived or disappointed.

A dictionary of this kind is intended for two purposes: first, as a book of reference, to lie on the table of a man of letters, for occasional consultation where recollection has failed, or where a subject occurs in reading or conversation which had not previously come within the course of his studies. The second is, to serve as an introductory or elementary work for students, or for those who may not have leisure to bestow on the great works of science, or to travel through the many volumes which at this time almost every branch of knowledge includes.

The first of these ends it is humbly presumed will be sufficiently answered by the present publication. Most of the technical terms in science and the arts, are inserted with a proper definition or explanation, in the alphabetical order; or should there be a casual omission, the word will still be found under the head of the science to which it belongs, and probably in the index to the treatises at the end of each volume. To some sciences it was found necessary to attach a glossary. The technical phrases, however, in anatomy, surgery, &c. are generally referred to those branches of science expressly treating of them, that nothing may appear, on casually opening the book, to offend the most modest or delicate reader. Terms also which now constitute a part of common colloquial language, and which, therefore, every person must understand, have been omitted.

With respect to the second object, no pains have been spared in preparing those articles which treat of the respective sciences. In a work of this nature it cannot be expected that the whole should be original, nor could it in that case answer so well the ends for which it is designed. An Encyclopedia is in its nature a compilation; and its best commendation is, that it amasses together the best

information from the best sources. Yet in this work there is much original composition; and such is the progress of science, that it contains scarcely any articles of importance which are to be found in any similar publication.

In order also to facilitate as much as possible the study of the sciences, every attention, consistent with the nature of the work, has been paid to method; and the student will not be much at a loss to distinguish the order in which the several parts of each science are to be read. Thus, under Natural History, he will find a synopsis of the several branches, the classes and orders, and under these the names of the genera; under Zoology, again, he will not only meet the classes and orders, but also an immediate reference to the genera. Under Chemistry, he will find the outlines of the science, and references to the different branches, which are treated more at large in other parts of the work. Thus under Furnace and Laboratory, is included the whole of the apparatus; and he will then turn to Air, and the simple substances as they stand enumerated there, or under the word Elements. Astronomy and Mineralogy, he will see, have similar references. Electricity, Hydrostatics, Hydraulics, Magnetism, Mechanics, Meteorology, Optics, Pneumatics, and the Medical Branches, are complete in themselves. Those articles which relate to the Arts are also complete. Those which treat of the different subjects of Trade and Commerce are also complete, and contain all the new information which could be obtained on those important topics.

The Editor cannot conclude this address without frankly stating, that whatever may be thought of the merits of the new Dictionary of Arts and Sciences, they are more to be attributed to the very able assistance with which he has been favoured from different quarters, than to his own exertions. He wishes he could make his acknowledgments in terms equal to his sense of the obligation. To his industrious and truly able coadjutor, the Rev. Mr. Joyce, he is indebted for much general assistance, and for the exclusive superintendance of all the mathematical and astronomical articles. A similar acknowledgment is due to his friend and neighbour, Luke Howard, Esq. particularly for his attention to all those articles connected with the almost new, and important science, Meteorology.

The public will estimate better than he can point out the extent of his and their obligations to Mr. Grellier, of the Royal Exchange Assurance-Office, when he mentions, that all the articles relative to Trade, Commerce, Political Economy, Finance, and Revenue, were drawn up by that gentleman.

The Medical and Physiological articles were written by Dr. Uwins, of Somers Town; Husbandry and Surveying by Mr. Crocker, of Froome; Rhetoric by Dr. Thomson, well known as the Continuator of Watson's History; Architecture by Mr. Henderson, the plates by Mr. Moore; Exchanges by Mr. P. Hamsbrow; Farriery by Mr. Lawrence; and Anatomy by Mr. A. Walker.

Those articles which are connected with History and Antiquities, have been furnished by a distinguished scholar, as will be easily perceived; those relative to the Fine Arts, by a gentleman well known in the literary world; Poetry by a lady, who, like Vida, has asserted her title to the character of a critic, by having excelled in the art itself; the Military articles are the production of a literary gentleman who was educated in that profession; and some of the principal Law articles are by a member of one of the inns of court. Besides these, the editor has been favoured with single communications from Dr. Mavor, Mr. M. Smart, and several correspondents who desire their names to be concealed.

A DICTIONARY OF ARTS AND SCIENCES.

A, the first letter of the alphabet, is used, on many occasions, as a mark, or abbreviation. Thus, in the calendar, it is the first of the dominical letters: among logicians, it denotes an universal affirmative proposition: as a numeral, A signified one among the Greeks; but among the Romans it denoted 500, and with a dash over it, thus, $\bar{A}$, 5000. The Romans also used it on public occasions for *antiquare*, to antiquate or reject a proposed law; as did the judges of the same people for *absolvo*, I absolve or acquit; whence it had the name of *litera salutaris*. A is frequently also met with, denoting *Aulus*, *Augustus*, *Ager*, *Aiunt*, &c. A.A. stands for *Augusti*; A.A.A. for *aurum*, *argentum æs*; and, among chemists, for *amalgama*. A.M. is used for *anno mundi*, *artium magister*, or *ante meridiem*; A.A.U.C. for *anno ab urbe condita*; A.B. for *alia bona*, or *artium baccalaureus*; A.C. for *acta causa*, *alius civis*, or *ante Christum*; and A.D. for *anno domini*. On antient medals, A stands for *Argus*, and sometimes for *Athens*; but on French coins of modern date, it is the mark of the mint of *Paris*. A, $\bar{a}$, or $\bar{aa}$, among physicians, denote *ana*, or an equal weight or quantity of several ingredients. The letter A is also used by merchants, to signify accepted.

AAM, a measure of capacity used by the Dutch, otherwise called haam; it contains 128 mingles, or 288 English pints.

AAVORA, a fruit of a kind of palm-tree, found in the West Indies and in Africa. It is of the size of a hen's egg, and is included with others in a large shell. In the middle of the fruit there is a hard nut, which contains a white almond, very astringent, and used in cases of diarrhœa.

AB, in the Hebrew chronology, the eleventh month of the civil, and the fifth of the ecclesiastical year; it comprehended part of July and August, and contained thirty days.

ABACATUAIA. See ZEUS.

ABACK, a sea term, which signifies the situation of the sails in a ship, when the surfaces are driven by the wind flat against the mast. They may be brought *aback* by a sudden change of the wind, or an alteration in the ship's course.

ABACOT, the name of the antient coronet, or cap of state, worn by the English kings, the upper part of which was made up in the form of a double crown.

ABACTORS, drivers away and stealers of cattle in herds, or great numbers. In Spain this crime is very common, and the punishment severe.

ABACUS, in architecture, the uppermost member of the capital of a column. In the Tuscan, Doric, and Ionic orders, the abacus is flat and square; but in the richer orders, its four sides, or faces, are arched inwards, with some ornament, as a rose or other flower, in the middle of each arch, and its four corners cut off.

According to Vitruvius, the abacus was originally intended to represent a square flat tile, laid over an urn or a basket. The invention is ascribed to Callimachus: who observed a small basket covered with a tile, over the root of an acanthus plant which grew on the grave of a young lady; the plant shooting up encompassed the basket, till meeting the tile, it turned back in the form of scrolls. The philosopher took the hint, and executed a capital on this plan, representing the tile by the abacus, the leaves of the acanthus by the volutes, and the basket by the body of the capital. See ARCHITECTURE.

Scamozzi also uses abacus for a concave moulding in the capital of the Tuscan pedestal.

ABACUS, or ABACISCUS, in the antient architecture, likewise denoted certain compartments in mosaic pavements, and the like.

ABACUS, among the antient mathematicians, was a table strewed over with dust, or sand, on which they drew their figures or schemes.

ABACUS, an instrument for facilitating the operations of arithmetic, by means of counters. Its form is various; but that chiefly used in Europe, is made by drawing parallel lines, distant from each other at least twice the diameter of a counter; which placed on the lowermost line, signifies 1; on the second, 10; on the third, 100; on the fourth, 1000; and so on. Again, a counter, placed in the spaces between the lines, signifies only the half of what it would do on the next superior line. According to this notation, the same number, 1806 for example, may be represented by different dispositions of counters. See A and B, in Plate IX. fig. 1.

ABACUS *pythagoricus*, a multiplication-table, or a table of numbers ready cast up, to facilitate operations in arithmetic.

ABACUS *logisticus*, is also a kind of multiplication-table, in form of a right-angled triangle; each side contains the numbers from 1 to 60, and its area the product of each two opposite numbers.

ABAFT, in sea language, a term applied to any thing situated towards the stern of a vessel: thus, a thing is said to be abaft the foremast, or main-mast, when placed between the fore-mast, or main-mast, and the stern.

ABAFT *the beam*, denotes the relative situation of any object with the ship, when it is placed in that part of the horizon which is contained between a line at right angles with the keel, and that point of the compass which is directly opposite to the ship's course.

ABAGI, a silver coin, current in Georgia, worth about 18 pence.

ABARCA, a kind of shoe, made of raw hides, formerly worn by the peasants of Spain. Some mention another kind of abarca, made of wood, like the French sabots.

ABAS, a Persian weight, used in weighing pearls. It is one-eighth less than the European carat.

ABASED, *abaissé*, in heraldry, is said of the wings of eagles, &c. when the tip inclines downwards to the point of the shield; or when the wings are shut; the natural way of bearing them being spread. A chevrond, pale, bend, &c. are also said to be abased, when their points terminate in or below the centre of the shield. Lastly, an abased ordinary, is one placed below its due situation.

ABASSI, or ABASSIS, a silver coin, current in Persia, worth from 16 to 18 pence English. It derives its name from Shah Abbas II. under whom it was first struck.

ABATE, in the manege. A horse is said to abate, or take down his curvets, when he puts both his hind-legs to the ground at

once, and observes the same exactness in all the times.

ABATE, in law, signifies to overthrow, demolish, or destroy. It is likewise used to denote the act of him who steps into an estate, void by the death of the last possessor, before the heir can enter, and by this means keeps him out.

ABATELEMENT, is used for a prohibition of trade to all French merchants in the ports of the Levant, who will not stand to their bargains, or refuse to pay their debts.

The abatelement is a sentence of the French consul, and must be taken off before they can sue any person for the payment of their debts.

ABATEMENT, in law, signifies the rejecting a suit, on account of some fault either in the matter, or proceeding. Hence, plea in abatement is some exception alledged, and proved, against the plaintiff's writ, declaration, &c. and praying that the plaint may abate or cease; which being granted, all writs in the process must begin *de novo*.

ABATEMENT is also an irregular entry upon houses or lands, and in this sense, is almost synonimous with intrusion.

ABATEMENT, in heraldry, a mark which is attached to a coat of arms, in order to lessen its true dignity, and point out some imperfection or stain in the character of the person who bears it. Abatements are either made by reversion or diminution; the whole escutcheon being turned upside down, or another inverted one added, in the former case; and as to diminutions, they are either a delf, a point, a point dexter, a point champain, a plain point, a goar sinister, or two gussets.

ABATEMENT, in commerce, is a discretionary allowance for damage of goods sold, for a defect of weight of measure, on account of bad markets, &c.

Abatement in the customs, is an allowance made on the duty of damaged goods, upon the judgment of two merchants upon oath, and ascertained by a certificate from the surveyor and landing waiter.

ABATIS, in a military sense, is formed by cutting down many entire trees, the branches of which are turned towards the enemy, and designed to guard entrenchments, to cover the passage of a river, to block up roads,&c.

ABATOR, in law, one who enters into a house or lands, void by the death of the last possessor, before the true heir; and thereby keeps him out till he brings the writ *intrusione*.

ABB, in our old writers, is used for the yarn of a weaver's warp; and hence the wool of which it was made, had the name of abb wool.

ABBA, a Syriac term literally signifying father, and used as a title of respect and honour. Slaves were not allowed the use of this term, which explains the meaning of St. Paul, Rom. viii. 15. The Jews assumed the name as a title of dignity: and in many of the eastern churches it is the title which the people give to their bishops. But the bishops themselves bestow it particularly on the partriarch of Alexandria.

ABBE', the denomination of a class of persons in France, who have not obtained any fixed settlement in the churches, but are expectants of one that may happen to become vacant. Their dress is that of an academic, rather than of an ecclesiastic.

ABBESS, the superior of a convent of nuns. The abbess enjoys the same privileges, and has the same authority over her nuns, that the abbots have over their monks; spiritual functions only excepted, of which the sex renders her incapable.

ABBEY, the name of such religious houses as are governed by a superior, under the title of abbot or abbess. Abbeys differ in nothing from priories, except that the latter are governed by priors, instead of abbots.

The abbeys of England, at their dissolution under K. Henry VIII. became lay fees: no less than 190 were then dissolved, of between 200*l.* and 35,000*l.* yearly revenue, which at a medium amounted to 2,853,000*l. per annum;* an immense sum in those days.

The abbey lands before this dissolution were chiefly tythe free; and these exemptions were continued to the lay possessors by the act 31 Hen. viii. c. 13.

ABBOT, the superior, or governor of a monastry of monks erected into an abbey or prelacy.

The abbots of the primitive monasteries, from the poverty they professed, and commonly practised, had no other claim to superiority or respect than what arose from the sanctity of their lives; but afterwards, affecting not only pre-eminence over each other, but even to be independent of the bishop, there arose new species and distinctions of abbots into mitred and not mitred, croziered and not croziered, and œcumenical abbots.

ABBOTS, *Mitred*, were those who were privileged to wear a mitre, and besides enjoyed the full episcopal jurisdiction of their several precincts. Among us, these were called abbots-sovereign, or abbots-general, and were lords of parliament: they were twenty-seven in number, besides two mitred priors. The unmitred abbots continued subject to their diocesan bishop.

ABBOTS, *Croziered*, were those entitled to carry a crozier, or pastoral staff.

ABBOT, *Oecumenical*, the same with universal, was a title assumed among the Greeks, in imitation of the patriarch of Constantinople: nor have those of the Latin church been backward in this respect; some having called themselves *abbas abbatum*, or the abbot of abbots; and others assumed the title of cardinal-abbot.

Abbots, however, are chiefly distinguished, at present, into regular and commendatory; the former being real monks or religious, and the latter only seculars or laymen. These last, notwithstanding that the term *commendam* seems to signify the contrary, have the perpetual enjoyment of the fruits of their abbeys. Antiently the ceremony of creating an abbot consisted in clothing him with the habit called *cuculla*, or cowl; putting the pastoral staff into his hand, and the shoes called *pedales*, on his feet; but at present, it is only a simple benediction, improperly called, by some, consecration.

ABBOT is also a title given to others beside the superiors of monasteries: thus bishops, whose sees were formerly abbeys, are called abbots; as are the superiors of some congregations of regular canons, particularly that of St. Genevieve at Paris, and among the Genoese the chief magistrate of their republic formerly bore the title of abbot of the people. It was likewise usual, about the time of Charlemagne, for several lords to assume the title of *count-abbots, abba-comites;* and that for no other reason, but because the superintendency of certain abbeys was committed to them.

ABBREVIATE of *adjudication*, in Scotch law, is an abstract or abridgement of a decree which is recorded in a register kept for that purpose.

ABBREVIATION, is a contraction of a word or passage, made by dropping some letters, or by substituting marks or characters in their place. Abbreviations are employed in language three ways; in terms, in sorts of words, and in construction. Lawyers, physicians, chemists, &c. use many abbreviations.

ABBREVIATION of fractions, is the reduction of them to lower terms thus, $\frac{24}{36}=\frac{8}{12}=\frac{2}{3}$, and $\frac{9abx}{3bc}=\frac{3ax}{c}$.

ABBREVIATORS, a college of 72 persons in the chancery of Rome, whose business, according to Champini, is to draw up the pope's briefs, and reduce the petitions granted by him into proper form.

The abbreviators are divided into two parts, or ranks; the one called *abbreviatores de parco majore*, who are twelve in number. and all prelates; the other *abbreviatores de parco minore*, called also *examinatores*, who may be all lay-men.

ABBREUVOIR, in masonry, certain indentures made with a hammer, in the joints and beds of stones, in order that the mortar being received into these, may bind them the more firmly together.

ABCEDARY, ABCEDARIAN, or ABECEDARIAN, an epithet given to compositions, the parts of which are disposed in the order of the letters of the alphabet: thus, we say abcedarian psalms, lamentations, hymns.

These are met with chiefly among Hebrew writers, and as they have but 22 letters in their alphabet, poems of this kind consist of 22 lines, or systems of lines or periods, and every line or period begins with each letter in its order. The cxixth Psalm is a very remarkable instance of this kind. Psalms cxi. cxii. and Lam. iii. are perfectly alphabetical, in which every line is marked by its initial letter. There are others, as Psalms xxv. xxxiv. xxxvii. cxlv. &c. in which the stanza only is distinguished. This was a contrivance probably intended to assist the memory, and was employed in subjects of common use, as maxims of morality and forms of devotion.

ABDALS, in the Asiatic customs, a kind of furious enthusiasts, whose madness impels them frequently to run about the streets, and kill all they meet of a different religion from what they profess: this our sailors call *running a muck*, from the name of the instrument, a sort of poignard.

ABDEST, among Mahometans, a kind of washing or lotion practised both by Turks and Persians, before prayer, entering the mosque, or reading the alcoran.

ABDICATION, the act of a magistrate, who relinquishes or divests himself of an office. It differs from resignation, as this last is done in favour of some other person;

whereas abdication is done without any such view. In this sense, Dioclesian is said to have *abdicated* the crown; but Philip IV. of Spain resigned it. The parliament of England voted that James II. having endeavoured to subvert the constitution of the kingdom, had abdicated the government, and that the throne was thereby vacant.

ABDICATION is also used by civilians, for a father's discarding his son. This, called likewise a *familia alienatio*, was different from exheredation, or disinheriting, as being done in the father's life time; whereas exheredation never took place till his death: so that an abdicated son was actually disinherited, but not *vice versa*.

ABDICATION, among the Romans, was also used for a citizen's renouncing his liberty, and voluntarily becoming a slave.

ABDOMEN, the lower part of the trunk of the body, reaching from the thorax to the bottom of the pelvis. See ANATOMY.

For diseases and wounds of the abdomen, See MEDICINE and SURGERY.

ABDUCTION, in logic, a form of reasoning called by the Greeks *apagogue*; by which from a certain or undeniable proposition, we infer the truth of something supposed to be contained in that proposition: thus in this syllogism:

Whatever God has revealed is certainly true:
Now, God has revealed a future retribution;
Therefore a future retribution is certainly true.

In arguments of this kind, it is always necessary to prove the minor proposition to be contained in the major, or undeniable one, otherwise the reasoning loses all its force.

ABDUCTION, in surgery, a kind of fracture, wherein the bone being entirely broken near a joint, the two stumps recede considerably from each other. See SURGERY.

ABDUCTOR, or ABDUCENT, in anatomy, a name given to several muscles on account of their serving to withdraw, open, or pull back the parts to which they are fixed. See ANATOMY.

ABEL-TREE. See POPULUS.

ABELONIANS, a sect of heretics, called also *abelians* and *abeloites*, whose distinguishing doctrine was to marry, and yet live in professed abstinence; a tenet which, according to some authors, they founded on that text, 1 Cor. vii. 29. *Let them that have wives be as though they had none.* To perpetuate the sect, they allowed each man and woman to adopt a boy and a girl, who were to be their heirs, and who were to marry under the same obligation of continence.

ABERRATION, in astronomy, an apparent motion of the celestial bodies, occasioned by the progressive motion of light, and the earth's annual advance in her orbit.

This effect may be explained by the motion of a line parallel to itself, in a way similar to the explanation of the composition and resolution of forces in *mechanics*. Let the proportion of the velocity of a ray of light, to that of the earth in her orbit, be as BC (see Plate IX. figure 2.) to the line AC; then, by the composition of these two motions, the ray will seem to describe BA or DC, instead of its real course BC, and will appear in the direction AB, instead of its true direction CB. Therefore if AB represent a tube, carried with a parallel motion by an observer along the line AC, in the time that a particle of light would move over the space BC, the different places of the tube being A*b*, *a b*, *c d*, CD; and when the eye, or end of the tube, is at A, let a particle of light be supposed to enter at B; then when the tube is at *a b*, the particle will be at *e*, in the axis of the tube; and when the tube is at *c d*, the particle of light will be at *f*; and when the tube has arrived at CD, the particle will be at C, and will appear to come in the direction DC of the tube, instead of the true direction BC. Thus one particle succeeding another, forms a continued stream of light in the apparent direction DC. So that the apparent angle made by the ray of light with the line AE, is the angle DCE, instead of the true angle BCE; and the difference BCD, or ABC, is the quantity of the *aberration*.

We are indebted for this great discovery to the late Dr. Bradley, astronomer royal, who was led to it by the result of observations made with a view of determining the annual parallax of the fixed stars, or that which arises from the motion of the earth in its annual orbit about the sun. See PARALLAX.

ABERRATION *of the Planets*, is equal to the geocentric motion of the planet, or the space it appears to move as seen from the earth, during the time that the light employs in passing from the planet to the earth. Thus in the sun, the aberration in longitude is constantly 20″; that being the space moved by the sun, or, which is the same thing, by the earth, in eight minutes and seven seconds, which is the time that light takes in passing from the sun to the earth. Hence the aberration of the other planets is found: for knowing the distance of the sun from the earth, it will be by common proportion, as the distance of the earth from the sun is to the distance of the planet, so is 8′ 7″, to the time of light's passing from the planet to the earth; then computing the planet's geocentric motion in this time, that will be the aberration of the planet, whether it be in longitude, latitude, right ascension, or declination.

The aberration will be greatest in the longitude, and very small in latitude, because the planets deviate very little from the plane of the ecliptic; so that the aberration in the latitude of the planets may be neglected as insensible, the greatest in Mercury being only 4″$\frac{1}{3}$, and much less in the other planets. The aberration in declination and right ascension, depend on the situation of the planet in the zodiac. The aberration in longitude, being equal to the geocentric motion, will be more or less, according as that motion may be. It will be least when the planet is stationary; and greatest in the superior planets, when they are in opposition; but in the inferior planets the aberration is greatest at the time of their superior conjunction. The maxima of aberration for the several planets, when their distance from the sun is least, are as follow:

Saturn	27′	0
Jupiter	29	8
Mars	37	8
Venus	43	2
Mercury	59	0
The Moon	0	40

Between these numbers and nothing, the aberrations of the planets in longitude vary according to their situations. But that of the sun is always 20″: the sun may, however, alter his declination by a quantity which varies from 0 to nearly 8″, being the greatest about the equinoxes, and vanishing in the solstices.

ABERRATION, in optics, a deviation of the rays of light, whereby they are prevented from meeting in the same point.

Aberrations are of two kinds; one arising from the figure of the reflecting body, the other from the different refrangibility of the rays themselves: this last is called the *Newtonian aberration*, from the name of the discoverer.

With regard to the former species of aberration, or that arising from the figure, we may observe, that if rays issue from a point at a given distance, then they will be reflected into the other focus of an ellipse, when the luminous point is in one focus; or directly from the other focus of an hyperbola, and will be variously dispersed by all other figures. If the luminous point is infinitely distant or the incident rays parallel, then they will be reflected by a parabola into its focus. These figures being difficult to form, curved specula are commonly made spherical; the figure of which is generated by the revolution of a circular arc, which produces an aberration of all rays, whether they are parallel or not: and therefore it has no accurate geometrical focus, which is common to all rays.

ABERRATION, *crown of*, is a luminous circle about the real disk of the sun, and depending on the aberration of the solar rays, by which his apparent diameter is enlarged.

ABETTOR, or ABBETTOR, the person who promotes a crime or procures it to be committed: thus, an abettor of murder is one who commands or counsels another to commit it. An abettor, according as he is present or absent, at the time of committing the fact, is punishable as a principal or accessary.

An abettor is the same with one who is deemed *art and part* by the law of Scotland.

ABEYANCE, ABEIANCE, or ABBAYANCE, in law, the expectancy of an estate or possession: thus, when a parson dies, the fee of the glebe belonging to his church is said to be in abeyance during the time the parsonage is void,

It is a fixed principle of law, that the fee-simple of all lands is in somebody, or else in abeyance.

ABHORRERS, a name given to a party in England about the year 1680, in opposition to those who petitioned for a redress of grievances.

ABIB, the first month of the ecclesiastical year among the Hebrews. It was afterwards called Nisan, and answered to our March.

ABIGEAT, *abigeatus*, the crime of stealing or driving off cattle in droves, otherwise called *abactus*. It was more severely punished than simple theft, *viz.* by condemnation to the mines, banishment, or even death.

ABILITY, in a law sense, is the power of doing certain actions, principally with regard to the acquisition or transfer of property. Every person is supposed to have this power, who is not disabled by any specific law.

ABJURATION, in law, is used for renouncing, disclaiming and denying the Pretender to have any manner of right to the throne of these kingdoms; and that upon oath, which is required to be taken upon divers occasions under certain pains and penalties by many statutes, particularly 1 W. and M. 13. W. III. 1 Anne. 1 Geo. I.

ABJURATION, in our ancient customs, was an oath taken by a person guilty of felony, and who had fled to a place of sanctuary, to leave the world for ever. This is much the same with what in Scotland is called *signing an act of banishment*.

ABLATIVE, in Latin grammar, the name of the sixth case, which is peculiar to that language. The ablative is opposed to the dative; the latter expressing the action of giving, and the former that of taking away: thus, *ablatum est à me*, it was taken from me. It is sometimes called the comparative case, as being much used in comparing things together: thus, *dulcior melle*, sweeter than honey.

ABLATIVE *absolute*, among Latin grammarians, is so called, because governed by no other word.

ABLECTI, in Roman antiquity, a select body of soldiers, chosen from among those called *extraordinarii*.

ABLEGMINA, in Roman antiquity, choice parts of the entrails of victims. The ablegmina were sprinkled with flour, and burnt on the altar; the priests pouring some wine on them.

ABLUENTS, diluting medicines, or such as dissolve and carry off acrimonious and stimulating matter, in any part of the body, especially the stomach and intestines.

ABLUTION, in a religious sense, a ceremony in use among the antients, and still practised by the Mahometans: it consisted in washing the body, which was always done before sacrificing, or even entering their temples. This custom was probably derived from the Jews.

ABLUTION, in the church of Rome, a small quantity of wine and water, which the communicants formerly took to wash down, and promote the digestion of, the host. They also use this term for the water with which the priest washes his hands after consecrating the host.

ABLUTION, among chemists and apothecaries, is used for washing away the superabundant salts of any body; an operation otherwise called edulcoration.

ABOLITION, in law, denotes the repealing of any law or statute, or prohibiting some custom, ceremony, &c. sometimes also it signifies leave granted by the king, or a judge, to a criminal accuser to forbear any farther prosecution.

ABOLITION, is also used by antient civilians and lawyers, for desisting from, or annulling, a legal prosecution; for remitting the punishment of a crime; and for cancelling or discharging a public debt.

ABOLLA, a military garment, worn by the Greek and Roman soldiers: it was lined, or doubled, for warmth.

ABOMASUS, ABOMASUM, or ABOMASIUS, in comparative anatomy, names used for the fourth stomach of ruminating beasts, or such as chew the cud. These have four stomachs, the first of which is called *venter;* the second, *reticulum*; the third, *omasus*; and the fourth, *abomasus*. It is in the abomasus of calves and lambs that the runnet is found, used for curdling milk:

ABORTION, an untimely or premature birth of a fœtus, otherwise called a miscarriage; but if this happens before the second month of pregnancy, it is called a false conception.

Abortion, which is always a dangerous and but too often a fatal accident, may be owing to a multiplicity of causes; but the most frequent ones are immoderate fluxes of any kind, violent passions of the mind, stimulating medicines, strong purges or vomits, sudden commotions of the body, as running, leaping, falls, blows, &c. to which we may add a too frequent use of venery, copious bleeding in the foot, a debility or laxity of the womb, and a plethoric habit of body: this last is often the cause of abortion in young women, pregnant of their first child.

In order therefore to prevent abortion, the above causes must be carefully guarded against. It is likewise conducive to the same end, to bleed at proper times; as also to use strengthening and attemperating medicines. It ought however to be carefully attended to, not to give any thing restringent either internally or externally, when the abortion is become unavoidable. The signs of an approaching or threatened abortion are, a sudden flaccidity of the breasts, a constriction or subsiding of the belly, a pain in the head and eyes, grinding pains in the stomach, coldness of the extremities, faintings, shiverings, &c.

As to the immediate forerunners of an abortion, they are these: violent pains in the loins and hips, a dilation of the orifice of the womb, the formation of waters, an eruption of the same, a discharge of pure blood, or blood mixed with the waters. When these symptoms appear, immediate delivery becomes absolutely necessary, without waiting for strong pains, which seldom return after the flooding is grown so excessive. This is performed in the same manner as for a timely birth. See MIDWIFERY.

ABOUT, in sea language, the situation of a ship immediately after she has changed her course. *About-ship*, is the order to the ship's crew for tacking.

ABOUT, in military language, expresses the movement by which a body of troops changes its front, by facing according to any given word of command.

ABRA, a silver coin in Poland, nearly equivalent to the English shilling. The abra is current through all the dominions of the grand signior, where it passes for a fourth part of the Dutch dollar, called assani in the Levant.

ABRAHAMIANS, or ABRAHAMITES, in church-history, heretics who renewed the doctrines of the Paulicians; a sect, who, to the principles of the Manichees, added an abhorrence of the cross, which they are said to have employed in the most servile offices. The term is also used for another sect, who suffered death for the worship of images.

ABRAUM, a name by which some call adamic earth, a kind of clay used by cabinet-makers to give a red colour to new mahogany. It is found in the Isle of Wight, also in some parts of Germany and Italy.

ABRAXAS, a word denoting a power which presides over 365 others, the number of days in a year. It is thought to be made up of the Greek numerals A, 1; β, P, 100; A, 1; Ξ, 60; A, 1; Σ, 200: which added together make the number of 365.

ABRAXAS, a mystical term expressing the supreme God, under whom the Basilidians supposed 365 dependent deities.

It was the principle of the Gnostic hierarchy, whence sprang their multitude of æons From abraxas proceeded the primogenial mind; from the primogenial mind, the logos, or word; from the logos, the phronesis, or prudence; from phronesis, sophia and dynamis, or wisdom and strength; from these two proceeded principalities, powers, and angels; from these other angels, to the number of 365, who were supposed to have the government of so many celestial orbs committed to their care.

ABRAXAS, among antiquaries, an antique gem or stone, with the word abraxas engraven on it. There are many kinds of them, of various figures and sizes, mostly as old as the third century. They were used as amulets, and were supposed to have great efficacy in driving away flies.

ABREAST, a sea term, expressing the situation of two or more ships, that lie in a parallel direction. When the line of battle at sea is formed *abreast*, the whole squadron advances uniformly, the ships being equally distant from and parallel to each other.

ABRIDGING, in algebra, is the reducing a compound equation to a more simple form.

This is done to save room, or to simplify the expression. Thus the equation $x^2 + \overline{a+b} \times x - \frac{ab}{c} = 0$, by putting $p = a + b$ and $q = \frac{ab}{c}$, becomes $x^2 + px - q = 0$.

ABRIDGEMENT, signifies much the same with an epitome, or abstract of a large work.

The perfection of an abridgement consists in taking only what is material and substantial, and rejecting all superfluities, whether of sentiment or style. It is very seldom, however, that a good work will bear this retrenchment; and above all, the practice of *teaching* by abridgement is reprehensible. It is a practice which has unfortunately been too common in schools; and is calculated to make smatterers, and not scholars. Abridged history, for instance, can only give a dull chronology of events, without the manners, sentiments, characters, the knowledge of human nature in short, which well-written history is intended to convey; and abridged geography supplies only a knowledge of the latitude and longitude, or at most of the relative situations of places, with a few charges upon the memory, the least improving parts of the study. The climate, soil, the productions, the manners of the country, its commerce and political relations, are only to be learned from larger works. But the worst effect is, that when the pupil has committed a few barren facts to memory, he concludes himself master of the science; even his curiosity is blunted, and his desire of acquiring knowledge anticipated; and the great probability is, that he never afterwards is sanguine enough to open a work of real information on the subject.

ABRIDGEMENT, in law, is the shortening

a count or declaration; thus, in assize, a man is said to abridge his plaint, and a woman her demand in action of dower, if any land is put therein, which is not in the tenure of the defendant; for on a plea of non-tenure, in abatement of the writ, the plaintiff may leave out those lands, and pray that the tenant may answer to the remainder. The reason is, that these writs run in general, and therefore shall be good for the rest. *Cowel.*

ABROMA, in botany, a genus of the *polyadelphia dodecandria* class and order. The corolla consists of five petals larger than the calyx: and the essential character is, *pistils* 5; *capsule* five-celled one valved, gaping at top; *seeds* subovate, incompletely arilled.

We know of only two species: the one *abroma angusta*, a native of New South Wales, and the Philippine isles; the other of the East Indies. The former is a tree bearing a purple flower, the other only a shrub in its native climate. With us, the abroma angusta is treated as a stove plant, and may be propagated by cuttings; the abroma Wheleri is not known in Europe.

ABRUS, in botany and the materia medica, a genus of plants of the class and order diadelphia decandria, called vulgarly the *wild liquorice*. The essential character is, the calyx obscurely four-lobed, the upper lobe broadest. *Filaments* nine, united in a sheath at bottom, gaping at the back. *Stigma* blunt, *seeds* sub-globose.

We know of but one species of this elegant plant, which grows wild in both Indies, Guinea and Egypt; and produces those beautiful red seeds resembling beads with a black spor or eye at the end annexed to the pod, which have been so much admired. They have been worn in many countries as ornaments. They are eaten in Egypt, but are the most unwholesome and indigestible of the pulse tribe; one variety produces white, and another yellow seeds, but otherwise they are not essentially different. The abrus is with us a stove plant, raised from seeds sown in light earth, and plunged in a hot-bed. It sometimes ripens seed in England.

ABSCESS, an inflammatory tumour, containing purulent matter, pent up in a fleshy part.

Abscess is synonymous with apostem, imposthume, and imposthumation; and is always the effect of an inflammation, which frequently may be discussed without coming to a suppuration, or before an abscess is formed. See SURGERY, &c.

ABSCISSE, in conic sections, the part of the diameter of a curve line intercepted between the vertex of that diameter, and the point where any ordinate or semi-ordinate to the diameter falls.

From this definition it is evident, that there are an infinite number of variable abscisses in the same curve, as well as an infinite number of ordinates. In the parabola, one ordinate has but one abscisse; in an ellipsis, it has two; in an hyperbola conisisting of two parts, it has also two; and in curves of the second and third order, it may have three and four. In the parabola, the abscisse is a third proportional to the parameter and semi-ordinate. In the ellipsis, the square of the semi-ordinate is equal to the rectangle of the parameter into the abscisse, subtracting another rectangle of the same abscisse into a fourth proportional to the axis, the parameter, and abscisse. In the hyperbola, the squares of the semi-ordinates are to each other as the rectangles of the abscisse, into a line composed of the same abscisse and the transverse axis. See CONIC SECTIONS.

ABSCISSION, in rhetoric, a figure of speech, whereby the speaker stops sort in the middle of his discourse: *e. g.* "One of her age and beauty, to be seen alone, at such an hour, with a man of his character! I need say no more."

ABSINTHIUM. See ARTEMISIA.

ABSOLUTE *number*, is the known quantity which possesses one side of an equation; thus, in $x^2 + 12\ x = 24$, the absolute number is 24, which is equal to the square of x added to 12 times x.

ABSOLUTE *equation*, in astronomy, is the sum of the optic and eccentric equations. The apparent inequality of a planet's motion, arising from its not being equally distant from the earth at all times, is called its *optic* equation; this would subsist if the planet's real motion was uniform. The eccentric inequality is caused by the planet's motion not being uniform.

ABSOLUTELY, among divines, is used for completely, or with full power and effect, independently of any thing else: thus catholics hold that the priest forgives sins absolutely; whereas protestant divines do it only declaratively.

ABSOLUTELY, in grammar; a word is taken absolutely when it has no government: thus, in "Pray without ceasing;" the word pray is taken absolutely, as it governs nothing.

ABSOLUTION, among civilians, is used for a definitive sentence, declaring the accused person innocent, and releasing him from all farther prosecution.

ABSOLUTION, among catholics, is a pretension assumed by the priests to forgive sins absolutely, that is, by virtue of a power inherent in themselves. By stat. 23 Eliz. to procure absolutions from Rome is declared to be high treason. Protestant divines pretend to no such power, but only declare the scripture terms of pardon.

ABSOLUTION, in the Scotch presbyterian church, is chiefly used for a sentence of the church-judicatories, releasing a man from excommunication, and receiving him again into communion.

ABSOLUTIO *ad cautelam*, is a provisional absolution, granted to a person who has appealed from a sentence of excommunication.

ABSORBENTS, are such medicines as have the power of drying up redundant humours, whether applied to ulcers, or inwardly taken.

ABSORBENT *Vessels*, in anatomy, is a name indiscriminately given to the lacteals, lymphatics, and inhalent arteries. See ANATOMY.

ABSORBENT *Vessels* is also a name used by some naturalists for the fibres of the roots of plants, which draw nourishment from the surrounding earth. See PHYSIOLOGY OF PLANTS.

ABSORBING, the swallowing up or imbibing any thing: thus black bodies are said to absorb the rays of light; luxuriant branches to absorb or waste the nutritious juices, which should feed the fruit of trees, &c.

ABSORPTION, the effect of absorbing: thus we read of absorptions of the earth, when large tracts of land have been swallowed up.

Mount Vesuvius has in the course of time lost half its height; the upper part having been undermined by the fire beneath, and falling in, has been *absorbed* by the under part and the sea. In the year 1646, during the terrible earthquake in the kingdom of Chili, several whole mountains of the Andes disappeared, and were one after another wholly absorbed in the earth.

ABSORPTION. It is a well-known chemical fact, that in most cases of the combination of gaseous substances, either with other gases, or with liquids and solids, a very considerable diminution of the volume is experienced. This effect is called *absorption*.

ABSTEMII, a name given to persons who could not partake of the cup of the eucharist, on account of their natural aversion from wine.

ABSTERGENTS, medicines proper for cleansing the body from concretions and other impurities, not to be effected by simple abluents.

ABSTINENCE, the abstaining or refraining from certain enjoyments; but more especially from excessive eating and drinking; thus, it has always been a practice to abstain from a luxuriant diet at stated times, as well out of a religious view, as to confirm and preserve health.

Abstinence is highly extolled by some physicians; and that justly, when no more is meant by it than a proper regimen; but it must have bad consequences, when practised without a due regard to the constitution, age, strength, &c. of the person who uses it. There are many instances of the cure of disorders, and of protracting the term of life, by means of a strict and well-regulated abstinence. Cornaro, a nobleman of Venice, after all other means had been tried in vain, recovered, and lived to the age of a hundred years, by rigid abstinence only. Many of the early Christians who retired from persecution into the deserts of Arabia, lived to a very advanced age upon bread and water only. St. Anthony lived 105 years; James the hermit 104; Arsenius 120; Epiphanius 115, &c. The records of the Tower mention a Scotsman imprisoned, and watched six weeks, during which he took no sustenance whatever; and on this account he obtained his pardon.

ABSTRACT *idea*, among logicians, the idea of some general quality or property considered simply in itself, without any respect to a particular subject; thus, magnitude, equity, &c. are abstract ideas, when we consider them as detached from any particular body or person.

It is generally allowed, that there are no objects in nature corresponding to abstract ideas; nay, some philosophers, and particularly lord Bolingbroke, dispute the existence of abstract ideas themselves, thinking it impossible for the human mind to form any such.

Abstract ideas are the same with those called universal ones; and the manner of forming them, according to modern philosophers, is this: we readily observe a resemblance among some of our particular ideas, and thus form a general notion applicable to many individuals. Thus, horses are found to resemble each other in shape, voice, and the general configuration of their parts. Now, the idea which takes in this resemblance, excluding what is peculiar to each individual,

becomes of course common to this whole family or class of animals, and is therefore called a general, universal, or abstract idea.

ABSTRACT is an epithet given to several other things, on account of their purity or universality; thus, we say abstract numbers, abstract mathematics, &c.

ABSTRACTI, a name given to a sect of Lutherans, who asserted that Christ was to be adored not only in the concrete, as the son of God, but that his flesh in the abstract was an object of adoration.

ABSTRACTION, in logic, that operation of the mind whereby it forms abstract ideas.

According to Mr. Locke, abstraction is performed three ways. First, when the mind considers any one part of a thing by itself, without attending to the whole; as the arm, leg, &c. of a man's body. Secondly, by considering the mode of a substance, without taking in the idea of the substance itself: thus, geometricians consider the properties of lines, or the length of bodies, without attending to their breadth or depth. Thirdly, by generalizing our ideas in the manner mentioned under ABSTRACT *idea*.

This doctrine, however, of abstraction, is denied by Berkeley, bishop of Cloyne, who owns that he can imagine a man with two heads, or the upper part of a man joined to the body of a horse; "nay," adds he, "I can consider the hand, the eye, the nose, each by itself, abstracted or separate from the rest of the body: but then, whatever hand or eye I imagine, it must have some particular shape and colour; likewise the idea of a man that I frame to myself, must be either of a white or a black, or a tawny, a straight or a crooked, a tall or a low, or a middle-sized man. Neither can I, by any effort of thought, conceive an absolutely abstracted idea of motion, for instance, distinct from the body moving, and which is neither swift nor slow, curvilinear nor rectilinear; and the like may be said of all abstract ideas whatsoever."

ABSTRACTION, in chemistry, is the evaporating or drawing off, by means of heat, one part of a compound from the other. If the part abstracted is collected, it is called *distillation* or *sublimation*, according as the process is wet or dry.

ABUCCO, ABOCCO, or ABOCCHI, a weight used in the kingdom of Pegu, equal to twelve *teccalis* and a half. Two *abuccos* make an *agiro*, or *giro*; two *giri* make half a *biza*, which weighs 100 *heccalis* (2 pounds 5 ounces) the heavy weight, or 3 pounds 9 ounces light weight, of Venice. See WEIGHT.

ABUNDANT *numbers*, those whose aliquot parts added together make more than the whole number: thus the parts of 20 make 22, viz. 1, 2, 4, 5, and 10.

ABYSS has been used by some philosophers, particularly Dr. Woodward, to denote a vast cavity filled with water, which they supposed (but with little argument) to exist in the centre of the earth. Conformably with this idea, it has been imagined by some writers, that there is a communication between the Caspian sea and the ocean, by means of a subterraneous abyss; and to this it is attributed that the Caspian sea does not overflow, notwithstanding the number of large rivers that run into it, of which Kempfer reckons fifty in the extent of sixty miles. But the daily evaporation is by others thought sufficient to account for this fact.

ABYSS is also used for several other things, as the cavernous bowels of a mountain, or hell, or the bottomless pit, the centre of an escutcheon, a gulph, &c.

ABYSSINIAN church, that established in the empire of Abyssinia. It makes but a branch of the Cophts or Jacobites, a sect who admit only one nature in Jesus Christ.

ACACIA, in botany, a name applied, but erroneously, to several sorts of shrubs and trees. See GUILANDIA, GUIACUM, MIMOSA, POINCIENA, and SPARTIUM.

ACACIA, in the materia medica of the ancients, a gum made from the Egyptian thorn, and thought to be the same as our gum-arabic.

ACACIA *Germanica*, an inspissated juice, made of wild sloes, hardly ripe. The true acacia is said to be very scarce in the shops, where the German acacia is used in its stead, both being powerful astringents, and consequently good in hæmorrhages, and all kinds of fluxes.

ACACIA, AKAKIA, a roll or bag represented on the medals of the Greek and Roman emperors; some think it is only a handkerchief, which they used as a signal; others take it for a volume, or roll of memorandums or petitions; and finally, others suppose it to be a purple bag filled with earth, to remind the prince of his mortality.

ACACIANS, the name of several sects of heretics, some of whom maintained that the Son was only of a like, not the same substance with the Father; and others, that he was not only of a distinct, but also of a dissimilar substance.

ACADEMIC, or ACADEMICIAN, a member of some academy.

ACADEMICS is a term more particularly used for a sect of ancient philosophers, the followers of Socrates and Plato, who maintained that all things were uncertain, and consequently that men ought to doubt of every thing. They even went so far, as to doubt whether or not they ought to doubt, it being a received maxim among them, *se nil scire, ne hoc quidem, quòd nihil sciunt.*

Of this sect, however, Cicero, who was an academic philosopher himself, gives a more favourable account. He tells us, that all the difference between the academics, and those who imagined themselves possessed of the knowledge of things, consisted in this: that the latter were fully persuaded of the truth of their opinions; whereas the former held many things to be only probable, which might very well serve to regulate their conduct, though they could not positively assert the certainty of them. "In this," says he, "we have greatly the advantage of the dogmatists, as being more disengaged, more unbiassed, and at full liberty to determine as our judgment shall direct. But the generality of mankind, I know not how, are fond of error, and choose rather to defend with the utmost obstinacy the opinion they have once embraced, than with candour and impartiality examine which sentiments are most agreeable to truth."

ACADEMY, in Grecian antiquity, a large villa in one of the suburbs of Athens, where the sect of philosophers called Academics held their assemblies. It took its name from Academus or Ecademus, a citizen of Athens, as our modern academies take theirs from it.

ACADEMY was also used metaphorically, to denote the sect of academic philosophers.

ACADEMY, in a modern sense, signifies a society of learned men, established for the improvement of arts or sciences. Hence,

ACADEMIES *of antiquity*, are those designed for the illustration of whatever regards antiquity; as medals, coins, inscriptions, &c.

There are several academies of this kind in different parts of the world, as at Upsal in Sweden, at Paris, and at London. These two last are called the academy of inscriptions and belles-lettres, and the antiquarian society.

ACADEMIES *of architecture*. See ACADEMIES of Painting, *infra*.

ACADEMIES *of belles-lettres*, those chiefly designed for the cultivation of eloquence and poetry. Besides the academy of belles-lettres at Paris, and one at Caen, there are several in Italy, viz. one at Florence, and two at Rome.

ACADEMIES *chirurgical*, those established for the improvement of surgery.

ACADEMIES *cosmographical*, those which make geography and astronomy the chief objects of their researches. Such is that called the Argonauts, at Venice.

ACADEMIES of *dancing*. Of this kind there was one instituted by Louis XIV. with ample privileges worthy of the nation!

ACADEMIES *ecclesiastical*, those which employ their studies in illustrating the doctrines, discipline, ceremonies, &c. that obtained in each age of the church. Such is that of Bologna.

ACADEMIES *historical*, those erected for the improvement of history. Such are those at Lisbon and Tubingen.

ACADEMIES of *languages*, those established in many parts of Europe, for refining and ascertaining the language of each country; thus the Paris academy was designed to illustrate and polish the French, that of Madrid the Spanish or Castilian, &c. But besides these, there are others in Italy, Germany, &c.

ACADEMIES of *law*: such are those of Bologna and Beryta.

ACADEMIES *medical*, those instituted with a view to promote medical knowledge and improvements. Such is that of the *Naturæ Curiosorum*, in Germany, and those of Venice, Geneva, Palermo, &c. to which some add the colleges of physicians at London and Edinburgh.

ACADEMIES *musical*. These are frequent in most parts of Europe, but more especially in France and Italy.

ACADEMIES of *painting, sculpture*, and *architecture*. There is one of these at Paris, and another at Rome.

The royal ACADEMY of *arts* was instituted in London for the encouragement of *designing, painting, sculpture*, &c. in the year 1768. It has for its patron the king, and is under the direction of forty artists of the first rank in their profession. It furnishes living models to draw and paint after. Nine of the academicians are annually elected to attend and set the figures, to examine the performances of the students, and to give them the necessary instructions. The admission to this academy is free to all students qualified to reap advantage from the studies cultivated in it. There are professors of painting, architecture, anatomy, and perspective, who an-

nually read lectures on the subjects of their several departments.

The ACADEMY of *arts* at Petersburgh was established by the empress Elizabeth. The scholars are admitted at the age of six, and continue twelve years; they are lodged, clothed, boarded, and taught, at the expence of the crown. Besides this, there is the imperial academy of sciences at Petersburgh, the transactions of which were formerly entitled *Commentarii Academiæ Scientiarum Imperialis Petropolitanæ*, but now are called *Nova Acta Acad. Scient. Imp. Petrop.*

ACADEMIES of *sciences*, those chiefly designed for the improvement of natural history and mathematics, with their numerous branches, botany, chemistry, mechanics, astronomy, geography, &c.

There are many other academies in different countries: as at Cortuna, for the study of Etrurian antiquities; at Florence and Milan, for painting, &c.; the American, of arts and sciences; the royal Irish, &c. &c.

ACADEMY is also more particularly used with us for a kind of schools, where youth are instructed in various branches of learning. Of this kind we have two royal ones, viz. one at Portsmouth, for teaching navigation, drawing, &c. which may be called a naval or maritime academy; and another at Woolwich, where youth are taught fortification, gunnery, &c. which may be styled the military academy. Besides these, there are numerous academies, especially in London, for teaching mathematics, languages, writing, accounts, drawing, and other branches of learning. The dissenters have likewise their academies for teaching philosophy, divinity, &c. See UNIVERSITY.

ACADEMY *figure*, in painting, a draught or design, made after a model, with a crayon or pencil.

ACÆNA, a genus of the tetrandria monogynia class and order of plants. Its essential character is, the calyx four-leaved; corolla four-petalled; berry dry, inferior, one-seeded, with spines bent backwards. We know of only one species, the acæna elongata, which is a Mexican shrub of about two feet high.

ACAJOU, the cashew-nut tree. See ANACARDIUM.

ACALYPHA, in botany, a genus of the monoecia monodelphia class and order. The essential character is, in the male blossoms, calyx three or four-leaved; corolla none; stamina eight to sixteen. In the female, calyx three-leaved; corolla none; styles three; capsule three-grained, three-celled; seed one.

There are fourteen species of this plant: some of them annual, and resembling the broad leaved pellitory of the wall; some of them are shrubs, but none appear to have either beauty or utility to recommend their cultivation.

ACANACEOUS *plants*, those which are prickly, and bear their flowers and seeds on a kind of heads.

ACANGIS, in Turkish military affairs, the name of a kind of light-armed horse.

ACANTHA, the prickles of a thorny plant.

ACANTHA is also used by zoologists for the spines of certain fishes, as those of the echinus marinus, &c.

ACANTHACEOUS, an epithet given to all plants of the thistle kind, on account of the prickles with which they are beset.

ACANTHOPTERYGIOUS fishes, one of the general classes or families of fishes; distinguished by having the rays of their fins bony, and some of them prickly at the extremities.

ACANTHUS, bear's breech, in botany, a genus of plants of the class and order didynamia angiospermia. The essential character is, calyx two-leaved, bifid; corolla one-lipped, bent down, trifid; capsules two-celled. See Plate Nat. Hist. fig. 1.

There are about ten species, only four of which are exotic and tender. The acanthus mollis, or smooth-leaved acanthus, is that which was formerly used in medicine, though, we apprehend, with little effect, as it seems to differ very little in its medical virtue from the altheas, and other mucilaginous vegetables. It is also the plant which is said to have afforded the hint to Callimachus for the invention of the Corinthian capital. The Gothic sculptors are supposed to have adopted for their ornament the leaves of the acanthus spinosus.

ACARUS, the tick or mite, a numerous genus of insects, of the order of aptera, or those which have no wings. The acarus has eight legs; two eyes, one on each side of the head; and two jointed tentacula. They are in general very prolific. The eggs of the cheese mite hatch in about fourteen days in summer, but in winter take more. Ninety millions of these eggs may be comprehended in the size of a pigeon's. The acarus will live seven months without food. There are thirty-five species. See Plate Nat. Hist. fig. 1—3.

ACATALECTIC, a term in antient poetry, applicable to such verses as have all their feet and syllables, without any defect at the end. In the following lines of Horace, the first two are *acatalectic*, the last *catalectic*:

Solvitur acris, hyems, grata vice
Veris et Favoni;
Trahuntque siccas machinæ carinas.

ACATALEPSY, among antient philosophers, the impossibility of comprehending something. The distinguishing tenet of the *pyrrhonists* was, their asserting an absolute acatalepsy with regard to every thing.

ACATERY, or ACCATRY, an officer of the king's household, designed to be a check between the clerks of the kitchen and the purveyors.

ACATIUM, in antiquity, a kind of boat or pinnace used in military affairs. The acatium was a species of the *naves actuariæ*.

ACAULOSE, or ACAULOUS, *(Acaulis)* among botanists, a term used for such plants as have no *caulis*, or stem.

ACCALIA, in Roman antiquity, solemn festivals held in honour of Acca Laurentia, Romulus's nurse: they were otherwise called *Laurentalia*.

ACCAPITARE, in our old law books, the act of becoming a vassal, or paying homage to some lord. Hence

ACCAPITUM, signified the money paid by a vassal, upon such an occasion.

It is likewise used for the relief due to the chief lord. See RELIEF.

ACCEDAS *ad curiam*, in law, a writ lying where a man has received or fears false judgment in a hundred-court, or court-baron. It is issued out of the Chancery, and directed to the sheriff; but returnable in the King's Bench or Common Pleas. It lies also for justice delayed, and is said to be a species of the writ *Recordare*.

ACCELERATION, in mechanics, denotes the augmentation or increase of motion in accelerated bodies. The accelerated motion of falling bodies is produced by the impulse of gravity, which keeps continually acting upon them, and thereby communicates a new augmentation of motion every instant. If this increase is equal in equal times, the motion is said to be uniformly accelerated. See MECHANICS.

ACCELERATION, in astronomy, is a term applied to the fixed stars. The *diurnal* acceleration is the time by which the stars, in one diurnal revolution, anticipate the mean diurnal revolution of the sun; that is, a star rises or sets, or passes the meridian, about 3′ 36″ sooner each day. This apparent acceleration of the stars is owing to the real retardation of the sun, which depends upon his apparent motion towards the east, and that is at the rate of 59′. 8½″ daily: therefore to find the acceleration we say, As 360° : 59′ 8½″ :: 24h. : 3min. 56 sec. nearly, the acceleration required.

This acceleration serves to regulate the length and vibrations of pendulums. If, for instance, the pendulum marks 9h. 6m. when a fixed star sets or passes behind any object one day; and on the next, the eye being precisely in the same situation, the same appearance occurs at 9h. 2m. 4s. by the pendulum; it may be inferred, that such a pendulum is truly regulated, or measures time accurately.

ACCELERATION *of the moon*, is a term used to express the increase of the moon's mean motion from the sun, compared with the diurnal motion of the earth, which is said to be about 10″ in a hundred years. This by some is thought to be occasioned by the sun becoming less from the particles of light continually flowing from it, which renders the motion of the earth slower; or if the earth's by any means be increased, the motion of the moon will be accelerated. This acceleration is shewn by M. La Place to arise from the action of the sun upon the moon, combined with the variation of the eccentricity of the earth's orbit.

ACCENDENTES, or ACCENSORES, in the church of Rome, a lower rank of ministers, whose business it is to light, snuff, and trim the candles and tapers.

ACCENDONES, or ACCEDONES, in Roman antiquity, a kind of officers in the gladiatorian schools, who excited and animated the combatants during the fight.

ACCENSI, in the Roman armies, certain supernumerary soldiers, designed to supply the place of those who should be killed, or anywise disabled. Accensi also denoted a kind of inferior officers, appointed to attend the Roman magistrates.

ACCENT, in a general sense, denotes a certain tone or manner of speaking peculiar to some nation, country, or province; thus we say, the Scotch accent, the Irish accent, &c. Among grammarians, it is the raising or lowering the voice in pronouncing certain syllables.

We have three kinds of accents, viz. the acute, the grave, and the circumflex. The acute accent, marked thus (/), shews that the

voice is to be raised in pronouncing the syllable over which it is placed. The grave accent is marked thus (`), and points out when the voice ought to be lowered. The circumflex is compounded of the other two, and marked thus (^ or ʌ): it denotes a quavering of the voice, between high and low.

Some call the long and short quantities of syllables accents, but erroneously. See QUANTITY.

Accents not only give a pleasing variety and beauty to the modulation of the voice, but serve to ascertain the true meaning of the word, as in *présent* and to *presént*. The Chinese are remarkable for the use they make of accents: thus the word *ya*, according to the way in which they place the accent, signifies God, a wall, an elephant, stupidity, and a goose. The Hebrew likewise abounds with them; there being no less than twenty-five tonic accents, shewing the proper tone of the syllables over or under which they are placed; besides four euphonic ones, serving to render the pronunciation more sweet and agreeable. It is generally allowed, however, that the accents now in use were unknown to the antient Hebrews.

Concerning the antiquity of the Greek accents authors are not agreed; some making them of modern date, and others contending for their having been known to the antient Greeks.

ACCENT, in music, a certain modulation or warbling of the sounds, to express passion; either naturally by the voice, or artificially by instruments. Every bar or measure is divided into the accented and unaccented parts; the former being the emphatical, on which the spirit of the music depends. The harmony ought always to be full, and void of discords, in the accented part of the measure.

ACCENTOR, in the old music, denotes one of the three singers in parts, or the person who sung the predominant part in a trio.

ACCEPTANCE, in common law, the tacitly agreeing to some act before done by another, which might have been defeated without such acceptance. Thus if a husband and wife, seized of land in right of the wife, make a joint lease of feoffment, reserving rent, and the husband dies; after which the widow receives or accepts the rent; such receipt is deemed an acceptance, confirms the lease or feoffment, and bars her from bringing the writ *cui in vita*.

ACCEPTANCE, among merchants, is the act by which the party on whom a bill of exchange is drawn, makes himself liable to the amount. An acceptance may be absolute to the bill itself at all events; or it may be partial, that is, to pay a certain part of it; or it may be conditional, that is, upon the performance of a certain condition; in which last case, when the condition is performed, the acceptance becomes absolute. An acceptance may also be collateral, as an acceptance upon protest.

An acceptance may be given either verbally or in writing; the latter, however, is the most regular and customary. But any thing tending to shew that the party means to be bound by his undertaking; such as the signature of the initials, or the day of the month, keeping the bill longer than usual, or any verbal promise or agreement; will be an acceptance.

Bills payable at sight are not accepted, because they must either be paid on being presented, or else protested for want of payment. The acceptance of bills payable at a fixed day, at usance, &c. needs not be dated; because the time is reckoned from the date of the bill; but it is necessary to date the acceptance of bills payable at a certain number of days after sight, because the time does not begin to run till the next day after that acceptance. This kind of acceptance is made thus: *Accepted such a day and year*, and signed.

In general, he to whom a bill of exchange is made payable ought to demand the acceptance of the person on whom it is drawn, and that in the full extent of the terms of the bill, and on refusal of acceptance to return it with protest. This he ought to do for his own security, as well as for that of the drawer. Thus, if the bearer of a bill consents to an acceptance at twenty days sight, instead of eight days expressed in the bill, he runs the risk of the twelve days prolongation; so that he can have no remedy against the drawer, should the acceptor break in that time. Again, if a bill is drawn for three thousand pounds, and the bearer agrees to take an acceptance for two only, and should receive no more than that sum, the remaining thousand would be at the hazard of the bearer, as well as in the former case.

If, therefore, a bill is only accepted in part, or for a longer time than that expressed in it, the bearer ought to protest it, at least for the sum not accepted. Again, if the acceptor breaks, or refuses to make payment when the bill becomes due, it is necessary to get the bill immediately protested by a public notary, to be sent along with the protest to the remitter, to procure satisfaction from the drawer.

By statute, inland-bills of exchange must be accepted by signing or endorsing in writing, and protested for refusal of such acceptance, otherwise the drawer is not liable to costs; it must likewise be returned to the drawer within fourteen days. Such protest, however, is not necessary, unless the value is acknowledged in the bill to be received, and unless the bill is drawn for 20l. or upwards.

A bill drawn on two jointly must have a joint acceptance, otherwise be protested; but if on two or either of them, the acceptance of one is sufficient.

ACCEPTANCE, among civilians, denotes the consenting to receive something offered to us, which by our refusal could not have taken effect; or acceptance is the actual concurrence of the will of the donee, without which the donor is at liberty to revoke his gift at pleasure.

ACCEPTANCE, in the church of Rome, is particularly used for the receiving the pope's constitutions.

The acceptance of the constitution *unigenitus* has occasioned, and still continues to excite, a world of confusion in the popish countries, but more especially in France, where many of the clergy refuse to accept it.

ACCESSARY, or ACCESSORY, in law, a person who is in anywise aiding in the commission of some felonious action.

By statute, he who counsels, abets, or conceals, the committing of such an action, or the person who has committed it, is deemed an accessary.

There are two kinds of accessaries, viz. before the fact, and after it. The first is he who commands or procures another to commit felony, but is absent when it is done; for if he is present, he is a principal. The accessary after the fact is one who receives, comforts, or assists, the felon; knowing him to be such.

In the highest crimes, as high treason, &c. and the lowest, as riots, forcible entries, &c. there are no accessaries, but all concerned are principals.

It is a maxim among lawyers, that where there is no principal, there can be no accessary; so that it is necessary the principal be first convicted, before the accessaries can be arraigned. If, however, the principal cannot be taken, the accessary may be prosecuted for a misdemeanor, and punished by fine, imprisonment, &c. Accessaries in petty treason, murder, and felony, are not allowed their clergy.

A wife may assist her husband, without being deemed accessary to his crime; but not *e contra*. A servant assisting his master to escape, is reckoned an accessary; also furnishing others with weapons, or lending them money, &c. will make persons accessaries. Persons buying or receiving stolen goods, knowing them to be such, are deemed accessaries to the felony. Also if the owner of stolen goods, after complaint made to a justice, takes back his goods, and consents to the escape of the felon, he becomes accessary after the fact.

ACCESSION, a term of various import; thus, among civilians, it is used for the property acquired in such things as are connected with or appendages of other things; among physicians, it signifies the same with what is more usually called paroxysm; among politicians, it is used for a prince's agreeing to and becoming a party in a treaty before concluded between other potentates, or it more particularly denotes a prince's coming to the throne by the death of the preceding king; and lastly, it is used by Romanists for a peculiar way of electing a pope, which is, when one candidate has got two thirds of the votes, the rest are enrolled by accession.

ACCESSORY *nerves*, or *par* ACCESSORIUM, a pair of nerves of the neck: which arising from the spinal marrow in the vertebræ of the neck, enters the cranium by the great foramen in the os occipitis. Here it is joined by the par vagum, and coming out of the cranium again by the same aperture, it recedes from the par vagum, and is bent back to the trapezius, a muscle of the shoulder. See ANATOMY.

ACCIACATURA, is a term in music, which denotes the putting down with any interval the half note below it, and instantly taking off the finger which has struck the lowest of the two notes, continuing the sound of the other note till the harmony is changed.

ACCIDENS, *per*, is used to denote what does *not* follow from the nature of a thing, but from some accidental qualities of it, in which sense it stands opposed to *per se*, which denotes the nature and essence of a thing; thus fire is said to burn *per se*; but a piece of iron made hot, only burns *per accidens*, by a quality accidental to it.

ACCIDENT, among logicians, is used in a threefold sense. 1. Whatever does not essentially belong to a thing, as the clothes a man wears, or the money in his pocket. 2. Such properties in any subject as are not essential to it; thus whiteness in paper is an

accidental quality. 3. In opposition to substance, all qualities whatever are called accidents, as sweetness, softness, &c.

ACCIDENT *absolute* is used by the Romish church for an accident which may possibly subsist, at least miraculously, without any subject; an absurdity which has been strenuously maintained by many of their casuists, and even solemnly decreed by some of their councils.

ACCIDENT, in heraldry, an additional note or mark, in a coat of arms, which may be either omitted or retained, without altering the essence of the armour.

ACCIDENTAL, in philosophy, is applied to that effect which proceeds from a cause occurring by *accident*, without being subject to general laws or regular returns. In this sense accidental is opposed to constant. The sun's greater or less altitude is the *constant* and chief cause of the heat in summer and cold in winter; but wind, snow, or rain, are accidental causes.

ACCIDENTAL *colours*, are those which depend upon the affections of the eye, in contradistinction to such as belong to the light itself. The impressions made on the eye by looking stedfastly on objects of a particular colour, frequently give a false colouring to other objects which are viewed during their continuance.

ACCIDENTAL *point*, in perspective, that point in the horizontal line, where all lines parallel among themselves meet the perspective plain. See PERSPECTIVE.

ACCIDENTAL, in music, is an epithet added to such sharps, flats, and naturals, as do not occur in the clef, and which imply some change of key or modulation different from that in which the piece began.

ACCIPENSER, in ichthyology, a genus of fishes, belonging to the order of nantes, and class of amphibia, in the Linnæan system. The accipenser has a single linear nostril: the mouth is in the under part of the head, and contains no teeth; the cirri, are below the snout, and before the mouth. There are three species of this genus, viz.

1. ACCIPENSER Huso has four cirri; the body is naked, *i. e.* has no prickles or protuberances. The skin of the huso is so tough and strong, that it is employed to draw carts and other wheel carriages; and the ichthyocollo, or isinglass of the shops, is made from its sound or scales. The huso is the largest of the genus, and grows to 24 feet in length. It inhabits the Danube and the rivers of Russia.

2. ACCIPENSER RUTHENUS has four cirri; and fifteen squamous protuberances. It is a native of Russia.

3. ACCIPENSER STURIO, or the sturgeon, has four cirri and 11 squamous protuberances on the back. This fish annually ascends our rivers, but in no great numbers, and is taken by accident in the salmon nets. It seems a spiritless fish, making no manner of resistance when entangled, but is drawn out of the water like a lifeless lump. It is seldom taken far out at sea, but frequents such parts as are not remote from the æstuaries of great rivers. It is admired for the delicacy and firmness of its flesh, which is white as veal, and extremely good when roasted. It is generally pickled. The greater part of what we receive comes either from the Baltic rivers or North America. Great numbers are taken during summer in the slake Frischehaff, and Curisch-haff near Pillau, in large nets made of small cord. The adjacent shores are formed into districts, and farmed out to companies of fishermen, some of which are rented for 6000 guilders, or near 300*l.* *per annum*. They are found in vast abundance in the American rivers in May, June, and July; at which time they leap some yards out of the water, and, falling on their sides, make a noise to be heard in still water at an immense distance. Caviare is made of the rows of this, and also of all the other sturgeons, dried, salted, and packed up close. Isinglass is likewise made of the sound of this fish, but in very small quantities. The sturgeon grows to the length of 18 feet, and the weight of 700 pounds; but it is seldom taken in our rivers of that bulk. In the manner of breeding, this fish is an exception among the cartilaginous kind; being, like the bony fish, oviparous, and spawning in water. See Plate Nat. Hist. fig. 4—6.

ACCIPITRES the name of a whole order of birds, the distinguishing characteristic of which is, that they have a hooked or crooked beak.

This order comprehends four genera, viz. the vulture, falco, strix, and lanius kinds; and 72 species.

ACCLAMATION, in Roman antiquity, a shout raised by the people to testify their applause, or approbation of their princes, generals, &c. Such is that of Ovid, Fast. I. 613. *Augeat imperium nostri ducis, augeat annos.*

The acclamations of the theatres, which were at first confused and tumultous shouts, became in process of time a kind of regular concerts. When Nero played in the theatre, a signal was given, and upon this 5000 soldiers began to chaunt his praise, which the spectators were obliged to repeat. The honour of acclamations was chiefly bestowed on the emperors; but sometimes it was conferred on their children and favourites, and on magistrates who presided at their games.

The Greeks were accustomed to practise acclamation, an instance of which is mentioned by Plutarch, in consequence of Flaminius's restoring liberty to Greece, when the shouts were so loud, that it was hyperbolically said, the birds fell from the sky with the noise.

Acclamations which were at first practised in the theatre, passed to the senate, and other departments of civil society, and were at length admitted into the acts of councils, and the ordinary assemblies of the church. Chrysostom checked acclamations of this kind, but Augustine received them very willingly. Sermons were applauded with hands and feet, by leaping up and down, and exclaiming "orthodox," and by shaking the loose garments, and waving handkerchiefs. These were some of the antient forms of acclamation: of the Hebrews, "Hosanna;" of the Greeks, Αγαθη Τυχη, good luck; of the Romans, *Dii te nobis servent*, may the Gods preserve you! To the disgrace of the famous French convention in 1792, it may be added, decrees were voted in a legislative assembly, not upon discussion, but, "by acclamation."

ACCLAMATION *medals*, among antiquaries, those whereon the people are represented as expressing their joy by acclamation.

ACCOLADE, in antient customs, the ceremony of conferring knighthood, by the king's laying his arms about the young knight's neck, and embracing him.

ACOLLE'E, in heraldry, a term used in different senses; sometimes it denotes the same with accolade; sometimes two things joined together; at other times, animals with collars, or crowns about their necks; and finally, battons, or swords placed saltierwise behind the shield.

ACCOMMODATION, or ACCOMMODATING, in geometry, is the fitting a line or figure into a circle, &c. agreeably to the conditions of the problem; and in philosophy, is the application of one thing by analogy to another.

ACCOMPANIMENT, in music, is used for the instruments which accompany a voice, to make the music more full. Among the moderns, the accompaniment frequently plays a different part of melody, from the song it accompanies; but authors are not agreed, whether or not it was so among the antients.

ACCOMPANIMENT, in heraldry, denotes any thing added to a shield by way of ornament, as the belt, mantling, supporters, &c. It is also used for several bearings about a principal one; as a saltier, bend, fess, &c.

ACCOMPLICE, in law, a person who is privy to, or aiding in, the perpetration of some crime. It is generally applied to such accessaries as are admitted to give evidence against fellow criminals. By the law of Scotland, accomplices cannot be prosecuted till the principal offenders are convicted.

ACCORD, in music, the same with what is more usually called concord. See CONCORD. It is sometimes used for chord.

ACCORD, in law, a verbal agreement between two or more, where any one is injured by a trespass, or other offence committed, to make satisfaction to the injured party; who, after the accord is performed, will be barred in law from bringing any new action against the aggressor for the same trespass. It is safest, however, in pleading, to allege satisfaction, and not the accord alone; because in this latter case, a precise execution in every part must be alleged; whereas, in the former, the defendant needs only say, that he paid the plaintiff such a sum in full satisfaction of the accord, which he received.

ACCOUNT, or ACCOMPT, in a general sense, is used for all arithmetical computations, whether of time, weight, measure, money, &c. Account is also used collectively, for the books in which merchants, traders, and bankers, enter all their business, traffic, and bargains with each other. See BOOK-KEEPING.

ACCOUNT, in law, is a writ or action, which lies against a person, who, because of his office, or business, is obliged to render an account to another, but refuses to do it; as a bailiff, for instance to his lord. It is now seldom used.

ACCOUNTS, *Chamber of*, in the antient French polity, a sovereign court, answering nearly to our exchequer.

ACCOUNTANT *general*, in the court of chancery, an officer appointed by act of parliament to receive all monies lodged in court, and convey the same to the bank of England for better security. The salary of this officer and his clerks is to be paid out of the interest made of part of the money; it not being allowable to take fees in this office.

ACCOUNTS, *public*, *commissioners of*, are commissioners appointed, with handsome salaries, to examine and state in what man-

ner, and at what times, the receipts, issues, and expenditures of the public monies are accounted for; and to con ider and report, by what means and methods the public accounts may in future be passed, and the accountants compelled to pay the balances due from them, in a more expeditious, effectual, and less expensive manner.

ACCRETION, in natural history, the increase or growth of a body by an external addition of new parts: thus it is salts, shells, stones, &c. are formed.

ACCRETION, among civilians, a term used for the property acquired in a vague or not occupied thing, by its adhering to or following another thing already occupied; thus, if a legacy is left to two persons, and one of them dies before the testator, the legacy devolves to the survivor by right of accretion. Alluvion is another instance of accretion.

ACCROCHE', in heraldry, denotes one thing being hooked into another.

ACCRUED, in heraldry, a term applied to a tree full blown.

ACCUBATION, the posture used among the Greeks and Romans at table: which was with the body extended on a couch, and the head resting on a pillow, or on the elbow supported by a pillow.

Pitiscus tells us the manner in which the guests were disposed, which was this: a low round table was placed in the dining-room, about which stood sometimes two, but more usually three beds or couches; from the number whereof the dining-room got the name of *biclinium* or *triclinium*. These couches were covered with richer or plainer cloths, according to the quality of the person, and furnished with quilts and pillows. Each couch usually contained three persons; it being deemed sordid to crowd more. The first lay at the head of the bed, with his legs extended behind the second, who lay in the same manner to the third. The middle place passed for the most honourable. However, before placing themselves, they always took care to pull off their shoes, and put on what was called the *vestis cœnatoria*, or the dining garment.

ACCUMULATION, among lawyers, denotes the concurrence of several titles to the same thing, or of several circumstances or proofs to make out one fact.

ACCUMULATION OF DEGREES, in an university, the taking several of them together, or at smaller distances from each other than usual, or than the rules allow of.

ACCUSATION, among civilians, the bringing a criminal action against any person. The antient Roman lawyers distinguished between postulatio, delatio, and accusatio. For, first, leave was desired to bring a charge against one, which was called postulare: then he against whom the charge was laid, was brought before the judge; which was called deferre, or nominis delatio: lastly, the charge was drawn up and presented, which was properly the accusatio. The accusatio properly commenced, according to Pædianus, when the reus or party charged, being interrogated, denied he was guilty of the crime, and subscribed his name to the delatio made by his opponent. In England, by Magna Charta, no man shall be imprisoned or condemned on any accusation, without trial by his peers, or the law; none shall be vexed with any accusation, but according to the law of the land; and no man may be molested by petition to the king, &c. unless it be by indictment or presentment of lawful men, or by process at common law. Promoters of accusations are to find surety to pursue them; and if they do not make them good, shall pay damages to the party accused, and also a fine to the king. No person is obliged to answer upon oath to a question whereby he may accuse himself of any crime.

ACCUSATIVE, among Latin grammarians, the fourth case, which is always governed by an active verb or preposition, expressed or understood; thus, *amo Deum*, I love God; *eo Londinum*, i. e. *eo ad vel versus Londinum*, I am going to London, or I am on my way to London. In the English noun there is no difference between the nominative and accusative, except that the *former* precedes and the *latter* follows the verb.

ACER, the maple-tree in botany. It is of the class and order polygamia monoecia. The essential character is calyx five cleft; corolla five-petalled; stamina eight or ten; germen two (or three) superior; stylus simple; capsule two, sometimes three, with one seed in each terminated by a wing. The male blossoms are without germen or stylus.

The maple genus consists entirely of trees, and embraces twenty species. The acer pseudoplatanus or great maple, vulgarly called the sycamore tree or mock-plane, and in Scotland the plane tree, is too well known to require a description. Before earthenware came into common use, the wood of this tree was in great request for trenchers; and it is still much used by the turners for bowls, dishes, &c. It is of quick growth, but not of long duration. In spring and autumn the wounded stem of this tree will, like the birch, pour forth a saccharine juice, from which wine may be made. There are two varieties in the nurseries—one with very boad leaves, the other variegated; both very ornamental for large plantations.

The acer campestre is also well known, growing very commonly in our woods and hedges. It is much cultivated in some parts of the kingdom for hop-poles. The *scarlet* maple is also propagated with us for its beautiful scarlet flowers.

The acer saccharinum, or American sugar maple, however, is perhaps the most distinguished of the tribe. It grows to the height of forty feet; and large tracts in North America are covered with it. The sugar is procured by tapping (or wounding) the tree with an augur about the months of February, March, or April, when the sap is rising; and from 23 gallons one quart of sap drawn from two trees in twenty-four hours, 4 pounds 13 ounces of sugar have been obtained; and in somec ases one pound of sugar from every 3 gallons of sap. The sugar thus obtained is grained, clayed, and refined, in every respect as that from the cane in the West Indies, and is of a very excellent quality. There is no doubt that it might be cultivated with great advantage in this country; since the Indians of Canada have practised the making of sugar from the maple, time out of mind, even in that ungenial climate.

ACERRA, in antiquity a kind of altar erected near the bed of a dead person, on which incense and other perfumes were burnt till the time of the burial.

ACERRÆ also denoted the pots wherein the incense was burnt; hence we read of *plena acerra*, a full acerra.

ACETABULUM, in antiquity, a kind of utensil wherein sauce was served to table, and not unlike our salts or vinegar cruets.

ACETABULUM was also a Roman measure, used as well for dry things as liquids; and equal to a cyathus and a half.

ACETABULUM, in anatomy, a hollow cavity in the heads of certain bones serving to receive the protuberant heads of others, and forming the articulation called enarthrosis. See ANATOMY.

AC-ETIAM, in law, a clause devised by the officers of the king's-bench, and added to the usual complaint of trespass. This is done in some cases to save the suitors the trouble and expence of suing out special originals.

ACETIC ACID differs from acetous acid, by having a larger proportion of oxygen. See ACETOUS ACID and CHEMISTRY.

ACETITE *of Potash*. This salt occurs native in the sap, and some other vegetable juices, and also in the urine of quadrupeds. It is prepared artificially by adding carbonate of potash to distilled vinegar, till the liquor contains a slight excess of acid; if the salt is wanted in a solid state, it may be obtained by evaporation. It has a strong affinity for water, and deliquiates readily in the air. For this and the other acetites see CHEMISTRY.

ACETOUS ACID, a transparent colourless fluid, obtained from distilled vinegar, in the proportion of 7 or 8 per cent. to the distilled vinegar. See CHEMISTRY. This acid forms an important article in the materia medica. Common vinegar, which is this acid in an impure state, is also much used in food, and for the preservation of animal and vegetable substances.

ACETUM *rosatum*, vinegar of roses, is made of rose-buds infused in vinegar five or six weeks; the roses are then pressed out, and the vinegar preserved. It is used in cases of head-ach.

ACETUM *prophylacticum*, is a preparation of acetic acid, camphor, flower of lavender, &c. It is called also the *vinegar of the four thieves*, who during the plague at Marseilles plundered the sick, the dying, and the dead, and escaped unhurt by the use of this preparation.

ACHALALACTLI. See ALCEDO.

ACHANE, in Persian antiquity, a corn measure equal to forty-five attic medimni.

ACHANIA, a genus of the monodelphia polyandria class, and the natural order of columniferæ. The essential character is, calyx double; outer many-leaved; corolla convolute; berry five-seeded.

The achania genus includes three species, all exotics, and cultivated (chiefly from cuttings) as stove plants.

ACHERNER, a star of the first magnitude, in the southern extremity of the constellation Eridanus; invisible in our latitude. See ERIDANUS.

ACHERSET, an old English measure of corn, probably the same with our quarter, or eight bushels; the monks of Peterborough had, among other things, an allowance of 12 *achersotes de frumento*.

ACHIAR a Malayan word, signifying a mixture of all sorts of fruits and roots, pickled with vinegar and spice. The Dutch import this pickle from Batavia.

ACHILLEA, a genus of plants compre-

lending the millefolium and ptarmica of Tournefort. It is of the class and order syngenesia polygamia superflua. The corolla is compound radiate: and the essential character is, calyx ovate, imbricate; florets of the ray about four; down none; recept. chaffy.

It includes twenty-seven species, most of them hardy, though natives of the south of Europe, only two being indigenous here. The achillea ptarmica, or sneezewort, is of this description. It is used in medicine as a sternutatory; and in Siberia in decoction, to stop hæmorrhages. A beautiful double variety is cultivated in our gardens under the name of white bachelors' buttons. The other English milfoil is the yarrow, well known in our meadows. This ha also by some been recommended in hæmorrhages, dysenteries, &c.

ACHILLES, an appellation sometimes given to the principal argument, made use of by each sect of antient philosophers, in defence of their system. It has obtained this name in allusion to the strength of Achilles; and is particularly used for Zeno's argument against motion, which consisted in making a comparison between the swiftness of Achilles and the slowness of a tortoise; whence he inferred, that a slow body, if but ever so small a distance before a swift one, could never be overtaken by it.

ACHILLES, *tendon of*. See ANATOMY.

ACHIMBASSI, the name of an officer who presides over the practice of medicine at Cairo.

ACHIROPOETOS, in church history, a name given to certain pictures of Christ, supposed to have been painted in a miraculous manner.

ACHOR, a kind of running ulcer on the face, chiefly infesting children, but sometimes also grown persons.

ACHRAS, the wild pear-tree, a genus of plants of the class and order hexandria monogynia, the flower of which consists of five erect petals, of a cordated shape; and the fruit is an oval berry divided into ten cells. The essential character is, calyx six-leaved; corolla ovate, sexfid, with six scales alternate, more within; pome celled; seeds solitary. There are four species, and they are called mammee, sapoti, and bully tree. They are all natives of the West Indies, where the fruit is eaten.

ACHROMATIC, a term used to denote telescopes contrived to remedy the aberration in colours. See OPTICS.

ACHTELING, a measure for liquids used in Germany.

ACHYRANTHES, a genus of the pentandria monogynia class of plants, belonging to the natural order of misal laneæ, Linn. The characters are: The calyx is a double perianthium; the exterior one consisting of three lanced acute leaves, which are persistent; the interior of five leaves, also persistent. No corolla; the nectarium is five-valved, surrounding the germen, bearded at the top, concave, and falling off. The stamina consist of five filaments the length of the corolla; the antheræ are ovate and incumbent. The pistillum has a top-shaped germen; the stylus is filiform, and the length of the stamina; the stigma is villous, and divided into two segments. The perianthium is a roundish one-celled capsule, not gaping. The seed is single and oblong. Of this genus eleven species are enumerated; but the character of the genus does not agree in them all. They are all natives of the Indies. Only one of them, the altissima, is commonly cultivated in botanic gardens, and that more for the sake of variety than beauty. It grows to the height of three feet, with oblong pointed leaves. The flowers come out in long spikes, from the extremities of the branches, and appear in July, the seeds ripening in September. Plants of this kind must be reared in a hotbed, and may be transplanted when they have acquired sufficient strength. If kept in pots, and sheltered during the winter in a warm greenhouse, they will live two or three years.

ACIA, a genus of the monadelphia dodecandria class and order, and natural order of pomaceæ. The essential character is, calyx five-parted; coralla five petalled, unequal; drupe full of chinks. We know of only one species, a native of Guiana, which rises to a tree of sixty feet in height. The fruit is eaten by the Creoles, and accounted pleasant.

ACICULÆ, certain small spikes, or prickles, in form of needles, wherewith nature has armed several animals, as the hedgehog, *echinus marinus*, &c.

ACID, in chemistry. The word acid, originally synonymous with sour, and applied only to bodies distinguished by that taste, has been gradually extended in its signification by chemists, and now comprehends under it all substances possessed of the following properties:

1. When applied to the tongue, they excite that sensation which is called *sour* or *acid*.

2. They change the blue colours of vegetables to a red. The vegetable blues employed for this purpose are generally tincture of litmus and syrup of violets or radishes, which have obtained the name of *re-agents* or *tests*. If these colours have been previously converted to a *green* by alkalies, the acids restore them again.

3. They unite with water in almost any proportion.

4. They combine with all the alkalies, and most of the metallic oxides and earths, and form with them those compounds which are called *neutral salts*.

It must be remarked, however, that every acid does not possess all these properties, but they all possess a sufficient number by which they may be distinguished from other substances.

The acids are by far the most important class of bodies in chemistry. It was by their means indeed, by studying their properties, and by employing them as instruments in the examination of other bodies, that men of science laid the foundation of chemistry, and brought it to that state in which we find it at present. The nature and composition of acids, therefore, became a very important point of discussion, and occupied the attention of the most eminent cultivators of the science.

Paracelsus believed that there was only one acid principle in nature, which communicated taste and solubility to the bodies in which it was combined. Beecher embraced the same opinion; and added to it, that this acid principle was a compound of earth and water, which he considered as two elements. Stahl adopted the theory of Beecher, and endeavoured to prove that this acid principle is sulphuric acid; of which, according to him, all the other acids are mere compounds. But his arguments were only conjectures or vague experiments, from which nothing could be deduced. Nevertheless, his opinion, like every other which he advanced in chemistry, continued to have supporters for a long time, and was even countenanced by Macquer. At last its defects began to be perceived: Bergman and Scheele declared openly against it: and their discoveries, together with those of Lavoisier, demonstrated the falsehood of both parts of the theory, by showing that sulphuric acid does not exist in the other acids; and that it is not composed of water and earth, but of sulphur and oxygen.

The opinion, however, that acidity is owing to some principle common to all the salts, was not abandoned. Wallerius, Meyer, and Sage, had advanced different theories in succession about the nature of this principle; but as they were founded rather on conjecture and analogy than direct proof, they obtained but few advocates. At last Mr. Lavoisier, by a number of ingenious and accurate experiments, proved that several combustible substances when united with oxygen form acids; that a great number of acids contain oxygen; and that when this principle is separated from them, they lose their acid properties. Thus phosphorus, charcoal, and sulphur, being separately inflamed in oxygen gas, combine with its base; acquire an additional weight, equivalent to that of the air consumed, or absorbed; and are converted into phosphoric, carbonic, and sulphuric acids.

The Lavoiserian theory is further supported by experiments, in which the known acids are decomposed into oxygen and one or more combustible bases. If purified nitre (nitrat of potash), previously deprived of its water of crystallization, is exposed in a silver retort to a low red heat, a large quantity of gas, consisting of oxygen and azote, in the proportion of four of the former to one of the latter, will be given out, and pure potash will remain in the retort; the weight of which, with that of the gases, will be equivalent to that of the original nitre. But force the gases into union, by means of the electric spark, their volume is gradually diminished, and at length the whole is reduced to an acid liquor, possessing all the qualities of nitrous acid; if this, and the potash remaining in the first process, are mixed together, chemical union immediately ensues, and nitre is reproduced. He concluded, therefore, that the acidifying principle is oxygen, and that acids are nothing but combustible substances combined with oxygen, and differing from one another according to the nature of the combustible base.

This conclusion, as far as regards the greater number of acids, is certainly true. All the simple combustibles, except hydrogen, are convertible into acids; and these acids are composed of oxygen and the combustible body combined. This is the case also with four of the metals. It must not, however, be admitted without some limitation.

1. When it is said that oxygen is the acidifying principle, it is not meant to affirm that oxygen possesses the properties of an acid, which would be contrary to truth; all that can be meant is, that it enters as a component part into acids, or that acids contain it as an essential ingredient.

2. But, even in this sense, the assertion cannot be admitted: for it is not true that oxygen is an essential ingredient in all acids, or that no

body possesses the properties of an acid unless it contains oxygen. Sulphurated hydrogen, for instance, possesses all the characters of an acid, yet it contains no oxygen.

3. When it is said that oxygen is the acidifying priniple, it cannot be meant to affirm that the combination of oxygen with bodies produces in all cases an acid, or that whenever a body is combined with oxygen the product is an acid; for the contrary is known to every chemist. Hydrogen, for instance, when combined with oxygen, forms not an acid, but pure water, and the greater number of metallic bodies form only oxides.

All that can be meant, then, when it is said that oxygen is the acidifying principle, is merely that it exists as a component part in the greater number of acids; and that many acids are formed by combustion, or by some equivalent process. The truth is, that the class of acids is altogether arbitrary; formed when the greater number of the bodies arranged under it were unknown, and before any precise notion of what ought to constitute the characteristic marks of an acid had been thought of. New bodies, when they were discovered, if they possessed any properties analogous to the known acids, were referred without scruple to the same class, how much soever they differed from them in other particulars. Hence we find, under the head of acids, bodies which have scarcely a single property in common except that of combining with alkalies and earths.

From what has been stated, however, it follows, that the acids are compound bodies, and almost all of them formed by the union of some other substance with oxygen: this substance is called the base, or radical. In some cases the radical has never been found in a separate state, when it is said to be *unknown*. See ACIDIFIABLE *base*.

The acids as combined with oxygen may be arranged as follows:

States of Oxygenation, according as the compound contains less or more oxygen.

	Bases.	1*st.*	2*d.*	3*d.*
With simple radicals.	Sulphur	Sulphureous	Sulphuric	
	Azote	Nitrous	Nitric	
	Phosphorus	Phosphoreous	Phosphoric	
	Carbon		Carbonic	
	Arsenic	Arsenious	Arsenic	
	Molybdena		Molybdic	
	Chrome		Chromic	
With double radicals.	Carbon and hydrogen in different proportions	Acetous	Acetic	
			Tartaric	
			Citric	
			Oxalic	
			Malic	
			Gallic	
			Benzoic	
			Succinic	
			Saccholactic	
			Formic	
			Sebacic	
With triple radicals.	Carbon, Hydrogen, and Azote.		Prussic	
			Lithic	
With unknown radicals.			Muriatic	Oxymuriatic
			Fluoric	
			Boracic.	

See CHEMISTRY.

ACIDIFIABLE *base*, or RADICAL, is any substance, whether simple or compound, that is capable of uniting without decomposition, with such a quantity of oxygen as to become possessed of acid properties. Almost all the acids agree with each other in containing oxygen, but they differ in their radicals; of course the acidifiable base or radical determines the species of acid. Sulphur combined with oxygen forms sulphuric or vitriolic acid. Almost all substances will combine with oxygen, but they are not all acidifiable bases. That the process of acidification may take place, a large proportion of oxygen is necessary, otherwise the result is only an oxyd. See CHEMISTRY.

ACIDOTUM, a genus of the monoecia polyandria class and order. The essential character is: male, calyx five-leaved; corolla none; stamina fixed to a globular receptacle. Female, calyx six-leaved; corolla none; style trifid; capsule three grained. One species only is noted of this plant, which is a native of Jamaica. But of its qualities little seems to be known.

ACIDULÆ, a term used for the cold mineral waters, distinguished by their sparkling appearance when poured from one vessel to another, and by their brisk acidulous taste. They contain a considerable quantity of free carbonic acid.

ACIDULUM, a term to express a kind of native compound salts, in which the alkaline base is supersaturated with acid; these are employed in chemical processes, and for economical purposes as acids. The two species already known are, the tartareous acidulum or acidulous tartrite of potash; and the oxalic acidulum, or acidulous oxalat of potash.

ACINACES, a kind of cutlas, or scimetar, in use among the Persians.

ACINUS, a name given to grapes or berries growing in clusters, in opposition to baccæ, or such berries as grow single.

ACLIDES, in Roman antiquity, a kind of missive weapon, with a thong fixed to it, whereby it might be drawn back again.

Most authors describe the aclides, as a sort of dart or javelin; but Scaliger makes it roundish, or globular, with a wooden stem to poise it by.

ACNIDA, Virginian hemp, a genus of the dioecia class, and pentandria order of plants. The characters are: in the male, the calyx is a perianthium consisting of five leaves, ovate, concave, acute, and membranous on the margin. No corolla. The stamina consist of five very short capillary filaments; the antheræ are versatile, two-celled, and forked at both ends. Female on a separate plant, of which the calyx consists of an involucrum many-leaved, linear, and deciduous; and a perianthium two-leaved, very small, and persistent. No corolla. The pistillum has an ovate germen; the styli are five, long, reflected, and downy; the stigmata are simple. The pericarpium is an egg-shaped fruit, compressed, many angled, sulcated, and covered with a succulent calyx. The seed is solitary, round, and compressed. There is only one species of it, viz. the acnida cannibina. It is a native of Virginia, but rarely cultivated in Europe, except for the sake of variety. It has little beauty, and at present is applied to no useful purpose.

ACNUA, a measure of land, among the antient Romans, containing about a quarter of an acre.

ACOEMETI, a kind of antient monks, who performed divine worship night and day in their churches. They divided themselves into three classes, each of which officiated in their turn, and relieved others, so that their churches were never silent, night or day.

ACOLUTHI, or ACOLYTHI, denote candidates for the ministry, so called from their continually attending the bishop. It is a term applied to persons who are stedfast and immoveable in their resolutions.

ACOLUTHI, is used for the body-guards who attended the emperors of Constantinople.

ACOLUTHI, is also an appellation given to the stoics, on account of their steady adherence to what they had once resolved.

ACOLYTHIA, in the Greek church, denotes either the order of divine service, or the book containing it.

ACON, an instrument used in antient exercises, like the dircus; a name likewise given to an antient order of knighthood.

ACONITI, an appellation given to some of the antient *athletæ*, who anointed their bodies with oil, instead of covering them with dust; or who overcame their antagonists with ease.

ACONITON, signifies not plaistered, and is a name applied to vessels not lined within.

ACONITUM, wolfsbane, or monks-hood, a genus of plants of the class and order polyandria trigynia. The essential character is, calyx none; petals five, the highest arched; nectaries two, peduncled, recurved; capsules three or five.

Nine species, all hardy herbaceous perennials, are enumerated of this genus, which has received the name of monks-hood from its flower, being composed of five irregular petals, resembling in some measure a man's head with a helmet or hood on it. The upper petal represents the hood or helmet; the two lower ones stand for that part which covers the lower jaw; and the two wings seem adapted for covering the temples. From the centre of the flower there arise two pistils, resembling feet, and received into the hollow of the upper petal, or hood; as is also another pistil, which finally becomes a fruit, composed of several membranaceous vaginæ collected into a head, and usually containing angular and wrinkled seeds.

All the species of aconite are extremely acrimonious, occasioning mortal convulsions, or inflammations that end in a mortification. It is even said that some persons by only smelling at the flower of the common monks-hood have been seized with swooning fits, and lost their sight for two or three days: Like other poisons, however, it has been used as a medicine in small doses, particularly in rheumatisms and intermittents.

ACONTIAS is used for a kind of meteor, with a roundish or oblong head, and a long slender tail, resembling a javelin.

ACONTIUM, in Grecian antiquity, a kind of dart or javelin, resembling the Roman pilum.

ACORN, a little ornamental piece of wood, in the shape of a cone, fixed on the top of the spindle on the mast-head, above the vane, to keep it from coming off the spindle in a whirlwind.

ACORUS, *calamus aromaticus, sweet flag*, or *sweet rush*, a genus of the monogynia order, belonging to the hexandria class of plants, and ranking in the second natural order, piperitæ. The characters are, the calyx is a cylindric simple spadix covered with florets; there is no spatha, nor perianthium; the corolla is composed of six obtuse, concave, loose petals; the stamina consist of six thickish filaments, somewhat longer than the corolla; the antheræ are thickish and didymous; the pistillum has a gibbous oblong germen the length of the stamina, no stylus, the stigma a prominent point; the pericarpium is a short triangular, obtuse three-celled capsule, attenuated at both ends; the seeds are numerous, and of an oblong egg shape. There are two species: the acoros calamus grows naturally in shallow standing waters, and is found wild in rivulets and marshy places about Norwich and other places in this island, in the canals of Holland, in Switzerland, and in other countries of Europe. The shops have been usually supplied from the Levant with dried roots, which do not appear to be superior to those of our own growth. The root of this plant has a very agreeable flavour, which is greatly improved by drying. It is reckoned carminative and stomachic, having a warm, pungent, bitterish taste, so is frequently used as an ingredient in bitters.

ACORUS, a blue coral, found on the coasts of Africa, from Rio del Re, to the river Camarones. It grows in form of a tree, on a rocky bottom.

ACOUSMATICI, in Grecian antiquity, such disciples of Pythagoras as had not finished their five years probation.

ACOUSTICS, the science of hearing, or of sounds in general. See PNEUMATICS.

ACOUSTIC *duct*, in anatomy, a name sometimes given to the external passage of the ear, more usually called meatus auditorius. See ANATOMY.

ACOUSTIC *instrument*, or Ear Trumpet, one contrived to assist hearing. It is fashioned in manner of a horn, with a perforation in the smaller end, which is fitted to be put into the ear.

ACQUEST, or ACQUITS, in law, denotes goods not descended by inheritance, but acquired by purchase or donation.

ACQUIETANDIS *plegiis*, in law, a writ which lies for a surety against a creditor, who refuses to acquit one after the debt is paid. *Cowell.*

ACQUIETANTIA *de shires et hundredis*, a freedom from suits and services in shires and hundreds.

ACQUITTAL, in law, is a deliverance or setting free from the suspicion of guilt.

Acquittal is either in fact, or in law; in fact, it is where a person, on a verdict of a jury, is found not guilty: in law, it is when two persons are indicted, one as a principal, &c. the other as accessary: here if the former is discharged, the latter of consequence becomes acquitted.

It is also used for a freedom from entries and molestations of a superior lord, on account of services issuing out of land.

ACQUITTANCE, a discharge in writing for a sum of money, witnessing that the party has paid the same.

Every man is obliged to give an acquittance on receiving money; and a servant's acquittance for money received for the use of his master, shall bind him, provided the servant used to receive his master's rents. An acquittance is a full discharge, and bars all actions, &c.

ACRE, a measure of land containing four square roods, or one hundred and sixty square poles.

The *arpent*, or French acre, is equal to $1\frac{1}{4}$ of the English acre. That of Strasburgh is only about one-half of the English acre. The Scotch acre is to the English acre by statute, as 100,000 to 78, 694.

We have computations of the number of acres contained in several countries: thus, England is said to contain forty-six millions and upwards; and the United Provinces about four and one-third millions.

ACRE-*tax*, a tax levied upon lands, at a certain rate by the acre, otherwise called acre-shot.

ACRID, an appellation given to such matter as is of a sharp or pungent taste.

Antient naturalists distinguished two kinds of acrid tastes; one proceeding from hot and dry, as in pepper; the other from hot and moist, as in garlic.

ACRIFOLIUM, signifies any prickly leaved plant.

ACROATIC, in the Aristotelian schools, a denomination given to such lectures as were calculated only for the intimate friends and disciples of that philosopher; being chiefly employed in demonstrating some speculative or abstruse part of philosophy. Acroatic is also used, in a more general sense, for any thing that is sublime or abstruse; thus we read of an acroatic philosophy, theology, &c.

ACROATICI, an appellation given to such of Aristotle's disciples as were instructed in his acroatic, or sublime philosophy. The acroatic lectures stood contradistinguished from the exoteric, which were adapted to a common auditory.

ACROBATICA, or ACROBATICUM, in Grecian antiquity, an engine on which people were raised aloft, that they might have the better prospect.

ACROCHIRISMUS, in Grecian antiquity, a kind of gymnastic exercise performed with the fists, without closing at all.

ACROCHIRISTES, in Grecian antiquity, one who practised, or excelled at, the exercise called achrochirismus.

ACROCORDUS, or Warted Snake, a genus of snake, with body and tail completely covered with warts: there are three species; 1st. The Acrochordus Javanicus, which is whitish beneath, with the sides marked by dusky spots. The remarkable snake which gave rise to the institution of this new genus, is a native of the island of Java, and was first described by Mr. Hornsted in the Swedish transactions for the year 1787. It was found in a large pepper-ground near Sangasan, in the year 1784, and measured about eight feet in length; the thickness of the neck being six inches, that of the largest part of the body ten inches, and that of the tail an inch and an half: the colour of the upper part of the animal was blackish, and of the under part whitish; the sides marked with dusky spots: the head truncated, depressed, and scaly: the jaws equal, the superior being emarginated beneath; the inferior curved: the eyes lateral, on the fore part of the head; the irides lived: the nostrils circular, small, approximated, and situated above the tip of the snout: the rictus or gape rather small for the size of the body: the teeth in both jaws subulate, very sharp, and reversed, without any appearance of fangs, and accompanied by a double row of very small teeth in the palate: the tongue thick at the base, the forked part black and slender: the body entirely covered, as well as the tail, with rough tricarinated warts: the vent small, the body very suddenly tapering towards the tail. This snake was secured by a Chinese, by means of a split bamboo applied over its neck, and thus carried to Batavia, where, on being skinned and opened, exclusive of a quantity of indigested fruit, were found five completely formed young, measuring nine inches each: the flesh of the animal was eaten by the Chinese people, who affirmed that it was excellent food, and the skin, being preserved in spirits, was brought over to Europe by Mr. Hornsted, and deposited in the Museum of the King of Sweden.

2dly. Doubtful or Brown Acrochordus, with carinated abdomen, and sides spotted with black. In its general appearance and proportion so very nearly does the present serpent resemble the preceding, or Javan species, that one description might almost serve for both, except that the head in this is covered with very minute rough or warted scales, differing in size alone from those on other parts of the animal; whereas, if we may rely on the accuracy of Mr. Hornsted's description and figure of the Javan Acrochordus, that part is covered with flat, ovate scales, and of a far different appearance from the muricated or wart-like scales on every other part. The size of the present specimen also falls much short of the former, measuring only about three feet in length: its colour is an obscure brown, with some ill-defined clouds and patches of a darker colour dispersed along the sides and abdomen: the shape of the vent, thickness of body, and sudden contraction at the beginning of the tail, as well as the comparative size and shape of that part are exactly similar: the abdomen, however, in this serpent is slightly carinated beneath towards the tail, which is a circumstance not particularized in Mr. Hornsted's description of the Javan species. The present specimen is in the British Museum, and the engraving which accompanies this article will shew in the most satisfactory manner the resemblances and discrepances between this and the former animal. Its native place is not particularized. See Plate Nat. Hist. fig. 7.

3dly. Fasciated Acrochordus, with carinated abdomen, and whitish ascendent lateral

bands. This is so much allied to the preceding, that it may perhaps be doubted whether it really difers in any other respect than age, size, and cast of colours, measuring about 18 inches in length, and being of a dusky-brown colour, with several paler fasciæ which take their rise from the abdomen, and ascend on the sides: the abdomen is carinated, as in the former. This is certainly the Hydrus granulatus of Mr. Schneider, who, in his work on the Amphibia, describes it as a water-snake, though, seemingly, without any other foundation than its having a carinated abdomen; its other characters by no means agreeing with those of the genuine Hydri.

ACROMION, or ACROMIUM, in anatomy, the name of the upper part of the scapula, or shoulder-blade. See ANATOMY.

ACROMONOGRAMMATICUM, a kind of poem, wherein every verse begins with the same letter with which the preceding verse terminates.

ACROSPIRED, in malt-making, a term used for such grains of barley as shoot or sprout out at the blade-end, as well as at the root-end.

ACROSTIC, in poetry, a kind of poetical composition disposed in such a manner, that the initial letters of the verse make some person's name, title, motto, &c.

ACROSTICUM, *Wall Rue*, the name given by Linnæus to a distinct genus of fern (of the class and order crytogamia filices) formerly called ruta. The generic character is, that the fructification covers the whole under the surface of the frond. The species are 44 in number, two only of which are natives of Britain.

ACROSTOLIUM, in the naval architecture of the antients, the extreme part of the ornament used on the prows of their ships. This was of various forms; sometimes in the shape of a buckler, helmet, animal, &c. but more frequently circular, or spiral. It was usual to tear the acrostolia from the prows of vanquished ships, as a token of victory. Authors, not unfrequently, confound the acrostolia with the decorations of the poop, as also with the rostra; from which, however, they are very distinct.

ACROTELEUTIC, among ecclesiastical writers, an appellation given to any thing added at the end of a psalm or hymn; as the *gloria Patri*, or doxology.

ACROTERIA, in architecture, small pedestals upon which globes, vases, or statues, stand at the ends or middle of pediments, or frontispieces. The height of those at the extremes should be only half that of the tympanum; whereas that in the middle ought to be one-eighth part more.

ACROTERIA likewise denotes the figures placed as ornaments, or crownings on the tops of churches; and sometimes sharp pinnacles standing in ranges about flat buildings, with rails and ballusters.

ACROTERIA, among antient physicians, a term used to denote the larger extremities of the body, as the head, hands, and feet.

ACROTERIA is also used for the tips of the fingers, and sometimes for the eminences of the bones.

ACT, among logicians, denotes an operation of the human mind; in which sense comprehending, judging, willing, &c. are called acts.

ACT, among lawyers, is used for an instrument or deed in writing, serving to prove the truth of some bargain or transaction. Thus, records, certificates, &c. are called acts.

ACT is also used for the final resolution, or decree, of an assembly, senate, council, &c.

Acts of parliament are called statutes; acts of the royal society, transactions; those of the French academy of sciences, memoirs; those of the academy of sciences at Petersburg, commentaries; those of Leipsic, *acta eruditorum*; the decrees of the lords of session at Edinburgh, *acta sederunt*, &c.

ACT, in the *universities*, a thesis maintained in public by a candidate for a degree. At Oxford, the term when masters or doctors complete their degrees, is called *the act*, which is held with great solemnity: at Cambridge, it is called the *commencement*, as being the commencement of the long vacation.

ACT *of faith*, *auto da fé*, in the church of Rome, a kind of jail delivery, for burning or setting at liberty the prisoners of the inquisition, or heretics as they are called.

An act of faith is the utmost exertion of brutal tyranny, and a reproach to humanity itself; the tragical part of which, is thus described by those who have seen it. The prisoners being clothed in peculiar habits, are carried in solemn procession to the place of execution; where there are as many stakes set up as there are prisoners to be burnt, with a quantity of dry furze about them. Those who make profession of dying in the communion of the church of Rome, are first strangled, and then burnt to ashes; but those who persist in their heresy, are chained to stakes about four feet high, a board being fixed on the top of the stake, on which the victim is seated. This being done, the jesuits, after repeated exhortations to be reconciled to the church, deliver them over to the devil, who they tell them is standing at their elbow to receive their souls, and carry them with him into the flames of hell; which instance of popish charity is followed by loud shouts from the deluded mob, exclaiming *let the dogs' beards be singed*; this they do by holding a bush of flaming furze, fastened to a pole, to their faces, till they are burnt to a coal. At last, fire is set to the furze at the foot of the stake; but the unhappy sufferers are placed so high, that the flame seldom reaches above the seat on which they sit, so that they seem rather roasted than burnt.

Such is the wretched death these poor victims suffer, and that for no other reason (for crime it certainly is not) than that they do not believe all the absurdities of popery! There cannot be a more lamentable spectacle; yet it is beheld by both sexes, and by persons of all ages, with transports of joy and satisfaction. How shocking is the practice! how detestable, beyond expression, are the authors and promoters of it! From such a religion, and such diabolical maxims, will not every protestant most fervently pray God to deliver us?

As to those who escape the flames, some are imprisoned, and others obliged to do penance during their lives.

ACTA denoted, among the Romans, a pleasant garden formed near the bank of a river, in which they gave themselves up to all kinds of pleasure.

ACTÆA, or herb Christopher, a genus of the *polyandria monogynia* class and order. The essential character is, calyx four-leaved; corolla four-petalled; berry one-celled; seeds semiorbicular, in two rows.

The genus includes four known species; one of which, the actæa spicata, grows wild in England, and is sometimes used in medicine as a powerful repellent. Caution, however, is necessary in employing it. The actæa racemosa is an American plant, and is called black snake-root, to distinguish it from the common snake-root. It is used in that country as an antidote against several kinds of animal poisons, and particularly that of the rattlesnake.

ACTS, in dramatic poetry, are certain divisions, or parts of a play, designed to give some respite both to the actors and spectators. The acts are always five in regular and finished pieces: a rule not unknown to the Romans, as appears from Horace.

Neu brevior quinto, neu sit productior, actu.

According to some critics the first act, besides introducing upon the stage the principal characters of the play, ought to propose the argument or subject of it; the second, to bring this into action; the third, to raise obstacles and difficulties; the fourth, to find remedies for these, or to raise new ones in the attempt; the fifth concludes the piece by introducing some incident to unravel the whole plot.

ACTIAN *games*, in Roman antiquity, those instituted in commemoration of the victory at Actium. Strabo, whose opinion is now generally followed, tells us, that they returned only every fifth year, and were sacred to Apollo, thence called *actius*.

ACTIAN *years*, an æra, or series of years, commencing from the battle of Actium, and otherwise called the æra of Augustus.

ACTINIA, a genus of the mollusca order of worms; its body is rough and wrinkled, furnished with eccentric cirri and with a single terminal aperture; it attaches itself to rocks and other substances, among which it is found. These animals are called urtica marina, sea anemonies and nettles; the latter appellation is given from the painful sensation experienced when they are handled. They are viviparous, and feed on shell-fish. There are five species.

ACTION, in mechanics and physics, is the pressure or percussion of one body against another. It is one of the laws of nature, that action and re-action are equal; that is, the resistance of the body moved is always equal to the force communicated to it; or, which is the same thing, the moving body loses as much of its force as it communicates to the body moved. See MECHANICS.

ACTION, in rhetoric, may be defined, the accommodation of the voice, but more especially the gesture of an orator, to the subject he is upon. It is chiefly directed to the passions of the audience.

The power of action has been known at all times. Cicero tells us, "That it does not so much matter what an orator says, as how he says it." Horace, in his Art of Poetry, is no less explicit in setting forth its vast influence on mankind.

With those who laugh, our social joy appears;
With those who mourn, we sympathise in tears.
If you would have me weep, begin the strain;
Then I shall feel your sorrows, feel your pain.

After all, the utility, and even morality, of

studied action is controverted. It is certainly enough if an orator studies sufficient of external grace that there shall be nothing disgusting in his manner or delivery. In truth, the attempts at theatrical action in some young orators, and particularly in the pulpit, are calculated to make themselves, and what they say, ridiculous, rather than respected, in the eyes of all judicious persons.

ACTION, in poetry, denotes much the same with the fable or subject of an epic or dramatic poem; only that the former may be real, whereas the latter is always feigned.

It is necessary to the perfection of an action that it be but one, that it be entire, that it be important or affecting, and that it have a suitable duration without being interrupted. It is no breach, however, of the unity or integrity of the principal action, that there are subordinate ones, serving to obstruct the hero's measures.

ACTION, in a theatrical sense, is nearly the same with action among orators; only the actor adapts his action to an assumed character, whereas the orator is supposed to be in reality what his action expresses, whether joyful, grieved, &c. The perfection of theatrical action consists in imitating nature, or expressing, in a lively manner, the behaviour of a man of the assumed character and circumstances.

ACTION, in painting and sculpture, denotes the posture of a statue or picture, serving to express some passion, &c.

ACTION *of the mouth*, in the manege, signifies a horse's champing upon the bit of the bridle, thereby emitting a ropy foam; which is looked upon as a sign of health, vigour, and mettle.

ACTION, in law, denotes either the demanding, in a legal manner, what is any man's due; or the process brought for recovering the same. The suit, till judgment, is properly called the action; but not after; and therefore a release from all actions is no bar to execution.—*Co. Litt.* 281.

Actions are either criminal or civil.

Criminal actions are to have judgment of death, as appeals of death, robbery, &c. or only judgment for damage to the injured party, fine to the king, and imprisonment. Under the head of criminal actions may likewise be ranked penal actions, which lie for some penalty or punishment on the party sued, whether corporal or pecuniary.

Actions upon the statute are also brought on breach of any statute, or act of parliament, by which an action is given that did not lie before; as where a person commits perjury to the prejudice of another, the injured party shall have an action upon the statute. And, lastly, popular actions, so called, because any person may bring them on behalf of himself and the crown, by information, &c. for the breach of some penal statute. These are called *qui tam* action, from the words of the writ.

Civil actions are divided into real, personal, and mixt.

ACTION, *real*, concerns only real or landed property, for that is the only property which our ancestors accounted real. It is therefore that whereby a man claims a title, lands, tenements, &c. in fee, or for life; and this action is either possessory, or ancestral; possessory, when the lands are a person's own possession or seisin; ancestral, when they were of the possession or seisin of his ancestors.

ACTION *personal*, is one brought upon any contract for money or goods, or on account of trespass, or other offence committed; and thereby the debt, goods, chattels, &c. claimed.

ACTION, *mixt*, is one lying as well for the real property demanded as against the person who has it, and on which the thing is recovered with damages for the wrong sustained: such is an action of waste, sued against a tenant for life, the place wasted being recoverable, with treble damages for the wrong done.

All actions seem to be temporary and limited. A real action may be prescribed against, in five years after a fine levied, or recovery suffered. Writs of formedon for any title to lands in being, must be sued out within twenty years. Actions of debt, account, detinue, trover, and trespass, are to be brought within six years, of assault and battery within four years, and of slander within two years, after cause of action, and not afterwards.

It ought, however, to be observed, that the right of action in these cases is saved to infants, feme coverts, and persons in prison, or beyond sea, &c. provided they commence their suits within the time limited after their inabilities are removed.

Actions may be brought against all persons whatever, but those attainted of high treason or felony. An outlawed or excommunicated person, &c. cannot bring any action till pardoned, absolved, &c. A feme covert must sue with her husband, and infants by their guardians.

ACTION *upon the case*, is a general action which lies for the redress of wrongs and injuries done without force, and which by law are not specifically provided against. This at present is the most frequent of all actions, being brought in all cases where no certain form has been established; and the reason why it is called an action upon the case, is because the whole cause or case is set forth in the writ. It may be brought as well where there is another action as where no other lies.

ACTION, *upon the case for words*, is brought where a person is injured in his reputation; and for words which affect the life, office, trade, &c. or tend to the loss of preferment in marriage, or otherwise; or to the disinheritance, or other damage of a person.

ACTION, *prejudicial*, otherwise called *preparatory*, one which arises from some doubt in the principal: as, where one sues his younger brother for lands descended from the father, on which it is objected to him that he is a bastard. Here this point of bastardy is to be first tried or judged, before the principal cause can proceed.

ACTION *of a writ*, is when a person pleads some matter, by which is shown, that the plaintiff had no cause to have the writ brought; though, perhaps, he may have another writ for the same matter. It is hence called, a plea to the action of the writ, in contradistinction from a plea to the action.

ACTION, among physicians. The actions of the human body are divided into the vital, animal, or natural ones.

Vital actions are those, without which life could not be maintained: such is the motion of the heart and lungs.

Under animal actions are comprehended the senses, imagination, judgment, and voluntary motions, without which we could not live comfortably.

Lastly, natural actions are those which, though not so immediately necessary to life, but that we may live some time at least without them, yet are absolutely necessary to our well-being: such is digestion.

ACTION, in commerce, a term used abroad for a certain part or share of a public company's capital stock. Thus, if a company has 400,000 livres capital stock, this may be divided into 400 actions, each consisting of 1000 livres. Hence, a man is said to have two, four, &c. actions, according as he has the property of two, four, &c. thousand livres, capital stock.

The transferring of actions, abroad, is performed much in the same manner as stocks are with us.

ACTIONARY, or ACTIONIST, in commerce, a term used among foreigners, for the proprietor of an action, or share of a public company's stock.

ACTIVE, among grammarians, an appellation given to words expressing some action, as I write, I read, &c.

These are denominated verbs, or active verbs, from the Latin *verbum*, a word.

ACTOR, in a theatrical sense, is a man who acts some part or character in a play.

Actors were at first few in number, one or two persons often acting all the characters in a play. At present, however, their number is not limited: a circumstance which creates such a diversity as must greatly interest the spectators.

It is remarkable with what difference actors were treated among the antients. At Athens they were held in such esteem, as to be sometimes appointed to discharge embassies, and other negotiations: whereas, at Rome, if a citizen became an actor, he forfeited his freedom. Among the moderns, actors are best treated in England; the French having much the same opinion of them as the Romans had.

ACTOR was the name of a person who had the superintendance of all the goods of a Roman citizen. He was called *actor bonorum*.

ACTOR *summarum*, a slave, to whom was committed the office of cash-keeper.

ACTOR, among civilians, the proctor or advocate in civil courts or causes.

ACTORUM *tabulæ*, tables instituted by Servius Tullius, in which the births of children were registered.

ACTUARIÆ *naves*, in Roman antiquity, a kind of ships designed chiefly for expedition.

ACTUARIUS, an officer, or rather notary, appointed to write down the proceedings of a court.

ACTUARII were also officers who kept the military accounts, and distributed the corn to the soldiers.

ACTUS, in antiquity, a measure of length, containing one hundred and twenty Roman feet.

The square of the actus was just half of the Roman acre, or jugerum.

ACULEATE, or ACULEATED, an appellation given to any thing that has aculei, or prickles: thus fishes are divided into those with aculeated, and not aculeated fins.

ACULER, in the manege, is said of a horse, when working upon volts, he does not go far enough forward, at every time or motion; so that his shoulders embrace or take in too little ground, and his croupe comes too near the center of the volt.

ACUMINA, in antiquity, a kind of military

oven, taken from the points or edges of spears, swords, &c.

ACUPUNCTURE, in the Chinese and Japanese surgery, a method of curing several disorders, by pricking the part affected with a needle.

This operation is performed with a gold or silver needle, which they strike into the body with their hand, or with a hammer provided for that purpose. Not only the legs, arms, and the like parts, are pricked in this manner, but likewise the head and abdomen.

They have recourse to acupuncture in the head for head-achs, lethargies, epilepsies, convulsions, diseases of the eyes, &c. and in the abdomen for colics, dysenteries, want of appetite, surfeits, &c.

ACUTE, an appellation given to such things as terminate in a sharp point or edge: thus, we say an acute angle, acute-angled triangle, &c. See GEOMETRY.

ACUTE *diseases*, among physicians, those which suddenly rise to their crisis, and terminate in a few days. They are extremely dangerous, as not affording time to administer proper medicines.

ACUTE, in music, an epithet given to sharp or shrill sounds, in opposition to those called grave.

ACUTIATORES, in antiquity, a kind of smiths retained in the antient armies for sharpening the arms.

ACUTITION, in grammar, the pronouncing, or marking, a syllable with an acute accent.

AD, a Latin preposition, expressing the relation of one thing to another.

It is frequently prefixed to other words: thus,

AD *bestias*, in antiquity, a kind of punishment, which consisted in throwing the criminal to wild beasts.

AD *hominem*, among logicians, an argument drawn from the professed belief or principles of those with whom we argue.

AD *libitum*, at discretion, in music, the same with piace, or si piace.

AD *ludos*, in Roman antiquity, a kind of punishment, whereby the criminals entertained the people, either by fighting with wild beasts, or with each other.

AD *metalla*, in Roman antiquity, the punishment of such criminals as were condemned to the mines, and therefore called metallici. A piece of excellent policy, thus to make the punishment of rogues doubly subservient to the good of the commonwealth.

AD *valorem*, among the officers of the king's revenue, a term used for such duties, or customs, as are paid according to the value of the goods sworn to by the owner.

ADACTED, in military affairs, is a term applied to stakes, or piles, driven into the earth by large malls shod with iron, as in securing ramparts or pontoons.

ADAGIO, softly, leisurely, in music, a term used to denote the slowest of all times, the grave only excepted. Sometimes it is repeated adagio adagio, to signify a still greater retardation of time.

ADALIDES, in Spain, officers of justice for matters that respect the military forces.

ADAMANTINE *spar*. See MINERALOGY.

ADAMANTINE, *terræ*, the sixth order of earths; to this order belongs the *corundum*.

ADAMI *pomum*, in anatomy, a prominence in the fore part of the throat; so called from an idle notion, that a piece of the forbidden apple stuck in Adam's throat, and occasioned this tumour, which in reality is only the convex part of the first cartilage of the larynx.

ADAMIC *earth*, *terra-adamica*, a name by which some call the common red clay supposed to be the adamah, or ruddy earth, of which the first man was formed.

ADAMITES, a sect of heretics who went naked; pretending that mankind were restored to the original state of innocence, wherein Adam wast created.

ADANSONIA, Ethiopian sour gourd, or monkey's head, is a genus of the monadelphia order and polyandria class, called after the famous French traveller in Senegal, Adanson. The essential character is, calyx simple, deciduous; style very long; stigmas many; capsules woody, ten-celled, with farinaceous pulp, and many seeds.

We know of but one species, the adansonia digitata. In its native country, Africa, it grows to a very large tree. Its height however is not above 12 or fifteen feet, but its circumference is often 60 or 70 feet. The fruit is pleasant, of an acid flavour, and eaten with sugar. The pulp, or a syrup made of it, is used in putrid fevers; and at Cairo the pulp reduced to a powder is administered in fluxes, dysenteries, &c. It has grown (from seeds sown in a hot-bed) to the height of 18 feet in our stoves.

ADAR, in Hebrew chronology, the twelfth month of the ecclesiastical, and the sixth of the civil year. It has only twenty-nine days, and answers to the last half of our February and the first part of March.

ADARCON, a coin mentioned in the scriptures, usually of gold, worth about 15 shillings.

ADARME, in commerce, a small Spanish weight used in America, and nearly equivalent to our dram.

ADCRESCENTES *milites*, under the Roman emperors, a kind of junior soldiers, not unlike our cadets.

ADDER. See COLUBER.

ADDEXTRATORES, the pope's mitre-bearers; so called, according to Ducange, on account of their walking at the pope's right hand, when he rides to visit the churches.

ADDICTI, in Roman antiquity, slaves who were reduced to that state because they could not satisfy some creditor; whose slaves they became till they could pay or work out the debt.

ADDICTION, *addictio*, among the Romans, was the making over of goods to another, whether in the way of sale, or by sentence of court: the goods so delivered were called *bona addicta*.

Debtors were sometimes delivered over in the same manner, and thence called *servi addicti*, as above.

ADDITION, in arithmetic, the first of the four fundamental rules of that art: for this and addition of fractions and decimals, see ARITHMETIC.

ADDITION, in algebra, is the connecting or putting together all the letters or numbers to be added, with their proper signs + or —. See ALGEBRA.

ADDITIONS, in law, denote all manner of designations given to a man, over and above his proper name and surname, to show of what estate, degree, mystery, place of abode, &c. he is.

ADDITIONS of degree, are the same with titles of honour, or dignity: as knight, lord, earl, duke, &c.

ADDITIONS of estate, are yeoman, gentleman, esquire, &c.

ADDITIONS of mystery or trade, are carpenter, mason, painter, engraver, &c.

ADDITIONS of place or residence, are London, Edinburgh, Bristol, York, Glasgow, Aberdeen, &c.

These additions were ordained to prevent one man's being grieved, or molested, for another; and that every person might be certainly known, so as to bear his own burden.

If a man is of different degrees, as duke, earl, &c. he shall have the most worthy; and the title of knight, or baronet, is part of the party's name, and therefore ought to be rightly used; whereas that of esquire, or gentleman, being as people please to call them, may be used or not, or varied at pleasure.

An earl of Ireland is no addition of honour here; nay, the law-addition to the children of British noblemen is only that of esquire, commonly called lord.

Writs without the proper additions, if excepted to, shall abate; only where the process of outlawry does not lie, additions are not necessary. The addition of a parish not in any city, must mention the county, otherwise it is not good.

ADDITION *of ratios*, the same with what is otherwise called composition of ratios.

ADDITION, among distillers, a general term for such things as are added to the wash, or liquid, while fermenting, with a view to increase the vinosity and quantity of the spirit, or to give it a particular flavour.

ADDITION, in heraldry, something added to a coat of arms, as a mark of honour; and therefore directly opposite to abatement. Among additions we reckon a border, quarter, canton, gyron, pile, &c. In this manner the arms of a kingdom or state have been added to those of noblemen; as happened to the dukes of Boufflers and Richlieu in the Italian war, who, by a decree of the senate of Genoa, were permitted to add the ensigns of that republic to those of their families.

ADDITION, in music, a dot marked on the right side of a note, to signify that it is to be sounded or lengthened half as much more as it would have been without such mark.

ADDUCTOR, in anatomy, a general name for all such muscles as serve to draw one part of the body towards another. See ANATOMY.

ADEB, in commerce, a weight used in Egypt, principally for weighing rice.

It is about two drams less than an English pound.

ADELIA, a genus of the dioecia monadelphia class and order. Its essential character is, male blossom; calix three-parted; corolla none; stamina many, united at the base. Female, calix five-parted; corolla none, styles 3 torn, caps. tricoccous.

There are three species of shrubs which bear this name, all of them natives of Jamaica. We do not find them remarkable for any particular quality, and therefore, as their flower has no beauty, they are seldom cultivated here. They may, however, be raised from seed, and treated as stove plants.

ADELPHIANI, a sect of heretics, who always fasted on Sundays.

ADEMPTION, among civilians, denotes the revocation of some donation or favour.

The ademption of a legacy may be done either in express terms, or indirectly by disposing of it otherwise.

ADENANTHERA, a genus of shrubby plants of the class and order decandria monogynia. The flower is companulate; and the essential character is, calix five-toothed, petals five, globose glands affixed to the outer tip of the anthers (whence its name), legume membranaceous.

Three species are at present known, but the adenanthera pavonina is the only one which has been as yet cultivated in England, where, however, it has not flowered. The seeds, which are obovate, rounded, and convexly lens-shaped, are very beautiful, and from their equality in weight (being each four grains), are used by goldsmiths and jewellers; they are also eaten by the common people in India, and form a cement when beaten up with water and borax. It is one of the largest and handsomest trees in the East Indies, and commonly lives 200 years. The wood is solid and durable. With us it forms a handsome shrub for the decoration of our stoves.

ADENOS, a kind of cotton, otherwise called marine cotton. It comes from Aleppo by way of Marseilles, where it pays twenty per cent. duty.

ADENOSE, *abscess*, is used for a hard tubercle, difficult to be discussed, and resembling a gland.

ADESSENARIANS, a sect of christians, who maintain that Jesus Christ is really present in the eucharist, though not by way of transubstantiation.

The adessenarians differ among themselves, some of them holding that the body of Jesus Christ is in the bread; others, that it is about the bread; others, that it is with the bread; and others, that it is under the bread.

ADFECTED *equations*, in algebra, those wherein the unknown quantity is found in two or more different powers: such is $x^3 - ax^2 + bx = a^2b$.

For the solution of these and other equations see ALGEBRA.

ADFILIATION, a Gothic custom, whereby the children of a former marriage are put upon the same footing with those of the second marriage. This is otherwise called *unio prolium*, and still retained in Germany, under the name *einkindschafft*.

ADHESION, in physiology, is used to denote the sticking together of two bodies. Muschenbroek has given many curious experiments on the adhesion of bodies, which he properly attributes to attraction

ADHESION, in medicine and anatomy. There are frequent instances of the adhesion of the lungs to the pleura and diaphragm, which occasions many disorders.

ADHIL, in astronomy, a star of the sixth magnitude, upon the garment of Andromeda, under the last star in her foot.

ADIANTUM, *maidenhair*, in botany, a genus of plants of the cryptogamia class, and of the order of filices. The generic character is, the fructifications collected in oval spots under the reflected tops of the fronds.

There are thirty-nine species, but only one, the adiantum capillus Veneris, is a native of Great Britain, and even that is found only in a few places in Scotland and Wales. Like the other plants of this class it has no visible flower; the seeds being contained in capsules, placed in the sinuses and folds of the leaves, and surrounded each with an elastic ring, which contracting, bursts the capsule and scatters the minute seeds: as, however, the leaves of all the species of maidenhair have one general appearance, it is easy to distinguish them from other plants of the fern kind.

Maidenhair was once highly esteemed as an expectorant, but is now generally rejected. Indeed, it has been well remarked, that if the syrop of capillaire, which is pretended to be made from it, has any virtue, it is derived from the orange-flower water, which is also an ingredient.

ADIAPHORISTS, or ADIAPHORITES, names given to the modern Lutherans, in the sixteenth century. The name imports lukewarmness, or indifference; being compounded of the privative α, and $\delta\iota\alpha\varphi o\rho o\varsigma$ different.

ADIAPHOROUS, an epithet given by Mr. Boyle to a spirit distilled from tartar and some other vegetable bodies: it is said to be neither acid nor urinous, and in many respects different from any other spirit.

ADJECTIVE, a word expressing some quality, or other accident, of the substantive with which it is joined: thus, in the phrase, pure gold, the word *pure* is an adjective, shewing the quality of the gold. When the quality is the subject whereof we speak, it becomes a substantive: thus if we say, good is always to be chosen, the word good is a substantive; but in the phrase, Peter is a good man, the word good is evidently an adjective, expressing the character of Peter.

AD INQUIRENDUM, in law, a writ commanding inquiry to be made concerning something connected with a cause depending in the king's courts; as of bastardy, or the like.

ADJOURNMENT, in law, the putting off a court, or meeting, to another time or place.

ADJOURNMENTS *of parliament* differ from prorogations, in being not only for a shorter time, but also each house has the privilege of adjourning itself, whereas a prorogation can only be the act of the king.

ADIPOCIRE, is a term that denotes a body converted from a muscular to a waxy substance. See CHEMISTRY.

ADIPOSE, in a general sense, denotes something belonging to the fat of the body; and is a term chiefly used by physicians and anatomists, in whose writings we read of adipose cells, adipose ducts, adipose membrane, adipose vessels, &c.

ADJUDICATION, is sometimes used for transferring the property of a thing sold by auction to the highest bidder.

ADJUNCT, among philosophers, something added to another, to which it does not naturally belong: thus water in a spunge is an adjunct to it; so are clothes to a man. Adjuncts are what we commonly call circumstances: these, in ethics, are commonly reckoned seven, *quis, quid, ubi, quibus auxiliis, cur, quomodo, quando*.

ADJUNCTS, in the Paris academy of sciences, are a set of members attached to the study of some particular science. They are twelve in number: two for geometry, two for astronomy, two for anatomy, two for mechanics, two for chemistry, and two for botany.

AD JURA REGIS, in law, a writ which lies for a clerk presented to a living by the king, against those who endeavour to eject him, to the prejudice of the king's title.

ADJUTAGE, or AJUTAGE, in hydraulics, the tube fitted to the mouth of a jet-d'eau.

It is through the adjutage that water is played, and directed into any desired figure; so that the great diversity of fountains consists chiefly in the different structure of their adjutages.

ADJUTANT, in the military art, an officer whose business it is to assist the major, and therefore sometimes called the aid-major.

Each battalion of foot, and regiment of horse, has an adjutant, who receives the orders every night from the brigade-major, and after carrying them to the colonel, delivers them out to the serjeants. When detachments are to be made, he gives the number to be furnished by each company, and assigns the hour and place of rendezvous; he also places the guards; receives and distributes the ammunition to the companies; and by the major's orders regulates the price of bread, beer, &c.

ADJUTANTS *general*, among the jesuits, were a select number of fathers who resided with the general of that order; they had each a province or country assigned them, as England, Germany, &c. and their business was to inform the father-general of state occurrences in such countries.

ADLEGATION, in the customs of Germany, a right claimed by several princes of that empire to send plenipotentiaries conjunctly with those of the emperor, to all negotiations wherein the empire in general is concerned.

The emperor disputes this privilege of adlegation, but allows them to send ambassadors about their own private affairs.

ADMANUENSES, in our old law books, a term denoting laymen, who swore by laying their hands on the book; whereas the clergy, were forbidden to swear on the book, their word being deemed equal to an oath.

ADMEASUREMENT, in law, a writ for adjusting the shares of something to be divided. Thus,

ADMEASUREMENT *of dower* takes place when the widow of the deceased claims more as her dower than what of right belongs to her. And,

ADMEASUREMENT *of pasture* may be obtained when any one of the persons who have right in a common pasture, puts more cattle to feed on it than he ought.

ADMINICULATOR, in church-history, an officer otherwise called advocate of the poor.

ADMINISTRATION, in law, the office of an administrator. See ADMINISTRATOR.

Whenever a man dies intestate, letters of administration are taken out in the prerogative court.

ADMINISTRATION is also used for the management of the affairs of a minor, lunatic, &c.

ADMINISTRATION, among ecclesiastical writers, denotes the power wherewith a parson is invested; and that as well in regard to the temporalities of his cure, as to its spiritualities, viz. the power of excommunicating, of administering the sacraments, &c.

ADMINISTRATION, among anatomists, denotes the art of properly dissecting the parts of the human body, and particularly of the muscles.

ADMINISTRATION, in commerce, a regu-

lation at Calao, a city of Peru, obliging all ships allowed to trade on the coast, to unload their European goods, and pay certain duties.

ADMINISTRATOR, in law, the person to whom the goods, effects, or estate, of one who died intestate, are entrusted; for which he is to be accountable, when required.

The bishop of the diocese where the party dies, is regularly to grant administration; but if the intestate has goods in several dioceses, administration must be granted by the archbishop in the prerogative court.

The persons to whom administration is granted, are a husband, wife, children whether sons or daughters, the father or mother, brothers or sisters, and, in general, to the next of kin, as uncle, aunt, cousin; then to a creditor.

An action lies for and against an administrator, as for and against an executor; he is accountable, however, no farther than to the value of the goods.

ADMINISTRATOR is also used in several other senses, as for an advocate of a church; for a person appointed to receive and manage the revenues of an hospital or religious house; for a prince who enjoys the revenues of a secularized bishopric; and lastly, for the regent of a state during a minority, or a vacancy of the throne.

ADMIRAL, in maritime affairs, a great officer, who commands the naval forces of a kingdom or state, and decides all maritime causes.

According to Ducange, the Sicilians were the first, and the Genoese the next, who gave the name of admiral to the commanders of their fleets; deriving it from the Arabic *amir* or *emir*, a designation applicable to any commanding officer.

For some time past, we have had no lord-high-admiral in Britain; that office being executed by a certain number of commissioners, called lords of the admiralty.

ADMIRAL also denotes the commander in chief of a single fleet or squadron; or, in general, any flag officer whatever.

In the British navy, besides the admiral who commands in chief, there are the vice-admiral, who commands the second squadron; and the rear-admiral, who commands the third division. The admiral carries his flag at the main-top-mast-head; the vice-admiral at the fore-top-mast-head; and the rear-admiral at the mizen-top-mast head.

The admiral when on shore, is entitled to receive military honours, and ranks with generals in the army.

ADMIRAL, *Vice*, likewise denotes an officer invested with the jurisdiction of an admiral, within a certain county or district. There are upwards of twenty such vice-admirals in Great Britain; but an appeal lies from their sentence or determination, to the admiralty-court in London.

In France the admiral is one of the great officers of the crown, general of the marine, and of all the naval forces of the kingdom. From him the captains and masters of trading vessels are obliged to take their licences, passports, commissions, and safe-conducts.

The tenth of all prizes belongs to him, and the whole of all fines adjudged in the courts of admiralty. He also has the duty of anchorage, tonnage, &c.

ADMIRAL is also an appellation given to the most considerable ship of a fleet of merchantmen, or the vessels employed in the cod-fishery of Newfoundland. This last has the privilege of choosing what place he pleases on the sandy shore, to dry his fish. He also gives proper orders, and appoints the fishing places to those who come after him; and as long as the fishing season continues, he carries a flag on his main-mast.

ADMIRAL, in conchology, the name of a beautiful shell of the volute kind, much admired by the curious.

There are four species of this shell, viz. the grand-admiral, the vice-admiral, the orange-admiral, and the extra-admiral. The first is extremely beautiful, of an elegant white enamel, variegated with bands of yellow, which represent, in some measure, the colours of the flags in men of war. It is of a very curious shape, and finely turned about the head, the clavicle being exerted; but its distinguishing character is a denticulated line, running along the centre of the large yellow band; by this it is distinguished from the vice-admiral, the head of which is also less elegantly formed.

The orange-admiral has more yellow than any of the others, and the bands of the extra-admiral run into one another.

ADMIRALTY properly signifies the office of lord-high-admiral, whether discharged by one, or several joint-commissioners called lords of the admiralty.

In Holland there are five admiralties, boards, or chambers, composed of the deputies of the nobles, the provinces, and towns; who have the care of fitting out fleets, and in general, of all maritime affairs.

ADMIRALTY-*Court*, or court of admiralty, in the British polity, a sovereign court, held by the lord-high-admiral, or the commissioners of the admiralty.

This court has cognizance in all maritime affairs, civil as well as criminal.

All crimes committed on the high-seas, or in great rivers beneath the bridge next to the sea, are cognizable only in this court; which, by statute, is obliged to try the same by judge and jury. But in civil causes it is otherwise, these being all determined according to the civil law; the reason of which is, that the sea is without the jurisdiction of the common law.

In case any person is sued in the admiralty court, contrary to the statutes, he may have the writ of supersedeas to stop farther proceedings, and also an action for double damages against the person suing.

Subordinate to this court there is another of equity called court-merchant; wherein all causes between merchants are decided, agreeably to the rules of the civil law.

ADMIRATION, in a general sense denotes the act of being much delighted with, or highly prizing, some rare excellence; and sometimes the astonishment conceived at some extraordinary event.

"It is obvious," says Dr. Cogan, "that the range of *admiration* is from the simple approbation of the mind, up to the most lively sensation, according to our conceptions of the extent of excellence, and also the degrees of our interest in its effects. It is also blended with various other emotions according to different circumstances attendant upon the passion. It is frequently introduced by *surprise:* when, for example, the discovery of these excellences is sudden and unexpected, and then it becomes a vivid emotion. It is generally connected with some degree of *wonder*; as we are frequently ignorant of the causes which enabled any one greatly to excel ourselves or others; but as it is always excited by the real discovery of some qualities, it is not to be confounded with an emotion that proceeds from ignorance and embarrassment previous to the discovery." Grammarians have a character for expressing this affection or state of mind, called a point of admiration, and marked thus (!).

ADMISSION, among ecclesiastical writers, denotes the act of a bishop's admitting or allowing a clerk to be able, or qualified for serving a cure. This is done after examination, by pronouncing the formula *admitto te habilem*. If any person presume to be admitted, who has not episcopal ordination, he shall forfeit 100*l*. No person is to be admitted into a benefice with a cure of 30*l*. per annum in the king's books, unless he is a bachelor in divinity at least, or a preacher lawfully allowed, or licensed by some bishop.

ADMITTENDO *clerico*, a writ granted to a person who has recovered his right of presentation in the common pleas: by which the bishop, or metropolitan, is ordained to admit his clerk.

ADMITTENDO *in socium*, a writ associating certain persons, usually knights, and other gentlemen of the county, to the justices of assize already appointed.

ADMONITIO *fustium*, among the Romans, a military punishment, not unlike our whipping, only that it was performed with vine-branches.

ADMONITION, in church-history, a part of discipline, which consists chiefly in warning an offender of the irregularities he is guilty of, and advising him to amend.

By the antient canons, nine admonitions were required before excommunication.

ADMORTIZATION, in the feudal customs, reducing the property of lands or tenements to mortmain.

ADNATA, in anatomy, one of the tunics or coats of the eye, otherwise called conjunctiva and albuginea.

It is the same part with what is called the white of the eye, formed by the tendinous expansions of the muscles which move the eye. See ANATOMY.

ADNATA, or ADNASCENTIA, among gardeners, terms used for such off-sets, as by a new germination under the earth, proceed from the lily, narcissus, hyacinth, and other flowers; and afterwards grow to the roots. These by the French are called *cayeux*.

ADNATA is also a term used for such things as grow upon animal or vegetable bodies, whether inseparably, as hair, wool, horns, &c. or accidentally, as the several episitical plants.

ADNOUN, or ADNAME, terms sometimes used to denote an adjective.

ADONIA, festivals kept in honour of Venus, and in memory of her beloved Adonis.

The adonia lasted two days, on the first of which the images of Venus and Adonis were carried with great solemnity, in manner of a funeral; the women crying all the while, tearing their hair, and beating their breasts. On the second, changing their note, they sung his praises, and made rejoicings, as if Adonis had been raised to life again.

The adonia were celebrated by most antient nations, as the Greeks, Egyptians, Syrians, Lycians, &c. The prophet Ezekiel, c. viii.

verse 14. is thought to allude to these festivals.

ADONIC, in antient poetry, a kind of verse consisting of a dactyle and spondee or trochee. This kind of verse had its name adonic, on account of its being originally used in the lamentations for Adonis. However, its principal use among poets, is to serve as a conclusion to each strophe of sapphic verse.

ADONICUS, a name given by the Arabs to the sun, under which appellation they worshiped him, by daily offering him incense and perfumes.

ADONIDES, an appellation given to such botanists as have given descriptions or catalogues of the plants cultivated in some particular place.

ADONIS *flos*, a genus of plants, called in English pheasant's-eye. It is of the class and order polyandria polygynia; and the essential character is, calyx five-leaved; petals, five or more without a nectary; seeds naked.

The genus includes six species much resembling the anemone in appearance, only smaller. The adonis autumnalis, an annual plant, is common in our gardens, and even in the fields about London. Its flowers are of a bright scarlet, with a black spot or eye at the bottom. The adonis vernalis is also cultivated in our gardens; but though a native of Switzerland and Germany, we have observed that it is somewhat tender, probably from its shooting so early in the spring; it has a large yellow flower.

ADOPTIANI, a sect who maintained that Christ, with respect to his human nature, was not the natural, but adoptive son of God.

ADOPTION, a solemn act, whereby one man made another his heir; investing him with all the rights and privileges of a son.

Adoption was in frequent use among the Greeks and Romans, who had many regulations concerning it. The Lacedemonians, in order to prevent inconsiderate adoptions, had a law, that they should be transacted, or at least confirmed, before their kings; at Athens, slaves, madmen, and persons under age, were incapable of adopting; and at Rome, adoptions were confirmed before the prætor, in an assembly of the people, or by a rescript of the emperor. Young men were not permitted to adopt their elders; on the contrary, it was necessary that the adopter should be eighteen years older than his adopted son, to give an appearance of probability of his being the natural father. Children, thus adopted, were invested with all the privileges, and obliged to perform all the duties, of legitimate children, even to the assuming the names of the person who adopted them; and being thus provided for in another family, they ceased to have any claim for inheritance, or kindred, in the family they had left, unless they first renounced their adoption; which, by Solon's laws, they were not permitted to do, till they had begotten children to bear the name of their adopted father. On the other hand, the person who had once adopted children, was not permitted to marry afterwards, without express leave from the magistrate; whom it was usual to petition for such a licence, in case the adopted children acted an ungrateful part.

Among the Romans, before adoption could take place, the natural father was obliged to renounce all authority over his son, and with great formality consent that he should be translated into the family of the adopter. The adoption of a person already free was called adrogation. The ceremonies of adoption being various, have given rise to a great many different kinds of it: thus, we read of adoption by testament, when a man adopted another by his last will; adoption by arms, or presenting the adopted son with a suit of armour; adoption by cutting off the hair; adoption by matrimony, or adopting the children of a wife by a former husband.

By the Gentoo laws, information must be given to the magistrate, by the person who is desirous of adopting a child, and a sacrifice performed, and he is also to give gold and rice to the father of the child. A woman is not allowed to adopt a child without her husband's order; and he who has no son, or grandson, or great-grandson, has liberty to adopt one son, but no more. Among the Turks, the ceremony of adoption is performed by obliging the person adopted to pass through the shirt of the adopter. Hence among that people, to adopt is expressed by the phrase, "to draw another through my shirt."

ADOPTION is also used in speaking of the admission of persons into certain hospitals, particularly that of Lyons: sometimes the term is used in the sense of incorporation; thus the French academy of Marseilles was *adopted* by that of Paris.

ADOPTIVE *arms*, in heraldry, those enjoyed by the concession of another, which the adopter is obliged to marshal with his own, as being the condition of some honour or estate left him.

ADOPTIVE is sometimes also used for borrowed or foreign: thus, besides their domestic gods, the Romans had a multitude of adoptive deities, borrowed from foreign nations.

ADORATION denotes the act of worshiping God, or a being supposed to be God. The word comes from *ad*, to; and *os*, *oris*, the mouth; and imports, to kiss the hand, this being universally acknowledged to be a mark of great respect. Among the Jews, adoration consisted in kissing the hands, bowing, kneeling, and even prostration. Hence, in their language, the word kissing is used for adoration. As to the ceremony of adoration among the Romans, it was performed with the head veiled, or covered; the devotee applying his right-hand to his lips, the fore-finger resting on the thumb, which was erect; and then bowing, he turned himself round from left to right. The Gauls, on the contrary, thought it more religious to turn from right to left; and the Greeks, to worship with their heads uncovered. The Christians follow the Grecian rather than the Roman mode, by uncovering, when they perform any act of adoration.

ADORATION, *barbarous*, denotes that used by heathen nations. The Phenicians adored the winds, on account of the terrible effects produced by them. The same practice was adopted by the Greeks, Persians, Romans, &c. The Troglodytes adored tortoises; the Scythians, swords; the Romans, axes; and the Arabs, stones; the Indians adored vipers; the Bengalese and the Canadians, the sun. The Manta, a Peruvian people, antiently adored a huge emerald, by offering to it emeralds of a lesser size; all of which the priests kept for their own use.

ADORATION is also used, in a civil sense, for any extraordinary homage or respect paid by one man to another. Thus the Persians adored their kings, by falling prostrate before them, striking the earth with their foreheads, and kissing the ground. This was an act of servility, which Conon, a citizen of Athens, refused to comply with, when introduced to Artaxerxes; neither would the philosopher Calisthenes perform it to Alexander the Great, as judging it impious and unlawful. The Roman emperors were adored, by bowing or kneeling at their feet, laying hold of their purple robe, and immediately withdrawing the hand, and kissing it.

ADORATION is more particularly used for the ceremony of paying homage to the pope, by kissing his feet; which not only the people, but the greatest prelates, and even princes, make no scruple of performing. Protestants have hence taken occasion, and not without reason, to charge the popes with excessive pride, and even impiety.

ADORATION is still more particularly used for a method of electing a new pope, when the cardinals, instead of proceeding in the usual way, unanimously fall down and adore one of their own number. Adoration is the last ceremony of a regular election, but here it is the election itself, or rather supersedes it.

ADORATION, *perpetual*, in the church of Rome, a kind of religious society, frequent in the popish countries; which consists of devout persons, who, by regularly relieving each other, keep constantly praying before the eucharist both day and night.

ADOREA, in Roman antiquity, a word used in different senses; sometimes for all manner of grain; sometimes for a kind of cakes made of fine flour, and offered in sacrifice; and, finally, for a dole or distribution of corn, as a reward for some service: whence, by metonymy, it is put for praise or rewards in general.

ADOSSEE, in heraldry, a term used for two rampant animals, placed back to back. It also denotes any other figures, as axes, keys, &c. placed with their heads facing different ways.

ADOXIA, a genus of plants, of the class and order of octandria tetragynia. The essential character is, calyx bifid, inferior; corolla four or five cleft, superior; berry four or five celled, united with the calyx.

We know of but one species; the adoxia moschatelina, so called from its smelling like musk. It is otherwise called bastard fumitory, and grows wild in shady places, as in Hampstead and Charlton woods.

AD PONDUS OMNIUM, among physicians, denotes that the last-mentioned ingredient ought to weigh as much as all the rest put together.

AD QUOD DAMNUM, in law, a writ which ought to be issued before the king grants certain liberties, as a fair, market, highway, &c. ordering the sheriff to inquire by the country what damage such a grant is likely to be attended with.

ADRIFT, in sea language, denotes the state of a vessel broken from her moorings, and driven by the wind or waves.

ADSCENDENS *caulis*, denotes in botany, a stalk or branch inclining upwards.

ADSENTIRI, a term used to express the assent of the Roman soldiers to any propositions that were made to them by their commanders, which they did by lifting up their hands with acclamation, and striking their bucklers against their knees.

ADSIDELLA, in antiquity, the table at which the flamens sat during the sacrifices.

ADSTRICTION, among physicians, is used to denote the too great rigidity and closeness of the emunctories of the body, particularly the pores of the skin; also for the styptic quality of medicines.

AD TERMINUM *qui præteriit*, in law, a writ of entry, that lies for the lessor or his heirs, if after the expiration of a term for life or years, granted by lease, the tenant or other occupier of the lands, &c. withholds the same from such lessor.

ADVANCE, in the mercantile style, denotes money paid before goods are delivered, work done, or business performed.

To pay a note of hand, or bill, by advance, is to pay the value before it becomes due; in which case it is usual to allow a discount for the time it is pre-advanced.

ADVANCED *ditch*, or moat, in fortification, is that drawn round the glacis or esplanade of a place.

ADVANCED-*guard*, or VANGUARD, in the art of war, denotes the first line or division of an army, ranged or marching in order of battle; or it is that part which is next the enemy, and marches first towards them.

ADVANCED-*guard* is more particularly used for a small party of horse stationed before the main-guard.

ADVANCER, among sportsmen, denotes one of the starts or branches of a buck's attire, between the back antler and the palm.

ADUAR, in the Arabian and Moorish customs, a kind of ambulatory village, consisting of tents; which these people remove from one place to another, as suits their convenience.

ADVENTITIOUS, among civilians, denotes all such goods as are acquired accidentally, or by the liberality of a stranger, &c.

ADVENTITIOUS *fossils*, the same with extraneous or foreign ones, found embodied in other fossils: such are shells, bones, &c. in stone.

AD VENTREM *inspiciendum*, in law, a writ by which a woman is to be searched whether she be with child by a former husband, on her withholding lands from the heir.

ADVENTURE, *bill of*, among merchants, is a writing signed by a merchant, testifying that the goods mentioned in it to be shipped on board a certain vessel, belong to another person, who is to run all hazards; the merchant only obliging himself to account to him for the produce of them, be it what it will.

ADVENTURER, in a general sense, denotes one who hazards something. By statute 13 Geo. II. c. 4. adventurers may obtain a charter for whatever settlements in America they shall take from the enemy.

ADVENTURERS, or *merchant*-ADVENTURERS, a company of merchants formerly erected for the discovery of lands, trades, &c.

ADVERB, in grammar, a word joined to verbs, expressing the manner, time, &c. of an action: thus, in the phrase, *it is conducive to health to rise early*, the word *early* is an adverb; and so of others.

Adverbs are also added to nouns, and even to other adverbs, in order to modify or ascertain their meaning; whence some grammarians call them modifications: thus, in the phrase, *he prayed very devoutly*, the word *devoutly* qualifies the action of prayer, and the word *very* does the same in regard to devoutly.

Adverbs, though very numerous, may be reduced to certain classes; the principal of which are those of order, of place, of time, of quantity, of quality, of manner, of affirmation, doubting, comparison, interrogation, diminution, &c.

Mr. H. Tooke has shown, in his Επεα Πτεροεντα, that most of the English adverbs are either corruptions of other words, or abridgments of sentences: thus the termination *ly* is the corruption of *like*, as honestly is honest-like. *Lo* is the imperative of *look*, &c.

By others adverbs are derived from three sources: (1.) from a species of interjection, denoting an impulse of the mind, as *now*, *then*, *not*; (2.) from a composition of two or three words into one, as *always*, *altogether*, &c.; and (3.) from adjectives, by adding a syllable void of signification itself, but which seems to denote that the word has changed its state into that of an adverb, as *greatly*. The last syllable, however, was originally a contraction of some word that denoted similitude, or participation; and indeed if we could examine language critically, we have no doubt that Mr. Tooke's theory might be demonstrated, and *all* of them proved to be originally words with a full meaning.

In the Hebrew most adverbs, particularly those of quality, are expressed by nouns, both substantives and adjectives, either simply, or connected with a preposition.

ADVERSARIA, among the antients, was a book of accounts, not unlike our journals, or day-books. The word is more particularly used, among men of letters, for a kind of common-place-book, wherein they enters whatever occurs to them worthy of notice, whether in reading or conversation, in the order in which it occurs: a method which some persons prefer to that of digesting them under regular heads.

ADVERSATIVE, in grammar, is a word expressing some difference between what goes before and what follows it. Thus in the phrase, *he loves knowlege but has no application*, the word *but* is an adversative conjunction; between which and a disjunctive one there is this difference, that the first sense may hold good without the second opposed to it, which is otherwise in regard to disjunctive conjunctions.

Mr. Tooke, in the book above-quoted, observes well, that there are two senses to the word *but*; in the *first* it is a corruption of *bot*, the imperative of the Saxon verb *botan*, *to boot*, *superadd* or *supply*; and in the *second*, it is a contraction of *be-utan*, *to be out*; in illustration of this theory is given the following couplet:

"*But* thy work shall endure in laude and glorie,
But spot or faulte condigne eterne memorie."

The meaning is "*superadd* (to something said before) thy work shall endure in laude and glorie; *be out* or *without* spot or faulte."

ADVERSATOR, in antiquity, a servant who attended the rich in returning from supper, to give them notice of any obstacles in the way, at which they might be apt to stumble.

ADVERTISEMENT is particularly used for a brief account of an affair inserted in the daily or other public papers, for the information of all concerned, or who may find some advantage from it. By the statute law the penalty of 50*l.* is inflicted on persons advertising a reward with "*no questions to be asked*," for the return of things lost or stolen. The same penalty attaches to the printer.

ADVICE, or *letter of* ADVICE, a letter missive, by which a merchant, or banker, informs his correspondent, that he has drawn a bill of exchange, that his debtor's affairs are in a bad state, or that he has sent a quantity of merchandize, whereof the invoice is usually annexed. A letter of advice for the payment of a bill of exchange should mention the name of the person for whose account it is drawn; the day, month, and year; the sum drawn for; the name of him from whom the value is received; and the person's name to whom it is payable.

For want of such advice it is very allowable to refuse accepting a bill of exchange.

ADVICE *boat*, a small vessel employed to carry expresses or orders with dispatch.

AD VITAM *aut culpam*, denotes an office to be held *quamdiu se bene gesserit*, that is, till the death or some delinquency of the possessor.

ADULT, among civilians, denotes a youth between fourteen and twenty-five years of age.

ADULTERATION, in a general sense, denotes the act of debasing, by an improper mixture, something that was pure and genuine. Thus,

ADULTERATION *of coin*, is the casting or making it of a metal inferior in goodness to the standard, by using too great a proportion of alloy. This is a crime which all nations have made capital.

ADULTERATION, in pharmacy, is the using ingredients of less virtue in medicinal compositions, to save expence; a practice with which the dealers in medicine and drugs are but too well acquainted.

ADULTERATION, among distillers, vintners, &c. is the debasing of brandies or wines, by mixing them with some improper liquor.

By stat. 1. W. and M. c. 34. whoever sells adulterated wine, is to forfeit three hundred pounds. We have laws also against the adulteration of coffee, tea, tobacco, snuff, beer, bread, wax, hair-powder, &c.

ADULTERY, the crime of married persons, whether husband or wife, who are guilty of a violation of their marriage vow.

By the law of Moses, both man and woman, who had been guilty of adultery, were put to death. The antient Romans had no formal law against adultery; Augustus being the first who made it punishable by banishment, and in some cases by death. By an edict however of Antoninus, a husband could not prosecute his wife for adultery, unless he was innocent himself. And by the regulations of Justinian, at the instance of his wife Theodora, the punishment of adultery in the woman was mitigated; whipping, and shutting up in a convent for two years, being deemed sufficient, after which time, if the husband did not take back his wife, she was shut up for life. Among the Greeks, adultery was punished variously; sometimes by fine, and at others by what they called *paratilmus*: nay, the Lacedemonians are even said to have permitted it. Adultery among European nations is reckoned a private offence, none but the husband being suffered to intermeddle in the affair; and what is no less remarkable, though the husband be guilty of adultery, the wife, except in Scotland, is not allowed to prosecute him for the same.

In England adultery is accounted a spiritual offence, and therefore the injured party can have no other redress but to bring an ac-

tion of damages against the adulterer; and to divorce and strip the adultress of her dower, is all the punishment she incurs. And, indeed, it must be owned, that the laying a heavy fine upon the man, and punishing the woman in the manner just mentioned, is as likely, if not more so, to prevent the frequency of adultery, as more severe methods.

ADULTERY is also used for any kind of unchastity; in which sense divines understand the seventh commandment.

ADULTERY, in the scripture language, is likewise used for idolatry, or forsaking the worship of the true God for that of a false one.

ADUMBRATION, in heraldry, denotes the shadow of any beast or charge outlined, and painted of a darker colour than the field.

ADVOCATE, *advocatus*, among the Romans, a person who undertook the defence of causes, which he pleaded much in the same manner as our barristers do at present.

Advocates were held in great honour during the first ages of the Roman commonwealth, being styled *comites*, *honorati*, *clarissimi*, and even *patroni*. The term advocate is still retained in all countries where the civil law obtains. In Scotland there is a college of advocates, consisting of one hundred and eighty persons, appointed to plead in all actions before the lords of session. In France there are two kinds of advocates; or those who plead, and those who only give their opinions, like our chamber-counsellors.

ADVOCATE, *lord*, one of the officers of state in Scotland, who pleads in all causes of the crown, or wherein the king is concerned. The lord advocate sometimes happens to be one of the lords of session; in which case, he only pleads in the king's causes.

ADVOCATE *fiscal*, *fisci advocatus*, in Roman antiquity, was an officer of state under the Roman emperors, who pleaded in all causes wherein the *fiscus*, or private treasury, was concerned.

ADVOCATES *consistorial*, officers of the consistory at Rome, who plead in all oppositions to the disposal of benefices in that court: they are ten in number.

ADVOCATE *of a city*, in the German polity, a magistrate appointed, in the emperor's name, to administer justice.

ADVOCATE, among ecclesiastical writers, a person who undertook the defence of a church, monastery, &c. Of these there were several kinds; as elective advocates, or those chosen by the chapter, bishop, abbot, &c. nominative advocates, or those appointed by the emperor, pope, &c. military advocates, those who undertook the defence of the church rather by arms than eloquence, &c. There were also feudal advocates, supreme and subordinate advocates; and matricular advocates, or those of the mother or cathedral church.

ADVOCATION, among civilians, the act of calling another to assist in pleading some cause.

ADVOCATION, *letters of*, in the law of Scotland, a writ issued by the lords of session, advocating, or calling, a cause from an incompetent judge to themselves.

ADVOCATIONE *decimarum*, a writ which lies for claiming a fourth part of tithes or upwards belonging to any church.

ADVOWSON, in law, is the right of patronage, or presenting to a vacant benefice.

Advowsons are either appendant, or in gross. Appendant advowsons are those which depend on a manor, or lands, and pass as appurtenances of the same; whereas advowson in gross is a right of presentation subsisting by itself, belonging to a person, and not to lands. Whenever the property of an advowson has been once separated from the property of the manor by legal conveyance, it never can afterwards be re-united, but remains for ever an advowson in gross. In either case, advowsons are no less the property of the patrons than their landed estate: accordingly they may be granted away by deed or will, and are assets in the hands of executors. Papists, however, and Jews, seized of any advowsons, are disabled from presenting: the right of presentation being in this case transferred to the chancellors of the universities, or the bishop of the diocese.

ADYTUM, in pagan antiquity, the most retired and sacred place of their temples, into which none but the priests were allowed to enter. The term is purely Greek, signifying inaccessible.

ADZE, a kind of crooked ax, used by coopers, &c. otherwise called addice.

ÆACEA, in Grecian antiquity, solemn festivals and games celebrated at Ægina, in honour of Æachus; who, on account of his justice upon earth, was thought to have been appointed one of the judges in hell.

ÆCHMALOTARCHA, in Jewish antiquity, the title given to the principal leader or governor of the Hebrew captives residing in Chaldæa, Assyria, and the neighbouring countries. The Jews themselves call this magistrate *Rosch-galuth*, *i. e.* chief of the captivity. Basnage assures us, that there was no æchmalotarch before the end of the second century: and Prideaux says, that the æchmalotarch, at present, is only the head of their religion, like the *episcopus Judæorum* in England, the altarch at Alexandria, and the ethnarch at Antioch.

ÆDES, in Roman antiquity, signified an inferior kind of temple, consecrated indeed to some deity, but not by the augurs. There were a vast number of these in antient Rome; thus we read of the *ædes fortunæ*, *ædes pacis*, *ædes Herculis*, &c.

ÆDICULA, a term used to denote the inner part of the temple, where the altar and statue of the deity stood.

ÆDILE, in Roman antiquity, a magistrate whose chief business was to superintend buildings of all kinds, but more especially public buildings; as temples, aquæducts, bridges, &c.

To the ædiles likewise belonged the care of the highways, public places, weights and measures, &c. They also fixed the prices of provisions, punished lewd women, and such persons as frequented gaming-houses. The custody of the plebiscita, or orders of the people, was likewise committed to them. They had the inspection of comedies, and other theatrical pieces; and were obliged to exhibit magnificent games to the people at their own expence, whereby many of them were ruined.

At first the ædiles were only two in number, and chosen from among the common people; but these being unable to support the expence of the public shews, two more were created out of the patrician order: these last took upon themselves all the charges of the games, and were called *ædiles curules*, or *majores*, as the two plebeians were denominated *minores*.

Julius Cæsar, in order to ease these four, created two others, who were called *ædiles Cereales*, as having the inspection of all manner of grain committed to their care.

There were also ædiles in the municipal cities, who had much the same authority as those in Rome.

ÆDILITIAN *edict*, among the Romans, was particularly used for the ædile's sentence, allowing redress to the purchaser of a beast or slave that had been imposed on.

ÆDITUUS, in Roman antiquity, an officer belonging to temples, who had the charge of the offerings, treasure, and sacred utensils. The female deities had a woman-officer of this kind, called æditua.

ÆGAGROPILA, or ÆGAGROPILUS, in natural history, a ball composed of a substance resembling hair, generated in the stomach of the chamois-goat. It is a kind of bezoar, called *bezoar germanicum*, and is possessed of no medicinal virtue, any more than the balls of the same kind formed in the stomachs of cows, hogs, &c. See BEZOAR.

ÆGIAS, among antient physicians, a white speck on the pupil of the eye, which occasioned a dimness of sight, and was otherwise called *aigis* and *aiglia*.

ÆGICERAS, a genus of the class and order of the pentandria monogynia. The essential character is, calyx bell-shaped, half five-cleft; capsule bow-shaped, one-celled, gaping on the convex side; seed inverted. It is found in the Molucca islands, and in Ceylon. There are two species, the majus and minus.

ÆGILOPS, an abscess in the corner of the eye, next the nose; or, according to Heister, a small tumour caused by an inflammation or abscess, which in time, by the acrimony of its purulent matter, erodes the external skin, lacrymal ducts, and fat round the ball of the eye; sometimes it renders the neighbouring bones carious to a dangerous degree.

As to the method of treatment, the surgeon is first to endeavour to disperse the tumour, by moistening it several times a day with spirit of vitriol; but if he finds this impracticable, he is to forward the suppuration as much as possible, lest an obstinate fistula, or worse consequences, should be the effects of too long delay. For this purpose a plaster of diachylon with the gums, or emollient cataplasms, may be used. When fully ripe, the tumour is to be laid open with a lancet or scalpel, and the ulcer cleaned or healed in the ordinary way. See SURGERY.

ÆGILOPS, a genus of the polygamia and monœcia class and order, and of the natural order of grasses. The essential character is, calyx a glume, subtriflorous, cartilaginous; corolla a glume terminating in a threefold awn; stamina three; styles two; seed one.

There are four species of this grass, all of which seem to be annual. They grow in the southern parts of Europe.

ÆGIPHILA, a genus of the tetandria monogynia class and order, and the natural order of vitices. The corolla is salver-shaped: and the essential character is, calyx four-toothed; corolla quadrifid; style semibifid; berry four-seeded.

There are four species; one a native of Martinico, the others of Jamaica. They are all shrubs of a moderate height.

ÆGIS, in heathen mythology, is particularly used for the shield or cuirass of Jupiter and Pallas.

ÆGOMANTIA, a species of divination performed by means of a goat.

ÆGOPHTHALMUS, the goat's-eye stone, in natural history, a name indifferently given to any of the semipellucid gems, with circular spots in them, resembling the eye of a goat.

ÆGOPODIUM, or *goat weed, herb gerard,* or *wild masterwort,* a genus of the pentandria digynia class and order, and of the natural order of umbellatæ, or umbelliferæ. The characters are, the universal calyx is a manifold convex umbel; the partial one, consimilar and flat; there is no involucrum, and the proper perianthium is scarcely discernible: the universal corolla is uniform, the florets all fertile; the proper one has five inverse, ovate, concave, equal petals, inflected at the top; the stamina consist of five simple filaments twice the length of the corolla: the antheræ roundish; the pistillum has a germen beneath; two purple erect styles the length of the corollet; the stigmata are headed; no pericarpium; the fruit is ovate, striated, and bipartite; the seeds are two, ovate, on one side convex and striated, and flat on the other.

There is but one species, a native of England, and other parts of Europe. It is very common under hedges and about gardens; the leaves resemble those of angelica, and it bears small white flowers.

ÆGOPRICON, a genus of the monœcia monandria class and order, the characters of which are: the calyx both of the male and female is a tubular perianthium of one leaf divided into three segments; corolla wanting in both; the stamina consist of a single erect filament longer than the calyx, with an ovate anthera; the pistillum has an ovate germen, three divaricated styli, the simple persistent stigmata; the pericarpium is a globular berry, three-grained within, and three-celled: the seeds are solitary, and angular on one side.

There is but one species, which is a branching tree, a native of Surinam.

ÆGYPTIACUM, the name of several detergent ointments, used for eating off rotten flesh, and cleansing foul ulcers.

The ægyptiacum, as ordered in the Edinburgh dispensatory, is a composition of verdigrease, reduced to fine powder, five ounces; of honey, fourteen ounces; of vinegar, seven ounces: all which are to be boiled over a gentle fire, to the consistence of an unguent.

ÆGYPTILLA, in the natural history of the antients, a stone variegated with veins of a black, blue, or red colour; and said to be capable of giving water the colour and taste of wine.

The stone to which they ascribed this imaginary virtue, seems to have been a kind of onyx, or sardonyx.

ÆINAUTÆ, in antiquity, a denomination given to the senators of Miletus, from holding their deliberations on board a ship, and never returning to land till matters had been agreed on.

ÆLURUS, in Ægyptian mythology, the deity or god of cats; represented sometimes like a cat, and at others like a man with a cat's head.

ÆNEATORES, in Roman antiquity, a general name for the musicians of an army, viz. those who played on trumpets, horns, litui, buccinæ, &c.

ÆNIGMA, denotes any dark saying or question, wherein some well-known thing is concealed under obscure language.

The parable, gryphus, and rebus, are by some accounted three species, or branches, of ænigma. To compose an ænigma, two things are to be chosen which bear some resemblance to each other, on which some perplexing and intricate question, description, or prosopopœia, is to be founded. This last is most pleasing, as it gives life and action to things destitute of them.

Painted ænigmas are representations of some object, whether of nature or art, concealed under the human figure.

ÆOLIC, in a general sense, denotes something belonging to Æolia or Æolis.

ÆOLIC *dialect*, among grammarians, one of the five dialects of the Greek tongue, agreeing in most things with the Doric dialect.

ÆOLIC *verse*, in prosody, a kind of verse, consisting of an iambus or spondee, then of two anapests separated by a long syllable. Such is,

O stelliferi conditor orbis!

ÆOLIPILE, a hollow metalline ball, in which is inserted a slender neck or pipe; whence, after the vessel has been partly filled with water, and heated, issues a blast of vapour with great vehemence.

Great care should be taken that the aperture of the pipe be not stopped when the instrument is put on the fire, otherwise the æolipile will burst with a vast explosion, and may occasion no little mischief.

The æolipile is sometimes placed on a small carriage, and a cork thrust into the extremity of the pipe. When the vapour is sufficiently heated, it rushes out with the cork in one direction, while the carriage moves the contrary way.

ÆOLUS's *harp*, an instrument so named from its producing an agreeable harmony, merely by the action of the wind. The construction of the instrument is as follows: Let a box be made of as thin deal as possible, its length exactly answering to the width of the window in which it is to be placed; it must be five or six inches deep, and seven or eight inches wide. Across the top, and about four inches from each end, glue a piece of wainscot half an inch high, and a quarter of an inch thick, to serve as bridges for the strings to be stretched over, by means of pins inserted into holes a little behind the bridges, nearer the ends; half the number being at one end, and half at the other. These pins are like those of a harpsichord; and, for their better support in the thin deal, a piece of beech, about an inch wide, is glued on the inside of the lid, immediately under the place of the pins, the holes for receiving them being bored through this piece. It is strung with fine catgut, or blue first-fiddlestrings, more or less, at pleasure, on the outside and lengthways of the lid, fixing one end to one of the small pins, and twisting the other end about the opposite or stretching pin. Two sound-holes are cut in the lid, and the thinner this is the better will be the performance.

When the strings are tuned in unison, and the instrument placed with the stringed side outwards, in the window to which it is fitted, the air will cause the instrument to give a sound like a distant choir, increasing and decreasing according to the strength of the wind.

ÆON properly signifies the age or duration of any thing. Æon, among the Platonists, however, was used to denote any virtue, attribute, or perfection: hence they represented the deity as an assemblage of all possible æons, calling it pleroma or fulness.

ÆORA, among antient physicians, a peculiar kind of exercise, which consisted in being carried about in a litter or other vehicle. Sometimes the patient's bed was hung by ropes, in the manner of a hammock, and moved backwards and forwards. Travelling in a chariot, or on board a ship or boat, were also accounted so many kinds of æora.

ÆRA, in chronology, a series of years, commencing from a certain fixed point of time, called an epocha: thus, we say the Christian æra, that is, the number of years elapsed since the birth of Christ.

The generality of authors, however, use the terms æra and epocha in a synonymous sense, or for the point of time from which the computation commences; making no other difference between them, except that the former is chiefly used by the vulgar, and the latter by chronologers.

ÆRARIUM, in Roman antiquity, the treasury, or place where the public money was deposited. Ærarium and fiscus are sometimes used in a synonymous sense; though the latter, strictly speaking, contained only the money belonging to the emperor.

ÆRARIUM *sanctius*, an appendage added to the former, for containing the monies arising from the twentieth part of all legacies, which was kept for the extreme necessities of the state.

ÆRARIUM *privatum*, was the emperor's privy purse, or place where the monies arising from his private patrimony were deposited.

ÆRARIUM *Ilithiæ*, or *Junonis Lucinæ*, one where the monies were deposited, which parents paid for the birth of each child. There are several other treasuries mentioned in historians, as the *ærarium juventutis, Veneris,* &c.

ÆRARIUS was used by the Romans for a degraded citizen, whose name had been struck off the list of his century. The *ærarii* were so called on account of their being liable to all the taxes and other burdens of the state, without enjoying any of its privileges. Hence, *inter ærarios referri* was a great deal more severe punishment than *tribu moveri*.

AERATION *of soils* denotes the impregnation of them with air, by means of ploughing, harrowing, and other means of pulverization, which serve to introduce the air into the pores of the earth.

AERIANS, a branch of Arians, who to the doctrines of that sect added some peculiar dogmas of their own; as, that there is no difference between bishops and priests; a doctrine maintained by many modern divines, particularly of the presbyterian and reformed churches.

AEROLOGY is a scientifical account of the nature and less obvious properties of air. See AIR.

AEROMETRY, the art of measuring the motion, gravity, elasticity, rarefaction, condensation, &c. of air; in which sense aerome-

try is synonymous with pneumatics, a term in more common use. See PNEUMATICS.

AERONAUTICA denotes the art of sailing through the air, as a ship in the sea. This, however fanciful it was formerly accounted, has been lately reduced to a reality. See AIR BALLOON.

AEROPHOBIA, among physicians, signifies the dread of air, which is a symptom of phrenzy. Dr. Franklin says he has sometimes been seized with *aerophobia*, but experience soon convinced him that fresh air is eminently conducive to health. Any air, he says, is preferable to that of a close chamber, which has been again and again respired without change.

AEROPHYLACEA, a term used by some naturalists for certain caverns or reservoirs of air, supposed to exist in the bowels of the earth, by means of which they account for the origin of springs.

AEROSTATION. See AIR BALLOON.

ÆRUGINOUS, an epithet given to such things as resemble, or partake of the nature of, the rust of copper. Thus, an æruginous colour is green, or that of verdegris.

ÆRUGO *salis*, a kind of reddish slimy matter, separated from the Egyptian *natrum*; probably a mixture of bitumen and a red earth.

ÆRUSCATORES, in antiquity, a kind of strolling beggars, not unlike gypsies, who drew money from the credulous by fortune-telling and juggling.

The priests of Cybele were called *æruscatores magnæ matris*, on account of their begging in the streets; for which purpose they had little bells thereby to draw people's attention to them, much like some orders of mendicants abroad.

ÆRUSCATORES was also a denomination given to griping exactors, or collectors of the revenue.

ÆS, properly signifies copper, or money coined of that metal. Authors speak of *æs rude*, *æs grave*, and *æs signatum*. Some suppose the two former to denote the same thing, viz. money paid by weight and not by tale, as the *æs signatum*, or coined money, was. Others again consider the *æs grave* to have been large pieces of coined copper, containing a whole *as*, or pound weight. Kuster, on the other hand, thinks that *æs grave* was used to denote any kind of copper money, in opposition to that made of gold or silver, which was light.

Æs flavum, yellow copper, among the Romans, an appellation given to the coarser kinds of brass, the finest being called *orichalcum*. See BRASS and ORICHALCUM.

ÆRIS *flos*, among antient alchemists, a kind of small scales procured from melted copper, by exposing it to a vehement heat: but among the moderns it is sometimes used for *ærugo* or verdegris.

Æs *ustum*, among chemists, a preparation of copper, otherwise called *æs veneris*, *æs crematum*, &c. There are several ways of making it; but the most frequent is, by exposing plates of copper in a reverberatory furnace till they will crumble into a powder, which is called *æs ustum*: this is extremely drying and detersive, and therefore used for eating off dead flesh, and cleansing foul ulcers; and either sprinkled on the part in powder, or mixed in ointments. It is also used for colouring glass.

Æs. *Per æs et libram*, was a formula in the Roman law, by which purchases and sales were ratified. The phrase was originally used in speaking of things sold by weight, or by scales, but it was afterwards used on other occasions. Hence, in *adoptions*, the formula expressed that the person adopted was bought per *æs et libram*.

ÆSCHYNOMENE, or BASTARD SENSITIVE PLANT, a genus of the class and order diadelphia decandria. The corolla is papilionaceous; and the essential character is, calix bilobate, legume with truncate one-seeded joints.

It is a shrubby plant, and includes eight species, all exotics. Four species the Æ. aspera, Americana, Indica, and pumila, are annual plants. Only two of the species appear to be sensitive, viz. the Æ. Americana and sensitiva. The others are chiefly cultivated for their beautiful flowers; the legumes of some of the species are a foot and a half, and two feet, long. The Æ. cannabina, which is a native of the East Indies, treated as hemp, may be used as such. They are all very tender stove-plants in this country.

ÆSCULUS, horse chesnut, a genus of the heptandria monogynia class and order, or the natural order of trihilatæ. The essential character is, calyx one-leafed, five-toothed, ventricose; corolla five-petalled, irregularly coloured, inserted into the calyx; capsule three-celled.

The genus embraces three species. The common horse chesnut is well known. On its first introduction into this country, rather more than a century ago, from its very quick growth, it was more cultivated than it deserved. It is now found that it will seldom resist a great storm of wind; and the very short time its leaves continue, renders it unsightly a great part of the year; yet it must be confessed that its form is regular, and its blossoms beautiful. The wood is of little use but for burning, though it is said that it is now employed by the turners. The nuts are eaten by deer, and Hanbury affirms that hogs will fatten on them: Haller also relates, that sheep have been fed with them whole, and poultry with them when boiled. The yellow and scarlet horse chesnut are cultivated for the beauty of their flowers.

ÆTATE PROBANDA, in law, a writ which formerly lay to enquire whether the king's tenant was of full age; but now disused, since the abolition of wards and liveries.

ÆTHER, a term used by some philosophers for the most subtile of all fluids, which, commencing from the limits of our atmosphere, was thought to pervade the vast expanse of heaven.

Authors differ widely with respect to its nature; some making it a finer kind of air, others a kind of fiery effluvium from the sun and fiery stars, and others a fluid *sui generis*.

ÆTHER is supposed by some philosophers not only to fill up the intermediate space between the heavenly bodies, but to permeate all bodies whatever; also to be the medium of light; and, lastly, that it was the cause of gravity in the earth and other celestial bodies, assisted in the action of burning, and in the dissolution of other bodies, by menstruums. After all, modern philosophers make it a question whether there is any such fluid.

ÆTHER or ETHER, is more particularly used for an extremely volatile spirit, made by distilling alcohol with an acid, and then precipitating the acid gas with an alcali.

The properties of the æther obtained are supposed to vary a little according to the acid employed: accordingly every particular kind is distinguished by the acid employed in its preparation. Thus the æther obtained by means of sulphuric acid is called *sulphuric æther*; that by means of nitrous acid, *nitrous æther*.

1. Sulphuric æther is usually prepared by the following process: A mixture of equal parts of alcohol and sulphuric acid is put into the retort, to which a large receiver is then luted. It is proper to surround the receiver with ice, or at least with cold water. Heat is applied; and as soon as the mixture boils, the æther comes over and is condensed, and runs in large striæ down the sides of the receiver. As soon as it amounts to one half of the alcohol employed, the process must be stopt. The æther thus obtained is not quite pure, almost always containing a little sulphureous acid.

This acid may be separated by pouring the æther on a little potass, and distilling it over again by means of a moderate heat. Mr. Dize affirms that black oxide of manganese produces this effect still more completely than potass. All that is necessary is, to mix a quantity of this black oxide in powder with the impure æther, and to let it remain for some time, agitating it occasionally. The sulphureous acid is converted into sulphuric, and combines with the manganese. The æther is then to be distilled over by the heat of a water-bath.

The separation of the liquid from the sulphureous acid, with which it is mixed, is called the *rectification of the ether*. The usual method, and we may add the best, is the following, first employed by Mr. Woulfe: Fill three-fourths of a bottle with the impure æther, add a little water, and a portion of slacked lime. Agitate the bottle with violence, and keep it for some time in water before taking out the cork. If the smell of the acid is not removed, add a little more lime, and agitate a second time. Decant off the æther into a retort, and distil it over.

2. Æther thus obtained is a limpid and colourless liquor, of a very fragrant smell, and a hot pungent taste. Its specific gravity is only 0.7581.

It is so volatile that it can scarcely be poured from one vessel to another without losing a considerable portion of it by evaporation. When poured out in the open air, it disappears in an instant, and during its evaporation produces a very considerable degree of cold. If a glass vessel containing water, and surrounded with a cloth, is dipt into æther two or three times, and the æther each time allowed to evaporate from the cloth, the water in the glass freezes. In the open air æther boils at 98°, and in a vacuum at — 20°. Were it not, therefore, for the pressure of the atmosphere, it would always exist in the gaseous state.

It is exceedingly inflammable, and when kindled in the state of vapour, burns with rapidity, with a fine white flame, and leaves behind it a trace of charcoal. During its combustion carbonic acid is generated. How well soever it has been rarified, it always exhibits traces of sulphuric acid.

When æther in the state of vapour is made

to pass through a red hot porcelain tube, it is decomposed completely, and a great quantity of carburated hydrogen gas is obtained.

Æther, when exposed to a cold of — 46°, freezes and crystallizes.

3. Æther is soluble in 10 parts of water, according to the count de Lauraguis.

4. When æther is admitted to any gaseous body standing over mercury, it always doubles the bulk of the gas, as Dr. Priestley first observed. If oxygen gas, thus expanded by æther, is presented to a lighted candle, the æther burns with great rapidity, but produces no explosion. But if one part in bulk of this expanded oxygen is mixed with three parts of pure oxygen gas, and kindled, a very loud explosion takes place: the products are water and 2½ parts of carbonic acid. Mr. Cruikshank, to whom we are indebted for this instructive experiment, ascertains, that one part of the vapour of æther takes 6.8 parts of oxygen gas to consume it completely; and from the relative proportions of the two products, he has shewn that the carbon which æther contains is to its hydrogen as 5 to 1.

5. The action of the simple combustibles on æther has not been tried, if we except phosphorus, which it is capable of dissolving in small proportion. The solution is transparent; but the addition of a little alcohol to it renders it milky. This furnishes us with a method of ascertaining whether æther is sophisticated with alcohol.

6. Æther has no action on metals; but it revives several of the metallic oxides when mixed with their solutions in acids. It takes gold from its solution in nitro-muriatic acid.

7. It is probable that it has no action on fixed alkalies and earths; but it combines, or at least mixes readily, with ammonia.

It absorbs nitrous gas in considerable quantity.

8. Sulphuric acid seems capable of converting it into a peculiar kind of oil, known by the name of sweet oil of wine.

If we fill a bottle, capable of holding three or four English pints, with oxymuriatic acid gas, taking care to expel the water as completely as possible, and then throw into it about a dram or half a dram of good æther, covering its mouth immediately with a piece of light wood or paper, in a few seconds white vapour will be perceived moving circularly in the bottle: this will be soon followed by an explosion accompanied with flame; at the same time a very considerable quantity of charcoal will be deposited, and the bottle will be found to contain carbonic acid gas.

Æther is capable of dissolving the volatile oils. It combines with alcohol in almost any proportion.

The method of preparing *nitrous æther*, proposed by Navier, was this: twelve parts of alcohol are put into a strong bottle, which is kept surrounded with water, or rather with ice: eight parts of nitric acid are poured in at intervals, the mixture being agitated after every addition. The bottle is then well-corked, and the cork secured by leather. Æther gradually forms at the surface of the liquid. After five or six days, when the formation is supposed to be over, the cork is to be pierced with a needle to allow a quantity of nitrous gas to escape, which would otherwise carry the æther along with it. The cork is then to be drawn; the whole liquid is to be poured into a funnel, and by means of the finger the liquid below is allowed to run out while the æther is retained.

This method is somewhat hazardous; for the quantity of nitrous gas evolved is so great as often to burst the bottle. Dr. Black substituted in place of it a very ingenious process. He put into a glass phial the proper quantity of nitric acid; over this was poured gently a stratum of water, and the alcohol was poured over all. Thus there were three strata of liquids in the vessel: the acid lowermost, and the alcohol uppermost, separated from each other by the water. The acid and alcohol gradually combined with the water, and coming into contact acted on each other without violence; and thus the æther was formed without risk.

Dehne has given another process for obtaining nitric æther exceedingly tedious, but not attended with any risk. The alcohol is put into a tubulated retort, to which a large receiver is luted; one 48th part of nitric acid is to be added every four hours, drop by drop, till it amounts to about one half of the weight of alcohol; then the mixture becomes hot, and æther passes over into the receiver. After this a little more nitric acid is to be added every morning and evening. Æther gradually forms on its surface. The acid is to be added till it falls down to the bottom of the retort in the form of green globules, indicating the formation of perfectly saturated nitrous acid. This is a proof that no more æther will be formed.

Various other methods of preparing nitrous ether have been proposed by chemists; as the distillation of a mixture of sulphuric acid, nitre, alcohol, &c. But the process preferred by artists is that of Chaptal as corrected by Proust. A large retort is luted to a glass globular vessel furnished with a tube of safety. From this globe a tube passes to a second, likewise furnished with a tube of safety; and to this last vessel are connected three Woulfe's bottles in the usual way, which must be half full of alcohol. A mixture of 32 parts of alcohol and 24 of acid, of the specific gravity 1.3, is put into the retort. The heat of a chafing-dish is applied, and removed as soon as the effervescence begins. The greatest part of the æther is detained by the alcohol in the first Woulfe's bottle. This mixture is to be saturated with an alkali, and the æther separated by distillation.

Nitrous æther, by whatever process it is procured, is never pure at first, holding always in solution a considerable portion of nitrous gas: hence its extraordinary volatility. It contains also a certain portion of nitric acid, and a little oil to which it owes its yellow colour. The nitrous gas separates spontaneously when the æther is mixed with a considerable portion of water. By distilling it repeatedly from potass or sugar, the oil may be abstracted; and when kept for some time, the nitric acid is decomposed, and a little water and oxalic acid formed, which sink to the bottom of the vessel.

Nitric æther, as far as is known, agrees very nearly in its properties with sulphuric æther: it is equally fluid, light, and combustible: its state and odour are nearly the same, but not quite so pleasant, owing most probably to the foreign bodies, from which it cannot easily be completely freed.

According to Mess. Fourcroy and Vauqulin, æther is composed of the same ingredients as alcohol, but combined in different proportions. According to them, æther contains a greater proportion of hydrogen and oxygen, and a smaller proportion of carbon, than alcohol.

ÆTHIOPS, or ÆTHIOPS MINERAL, or HYDRARGYRUS *cum sulphure*, a preparation of mercury, made by rubbing in a marble or glass mortar, equal quantities of quicksilver and flowers of sulphur, till the mercury wholly disappears, and there remains a fine deep black powder, whence it has got the name of æthiops, and it is much used in medicine. The name is changed in modern pharmacy to that of hydrargyrus cum sulphure.

ÆTHIOPS *antimonialis*, a combination of the sulphurets of antimony and mercury; it is prepared by fusing crude antimony in an earthen crucible, and when it is on the point of fixing, add to it an equal weight of hot mercury: the mixture at first becomes more fluid, and after a while solid: when cold it must be levigated in a mortar and washed. The medical effects of this preparation in small quantities are sudorific; in larger doses it is a purgative and emetic.

ÆTHIOPS *vegetabilis* is prepared by burning the sea-wrack or sea-oak in the open air, and then reducing it into a black powder. It is used to reduce scrophulous swellings, and in cleansing the gums and teeth.

ÆTHUSA, a genus of the pentandria digynia class and order, belonging to the natural order of umbellatæ or umbelliferæ.

The calyx is an universal umbel expanding, the interior rays shorter by degrees; with a partial umbel, small and expanding. There is no universal involucrum; the partial one is dimidiated with three or five leaflets, and pendulous; the proper perianthium scarcely discernible. The universal corolla is uniform, with fertile florets; the partial one has five heart-inflected unequal petals. The stamina consist of five simple filaments, with roundish antheræ. The pistillum is a germen beneath, with two reflected styli; the stigmata obtuse. There is no pericarpium; the fruit is ovate, striated, and tripartite. The seeds are two, roundish, and striated. There is but one species, viz. the æthusa synapium, fool's parsley, or lesser hemlock (a native of Britain), which grows in corn-fields and gardens. This plant, from its resemblance to common parsley, has sometimes been mistaken for it; and when eaten, it occasions sickness. If the curled-leaved parsley only was cultivated in our gardens, no such mistakes would happen in future. Cows, horses, sheep, goats, and swine, eat it. It is noxious to geese.

AETIANS, in church-history, a branch of Arians, who maintained that the Son and Holy Ghost are in all things dissimilar to the Father.

ÆTIOLOGY is a figure of speech, whereby, in relating an event, we at the same time unfold the causes of it.

ÆTITÆ, or ÆTITES, a name given to pebbles or stones of any kind, which have a loose nucleus rattling within them, and called in English the eagle-stone. So far from being a particular genus of fossils themselves, we find ætitæ among very different genera, but the most valued is that formed of the several varieties of our common pebbles. As to the formation of ætitæ, the naturalists account for it from this consideration, that as the nuclei are coarser and more debased by earth than

the rest of the pebble, they shrink and contract themselves into a smaller size; by which means they will be separated from the surrounding crust, and become loose.

ÆTNA, a famous volcanic or burning mountain in Sicily. It is one of the highest mountains of the whole island, and situated on the eastern coast, not far from Catania.

The height of this mountain is said to be above ten thousand feet above the surface of the sea, and its circumference at the base one hundred and eighty miles. This may probably be exaggerated; but over the sides there are seventy-seven cities, towns, and villages, and allowing from twelve to fifteen hundred persons to each, the number of inhabitants of mount Ætna will be from 92,400 to 115,500. The ascent of this mountain is tedious, difficult, and dangerous. From Catania to the summit, the distance is about thirty miles, and the traveller must pass through three distinct climates, which may properly be denominated the torrid, the temperate, and the frigid.

ÆTNA-SALT, a name used by some writers for saline substances, found near the openings of mount Ætna, and other volcanos; being a concrete of sulphur and nitre, sublimed together.

ÆTOLARCHA, in Grecian antiquity, the principal magistrate or governor of the Ætolians.

AFFA, a weight used on the gold coast of Guinea, and equal to an ounce.

AFFECTIO *bovina*, a disorder incident to cattle, occasioned by a small worm, which eats its way all over the body.

AFFEERERS, or AFFEERORS, in law, persons appointed in courts-leet, courts-baron, &c. to settle upon oath the fines to be imposed upon those who have been guilty of faults which have no express penalty assigned by statute.

AFFETTUOSO, or *con* AFFETTO, in the Italian music, intimates that the part to which it is added ought to be played in a tender affecting way; and consequently rather slow than fast.

AFFIDATIO DOMINORUM, in old law books, denotes an oath of allegiance, taken by the lords in parliament.

AFFIDAVIT is an oath in writing, taken before some person who is legally authorized to take the same.

In an affidavit, the time, place of habitation, and addition, of the person who makes it, are to be inserted.

Affidavits should set forth the matter of fact to be proved, without taking any notice of the merits of the cause. They are read in court upon motions, but are not admitted in evidence at trials.

By statute, the judges of the courts at Westminster may commission persons in the several counties in England to take affidavits relating to any thing depending in their several courts; but there is an affidavit office in the court of chancery, under the direction of a master.

AFFINITY, *affinitas*, among civilians, denotes the relation of each of the parties married to the kindred of the other. Affinity is distinguished into three kinds: 1. Direct affinity, or that subsisting between the husband and his wife's relations by blood, or between the wife and her husband's relations by blood. 2. Secondary affinity, or that which subsists between the husband and his wife's relations by marriage. 3. Collateral affinity, or that which subsists between the husband and the relations of his wife's relations. The degrees of affinity are always the same with those of consanguinity. Hence, in whatever degree of consanguinity the kindred of one of the parties married are, they are in the same degree of affinity to the other.

By the canon law, direct affinity renders marriage unlawful to the fourth generation, inclusive: but the case is otherwise with respect to the secondary and collateral kinds. It is likewise to be observed, that the affinity contracted by a criminal commerce, is an impediment to marriage so far as the second generation: thus, a man is not allowed to marry the sister of a woman he has lain with. Nay, with regard to contracting marriage, affinity is not dissolved by death; for, though a woman may be admitted a witness for the brother of her deceased husband, she is not allowed to marry him.

In the Romish church, a kind of spiritual affinity is supposed to be contracted by baptism; so that it is not deemed lawful for a godfather to marry his god-daughter without a dispensation.

AFFINITY, *chemical*, denotes an attractive power by which substances of different natures will combine with others. It is sometimes called *elective attraction*, or *elective affinity*. See CHEMISTRY.

AFFIRMATION is used for the ratifying or confirming the sentence or decree of some inferior court: thus, we say, the house of lords affirmed the decree of the lord chancellor, or the decree of the lords of session.

AFFIRMATION also denotes a solemn attestation of the truth of some fact which the quakers are allowed to make instead of an oath. This sect hold all kinds of swearing to be unlawful; and therefore the legislature has appointed the following affirmation to be taken instead thereof, viz. *I A. B. do sincerely, solemnly, and truly declare and affirm*, &c. This affirmation is by statute put upon the same footing with an oath; every person convicted of affirming a falsehood, being liable to the penalties provided against wilful and corrupt perjury. It is also deemed equivalent to an oath, except in criminal cases, upon juries, and in places of profit or trust under the government.

AFFIRMATIVE, in the Roman inquisition, is a designation given to such heretics as openly avow the opinions they are charged with.

AFFIX, among grammarians, denotes much the same with prefix. In the Hebrew language there are a multitude of affixes, i. e. single letters or syllables, which, being prefixed to nouns and verbs, serve instead of pronouns and particles, and contribute greatly to the brevity of that language.

AFFLATUS, among heathen mythologists and poets, denotes the actual inspiration of some divinity. Thus Virgil:

Afflata est numine quando
Jam propriore Dei.

Tully, however, must be understood to extend the meaning of the word farther, when he attributes all great actions to a divine *afflatus*.

AFFRAY, or AFFRAYMENT, in law, formerly signified the crime of affrighting other persons, by appearing in unusual armour, brandishing a weapon, &c. But, at present, affray denotes a skirmish or fighting between two or more; and there must be a stroke given, otherwise it is no affray. It must also be public, for in private it is not an affray but an assault.

An affray is a common injury, punishable by the justices of the peace in their sessions, by fine and imprisonment.

A constable may also seize and carry affrayers before a justice, or confine them till they provide sureties for the peace. Any private person may also part an affray, or bring the parties before a magistrate.

AFFRONTE'E, in heraldry, an appellation given to animals facing one another on an escutcheon, a kind of bearing which is otherwise called *confrontée*, and stands opposed to *adossée*.

AFRICA, one of the quarters of the world. See GEOGRAPHY.

AFRICAN *company*, a society of merchants established by king Charles II. for trading to Africa; which trade is now laid open to all his majesty's subjects, paying ten per cent. for maintaining the forts.

AFRICAN *association*, was formed in 1788 with a view of promoting the discovery of the interior parts of Africa. Mr. Mungo Parke and others are now employed in this important work.

AFT, in the sea language, the same with abaft.

AFTER-*birth*, in midwifery, the membranes which surrounded the infant in the womb, more usually called the secundines. See MIDWIFERY.

AFTER-*math*, in husbandry, signifies the grass which springs or grows up after mowing; or the grass or stubble cut after corn. In some counties it is called rowen.

AFTER-*pains*. See MIDWIFERY.

AGA, in the Turkish language, signifies a great lord or commander. Hence, the aga of the janissaries is the commander in chief of that corps; as the general of the horse is denominated spahiclar aga. The aga of Algiers is president of the divan or council.

AGAPÆ, or AGAPES, love-feasts kept by the antient christians as tokens of brotherly charity and mutual benevolence.

AGAPANTHUS, a genus of the hexandria monogynia class and order. This is the African tuberose hyacinth, or African blue lily, with an umbellated flower. The coralla is one-petalled and funnel-shaped, hexapetaloid, regular, and this forms its essential character.

We have only one species, the flowers of which are absolutely those of the hemerocallis, but this genus is distinguished by its spathe. It is a native of the Cape of Good Hope, was cultivated at Hampton-court in 1692; but now forms a frequent and most beautiful ornament of our green-houses. It flowers in September, and continues a long time in bloom.

AGAPETÆ, an order of nuns among the primitive christians, who attended on and served the clergy. At first there was nothing scandalous in these societies, though they gave great offence afterwards, and were wholly abolished by the council of Lateran, in 1139.

AGAPIS *lapis*, a name given by antient writers to a stone of the colour of the lion's

skin: it was held in great esteem in many nations on account of its supposed virtues.

AGARICUS, the mushroom, a genus of the cryptogamia class and order of fungi. The generic character is a pileus, or cap with gills underneath: gills differing in substance from the rest of the plant, composed of two laminæ: seeds in the gills.

Authors have enumerated no less than 634 species of this fungus, and Dr. Withering gives 213 as British species. The agaricus campestris, or common mushroom, is cultivated with great success and profit in the gardens about London. The spawn is usually found in old hot-beds, or horse-dung, where the animals have been fed on a pasture; in which case it is supposed that the invisible seed which is scattered from the gills of the mushroom, is eaten with the grass by the cattle, and deposited unhurt in their excrements. There it vegetates, and forms those white fibrous radicles producing tubercles like potatoes, and which are called the spawn. The spawn may easily be known by the smell, which resembles that of the true mushroom, and which, if planted in a bed of fresh hot dung, and kept moderately dry, will soon produce a crop. It is the agaricus orcades, another of this genus, which produces the fairy rings so frequently observed in pasture fields. The agaricus cæsareus, the most splendid of all the genus, is eatable, but is rarely found in Britain. It was made the vehicle for conveying poison to Claudius Cæsar by his wife Agrippina.

AGATE, in natural history, a genus of semipellucid gems, variegated with veins and clouds, but no zones, like the onyx.

The Iceland agate is found either in detached masses, or forming a part of rocks. It has the appearance of black glass. It is usually invested with a grey or opaque crust. Its specific gravity is 2,348; colour black, or greyish black; when in very thin pieces it is green. It is composed, according to Bergman, of

69	silica
22	alumine
9	iron
100	

It is found in Iceland, Italy, and other places.

AGATE is also the name of an instrument used by the gold wire-drawers; so called from the agate in the middle of it, which forms its principal part.

AGATHOPHYLLUM, a genus of the class and order dodecandria monogynia. The essential character is, calyx superior, very short, toothless; corolla six-petalled, somewhat villous; stamina alternately inserted into the calyx and petals; drupe juiceless with a half six-celled nut, and one seed.

There is but one species, a large tree, a native of Madagascar, where the nut and leaves are used as spice.

AGAVE, a genus of the hexandria monogynia class and order, called also the American aloe.

The corolla is funnel-shaped, and the essential character is, corolla erect, superior; filaments longer than the corolla, erect. The species are six, including some varieties with striped leaves, of which the most remarkable is agave Americana, or great American aloe. It is a vulgar notion that this plant does not flower in less than a hundred years. The fact is, that its flowering depends upon its growth. In hot climates therefore it is known to bloom much sooner, and in this country if it was kept in a dry stove instead of a green-house, we have no doubt that it would flower earlier than it does. It is chiefly remarkable for the height to which the stem shoots up when it blooms (from twenty to thirty feet), for in our opinion there is no beauty whatever in the flower. Cortusus is said to be the first European who possessed this plant in 1561. It flowered in England about the year 1698, and now scarcely a summer passes without one flowering in some of the nurseries about London. In the course of the year 1805, one of the striped-leaved (said to be the first which ever flowered in England of that variety) was exhibited by Mr. Smith of Dalston.

In Spain and Portugal there are hedges of the great agave. The leaves are said to answer all the purposes of soap, and are also good for scowering pewter and other utensils; the inward spongy substance of the dried stalks may be used for tinder; and the fibres of the leaves, when washed, dried, and beaten, will make a strong thread for common purposes.

AGE is sometimes used in the same sense as generation, for a period of 30 years.

AGE, in chronology, denotes certain periods of the duration of the world. Thus, among Christian chronologers, we meet with the age of the law of nature, which comprehends the whole time between Adam and Moses; the age of the Jewish law, which includes the time from Moses to Christ; and, lastly, the age of grace, or the number of years elapsed since the birth of Christ.

Among antient historians, the duration of the world is also subdivided into certain periods, called ages; of which they reckon three: the first (reaching from the creation to the deluge which happened in Greece, during the reign of Ogyges) is called the obscure or uncertain age; the history of mankind, during that period, being altogether uncertain. The second, called the fabulous or heroic, terminates at the first olympiad; where the third, or historical age, commences. The antient poets also divide the duration of the world into four ages, or periods; the first of which they called the golden age, the second the silver age, the third the brazen age, the fourth the iron age. Not unlike these are the four ages of the world, as computed by the East-Indians, who extend them to a monstrous length.

AGE also denotes certain degrees or periods of human life, commonly reckoned four, viz. infancy, youth, manhood, and old age: the first of which extends to the fourteenth year; the second, to the twenty-fifth year; the third, to the fiftieth year; and the fourth, to the seventy-fifth year, or rather as long as a man lives. Shakspeare divides the term of life into seven ages.

AGE, in law, signifies certain periods of life, when persons of both sexes are enabled to do certain acts, which for want of years and discretion they were incapable of before: thus a man at twelve years of age, ought to take the oath of allegiance to the king; at fourteen, which is his age of discretion, he may marry, choose his guardian, and claim his lands held in socage. Twenty-one is called full age, a man or woman being then capable of acting for themselves, or managing their affairs, making contracts, disposing of their estates, &c.; which before that age they could not do. By the marriage act, no person, man or woman, can marry before 21, without the consent of parents or guardians. A woman is dowable at nine years of age, may marry at twelve, with consent of parents or guardian, and at fourteen choose her guardian. If a man or woman acts in any of the above mentioned capacities, before the time prescribed by law, he or she may retract at that time, otherwise they are supposed to agree to it anew, and it shall be deemed valid. Thus, if a man marries before fourteen, or a woman before twelve, they may either agree to the marriage, or not, at these several ages; and so in other cases. At fourteen, a person may dispose of a personal estate by will, but not of lands.

AGE-*prier*, *ætatem precari*, is when an action being brought against a person under age, for lands descended to him, he, by motion or petition, shows the matter to the court, praying the action may be staid to his full age: to which the court generally agrees. As a purchaser, however, a minor shall not have his age-prier; nor in any writ of assize, of dower, or petition; but he may in any action of debt. By the civil law the case is otherwise, an infant or minor being obliged to answer by his tutor or curator.

Among the Romans it was unlawful to offer for any public office, or magistracy, unless the candidate had attained to a certain age; which differed according to the offices sued for. Hence the phrases consular age, prætorian age, &c.

AGE *of the moon*, the time elapsed since her last conjunction with the sun. See ASTRONOMY.

AGEMA, in Macedonian antiquity, was a body of soldiery, not unlike the Roman legion.

AGEMOGLANS, AGIAMOGLANS, or AZAMOGLANS, in the Turkish customs, Christian children raised every third year, by way of tribute, from the Christians tolerated in the Turkish empire. The collectors of this odious tax used to take one child out of three, selecting always the handsomest.

AGENTS, among physicians and chemists, an appellation given to all kinds of menstruums.

AGENTS *of bank and exchange*, in the commercial polity of France, are much the same with our exchange-brokers.

AGENT *and patient*, in law, is said of a person who is the doer of a thing, and also the party to whom it is done. Thus, if a man who is indebted to another, makes his creditor his executor, and dies, the executor may retain so much of the goods of the deceased, as will satisfy his debt; by which means he becomes agent and patient; that is, the person to whom the debt is due, and the person who pays it.

AGENTES *in rebus*, in antiquity, signifies officers employed under the emperors of Constantinople, and differing only in name from the *frumentarii*, whom they succeeded

AGER, in Roman antiquity, a certain portion of land allowed to each citizen. It is also used, in middle-age writers, for an acre of land.

AGERATUM, a genus of the class and order syngenesia polygamia æqualis. The corolla is compound uniform; and the essential character is, receptacle naked; down five-

awned; calyx oblong, subequal: corolets quadrifid.

There are two species, natives of South America and China. They are of the description of tender annuals.

AGERATUS *lapis*, a stone used by the antients in dying and dressing of leather: possibly a species of pyrites.

AGGER, in the antient military art, a bank or rampart, composed of various materials, as earth, boughs of trees, &c. The agger of the antients was of the same nature with what the moderns call lines.

AGGER was also used in several other senses: as for a wall or bulwark, to keep off the sea: for the middle part of a military road, usually raised into a ridge; and sometimes for the heaps of earth raised over graves, more commonly called *tumuli*.

AGGLUTINANTS, a class of strengthening medicines, of a glutinous or viscous nature; which, by readily adhering to the solids, contribute greatly to repair their loss. They may be divided into two kinds: 1. Good nourishing food, especially jellies, whether of hartshorn, veal, mutton, &c. 2. Medicines, properly so called.

AGGLUTINATION, among physicians, signifies either the adherence of new substance, or the giving a glutinous consistence to the animal fluids, by which they were supposed to become more fit for nourishing the body.

AGGLUTINATION is also a term used by astronomers to denote the meeting of two or more stars in the same part of the zodiac, or the seeming coalition of several stars. It is more peculiarly understood of the seeming coalition of several stars, so as to form a nebulous star.

AGGRAVATION in the Romish canon law is used for an ecclesiastical censure, threatening excommunication, after three admonitions used in vain. From aggravation, they proceed to re-aggravation, which is the last *excommunication*.

AGGREGATÆ *terræ*, the seventh order of earths, comprehending those that are formed of the aggregate earths of the preceding orders. To this order belong the granites, gneissum, porphyrias, amygdalites, breccia, and arenarius.

AGGREGATE, a term used in botany to express those flowers which are composed of parts or florets, so united or incorporated by means either of the receptacle or calyx, that no one of them can be taken away without destroying the form of the whole.

AGGREGATION, in natural philosophy, denotes a species of union, by which several things, nowise connected by nature, are collected together, so as to form one whole.

AGIADES, in the Turkish armies, a kind of pioneers, employed in fortifying camps, &c.

AGILD, or AGILDE, in old law books, denotes a person of so little account, that whoever killed him was liable to no fine for so doing.

AGIO, in commerce, a term chiefly used in Holland and at Venice, where it denotes the difference between the value of bank stock, and the current coin.

Money in bank is commonly worth more than specie: thus, at Amsterdam, they formerly, before the barbarous French invasion, gave 103 or 104 florins for every 100 florins in bank. At Venice, the agio was fixed at 20 per cent.

The agio of the bank at Hamburgh is about 14 per cent., which is the supposed difference between the good standard money of the state, and the clipt, worn, and diminished currency poured into it from neighbouring states.

AGIO is also sometimes used for the profit arising from the discount of a note, bill, &c.

AGIO *of assurance*, the same with what we call policy of assurance.

AGIOSYMANDRUM, in the Greek church, subject to the Turks, a wooden machine, used instead of bells, the use of these being prohibited.

AGISTMENT, AGISTAGE, or AGISTATION, in law, the taking in other people's cattle to graze, at so much per week.

The term is peculiarly used for the taking in of cattle to be fed in the king's forests, as well as for the profits thence arising.

AGISTMENT is also used for a tax, burden, or charge, levied for repairing the sea-banks in different parts of England.

AGISTMENT *tithe*, is a small tithe paid to the rector or vicar for pasturage of cattle, horses, or sheep. It is, however, understood to be payable only for dry or barren cattle, and not for cattle that are nourished for the plough or pail, because the parson has tithe for them in other kind. It is paid by the occupier of the ground, and not by the person who may happen to put his cattle there to graze at a certain hire per head. It is commonly estimated at 2s. in the pound, according to the value of the land. See Burn's Eccl. Law, tit. *Tithes*.

AGISTOR, or AGISTATOR, an officer belonging to forests, who had the care of the cattle taken in to be grazed, and levied the moneys due on that account.

AGMEN, in the Roman art of war, denoted an army, or rather a part of it, in march: thus we read of the *primum agmen*, or vanguard; *medium agmen*, or main body; and the *postremum agmen*, or rear-guard. We also meet with the *agmen pilatum*, which was a part of the army, drawn up in form of an oblong parallelogram, and answering to what the moderns call column. The *agmen quadratum*, however, or square form, was that mostly practised in the Roman armies.

AGNOETÆ, a sect of heretics, so called on account of their maintaining that Christ was ignorant of many things, and particularly of the day of judgment: an opinion which they built upon the text, Mark xiii. 32.

AGNOMEN, in Roman antiquity, a kind of fourth or honorary name given to a person on account of some extraordinary action, virtue, or other accomplishment. Thus the agnomen Africanus was bestowed upon Publius Cornelius Scipio, on account of his great achievements in Africa. In cases of adoption, it was usual to retain their former cognomen, or family name, by way of agnomen: thus Marcus Junius Brutus, being adopted by Quintus Servilius Cæpio, called himself Quintus Servilius Cæpio Brutus.

AGNUS *dei*, in the church of Rome, a cake of wax, stamped with the figure of a lamb supporting a cross. These being consecrated by the pope with great solemnity, and distributed among the people, are supposed to have great efficacy: as to preserve those who carry them worthily, and with faith, from all manner of accidents; to expel evil spirits, &c. It is also a popular name for that part of the mass, where the priest strikes his breast thrice, and says the prayer beginning with the words *agnus dei*.

AGONALIA, festivals celebrated in honour of Janus, or of the god Agonius, whom the Romans invoked before undertaking any affair of importance. They seem to have been kept three times in the year, viz. on the 5th of the ides of January, on the 12th of the calends of June, and on the 3d of the ides of December.

AGONISTICI, a name given by Donatus to such of his disciples as he sent to fairs, markets, and other public places, to preach and propagate his doctrine.

AGONIUM, in Roman antiquity, was used for the day on which the *rex sacrorum* sacrificed a victim, as well as for the place where the games were celebrated, otherwise called agon.

AGONOTHETA, or AGONOTHETES, in Grecian antiquity, was the president or superintendant of the sacred games; who not only defrayed the expences attending them, but inspected the manners and discipline of the athletæ, and adjudged the prizes to the victors. At first there was only one agonotheta in the Olympic games; but several colleagues were afterwards joined with him, three of whom had the direction of the horse races, three others of the pentathlon, and the rest of the other exercises.

AGONYCLITÆ, or AGONYCLITES, a sect of christians, in the seventh century, who prayed always standing, as thinking it unlawful to kneel.

AGORANOMUS, a magistrate of Athens who had the regulation of weights and measures, of the prices of provisions, &c. The agoranomus answered in part to the ædile of the Romans.

AGOSTUS signifies the part of the arm from the fingers to the elbow: also the palm or hollow of the hand.

AGRARIAN *stations*, *agrariæ stationes*, in the Roman art of war, were a kind of advanced guards, posted in the fields.

AGRARIAN *laws*, among the same people, were those relating to the division and distribution of lands; of which there were a great number: but that called the *agrarian law* by way of eminence, was published by Spurius Cassius, about the year of Rome 268, for dividing the conquered lands equally among all the citizens, and limiting the number of acres which each citizen might enjoy.

AGREEMENT, in law, signifies the consent of persons to any thing done, or to be done.

There are three kinds of agreement. First, an agreement already executed at the beginning; as when money is paid, or other satisfaction made for the thing agreed to. Secondly, an agreement after an act done by another, to which a person agrees: this is also executed. Thirdly, an agreement executory, or to be executed in time to come.

An agreement is generally made preparatory to some more formal instrument of conveyance. On breach of an agreement there is a remedy either at common law, or in a court of equity. But when the matter is merely in damages, there the remedy is at law; because the damages cannot be ascertained by the conscience of the chancellor, but by the verdict of a jury. All agreements

to be valid ought to be on a stamp, or at least duly stamped at the stamp-office within the time limited by law, viz. *twenty-one* days after the date of the agreement.

AGRICULTURE. See GARDENING and HUSBANDRY.

AGRIMONIA, a genus of the dodecandria digynia class and order of plants, with rosaceous flowers, the cup of which at length becomes an oblong echinated fruit, containing one or two oblong seeds. The essential character is, calyx five-cleft, fenced with one another; petals five; seeds two, at the bottom of the calyx.

There are five species; two, the A. rupatoria, or common A., and the A. odorata, natives of Great Britain. The leaves of the common agrimony make a very pleasant tea, said to be good in the jaundice, in cachectic cases, and in obstructions of the liver and spleen. The country people also formerly used it, by way of cataplasm, in contusions and fresh wounds.

AGRIPPA, a denomination given by antient as well as modern physicians, to children born with the feet foremost. See MIDWIFERY.

AGROSTEMA, a genus of decandrious plants, according to Linnæus; but comprehended among the lychnises by Tournefort.

The class and order is decandria pentagynia. The corolla is wheel-shaped; and the essential character is, calyx one-leaved, coriaceous; petals five, clawed; border obtuse, undivided; capsule one-celled.

There are four species, all well known as highly ornamental to our fields and gardens. The A. githago, or corn cockle, though a troublesome weed to the farmer, is beautiful to the eye. It is an annual plant, and flowers in June and July. The agrostema coronaria, or rose-campion, has long been an inhabitant of our gardens, and the double variety is particularly handsome. It is biennial, and sometimes perennial, though apt, in the gardener's phrase, to *fog* off after it has flowered. The A. flos Jovis is more rare, but is an elegant perennial. The A. cœli rosa is an annual, very delicate and beautiful.

AGROSTIS, a genus of triandrious plants, called in English bent grass. It is of the class and order triandria digynia. The essential character is, calyx bivalve, one-flowered, a little less than the corolla; stigmas longitudinally shaped.

There are not less than 35 species of this grass; most of them are foreign, and some only annual. About eight species are enumerated as natives of Britain.

AGROSTOGRAPHIA signifies the history or description of grasses. Such is that of Scheuchzer, containing an accurate description of several hundred species of grass.

A-GROUND, expresses the situation of a ship, the bottom of which rests on the ground.

AGRYPNIA, denotes much the same with watchfulness, or an inaptitude to sleep; which is a very troublesome symptom of feverish, and other disorders.

AGRYPNIA, in the Greek church, the vigil of any of the greater festivals.

AGUE, a general name for all intermittent fevers, which, according to the different times of the return of the feverish paroxysm, or fit, are denominated quotidian, tertian, or quartan agues. See MEDICINE.

AGURAH, in Jewish antiquity, the name of a silver coin, otherwise called gerah and keshitah.

AGUSADURA, AGUSAGE, in our old customs, a certain fee paid by vassals to their lord, for the sharpening of their plough-tackle.

AGYNEIA, a genus of the monœcia monadelphia class and order. The essential character is, calyx six-leaved; corolla none. In the male flowers the anthers are three, growing to the rudiments of the style. In the female the germ is perforated at top, without style or stigma.

The genus comprehends two shrubs, natives of China, but of little note.

AGYNIANI, a sect of heretics who condemned all carnal commerce with women.

A-HEAD, refers to any object that lies immediately before a ship, or towards that point of the compass to which her prow is directed, used in opposition to *a-stern*.

A-HULL, denotes the situation of a ship, when all her sails are furled, on account of the violence of a storm, and when, having lashed her helm to the lee side, she lies nearly with her side to the wind and sea, her head being somewhat inclined to the direction of the wind.

AID, in law, denotes a petition made in court to call in help from another person, who has interest in land, or other thing contested. This is called *aid prier*, which not only strengthens the party that prays for the aid, but gives the other person an opportunity of avoiding the prejudice that might otherwise accrue to his own right. Thus, a tenant for life may pray aid of the person in reversion; and a city or borough that holds a fee-farm of the king, if any thing is demanded of them, may pray for aid of the king.

AID, *auxilium*, in antient customs, a subsidy paid by vassals to their lord on certain occasions.

Such were the aid of relief, paid upon the death of the lord mesne, to his heir; the *aid cheval*, or capital aid, due to the chief lord on several occasions; as to make his eldest son a knight, to make up a portion for marrying his daughter, and so in other cases.

AIGHENDALE, the name of a liquid measure used in Lancashire, containing seven quarts.

AIGUILLE, an instrument used by engineers to pierce a rock for the lodgment of powder; as in a mine, or to mine a rock, so as to excavate and make roads.

AIGUISCE', AIGUISSE', or EGUISCE', in heraldry, denotes a cross with its four ends sharpened, but so as to terminate in obtuse angles. It differs from the cross fitchee, inasmuch as the latter goes tapering by degrees to a point, and the former only at the ends.

AILANTHUS denotes, in Amboina, the tree of heaven, so called on account of its lofty growth; a genus of tree, the class and order of which are not ascertained: some accounting it polygamia monœcia, and some dioeceia decandria. It has male, female, and hermaphrodite flowers. It is a native of China, but grows very fast in our climate, and is recommended for ornamental plantations. If the bark is wounded, a resinous juice flows out, which hardens in a few days. The wood is hard, heavy, glossy, resembling satin. We know of only one species.

AILE, or AIEL, in law, a writ which lies where a person's grand-father, or great-grand-father, being seized of lands, &c. in fee-simple the day that he died, the stranger abates or enters the same day, and dispossesses the heir of his inheritance.

AIM FRONTLET, a piece of wood, hollowed out to fit the muzzle of a gun, to make it of an equal height with the breech, formerly made use of by the gunners to level and direct their pieces.

AIR. The most important discoveries of modern philosophy are those which relate to the composition of fluids, and of the elastic or *aerial* fluids in particular. The restricted form of a dictionary, which is confined to the alphabetical arrangement, renders the developement of science, so as to meet and satisfy the ideas of the young student, in some measure difficult. We shall depart from it in this instance, in order to render clear, if possible, the present most important article, which may serve in some measure as a key to the most valuable discoveries of modern science.

The air, even of the atmosphere, was formerly accounted an elementary principle. It never entered into the minds of philosophers that it was of a compound nature. It is indeed somewhat extraordinary that they never were led to investigate the causes of *fluidity* itself, or to enquire what were the circumstances which constituted a fluid substance.

Previous to the grand discovery of Dr. Black, Boerhaave, Hales, and some other philosophers, had suspected that the presence of heat, or the elementary matter of fire, was the efficient cause of fluidity. The melting of tallow, wax, and metals, by the application of heat, and the condensation of water into ice, by the withdrawing of it, had led them insensibly to this conclusion; which was confirmed on finding that mercury, which has so strong an attraction or affinity for the matter of heat or fire, that it remains fluid in the usual temperature of our atmosphere, became a solid metallic mass, ductile, and possessing all the qualities of a metal, in a certain degree of cold, beyond what is common in these climates.

The indefatigable Dr. Black, on investigating fully the nature of heat, or elementary fire, found that the first effect of its admission in a larger quantity than usual to solid bodies was to *expand* them; that the next effect was to reduce them to a *fluid* state; and that the last effect was to present them in the state of an *elastic* or aerial fluid. Thus, water, in what may be called its natural state, is *ice*; by the application of a higher degree of heat (above 32 degrees of our thermometer) it becomes fluid; and by increasing the heat to above 212 degrees, it is converted into vapour, which is an *elastic*, or compressible fluid. Hence it was concluded, that *heat*, elementary fire, or, as it is called in modern chemistry, *caloric*, is the only permanent fluid in nature, and the cause of all fluidity in all other substances whatever. It was found also, that certain substances had a stronger attraction for caloric than others; hence it was accounted for why certain matters continued in a fluid state, and some even in that of elastic fluids, in the ordinary state of our atmosphere. See CALORIC and FLUIDITY.

Some of these aeriform fluids are found to retain their elasticity only in a very high temperature. Such is the vapour from common water; such as forms smoke, clouds, &c.; and

such are the vapours which arise in distillation, and which are condensed as soon as the superfluous caloric, or heat, is withdrawn (See DISTILLATION), while others retain their aerial form in all the varieties of our atmosphere. Hence arose a distinction between *elastic fluids* and *permanently elastic fluids*. These latter, for a reason that will be presently assigned, were called *gases*. Some of these will be found to be *simple*, that is, when caloric is united with some simple elementary substance; others will be found of a compound nature, when two elementary substances are held suspended in a mixed state by the matter of caloric; and such is our common atmospheric air, which consists of two elementary substances; *oxygen* in the proportion of about one-fourth, and *azote* about three-fourths, suspended in a mass of *caloric*. See OXYGEN, AZOTE, &c.

Hence it is evident that the aeriform fluids differ from each other, according to the nature of the elementary principles which form their respective bases. This was, however, a matter which did not strike the early chemists. Though they perceived that those fluids which were occasionally raised in their processes, were permanently elastic, and different in their nature from common air, they did not enquire into their different properties, contenting themselves with giving them a name which meant nothing, denominating them, in general, *spiritus sylvestris*.

Van Helmont distinguished them by the name of *gas*, which he defined to be a spirit, or incoercible vapour, as the word *gas*, or rather *ghoast*, in the Dutch language, signifies. He supposes the *gas* to have been retained by the substances from which it is extracted, in a fixed or concrete form. He asserts, that sixty-two pounds of charcoal contain sixty-one of gas, and only one of earth, and attributes the fatal effects which workmen experience occasionally in mines to the emancipation of this spirit. On the same principle he accounts for the eructations from the stomach and bowels, and for the floating of drowned bodies; and he concludes by determining, that this gas is a fluid of a nature quite different from that of our common air.

The existence of two different kinds of vapour or elastic fluids, had been previously observed in mines and coal-works: the one was observed to affect animals with a sense of suffocation, and to extinguish life, and it therefore obtained the name of the *choak-damp*; the other, from the dangerous property of catching fire when a candle or any ignited body was brought in contact with it, was termed the *fire-damp*.

A specimen of the fire-damp, or inflammable air, was collected from a coal-mine of sir James Lowther, in Cumberland, and brought up in bladders to be exhibited to the Royal Society at London, in the year 1733; and in the year 1736 Mr. John Maud procured, from the solution of iron in oil of vitriol, a quantity of the very same species of inflammable air, and demonstrated that the same might be procured from most of the metals in certain circumstances.

The experiments of Van Helmont were greatly improved upon by the sagacious Boyle. He changed the name of gas to that of *artificial air*; he demonstrated, that this *artificial air* was not always the same; for instance, that the air produced by fermentation is essentially different from that which is formed from the explosion of gunpowder. He was the first who perceived that the volume of air was diminished by the combustion of certain substances.

This last observation of Mr. Boyle seems particularly to have attracted the attention of Dr. Hales, and he invented instruments for determining the quantities both of the air, which was on some occasion produced, and on other occasions absorbed, by different substances. These experiments deserve the attention of every philosopher, and for accuracy or ingenuity have never been exceeded.

Among other circumstances, which were particularly remarked by Dr. Hales, was the great quantity of air contained in the acidulated mineral waters, and to this air he suspected they were indebted for their sparkling and brightness, and some other of their peculiar qualities. In observing the absorption of air by bodies in combustion, he saw that this absorption had its limits: he remarked also, in some cases, the alternate production and absorption of air, as for instance in respect to the air which he produced from the burning of nitre, which air, he observed, was very soon diminished in bulk, though he did not perceive that the absorption was owing to the water, which he always used in his experiments. The production of an air capable of inflammation from the distillation of certain substances did not escape his observation; and he has advanced, that the augmentation of weight in the metallic calces was in some degree owing to the air which they imbibed. That the phosphorus of Homberg diminishes the air in which it is burned; that nitre cannot explode in vacuo; and that air is in general necessary to the crystallization of salts; are among the facts, which are noticed by this philosopher.

From the uncertainty, however, of Dr. Hales and his predecessors, with regard to several material circumstances, of which they appear to have had some casual glimpses, and from their total ignorance of others, the doctrine of the aerial fluids was but in a state of infancy, till the decisive experiments of Dr. Black, Mr. Cavendish, and Dr. Priestley, furnished us with a new system in this important department of natural history.

The first of these philosophers observed, that lime and magnesia, in their mild state, consist of an union of a certain aerial fluid with the earthy base; that this aerial matter is actually extracted by the operation of burning, which reduces ordinary calcareous earth to the state of quick-lime; and that it is afterwards re-absorbed by the quick-lime when exposed to the air. On this principle he was able, not only to account for the loss of weight by the burning of lime-stone, but to estimate to the greatest nicety the additional weight which it could acquire from the atmosphere. He extracted the gas, to which he gave the name of fixed or fixable air, also by another process, namely, by dissolving the calcareous earth in acids; he found that the causticity of lime depended upon its violently attracting from vegetable and animal matter a portion of that air of which it had been deprived, and that upon this principle he was enabled to render caustic the alkaline salts.

To Mr. Cavendish the second place in the order of this history belongs. He pursued the experiments of Dr. Black, and ascertained the quantity of fixed air which could be retained by the fixed and volatile alkalies. He accounted for the nature of acidulated waters by the fixable air which they contained. He procured a species of inflammable air from solutions of iron and zinc in vitriolic acid; and he was the first who remarked, that a solution of copper in spirit of salt, instead of yielding inflammable air, like that of iron, or zinc, afforded a particular species of air, which lost its elasticity by coming in contact with water.

Dr. Priestley commenced his philosophical career by some experiments upon fixable air: and the first of his communications to the public related to the impregnating of water with this air, by means of chalk and oil of vitriol, a method first hinted by Dr. Brownrigg of Whitehaven, and now commonly practised in the imitations of the acidulated mineral waters. The doctor tried the power of fixable air upon animal and vegetable life, and found it fatal to both.

The indefatigable mind of Dr. Priestley was not, however, to be satisfied with the investigation of a single object. He next turned his attention to the nature of atmospheric air. He observed, after Dr. Hales, its diminution by different processes, as by combustion, &c. but differs as to the cause. Dr. Hales supposed the specific gravity of the air to be increased; but Dr. Priestley judged, that the denser part of the air is precipitated, and that the remainder is actually made lighter. The discovery that the atmospheric air is purified by vegetation is also Dr. Priestley's.

On pursuing the experiments of Mr. Cavendish on inflammable air, the doctor found that it was not only producible from iron and zinc, but from every inflammable substance whatever.

Dr. Priestley discovered the cause that air, which has been respired, is fatal to animal life, to be, that it becomes impregnated with something stimulating to the lungs, for they are affected in the same manner as when exposed to any other kind of noxious air.

But his most important discovery was, that the nitrous air which he procured from the solution of metals in the nitrous acid, had the property of destroying the purest part of the common air. On pursuing his experiments Dr. Priestley found, on extracting airs from different substances, that the air produced from calcined mercury was of a purer nature, and more favourable to animal life and combustion, than common atmospheric air: it was, in truth, the same with the pure part of the air which was destroyed by the nitrous gas, as well as by breathing and combustion. He therefore denominated it PURE or VITAL AIR, and this was afterwards found to be what is now called OXYGEN AIR or GAS, the basis of which is oxygen, already noticed under the article ACID.

Dr. Priestley continued his experiments on inflammable air, and found that all the metals which yield it when dissolved in acids, yielded it by means of heat alone; his mode of extracting it was by subjecting the filings of the different metals in vacuo to the action of a burning-glass.

The next remarkable, and perhaps the most important discovery, was that of Mr. Cavendish, which has explained to us the nature and composition of water. Mr. Cavendish was led to this great discovery by an experiment of Mr. Warltire, related by Dr.

Priestley, in which it was found, that on inflaming a mixture of common and inflammable air by the electric spark, a loss of weight always ensued, and that the inside of the vessel in which it was fired became always moist or dewy, though ever so carefully dried before. On repeating the experiment, Mr. Cavendish did not perceive the diminution of weight which Mr Warltire supposed to take place, but the latter effect was completely exemplified. In prosecuting the experiment, it appeared that it was only the pure or empyreal part, that is, about one-fourth, of the common air which was consumed, and the water produced was perfectly tasteless and pure; on mixing vital with inflammable air in a due proportion, and passing through them an electric spark, the whole portion lost its elasticity, and was condensed into water.

Mr. Cavendish pursued his experiments with remarkable success, to ascertain the constituent principles of what was then called phlogisticated air, or that which constitutes the impure and unrespirable portion of the atmospheric air; and by passing the electric spark through common air, and through a certain mixture of vital and phlogisticated airs, he was able totally to condense the latter, and to ascertain its constituent principle to be the same with that of nitrous acid, with (as he then thought) a small portion of inflammable matter. In this latter opinion, however, he has since been corrected by Lavoisier, and other modern chemists, who have proved that azotic, or phlogisticated air (as it is called by the English chemists) is no other than the basis of the nitrous acid.

In Mr. Cavendish's experiment, as he probably used air which had been rendered impure by combustion, some small portion of charcoal, or other inflammable matter, might be contained in the air.

Some gases exist in nature without the aid of art, and may be collected; others are only producible by artificial means. The principal airs, or gases, noticed in modern philosophy are,

- Oxygen gas or air.
- Nitrogen gas or air.
- Hydrogen gas or air.
- Ammoniacal gas or air.
- Carbonic acid gas.
- Carbonated hydrogen gas.
- Sulphurated hydrogen gas.
- Phosporated hydrogen gas.
- Nitrous gas or air.
- Sulphureous acid gas.
- Gaseous oxyd of azote.
- Muriatic acid gas.
- Oxygenated muriatic acid gas.
- Fluoric acid gas.

Air *vital*, or *Oxygen gas*, formerly termed also dephlogisticated and empyreal air: is a substance destitute both of taste and smell, but possessing in an eminent degree the power of increasing and supporting animal life and combustion. It is heavier at the same time than atmospheric air, in the proportion of 103 to 100, and the latter maintains life only in consequence of the quantity of this fluid it contains. This proportion is rated at 27 in 100.

This air changes the colour of animal and vegetable substances. It is a composition of oxygen and caloric. Combustion by it is rendered amazingly intense; and its powers, when urged by the blowpipe, far exceed the powers of any burning lens.

A lighted wax taper, fixed to an iron wire, and let down into a vessel of this gas, burns with an inconceivable brilliancy. If the taper is blown out, and let down into a vessel of the gas, while the snuff remains red-hot, it instantly re-kindles. A red-hot piece of charcoal immersed in this gas, throws out beautiful sparks. In this gas thin iron wire will burn with beautiful effect. During every combustion in oxygen gas, the gas suffers a material diminution; and all bodies by combustion in it acquire an addition to their weight.

Oxygen, or the basis of oxygen gas, is naturally or artificially combined with a great variety of substances. From some of these it may be detached by the simple application of heat, since it has a remarkable attraction for caloric, or the matter of fire, with which, when it unites, it becomes expanded, and assumes the form of gas or air.

The substances from which it may be most easily extracted, by means of heat, are red lead, calcined mercury, nitre, and manganese. Dr. Priestley exposed a quantity of red lead in the focus of a burning glass twelve inches in diameter. A quantity of fixed air, or carbonic acid gas, as it is now called, was always produced at first; but after that was separated, the remainder was found to support flame, and to sustain animal life, much more vigorously than common air, and to have all the characters of dephlogisticated air, or oxygen gas.

By various succeeding experiments of Dr. Priestley and others, it however appears, that dephlogisticated or oxygen air, may be obtained not only by means of heat, but also by the action of the vitriolic and nitrous acids upon a number of mineral and metallic substances.

This kind of air may also be obtained by the same process, from the native oxid, or calx of manganese, or from minium or red lead, which, it is well known, is an oxid of lead, or lead united with oxygen.

The better to understand these effects, it must be observed, that this fluid is not found in these substances in an entire state; they only contain the basis of it, which is the oxygen; for metals neither calcine nor burn, but in consequence of their combination with oxygen, which by that means becomes solid, and joins its weight with theirs. This oxygen is then expelled by the application of heat or caloric, which, combining with it, causes it to pass into the state of an elastic fluid; during this process, the metal, losing the oxygen which had reduced it to the state of an oxid or calx, assumes its metallic properties, and loses the weight which it had acquired in becoming oxidated.

There is, however, a method by which oxygen gas may be obtained with less heat and greater facility, and it is as follows: put some red lead into a bottle, together with some good strong oil of vitriol, but without any water. Let the red lead fill about a quarter of the bottle, and the vitriolic acid be about the same quantity, or very little less; then apply a bent tube to the bottle, by inserting it through a cork, and having inverted another bottle filled with water in a bason about half-filled also with water, direct the other end of the crooked tube into the bottle inverted in the water. In this stage of the process we must observe, that without heat this mixture of red lead and vitriolic acid will not afford any oxygen air, or a very inconsiderable quantity; it is necessary, therefore, to apply the flame of a candle or wax taper to the bottle containing the ingredients, while the crooked tube opens a communication between this bottle and that inverted in the water. In this manner the red lead will yield a quantity of elastic fluid, which will pass through the crooked tube into the inverted bottle, and as the quantity of oxygen air increases in the inverted bottle, the water in it will be seen to subside; this air will not be all pure, because a considerable quantity of fixed air enters with it. In order to separate the fixed from the pure air, the inverted bottle, when filled with the compound of both, must be agitated in a bason of lime-water, by which means the lime-water will absorb the whole quantity of fixed air, and leave the dephlogisticated air or oxygen gas by itself.

Oxygen gas may also be obtained in considerable quantities from the decomposition of water, especially from pump water, which, when exposed to the sun, emits air slowly; but after it has remained so for a considerable time, a green matter adheres to the bottom and sides of the glass vessel in which it remained; afterwards it emits pure oxygen air in great quantities, and continues to do so for a long time after the green matter has exhibited symptoms of decay by turning yellow.

Dr. Ingenhousz rightly supposed this green matter to belong to the vegetable kingdom, and procured pure air by putting the leaves of plants into water, and exposing them to the sun. He observes that of land vegetables the fittest for this purpose are the poisonous plants, such as hyoscyamus, lauro-cerasus, nightshade, &c. But he extracted the purest air from some aquatic vegetables, and from turpentine trees, but especially from the green matter he collected from a stone trough, which had been kept filled with water from a spring near the high road.

While Dr. Priestley was engaged in a series of experiments to enable him to purify contaminated air, he discovered that vegetables answered this purpose most effectually. The experiment by which he illustrates his assertion was this: having rendered a quantity of air very noxious, by mice breathing and dying in it, he divided it into two receivers inverted in water, introducing a sprig of mint into one of them, and keeping the other receiver with the contaminated air in it alone. He found, about eight or nine days after, the air of the receiver, into which he had introduced the sprig of mint, had become respirable; for a mouse lived very well in this, but died immediately upon being introduced into the other receiver, containing the contaminated air alone.

It has since been observed, that several animal substances, as well as vegetables, have a power of separating dephlogisticated air, or oxygen gas, from water when exposed to the action of the sun for a considerable time.

The ingenious count Rumford observed, that raw silk has a remarkable power of producing pure air. He found, that by introducing thirty grains of this substance, first washed in water, into a thin glass globe four inches and a half in diameter, having a cylindrical neck three-fourths of an inch wide and twelve inches long, inverting the globe into a jar filled with the same kind of water, and exposing it to the action of the sun in the window, in less

than ten minutes the silk became covered with an infinite number of air bubbles, gradually increasing in size, till at the end of two hours the silk was buoyed up, by their means, to the top of the water. They separated themselves by degrees, and formed a collection of air in the upper part of the globe, which, when examined by the established test, appeared to be very pure. In three days he collected three and three-fourths of a cubic inch of pure air, into which a wax taper being introduced, that had just before been blown out, the wick only remaining red, it instantly took fire, and burned with a bright and enlarged flame. The water in the globe had acquired the smell of raw silk, it lost something of its transparency, and assumed a faint greenish cast.

It has been observed, that when this experiment was made in the dark, only a few inconsiderable bubbles were formed, which remained attached to the silk; nor was it otherwise when the glass globe was removed into a German stove. In the latter case, indeed, some single bubbles had detached themselves from the silk, and ascended to the top, but the air was in too small a quantity to be either measured or proved.

In these experiments, the oxygen or pure air was extracted by an actual decomposition of a part of the water, by means of a capillary attraction, aided by the solar influence; and in effect the same philosopher was enabled to extract it, though in a smaller quantity, by means of a number of very minute glass tubes immersed in water, and exposed to the sun.

The reason that pure air is the most essential of all the fluids to the support of life is, probably, because a great quantity of heat is necessary for this purpose, and because this fluid contains it in great quantity, and parts with it very freely when it meets with any substance with which it has an affinity. But as its basis (oxygen) combines itself very easily with the basis of coal which is found in the blood and lungs, and during this combination, loses part of its caloric, or heat, which goes to the support of life, the remainder of the caloric and oxygen, combined with the coal, form the acid carbonic gas or fixable air, which is always found to exist in a larger quantity in air which has been respired, than in atmospherical air which has not been subservient to that function. Of this a very easy experiment affords sufficient proof; it is founded on the property which the carbonic gas has of rendering lime-water turbid. A crooked tube open at both ends is partly filled with lime-water; a person applies his mouth to one end of the tube, and inspires, by drawing the air through the lime-water contained in it. By this the transparency of the lime-water is not affected; but it becomes turbid as soon as the person expires, which is owing to the carbonic acid formed in the lungs. It is therefore the great attraction which exists between the matter of coal and the basis of pure air which renders this fluid so proper for breathing. The pure air which we breathe performs two functions equally necessary to our preservation; it carries off from the blood that matter of coal, the superabundance of which would be pernicious, and the heat which this combination deposits in the lungs repairs the continual loss of heat which we experience from surrounding bodies. According to Dr. Priestley, and others, the basis of oxygen gas is also absorbed by the blood.

Since, therefore, a great quantity of heat is disengaged from pure air in respiration, it follows, that this fluid must be very pernicious to animals who breathe this air alone for a considerable time; which is consonant with the observations of physicians, who have attempted to cure phthisis by the respiration of vital air.

The basis of this empyreal or pure air, or oxygen gas, as the French chemists term it, is one of the constituent parts of water. It has been mentioned, that it is also the matter which gives the acid character to the acids; sulphur, for instance, is a very innoxious, insipid body, till by burning, that is by absorbing oxygen, it becomes vitriolic acid. Whether the basis of this empyreal air is a simple or compound substance, we are unable to determine; in the present state, however, of philosophical knowledge, we are justified in considering it as a simple elementary body, for it has never yet been decomposed.

AIR *Azotic*, or *Nitrogen gas*, named also mephitis, is a substance unlike the former, being incapable of supporting animal life. It extinguishes flame, and is only characterised by possessing none of the distinguishing qualities of the other known airs. It is lighter than common air, in the proportion of 985 to 1000. It may be considered indeed as the residue of common air, when vitiated by combustion. It is easily disengaged from animal matters, by a slight increase of temperature; but different parts of animals afford different proportions of it, and the concrescible fibrous matter the most. The portion of it they in general afford is proportioned to their quantity of volatile alkali.

Azotic or nitrogen gas may be procured by mixing equal weights of iron filings and sulphur into a paste with water, and placing the mixture in a proper vessel over water. Then invert over it a jar full of common air, and allow it to stand exposed to the mixture a day or two. The air contained in the jar will gradually diminish, as will appear from the ascent of the water within the jar, till at last only about three-fourths of its original bulk remain.

This gas is not absorbed by water: it immediately extinguishes a lighted candle, and other burning substances: it is fatal to animals confined in it: plants, however, live and flourish in it: by it delicate blue colours are slightly reddened; and when mixed with oxygen gas, in the proportion of three or four parts of azotic gas to one of oxygen, it composes a mixture resembling atmospheric air. Its basis is azote, an elementary substance, which is also the basis of nitrous acid or aquafortis. Its combination with oxygen gives it the acid character. In this state it is combined with that substance. In the state of atmospheric air it is only mixed.

AIR, *Inflammable*, or *Hydrogen gas*. This air, named also fire-damp, is peculiarly distinguished by its great levity and inflammability. It is the lightest substance whose weight we are able to estimate. When pure, it is thirteen times lighter than atmospheric air, and it immediately explodes on mixture with oxygen. It is formed by the union of hydrogen and caloric. Its lightness is particularly evinced by its use in balloons. Plants grow in this fluid without impairing its inflammability. Water imbibes about one-thirteenth part of it; and when again expelled, it is as inflammable as ever. By this addition both its bulk and specific gravity are increased; for it occupies one-eighth more space by its combination, and its weight is increased, so as to be only one-tenth lighter than common air.

Hydrogen gas is thus procured: let sulphuric acid, diluted with five or six times its weight of water, be poured on iron filings in a glass bottle or small retort. An effervescence will ensue, and the gas which escapes is inflammable air or hydrogen gas. This effect is produced by the decomposition of the watery parts of the acid; the oxygen is absorbed by the metal, and with the sulphur forms a solid saline mass (martial vitriol or copperas). The hydrogen which enters into the composition of the water is disengaged in the form of hydrogen gas.

According to M. Lavoisier, water is composed of eighty-five parts of oxygen and fifteen parts of hydrogen. This philosopher has instructed us in the following method of obtaining this gas by heat only.

Let water pass drop by drop through the barrel of a gun, while it remains red-hot amidst burning coals; let a crooked tube be placed at the end of this iron, and bent, so that it may be passed into a glass vessel full of water inverted in the pneumatic apparatus. There will then pass into the glass vessel an aeriform fluid, which is inflammable air or hydrogen gas. In this process the water suffers a decomposition, and while the hydrogen passes into the glass receiver, the oxygen unites with the substance of the gun barrel, and oxydates or rusts its internal surface.

The electric spark also, taken in any species of oil, produces hydrogen or inflammable air, this substance being a constituent part of all the oils. The same may be said of æther, and alcohol or spirit of wine, which contain a great proportion of hydrogen.

Mr. Cavallo informs us, that he has procured this kind of air from the ponds about London, in the following manner: fill a wide-mouthed bottle with pond-water, and keep it inverted in it; then with a stick stir the mud at the bottom of the pond just under the inverted bottle, so as to permit the bubbles of air which rise to be received in the inverted bottle; and this air will be found to be inflammable.

The ignes fatui are supposed to proceed from the inflammable air which abounds in marshy grounds, and to be set on fire by electric sparks.

The most remarkable properties of this gas are, 1st. its great inflammability, which arises from its propensity to unite with oxygen and form water. 2dly. Its extraordinary levity, as already noticed. 3dly. Metals are very easily revived or reduced from a calyx or oxyd to the metallic state when heated in a receiver filled with this air. This also arises from its attraction for oxygen, which in this case is expelled from the calx; and, uniting with the hydrogen in the receiver to form water, leaves the metal pure, and in its natural state. 4thly. Plants vegetate in this fluid without impairing its inflammability. 5thly. Water will imbibe about 1-13th of its bulk of this gas.

This gas remains permanent over water; it is inflammable. Fill a small jar or common

phial with the gas, and holding it with its mouth downwards, bring the gas into contact with the flame of a candle; the air will take fire, and burn silently with a blueish flame. In a strong phial mix equal parts of hydrogen gas and common air, and apply to the mouth a lighted candle, and it will burn with a sudden and loud explosion. One part of oxygen gas, and two or three of hydrogen gas, will give a report equal to that of a pistol.

Hydrogen gas has an unpleasant smell; it extinguishes burning bodies; it is fatal to animals; and is, as we have observed, considerably lighter than atmospherical air.

These then are the three simple or original gases, from which, variously modified, all the rest are produced; and the first of these productions is universally diffused, and of the first importance to life, constituting an essential part of what we constantly breathe, and by which we are surrounded, atmospheric air.

Air, *combined*, or *atmospheric gas*, is a mixture of two or three substances in the elastic state. By the powers of chemistry this fluid, when examined, is found to consist principally of oxygen air, azote, and carbonic acid, in certain proportions. From the abundant production of inflammable air, or hydrogen gas, at the surface of the earth, in consequence of the corruption or decomposition of animal and vegetable matters, this fluid must also be generated; yet its extreme levity will naturally carry it to the higher regions, so that, though a part of the atmosphere, it is placed in a situation beyond the examination of chemists.

To a mixture then of oxygen and azotic air, with carbonic acid, the term atmospheric air is applied; and this mixture is in the proportion of 27 parts of oxygen air, 72 of azotic, and 1 of carbonic acid gas.

The proofs of this composition of atmospheric air were first offered by Mr. Scheele, who found, on its exposure to certain substances, that it suffered a diminution of volume, and that by this diminution it was rendered unfit for the support of life. This abstracted part, therefore, could not fail to be oxygen or vital air; and from this mixture of oxygen and azote, he naturally inferred that atmospheric air came to be formed. This he farther confirmed by restoring oxygen to it, in consequence of which it regained all its properties of atmospheric air. On the same subject he was succeeded by Lavoisier, who, in addition to these facts, showed that the oxygen, or attracted part, was received by the substance producing the change, and could be often recovered again from it.

But though the composition of atmospheric air has been thus ascertained, something still remains wanting to complete it; and this is the manner of combining by experiment its parts. Hence it is doubted whether its parts exist naturally in a state of chemical combination, or of mechanical mixture. That the latter takes place appears probable from the different proportion of oxygen which it is found to contain in the higher and lower regions, it being always greater towards the surface of the earth; and from the unlimited proportion in which these airs can be mixed, while the different matters present in the atmospheric regions may tend strongly to prevent their separation. At the same time, as a proof of its simple mixture, it is soluble in 30 times its weight of water.

From this knowledge of the composition of atmospheric air, an attempt has been made to ascertain its purity, or its relative capability of supporting animal life in different situations. This is effected by eudiometry, or measuring the exact quantity of oxygen the air contains.

To do this it requires to add to the air some body capable of combining with its oxygen, and from the diminished volume of air, the quantity of oxygen is inferred.

Different substances have been employed for this purpose, and each preferred by different chemists.

The first eudiometer was made in consequence of Dr. Priestley's discovery, that when nitrous gas is mixed with atmospheric air over water, the bulk of the mixture diminishes rapidly; in consequence of the combination of the gas with the oxygen of the common air, and the absorption of the nitric acid thus formed by the water.

When nitrous gas is added to nitrogen gas, no diminution takes place; but when it is mixed with oxygen gas in proper proportions, the absorption is complete. Hence it is evident, that in all cases of a mixture of these two gases, the diminution will be in proportion to the quantity of the oxygen. Of course, it will indicate the proportion of oxygen in atmospheric air, and, by mixing it with different proportions of air, it will indicate the different quantities of oxygen which they contain, provided the component parts of air are susceptible of variation.

Dr. Priestley's method was, to mix together equal quantities of air and nitrous gas in a low jar, and then transfer the mixture into a narrow graduated glass tube, about three feet long, in order to measure the diminution of bulk. He expressed this diminution by the number of hundredth parts of nitrous gas and common air: and if the sum total was 200, or 2.00; suppose the residuum, when measured in the graduated tube, to amount to 104, or 1.04, and of course, that 96 parts of the whole had disappeared, he denoted the purity of the air thus tried by 104.

Atmospherical air is without taste, and for the most part without smell. It is invisible, transparent, necessary to the support of combustion, vegetation, and animal life, particularly respiration. It is absorbed in a certain quantity by water, and again expelled by boiling, or by the air-pump removing pressure.

Air, *alkaline*, or *ammoniacal gas*. This air possesses a strong pungent smell, and is even capable of inflaming the skin of animals. Its lightness is next to that of inflammable air, and in specific gravity it falls short of atmospheric air, in the proportion of 600 to 1000, and it is incapable of supporting animal life, and also combustion, though the flame of a candle enlarges before it is extinguished by it. It is proved to be a compound of azote and hydrogen, 1000 parts of it containing 807 of azote, and 193 of hydrogen. This air has a strong attraction for water, and is rapidly absorbed by it. When dissolved with water it produces heat; and when dissolved with ice it produces cold.

Ammoniacal gas was first discovered by Dr. Priestley: it is no where found in a natural state, but must be produced by an artificial process. To obtain it, put into a retort a certain quantity of liquid ammonia, and heat the bottom of the retort, and having suffered some air to escape from the retort and the tube, the gas may be collected in vessels filled with mercury. This gas, which seems to be nothing but ammonia deprived of water, is perfectly absorbable by water, and the solution forms liquid ammonia (the same which is vulgarly called sal volatile and spirit of hartshorn). It is the lightest of all the saline gases, has a penetrating odour, and gives a strong tint of green to blue vegetable colours. It combines rapidly with carbonic, muriatic, and sulphureous acid gases, and forms neutral salts, throwing out a great deal of heat, which arises from the free state of the caloric that had been combined with these gases.

Ammoniacal gas suffocates animals, and extinguishes burning bodies; but it is so far inflammable, that it increases the flame of a taper before it extinguishes it.

Carbonic *acid gas* is the first elastic aeriform fluid, different from common air, that was known. We are indebted to Dr. Black, of Edinburgh, for a knowledge of some of its most remarkable properties. In the year 1755 he discovered the affinity between it and the alkalis; and Bergman, in 1772, proved that it was an acid.

Carbonic acid gas cannot support flame, nor animal life; its taste is acid. Neither light nor caloric seem to produce any effect upon it, except that the latter dilates it. It is absorbed by water. These two fluids, after considerable agitation, at last unite, and form an acid fluid. The colder the water, and the greater the pressure applied, the more carbonic gas it will absorb. Water, so impregnated, sparkles upon agitation; it has an acidulous taste, and reddens tincture of litmus. Heat disengages the gas from the water. Carbonic acid gas precipitates lime from its solution in water. It is eagerly attracted by the alkalis. Its specific weight is to that of atmospheric air, as 1500 to 1000. It may be poured from one vessel into another.

Of all the bases of the gases, that of carbonic acid gas is diffused in the greatest abundance throughout nature. It is found in the state of gas, and also in combination with a great variety of bodies.

It may be easily obtained as follows: Put into a common retort a little marble, chalk, or lime-stone, and pour on it sulphuric acid, diluted with about six times its weight of water; an effervescence will ensue, and carbonic gas will be disengaged, which may be collected over mercury; but a mercurial apparatus is not absolutely necessary, since the gas may be collected over water, if it is to be used immediately.

Marble, lime-stone, and chalk, consist of this matter and lime. On presenting to it sulphuric acid, a decomposition takes place; the sulphuric acid having a greater affinity to the lime than the carbonic acid has. It therefore unites to it, and forms sulphate of lime, disengaging, at the same time, the carbonic acid in the state of gas.

Carbonic acid gas is often found in the lower parts of mines, caverns, tombs, and such other subterraneous places as contain materials for producing it: it is then called the *choke-damp*. The grotto Del Cane, near Naples, has long been famous for the quantity of this gas produced there, which is so great, that it runs out at the opening like a

stream of water. A dog, or any other animal, is immediately killed, if its nose is thrust into the lower part of the cavern. But the upper part of the cavern is quite free from the gas, as it does not rise high enough to mix with the atmospheric air.

Carbonic acid gas is likewise formed during fermentation. On account of its great weight, it occupies the empty space of the vessel in which the fermenting process is going on. It may, in this case, be collected by plunging a vessel into it.

LIGHT CARBONATED HYDROGEN GAS, is hydrogen gas holding in solution carbon or charcoal. There are several kinds of it obtained by different processes, which differ in their properties, and in the proportions of their constituent principles.

Light carbonated hydrogen gas has a disagreeable smell. It is neither absorbed nor altered by water. It is very inflammable, and burns with a denser and deeper coloured flame than pure hydrogen gas. Its specific gravity is greater than that of hydrogen gas, or of common air.

This gas is produced from animal, vegetable, and mineral substances. It is found very commonly in marshes and ditches, on the surface of putrid water, in burying-places, common sewers, and in those situations where putrid animal and vegetable matters are accumulated. It is also generated in the intestinal canal of living animals.

It may be plentifully obtained from most stagnated waters. To do this, fill a wide-mouthed bottle with water, and keep it inverted with a funnel in its neck: then stir the mud with a stick at the bottom just under the funnel, so as to collect the bubbles of air which rise in various places: as soon as the bottle is filled with gas, it must be corked under water.

It may also be obtained during the distillation of animal and vegetable matters. Let shavings of wood or saw-dust be put into a retort, and apply a gradual heat till the retort becomes red-hot: a great quantity of gas will be disengaged, which may be collected over water. On examining this gas, it will be found to consist of carbonic acid gas and carbonated hydrogen gas. In order to obtain the latter in a pure state, the whole must be mixed with lime-water, or with caustic alkali dissolved in water. The carbonic acid gas will be absorbed, and the carbonated hydrogen gas left behind.

HEAVY CARBONATED HYDROGEN GAS is not absorbed by water. It has an odour different from that of light carbonated hydrogen gas. It burns with a strong flame, similar to that of a resinous oil. When mixed with oxygenated muriatic acid gas, its bulk is diminished, and oil is formed. When the mixture of these two gases is exploded, a quantity of charcoal is immediately deposited in the form of fine soot. When burned with oxygen gas, or when passed through a red-hot tube filled with any oxyd from which oxygen is procured, carbonic acid gas is formed.

This gas is obtained by decomposing spirit of wine, by sulphuric acid in a great heat. It is also obtained abundantly, when alcohol is passed through a red-hot earthen tube. Sulphuric ether, mixed with sulphuric acid, and subjected to heat, also affords it.

Let four parts of sulphuric acid, and one of highly rectified ardent spirit, be mingled together gradually in a glass retort: heat will be disengaged, the mixture will become brown, and heavy carbonated hydrogen gas will be extricated. When heat is applied, the action is very violent, and the gas is procured very copiously, and may be received over water. The gas so obtained is mixed with a considerable quantity of sulphureous acid gas, from which it may be freed, by agitating it with lime-water, or a solution of potash.

SULPHURATED HYDROGEN GAS has the properties of an acid; for when absorbed by water, its solution reddens vegetable blues. It combines also with alkalis, earths, and with several metallic oxyds. Sulphurated hydrogen gas has an extremely offensive odour, resembling that of putrid eggs. It kills animals, and extinguishes burning bodies. When mixed with oxygen gas, or atmospheric air, it is inflammable.

To obtain it, take dry sulphuret of potash, put it into a tubulated retort in a sand-bath; or, supported over a lamp, direct the neck of the retort under the receiver placed in a pneumatic trough; then pour gradually upon the sulphuret diluted sulphuric acid: a violent effervescence will take place, and sulphurated hydrogen gas will be disengaged. When no more gas is produced, apply heat by degrees till it boils, and gas will again be procured abundantly.

The water employed for receiving it should be heated to about 80 or 90 degrees: at this temperature it dissolves little of the gas; whereas, if cold water is used, a vast quantity of it is absorbed.

Water impregnated with sulphurated hydrogen gas, slightly reddens blue vegetable colours.

It is this gas which gives to the mineral waters of Harrowgate and Aix-la-Chapelle their peculiar smell. Such waters may therefore be artificially imitated, by impregnating common water with this gas, and adding the other constituent parts to it.

This gas acts strongly on most metallic oxyds.

Dip a slip of paper into a solution of lead, and expose it to the action of sulphurated hydrogen gas; and the paper will instantly become blackened. Writing performed with this solution is invisible when dry, but becomes visible when immersed in a bottle filled with this gas.

In this instance, the hydrogen of the gas takes the oxygen from these bodies, and causes them to re-approach the metallic state; at the same time, the sulphur contained in the gas combines with the metal thus regenerated, and converts it into a sulphuret.

PHOSPHORATED HYDROGEN GAS consists of phosphorus dissolved in hydrogen gas.

It is the most combustible substance in nature. It is distinguished from all other gases by the property of taking fire immediately when brought in contact with atmospheric air. When mixed with oxygen gas, or with oxygenated muriatic acid gas, it burns with great violence. When bubbles of it are suffered to pass through water, they take fire in succession as they reach the surface of the fluid. It has an insupportable odour, similar to that of putrid fish.

To obtain it, take a small retort, put into it one part of phosphorus and ten of concentrated solution of potash; make the mixture boil, and receive the gas over mercury, or, if it is intended for immediate use, it may be collected over water. In this process a decomposition of the water takes place. Its oxygen unites to part of the phosphorus, forming phosphoric acid, which joins to the potash, and forms phosphate of potash. The hydrogen of the water dissolves another part of the phosphorus, and is converted into phosphorated hydrogen gas.

In preparing this gas the body of the retort should be filled as nearly as possible with the mixture, otherwise the first portion of gas which is produced inflames in the retort, a vacuum is formed, and the water is forced up into the retort, which endangers the bursting of it.

Phosphorated hydrogen gas is also formed by nature. The air which burns at the surface of certain springs, and forms what is called burning springs, and the *ignis fatuus* (jack o'lantern), which glides along burying-grounds, consist of this gas.

If the bubbles of air which come from the retort are suffered to escape into the atmosphere, they will burst with a slight explosion, and produce flashes of fire. A circular dense white smoke rises like a ring, enlarging itself continually in an extremely beautiful manner, if the air is perfectly tranquil.

This gas burns with a green light, in nascent oxygenated muriatic acid gas, under the surface of water. Put into a deep glass some phosphoret of lime, broken into pieces of the size of a pea, and add half as much oxygenated muriate of potash. Fill the vessel with water, and bring into contact with the materials at the bottom of the fluid some concentrated sulphuric acid. This may be most conveniently done, by letting the acid fall through a long funnel reaching to the bottom of the vessel. As soon as the decomposition of the water, and that of the oxygenated muriate takes place, flashes of fire dart from the fluid, and illuminate the bottom of the vessel with a beautiful green light.

A ribbon, impregnated with a solution of gold, may be gilt by the action of phosphorated hydrogen gas.

NITROUS GAS. This name is given to an aeriform fluid, consisting of a certain quantity of nitrogen gas and oxygen: first described by Priestley, but in some measure known before to Hales.

It is colourless, having no sensible taste, and is neither acid nor alkaline: it cannot be respired. The greater number of combustible bodies cannot burn in it. It is nevertheless capable of supporting the combustion of some bodies. Phosphorus burns in it, when introduced in a state of inflammation; pyrophorus takes fire in it spontaneously.

To obtain it, put into a small retort some pieces of copper, and pour on them nitric acid diluted with water; an effervescence takes place, and nitrous gas will be produced. After having suffered the gas to escape for a few minutes, on account of the common air contained in the retort, collect the gas in the water apparatus as usual. In order to obtain this gas in a pure state, it should be shaken for some time in contact with water.

We have seen before, that water was decomposed on bringing in contact with it a metal and an acid. But here the case is different; the water suffers no alteration; on the contrary, the acid undergoes a partial de-

composition; the metal robs the nitric acid of the greatest part of its oxygen, and becomes oxydated. The remainder of the acid having lost so much of its oxygen, becomes so altered, that, at the usual temperature, it can exist no longer in the liquid state, but instantly expands, and assumes the form of gas, ceasing at the same time to be an acid.

It was mentioned before, that nitrous gas greedily attracts oxygen gas from atmospheric air. During this union an acid is produced.

Pass up into a tall cylindrical glass vessel over water, about one part of nitrous gas and two of common air. The two fluids will speedily unite, red fumes will be produced, and the volume of the two combined gases will be diminished. A considerable degree of heat will be perceived, the water will rise in the vessel, and absorb the red vapours. When the two gases have mixed in proper proportion, nothing remains at last but the nitrogen gas of the atmospheric air.

Usually sixteen parts of common air are requisite to destroy completely seven of nitrous gas; this, however, varies according to the purity of the atmospheric air.

The nitrous gas, in this experiment, decomposes the atmospheric air; it takes the oxygen gas from the nitrogen gas, unites with it, and forms nitrous acid. The nitrous gas is therefore left behind; the heat which is generated, is that which kept the gases in solution, which is now set free.

If, instead of atmospheric air, oxygen gas is used, this experiment will be still more striking, and the gases will almost entirely disappear.

Upon this property which nitrogen gas has, of absorbing the oxygen of the atmosphere, Priestley formed the eudiometers, already mentioned.

GASEOUS OXYD of AZOTE, or NITROUS OXYD. The union of azote, or nitrogen and oxygen, which we considered before under the name of nitrous gas, does not constitute the first degree of oxygenation of nitrogen. There is another degree below this. This was formerly called dephlogisticated nitrous gas, but now gaseous oxyd of nitrogen, or nitrous oxyd. It was first discovered by Priestley.

Professor Davy has examined with great accuracy the formation and properties of all the substances concerned in its production; and to him we are indebted for a thorough knowledge of this gas. We shall describe its principal properties as we find them in his Researches.

Gaseous oxyd of nitrogen is a permanent gas. A candle burns in it with a brilliant flame and crackling noise: before its extinction the white inner flame becomes surrounded with a blue one. Phosphorus introduced to it in a state of inflammation burns with increased splendour, as in oxygen gas. Sulphur introduced into it when burning with a feeble blue flame, is extinguished; but when in a state of vivid inflammation it burns with a rose-coloured flame. Lighted charcoal burns in it more brilliantly than in atmospheric air. Iron wire with a small piece of wood affixed to it, and introduced inflamed into a vessel filled with this gas, burns rapidly, and throws out bright scintillating sparks.

Nitrous oxyd is rapidly absorbed by water which has been boiled; a quantity of gas equal to rather more than half the bulk of the water may be thus made to disappear: the water acquires a sweetish taste, but its other properties do not differ perceptibly from common water. The whole gas may be expelled again by heat. It does not change blue vegetable colours. It has a sweet taste, and a faint but agreeable odour.

This gas explodes with hydrogen, when electric sparks are made to pass through the mixture.

Animals, when confined wholly in this gas, give no signs of uneasiness at first, but they soon become restless, and then die.

When it is mingled with atmospheric air, and then received into the lungs, it generates highly pleasurable sensations: the effects it produces on the animal system are very extraordinary. It excites the body to action, and rouses the faculties of the mind, inducing a state of great exhilaration, an irresistible propensity to laughter, a rapid flow of vivid ideas, and unusual vigour and fitness for muscular exertions, in some respects resembling the sensations attendant on intoxication, without any languor, depression of spirits, or disagreeable feelings afterwards, but more generally followed by vigour, and a disposition to exertion, which gradually subsides. The accounts of these wonderful effects, which, when first announced, were scarcely credited, have been confirmed by a variety of experiments, so as to be past all kind of doubt.

This gas is produced when substances, having a strong affinity with oxygen, are added to nitric acid, or to nitrous gas. It may therefore be obtained by various methods, in which nitrous gas or nitric acid is decomposed by substances capable of attracting the greater part of their oxygen. The most commodious and expeditious, as well as the cheapest mode of obtaining it, is by decomposing nitrate of ammonia by heat in the following manner:

Put into a glass retort some pure nitrate of ammonia, and apply to it an Argand's lamp; the salt will soon liquefy, and when it begins to boil gas will be evolved. Increase the heat gradually, till the body and neck of the retort become filled with a milky-white vapour. In this state the temperature of the fused nitrate is between 340 and 480 degrees. After the decomposition has proceeded for some minutes, so that the gas, when examined, quickly enlarges the flame of a taper, it may be collected over water. Care should be taken during the whole process never to suffer the temperature of the fused nitrate to rise above 500 degrees Fahrenheit, which may be easily judged of from the density of the vapours in the retort, and from the quick ebullition of the fused nitrate; for if the heat is increased beyond this point, the vapours in the retort acquire a reddish and more transparent appearance, and the fused nitrate begins to rise, and occupy twice the bulk it did before. The nitrous oxyd, after its generation, should stand over water for several hours, and is then fit for respiration, or other experiments.

To experience its effects in breathing it, put about a gallon into a large bladder, or oiled silk bag, having a tube attached to it of three-fourths of an inch in diameter. First, the common air must be expelled from the lungs, before the tube is received into the mouth, and the nostrils must be accurately closed with the hand. It must then be breathed backwards and forwards into the bag for a few minutes.

SULPHUREOUS ACID GAS is no where found in a natural state, and is entirely a production of art.

It is obtained by exposing to heat in a retort, sulphuric acid, while it is exercising an action on some combustible body, such as oil, charcoal, mercury, &c.; in a word, on such bodies as can take up a portion of the oxygen combined with the sulphur contained in that acid. It is sulphur combined with a less quantity of oxygen than that which is necessary to make it *sulphuric* acid; the combustible body, therefore, takes a part of its oxygen from the sulphuric acid, which, by these means, becomes *sulphurous* acid; and caloric combining with this acid, causes it to assume the gaseous form. This process requires a mercurial apparatus, because this gas is entirely soluble in water.

Sulphureous acid gas is more than twice as heavy as atmospheric air. It extinguishes burning bodies, and suffocates animals immersed in it. It first reddens, and then destroys most of the vegetable colours. It has the property of whitening silk, and giving it a lustre.

Sulphureous acid gas combines with alkalis, and forms with them neutral salts, which differ from those produced by the sulphuric acid and the same alkalis, in their form, their savour, and particularly their property of being decomposed by the weakest acids, and even the acetous acid.

MURIATIC ACID GAS is obtained by exposing to heat fuming muriated acid, put into a retort, the beak of which is introduced below a bell filled with mercury, and placed on the shelf of a mercurial pneumatic apparatus.

You may obtain it also with the same apparatus, if, instead of muriatic acid, you expose to heat a mixture of muriate of soda, or marine salt and sulphuric acid; the sulphuric acid combines with the soda the base of the marine salt, and the muriatic acid remaining free, passes into the state of muriatic acid gas.

Muriatic acid gas is perfectly soluble in water, and in a very short time. If you therefore introduce into the bell in which the gas has been collected, a small quantity of water, the latter, by its relative lightness, will rise to the surface of the mercury; the gas will be immediately absorbed entirely, and dissolved in the water; the mercury will ascend towards the top of the bell; and the liquor found above the mercury will be real muriatic acid, more highly concentrated, according as there is more gas and less water.

Muriatic acid gas, therefore, is nothing else than the muriatic acid itself deprived of water; that is to say, as much concentrated as possible, and combined with caloric, which causes it to assume the gaseous form.

Muriatic acid gas has a sharp pungent odour. If a little of it is mixed with atmospheric air, it produces, like the muriatic acid, white fumes or vapours, occasioned by the combination of the gas with the moisture of the air.

The base of the muriatic acid gas is strongly combined with oxygen, for which it has so great an affinity, that it cannot be separated from it. The nature of this base is therefore unknown. Its affinity for oxygen is so strong, that it can even combine itself with a larger quantity of oxygen than is necessary to constitute an acid, and it then appears in the form of oxygenated muriatic gas.

This gas is much heavier than atmospheric air. It gives the same signs of acidity as the muriatic acid itself; and this indeed ought to be the case, as it is the same substance. It reddens blue vegetable colours, but it destroys neither them nor any of the other colours, as the oxygenated muriatic gas does.

It combines with all the alkaline bases, and forms with them muriatic salts. If it is mixed with ammoniacal gas, it combines with it, and forms muriate of ammonia.

It suffocates animals immersed in it, and extinguishes a lighted taper; but it first enlarges its flame, and makes it appear of a green or bluish colour at the edges.

OXYGENATED MURIATIC ACID GAS. The dephlogisticated muriatic acid of Scheele, under a gaseous form, is the muriatic acid gas surcharged with oxygen.

This gas is obtained by exposing the muriatic acid to heat and evaporation, whilst it is acting on a substance which contains oxygen; such, for example, as the native oxyd of manganese: if you therefore put black oxyd of manganese and muriatic acid into a glass retort, and expose them to heat, a strong fermentation will be excited, during which the muriatic acid will be converted into gas, but surcharged with oxygen, which is taken from the oxyd of the manganese, because it has a greater affinity for that substance.

It may be prepared in the water apparatus, though it is absorbable by water, if care is taken to fill the bells, or air-jars, completely with the gas, and to leave no water in them.

Oxygenated muriatic gas is not invisible, like the other gases; it is of a greenish yellow colour, which renders it very perceptible.

This gas destroys vegetable colours entirely. All flowers, and the green leaves of plants, are rendered white by it, and alkali is not capable of restoring their colours.

This effect can only be ascribed to the absorption of oxygen. This gas, which contains oxygen in excess, gives up a part, which vegetable substances absorb with avidity, and by this absorption lose their colour. The oxygenated muriatic acid gas then becomes converted into common muriatic acid gas.

This property has given rise to a new method of bleaching, which has proved successful. The application of the oxygenated muriatic acid, either in the gaseous or the liquid state, has assisted the process of whitening thread, cotton, linen, wax, &c. in a surprising degree, and it is now very generally employed for this purpose.

To shew its effects in bleaching, suspend some unbleached calico, or linen, moistened with water, in a jar filled with the gas; the natural colour of the cloth will soon begin to fade, and at last totally disappear. If different coloured patterns of printed calico are immersed for a few minutes in the gas, their colours will soon be destroyed, except those which are yellow.

Though oxygenated muriatic acid gas is exceedingly noxious to life, it does not extinguish combustion. If a burning taper, fixed to a wire, is immersed in it, the taper burns of a red colour, and more vividly than in atmospheric air; a greater quantity of smoke is emitted at the same time.

Fill a tall receiver, furnished with a ground stopper, with oxygenated muriatic acid gas over water, and let fall into it copper, in thin leaves, called Dutch gold. The leaf, before it reaches the bottom of the receiver, will burn with a pale green light.

Gold leaf may be burnt in the same manner. Copper wire, when heated to redness, also takes fire when introduced into the gas in that state.

FLUORIC ACID GAS. The radical of fluoric acid gas is unknown. It may be obtained by decomposing fluate of lime (Derbyshire spar), by means of sulphuric acid. For this purpose, put one part of powdered fluate of lime into a leaden retort, and pour over it two or three parts of sulphuric acid. A violent action ensues, and fluoric acid gas is extricated, which must be collected over mercury, either in a leaden or tin vessel, or in a glass receiver covered within with a coat of varnish or wax. When no more gas is produced, the action of the acid must be assisted by a gentle heat.

The most remarkable property of this gas is its power of dissolving silex: it therefore dissolves glass crystals, and various precious stones. It is heavier than common air. It does not maintain combustion, nor can animals breathe it. It is absorbed by water, and forms with it liquid fluoric acid. It has a penetrating odour. It corrodes animal and vegetable substances. Light has no effect upon it. It emits white fumes, when in contact with moist atmospheric air. It reddens blue vegetable colours. With ammonia, it forms a concrete body. It has no action upon platina, gold, silver, mercury, tin, lead, antimony, cobalt, nickel, or bismuth; but it corrodes iron, arsenic, and manganese.

The property of dissolving silex has caused it to be applied to etching on glass, which is done either by means of the fluorid acid gas, or liquid fluoric acid.

AIR BALLOON, a general name given to bags or other light substances filled with an aerial fluid. The art of flying, or of imitating the feathered tribe, has long been the object of earnest desire amongst men. Cars, artificial birds, wings, and other mechanisms for flying, generally absurd, and always insufficient, have frequently been exhibited to the undistinguishing eye of the vulgar; but the strictest enquiry into the accounts of authentic history, finds no mention of any success having ever attended the attempts of this nature previous to the year 1782. The recent discoveries made on the nature and properties of aerial fluids, by the industry of Black, Priestley, Cavendish, and others, suggested, some time before the above-mentioned year, the practicability of forming machines sufficient to elevate considerable weights into the regions of the atmosphere. Mr. Cavendish was the first who ascertained the specific gravity of hydrogen gas (then called inflammable air) and found it to be a vast deal lighter than common air. His experiments on this subject are published in the Philosophical Transactions for the year 1766. In consequence of this discovery, it was natural to conclude, that if a large bladder, or other envelope, was filled with hydrogen gas, and that if the weight of the envelope added to that of the contained gas, was less than the weight of an equal bulk of common air, the apparatus would mount up into the atmosphere for the same reason, and in the same manner, as a cork would rise from the bottom towards the surface of the sea, supposing the cork was left at liberty in the former place.

Dr. Black of Edinburgh thought of filling the allantois of a calf with hydrogen gas, for the purpose of shewing at his lectures that such a body would ascend into the atmosphere; but he never put the project to the test of actual experience.

Early in the year 1782 Mr. Cavallo made the first attempts to elevate a bag full of hydrogen gas into the surrounding air, and an account of his experiments was read at a meeting of the Royal Society on the 20th of June, 1782.

The weight of hydrogen gas, the mean weight of atmospherical air, and the weight of the substance of which the vessel or bag is to be formed, being ascertained, it is easy from those particulars to determine by calculation the dimensions of a vessel, which, when filled with hydrogen gas, might be lighter than an equal bulk of common air.

Upon this principle Mr. Cavallo tried bladders, the thinnest and largest that could be procured. Some of them were cleaned with great care, removing from them all the superfluous membranes, and other matter that could possibly be scraped off; but notwithstanding all those precautions, he found the largest and lightest of those prepared bladders to be somewhat too heavy for the purpose. Some swimming-bladders of fishes were also found too heavy for the experiment; nor could he even succeed to make any durable light balls by blowing hydrogen gas into a thick solution of gums, thick varnishes, and oil paint. In short, soap-balls, inflated with hydrogen gas, were the only things of this sort which he could elevate in air; and these perhaps were the first air balloons that were ever constructed.

Not long after this, news was received from France of the success which had attended an experiment of a similar nature made at Avignon, by Stephen Montgolfier; but the bag was not filled with hydrogen gas. It was filled with air rarefied by heat, which of course was lighter than an equal bulk of common air of the usual temperature.

It is said that the two brothers, Stephen and John Montgolfier, began to think on the experiment of the aerostatic machine as early as the middle or latter end of the year 1782. The natural ascension of smoke, and of the clouds in the atmosphere, suggested the first idea; and to imitate those bodies, or to enclose a cloud in a bag, so that the latter might be elevated by the buoyancy of the former, was the first project of those celebrated gentlemen.

Stephen Montgolfier, the eldest of the two brothers, made the first aerostatic experiment at Avignon, towards the middle of November, 1782. The machine consisted of a bag of fine silk, in the shape of a parallelopipedon, open on one side, the capacity of which was equal to about 40 cubic feet. Burning paper, applied to its aperture, served to rarefy the air, or to form the cloud; and, when sufficiently expanded, the machine ascended rapidly to the ceiling of the room. Thus the original discovery was made, which was afterwards confirmed, improved, and diversified, by different persons in different parts of the world.

As soon as the news of Mr. Montgolfier's successful experiment reached Paris, the

scientific persons of that capital, justly concluding that a similar experiment might be made by filling a bag with hydrogen gas, immediately attempted to verify the supposition. A subscription for defraying the expences that might attend the accomplishment of the project, was immediately opened; persons of all ranks ran with eagerness to sign their names, and the necessary sum was speedily raised. Messrs. Roberts were appointed to construct the machine, and Mr. Charles, professor of experimental philosophy, was appointed to superintend the work.

The obstacles, which opposed the accomplishment of this first attempt, were many; but the two principal difficulties were to produce a large quantity of hydrogen gas, and to find a substance sufficiently light to make the bag of, and at the same time impermeable to the gas. At last they constructed a globular bag of a sort of silk stuff, called *lutestring*; which, in order to render it impervious to the gas, was covered with a certain varnish, said to consist of dissolved elastic gum. The diameter of this bag, which, from its ball-like shape, was called a *balloon* (and from this the name *air balloons* was derived), was 12 feet two inches French, or about 13 feet English. It had only one aperture, like the neck of a bladder, to which a stop-cock was adapted. The weight of the balloon, when empty, together with the stop-cock, was 25 pounds.

The attempts to fill this bag commenced on the 23d of August, 1783. But the operators met with many difficulties and disappointments, from inadvertences, want of materials, want of precaution, &c. so much so, that the accomplishment of the experiment, viz. the actual ascent of the balloon, did not take place before the 26th of the same month. On the morning of that day the inflated balloon, having a small cord fastened to its neck, was permitted to rise only to the height of about 100 feet; but at five o'clock in the afternoon of the 27th, the balloon was disengaged from its fastenings, in the Champ de Mars, and rose majestically in the atmosphere before the eyes of a great many thousand spectators, and amidst a copious shower of rain. In about two minutes time it rose to the height of about 3123 feet. After remaining in the atmosphere only $\frac{3}{4}$ of an hour, this balloon fell in a field near Gonesse, a village about 15 miles from Paris. Its fall was attributed to a rupture that was found in it, and it was reasonably imagined, that the expansion of the hydrogen gas, when the balloon had reached a much less dense part of the atmosphere, had burst it. When this balloon went up, it was found upon trial to be 35 pounds lighter than an equal bulk of common air.

Thus in the years 1782 and 1783, it was ascertained that bags full of hydrogen gas, or of rarefied common air, either of which is lighter than common air in its usual state, would ascend into the atmosphere, and that they might take up considerable weights.

Soon after the success of the first attempt, the Montgolfiers repeated the experiment in the open air, and with bags of different sizes; but their first grand and public exhibition in the presence of a very respectable and numerous assembly, was made on the 5th of June, 1783, with an aerostatic machine or bag that measured 35 feet in diameter. The machine, inflated by the rarefied air, ascended to a considerable height, and then fell at the distance of 7668 feet from the original place of ascension. This experiment was described and recorded with great accuracy; and accounts of it were immediately forwarded to the court of France, to the academy of sciences, and almost as far as literary and entertaining correspondence could reach. The younger Montgolfier, arriving at Paris not long after the above-mentioned public exhibition, was invited by the Academy of Sciences to repeat his singular aerostatic experiment; in consequence of which invitation, that gentleman began to construct an aerostatic machine of about 72 feet in height, at the expence of the academy. But while this operation was going on, and as a successful experiment with an inflammable air balloon had already been performed on the 27th of August, the project of making balloons became general; and those who wished to make the experiment on the smallest scale soon calculated the necessary particulars, and found that the performance of the experiment was far from being either difficult or expensive. The baron de Beaumanoir, at Paris, by the suggestion of a Mr. Deschamps, was induced to try gold-beater's skin, and soon made a balloon by gluing several pieces of that skin together. This balloon was no more than 19 inches in diameter; it was of course easily filled with hydrogen gas; and on the 11th of September, 1783, it mounted with rapidity into the atmosphere.

Mr. Montgolfier having completed his large balloon, agreeably to the desire of the academy, made a private experiment with it on the 11th of September, which succeeded. On the following day another experiment was made with the same, before the commissaries of the academy, and a vast number of other spectators; but this experiment, in consequence of a violent shower of rain, was attended with partial success: and the aerostat was considerably damaged.

A similar machine was speedily constructed by the same Mr. Montgolfier, by whom the experiment was performed at Versailles on the 19th of September, before the royal family of France, and an innumerable concourse of spectators. The preparation for filling the machine with rarefied air consisted of an ample scaffold, raised some feet above the ground; in the middle of which there was a well or chimney, about 16 feet in diameter; in the lower part of which, near the ground, the fire was made. The aperture of the balloon was put round the chimney or well, and the rest of it was laid down over the well and the surrounding scaffold. As soon as the fire was lighted the machine began to swell, acquired a convex form, stretched itself on every side, and in 11 minutes time, the cords being cut, the machine ascended, together with a wicker basket or cage, which was fastened to it by means of a rope, and in which a sheep, a cock, and a duck, had been placed. These were the first animals that ever ascended with an aerostatic machine. The apparatus rose to the height of about 1440 feet, and remained in the atmosphere during eight minutes; then fell at the distance of about 10,200 feet from Versailles, with the animals safe in the basket.

After the success of this experiment with the animals, &c. and when ten months had scarcely elapsed since Mr. Montgolfier made his first experiment of this sort, Mr. Pilatre de Rozier publicly offered himself to be the first adventurer in the newly invented machine. His offer was accepted, his courage remained undaunted, and on the 15th of October, 1783, he actually ascended into the atmosphere, to the astonishment of a gazing multitude. The balloon with which he ascended was of an oval shape, its height being about 74, and its horizontal diameter 48 feet. The aperture or lower part of the machine had a wicker gallery about three feet broad, with a ballustrade both within and without, about three feet high. The inner diameter of this gallery, and of the neck of the machine which passed through it, was nearly 16 feet. In the middle of this aperture an iron grate or brazier was supported by means of chains, which came down from the sides of the machine. In this construction, when the machine was up in the air, with a fire lighted in the grate, it was easy for a person who stood in the gallery, and had fuel with him, to keep up the fire in the opening of the machine, by throwing the fuel on the grate through port-holes made in the neck of the machine; by which means the machine might be kept up as long as the person in its gallery thought proper, or till he had no fuel to supply the fire with.

The first aerial voyage, with an inflammable air balloon, was performed subsequent to the above-mentioned experiment, viz. on the 1st of December, 1783. Mr. Charles and Mr. Robert, who had constructed a balloon of this sort, as has been already mentioned, were the first adventurers. The balloon was globular, its diameter being 27½ feet. A net went over the upper hemisphere, and was fastened to a hoop, which went round the middle of the balloon. From this hoop ropes proceeded, and were fastened to a boat which swung a few feet below the balloon. In order to prevent the bursting of the machine by the expansion of the gas in an elevated region, a valve was made on the upper part of it, which, by pulling a string, would open and let out part of the gas. There was likewise a long silken pipe, through which the balloon was filled.

The apparatus for filling it consisted of several wooden casks placed round a large tub full of water, every one of which had a long tin tube, which terminated under a vessel or funnel, that was inverted into the water of the tub. A tube then proceeded from this funnel, and communicated with the balloon, which stood just over it. Iron filings and diluted sulphuric acid were put into the casks; and the gas which was extricated from those materials passed through the tin tubes, then through the water of the tub, and, lastly, through the tube of the funnel into the balloon. See the Plate, fig. 1.

When Messrs. Charles and Robert placed themselves in the boat, they had with them proper philosophical instruments, provisions, clothing, and some bags full of sand, by way of ballast. With this preparation they ascended at three quarters after one o'clock. At the time they went up, the thermometer, Fahrenheit's scale, stood at 52 degrees, the mercury in the barometer stood at 27 inches, from which they deduced their altitude to be nearly 600 yards. During the rest of their voyage the mercury in the barometer moved

generally between 27 inches and 27,65 ; rising and falling according as part of the ballast was thrown out, or some gas escaped from the balloon. The thermometer stood generally between 53 and 57 degrees.

Soon after their ascent they remained stationary for a short time; they then went horizontally, in the direction of N. N. W. They crossed the Seine, and passed over several towns and villages, to the great astonishment of the inhabitants, who did not expect to see such a spectacle, and who had perhaps never heard of this new sort of experiment. This delicious aerial voyage lasted one hour and three quarters. At last they descended in a field near Nesle, a small town, about 27 miles distant from Paris; so that they had gone at the rate of about 15 miles per hour, without feeling the least inconvenience; and the balloon underwent no other alteration than what was occasioned by the dilatation and contraction of the gas, according to the vicissitudes of heat and cold.

The success of the experiments, which have been already described, spread a universal enthusiasm throughout Europe; and the aerostatic experiments, both in the diminutive and in the large way, were soon undertaken in different countries. The first experiment of this kind was exhibited in London on the 25th of November, 1783, when an inflammable air balloon, 10 feet in diameter, was sent up by count Zambeccari, an Italian gentleman. The first aerial voyage undertaken in England, with an inflammable air balloon of 33 feet in diameter, made of oil silk, was performed by Mr. Lunardi, another Italian, on the 15th of September, 1784.

The abbe Bertholon seems to have been the first person who made use of small balloons for exploring the electricity of the atmosphere, which must be a very useful method, particularly in calm weather, when electrical kites cannot be raised. He raised several air balloons, to which long and slender wires were attached, the lower extremity of the wire being fastened to a glass stick or other insulated stand, whereby he obtained from such wires electricity enough to shew its kind, and even sparks.

On the 13th of January, 1784, an aerostatic machine, of about 37 feet in height, and 20 in diameter, was launched from the castle De Pisancon, near Romans, in Dauphiny. It rose with surprising velocity, and as the wind was north, it went southward: but when the machine had ascended to the height of about 1300 feet, it went back towards the north, and in less than five minutes time it ascended to the height of above 6000 feet. In less than ten minutes it fell at the distance of nearly four miles.

This experiment, and indeed the similar success of many others, shews that there frequently are in the atmosphere currents of air in different, and sometimes quite opposite, directions; this, however, is far from being always the case. If different currents could always be met with at different heights above the surface of the earth, the method of guiding balloons would be extremely easy; for the aerial traveller would have nothing more to do than to place himself in the favourable current, which he might do by throwing out either some ballast or some inflammable gas, according as he wished to go higher or lower.

The largest aerostatic machine ever made, and filled with rarefied air, was launched at Lyons on the 19th of January 1784, with not less than seven persons in its gallery, amongst whom were Joseph Montgolfier, and Pilatre de Rozier. The height of this machine was about 131 feet, and its horizontal diameter about 104. Its weight, when it ascended, including passengers, gallery, &c. was about 1600 pounds.

This machine, having suffered considerably in consequence of previous trials, was by no means in a perfect state when it ascended; nevertheless, when the action of the fire had inflated it, the seven persons, who in spite of every remonstrance had placed themselves in the gallery, refusing to relinquish their places, the machine was released from the ropes which confined it, and ascended majestically into the atmosphere. At a certain height, the wind turned it towards the west; but it afterwards proceeded east-south-east, ascending, at the same time, until it was at least 1000 yards high.

The effect which was produced on the spectators by this spectacle is described as the most extraordinary that was ever occasioned by any production of human invention. It was a mixture of the strangest nature imaginable. Vociferations of joy, shrieks of fear, expressions of applause, the sound of martial instruments, and the discharge of mortars, produced an effect more easily imagined than described. Some of the spectators fell on their knees, and others elevated their suppliant hands to the heavens; some women fainted, and many wept; but the confident travellers, without shewing the least appearance of fear, were continually waving their hats out of the gallery.

At about fifteen minutes after the ascent, the wind shifted again; but it was so feeble that the machine stood almost stationary for about four minutes. Unfortunately about this time a rent was made in the machine, which occasioned its descent; and when it came within 600 feet of the ground, its velocity was considerably accelerated. It is said that no less than 60,000 persons, besides the Marechaussee, ran to the spot, with the greatest apprehension for the lives of the adventurous aerial travellers. They were immediately helped out of the gallery, and luckily no person had received any hurt, except Mr. Montgolfier an insignificant scratch. The machine was torn in several places, besides a vertical rent of upwards of 50 feet in length, which clearly shews how little danger is to be apprehended from the use of those machines, especially when they are properly constructed and judiciously managed.

On the 5th of April 1784, Messrs. de Morveau and Bertrand, at Dijon, ascended with an inflammable air-balloon, which, according to their barometrical observations, seems to have reached the extraordinary height of 13,000 feet, when the cold was so great that the thermometer stood at 25°.

On the 15th of July, the duke de Chartres, the two brothers Roberts, and another person, ascended with an inflammable air-balloon, from the park of St. Cloud, at 52 minutes past seven in the morning. This balloon was of an oblong form, its dimensions being 55 feet by 34. It ascended with its greatest extension nearly horizontal; and after remaining in the atmosphere about 45 minutes, it descended at a small distance from its place of ascension. But the incidents that occurred during this aerial excursion deserve particular notice, as nothing like it had happened before to any of the aerial travellers. This machine contained an interior small balloon, filled with common air; by which means it was supposed that they might regulate the ascent and the descent of the machine, without any loss of the hydrogen gas, or of ballast. The boat was furnished with a helm and oars, that were intended to guide the machine, but which were in this, as well as in every other similar attempt, found to be quite useless.

On the level of the sea, the mercury in the barometer stood at 30,25 inches, and at the place of ascension it stood at 30,12. Three minutes after its ascension, the balloon was lost in the clouds, and the aerial voyagers lost sight of the earth, being involved in a dense vapour. Here an unusual agitation of the air, somewhat like a whirlwind, in a moment turned the machine three times from the right to the left. The violent shocks which the adventurers suffered, prevented their using any of the means prepared for the direction of the machine; and they even tore away the silk stuff of which the helm was made. Never, said they, a more dreadful situation presented itself to any eye, than that in which they were involved. An unbounded ocean of shapeless clouds rolled beneath, and seemed to forbid their return to the earth, which was still invisible. The agitation of the balloon became greater every moment. They cut the cords which held the interior balloon, which consequently fell on the bottom of the external balloon, just upon the aperture of the tube that went down to the boat, and stopped that communication. At this time the thermometer was a little above 44°. A gust of wind from below drove the balloon upwards, to the extremity of the vapour, where the appearance of the sun shewed them the existence of nature; but now both the heat of the sun, and the diminished density of the atmosphere, occasioned such a dilatation of the gas, that the bursting of the balloon was apprehended; to avoid which, they introduced a stick through the tube, and endeavoured to remove the inner balloon, which stopped its aperture within the external balloon; but the dilatation of the gas pressed the inner balloon so forcibly against that aperture, as to render every attempt ineffectual. During this time, they continually ascended, until the mercury in the barometer stood not higher than 24,36 inches, which shewed their height above the surface of the earth to be about 5100 feet. In these dreadful circumstances they thought it necessary to make a hole in the balloon, in order to give exit to the gas; and accordingly the duke himself, with one of the spears of the banners, made two holes in the balloon, which opened a rent of about seven or eight feet. In consequence of this, they then descended rapidly, seeing at first no object either on earth or in the heavens; but a moment after, they discovered the fields, and that they were descending straight into a lake, wherein they would inevitably have fallen, had they not quickly thrown over about 60 pounds weight of ballast, which occasioned their coming down at about 30 feet beyond the edge of the lake. Notwithstanding this rapid descent,

none of the four adventurers received any hurt; and it is remarkable, that out of six glass bottles full of liquor, which were simply laid down in the boat, one only was found broken.

In the course of the summer 1784, two persons, viz. one in Spain, and another near Philadelphia, in America, were very near losing their lives by going up with rarefied-air machines. The former, on the 5th of June, was scorched by the machine taking fire, and was hurt by the subsequent fall, so that his life was long despaired of. The latter, having ascended a few feet, was wafted by the wind against the wall of a house, and some part of the machinery was entangled under the eaves, from which he could not extricate it. At last the great ascensional power of the machine broke the ropes or chains, and the man fell from the height of about 20 feet. The machine presently took fire, and was consumed.

We shall now relate one of the most remarkable aerial voyages that were ever made with an aerostatic machine. It is the crossing of the English channel in an inflammable-air balloon of 27 feet diameter. The adventurer in this dangerous voyage was Mr. Blanchard, an intrepid Frenchman, who had already made five other aerial voyages with the very same balloon, both in France and in England. Mr. Blanchard is remarkable for having made a greater number of aerial voyages in England, in France, and elsewhere, both before and after the crossing of the English channel, than any other person recorded in the history of aerostation. The only trial worth remarking which Mr. Blanchard appears to have made in his aerial excursions, is the ineffectual use of oars, wings, &c. for directing the balloon. Profit seems to have been the principal, if not the sole object of his numerous excursions.

On Friday the 7th of January 1785, being a fine clear morning, after a sharp frosty night, and the wind being about N. N. W. though hardly perceptible, Mr. Blanchard, accompanied by Dr. Jeffries, an American gentleman, departed in the old balloon of 27 feet diameter, from Dover castle, directing their course for the French coast. Previous to the departure, the balloon, with the boat, containing the two travellers, several necessaries, and some bags of sand for ballast, were placed within two feet of the brink of the perpendicular cliff before the castle. At one o'clock the intrepid Blanchard desired the boat, &c. to be pushed off; but the weight being too great for the power of the balloon, they were obliged to throw out a considerable quantity of ballast, in consequence of which they at last rose gently and majestically, though making very little way, with only three bags of ballast of ten pounds weight each. At a quarter after one o'clock, the barometer, which on the cliff stood at 29,7, was fallen to 27,3; and the weather proved fine and warm. Dr. Jeffries describes with rapture the prospect which at this time was before their eyes. The country to the back of Dover, interspersed with towns and villages, of which they could count 37, made a beautiful appearance. On the other side the breakers, on the Goodwin Sands, appeared formidable. Upon the whole, they enjoyed a view perhaps more extended and diversified than was ever beheld by mortal eye. The balloon was much distended, and at 50 minutes past one o'clock was descending, in consequence of which they were obliged to throw out one bag and a half of sand. They were at this time about one-third of the way from Dover, and had lost distinct sight of the castle. Not long after, finding that the balloon was descending very fast, all the remaining ballast was thrown over, as also a parcel of books, in consequence of which the balloon rose again. They were now at about half way. At a quarter past two o'clock the rising of the mercury in the barometer shewed that they were descending; in consequence of which the remaining books were thrown into the sea. At 25 minutes after two, they were at about 3-fourths of the way, and an enchanting view of the French coast appeared before their eyes; but the lower part of the balloon was collapsed, owing to the loss or condensation of the gas, and the machine was descending, which obliged them to throw over provisions for eating, the oars or wings of the boat, and other articles. "We threw away," said Dr. Jeffries, "our only bottle, which, in its descent, cast out a steam like smoke, with a rushing noise; and when it struck the water, we heard and felt the shock very perceptibly on our car and balloon." But the balloon still approaching the sea, they began to strip and cast away their clothes. They even intended to fasten themselves to the cords and cut the boat away, as their last resource; but at this critical point, they had the satisfaction to observe that they were rising; their distance from the French shore, which they were approaching very fast, was about four miles. Fear was now vanishing apace; the French land shewed itself every moment more beautiful, more distinct, and more extended; Calais, and above 20 other towns and villages, were clearly distinguished. Exactly at three o'clock they passed over the high grounds about midway between Cape Blanc and Calais; and it is remarkable that the balloon at this time rose very fast, and made a magnificent arch; probably owing to the heat of the land, which rarefied in some measure the hydrogen gas. At last they descended as low as the tops of the trees, in the forest of Guinnes, and opening the valve for the escape of the gas, they soon after descended safe to the ground, after having accomplished an enterprise which will probably be recorded to the remotest posterity.

The following is the melancholy account of an experiment which was attended with the death of two aerial adventurers, one of whom was Mr. de Rozier, the first person that ever ascended with an aerostatic machine.

Mr. Pilatre de Rozier, desirous of diversifying and improving the new method of travelling through the air, formed a plan of combining the two species of aerostatic machines, from which he expected to render their joint buoyancy more lasting, and of course more useful. His plan was to place an inflammable-air balloon at top, and to affix to it by means of ropes, a rarefied-air balloon, so that a space of several feet might intervene between the two. The passenger or passengers were intended to take their places in the gallery of the lower machine, whence they could regulate the fire, and might, by a proper management of the fuel, elevate or depress the whole, without the necessity of losing any inflammable gas from the upper balloon.

Accordingly this plan was put in execution. The upper or inflammable-air balloon was of varnished silk, lined with a fine membrane, like goldbeaters' skin. The other balloon was of strong linen. On the 15th of June 1785, at seven o'clock in the morning, every thing being ready, Mr. Pilatre de Rozier and a Mr. Romain, placed themselves in the gallery of the balloon, with plenty of fuel, instruments, and other necessary articles, and rose in the atmosphere. The machine seemed to take the best possible direction, but the wind being both feeble and shifting, they changed their direction two or three times; but when they were at a considerable height, and not above $\frac{3}{4}$ of a mile from the place of ascension, the machine appeared to be in flames, and presently the whole was precipitated down to the ground. The unfortunate adventurers were instantly killed, their bones disjointed and dreadfully mangled by the tremendous fall.

How the inflammable air took fire, is variously conjectured; but it is natural to suppose, that the sparks of fire must have flown from the lower to the upper or inflammable-air balloon. On the ground, the bag of the upper balloon was in great measure burned or scorched; that of the lower was entire.

Omitting the various uninteresting, though not numerous aerial voyages undertaken in various parts of the world, during the 17 years subsequent to the above-mentioned dreadful accident of Pilatre de Rozier and Mr. Romain, we shall only add the account of two aerostatic experiments lately performed in England by Mr. Garnerin, a French aeronaut. The first of these is remarkable for the very great velocity of its motion; the second for the exhibition of a mode of leaving the balloon, and of descending with safety to the ground.

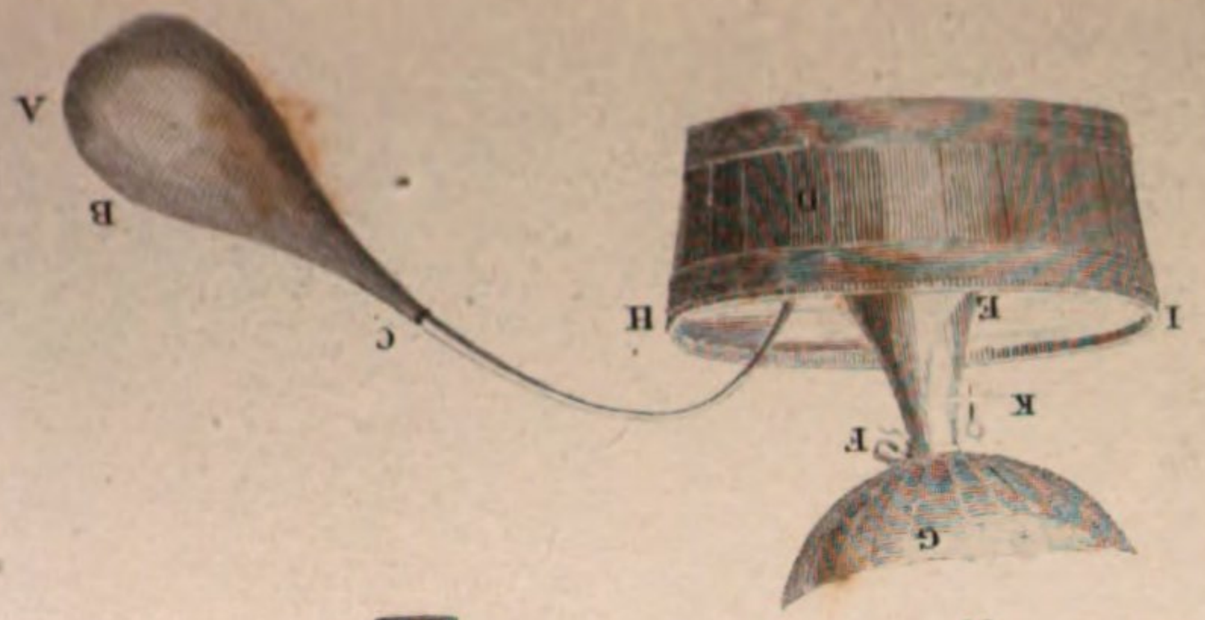
On the 30th of June 1802, the wind being strong though not impetuous, Mr. Garnerin and another gentleman ascended with an inflammable-air balloon from Ranelagh-gardens on the south-west of London, between four and five o'clock in the afternoon; and in exactly three quarters of an hour they descended near the sea, at the distance of four miles from Colchester. The distance of that place from Ranelagh is sixty miles; therefore they travelled at the astonishing rate of 80 miles per hour. It seems that the balloon had power enough to keep them up four or five hours longer, in which time they might have gone safe to the continent; but prudence induced them to descend when they discovered the sea not far off.

The singular experiment of ascending into the atmosphere with an inflammable-air balloon, and of descending with a machine called a parachute, was performed by Mr. Garnerin on the 21st of September 1802. He ascended from St. George's Parade, North Audley-street, and descended safe into a field near the small-pox hospital at Pancras.

The balloon was of the usual sort, viz. of oiled silk, with a net, from which ropes proceeded, which terminated in or were joined to, a single rope at a few feet below the balloon. To this rope the parachute was fastened in the following manner.

The reader may easily form to himself an idea of this parachute, by imagining a large umbrella of canvas of about 30 feet in diameter, but destitute of the ribs and handle. Several ropes of about 30 feet in length,

AEROSTATION.



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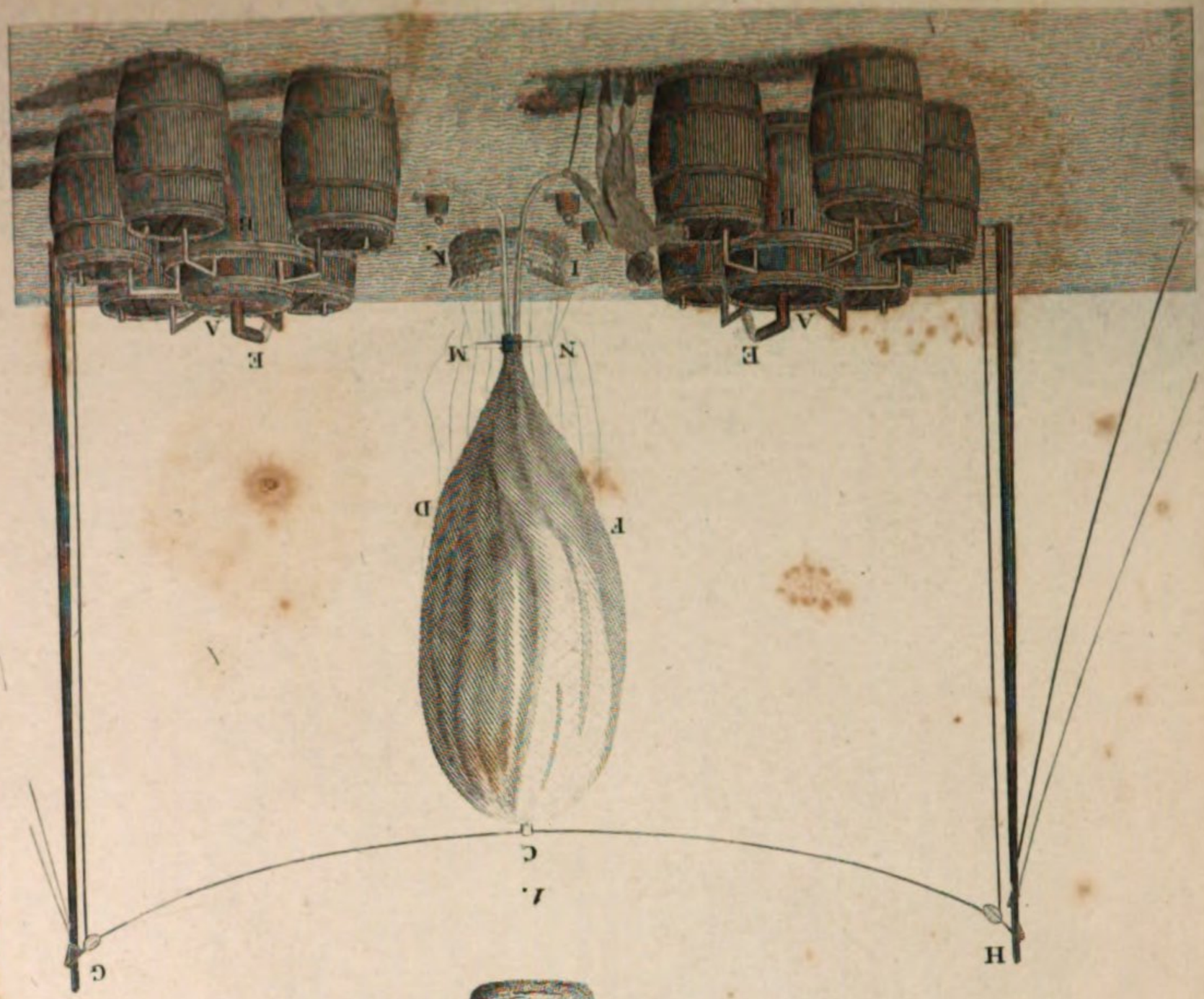

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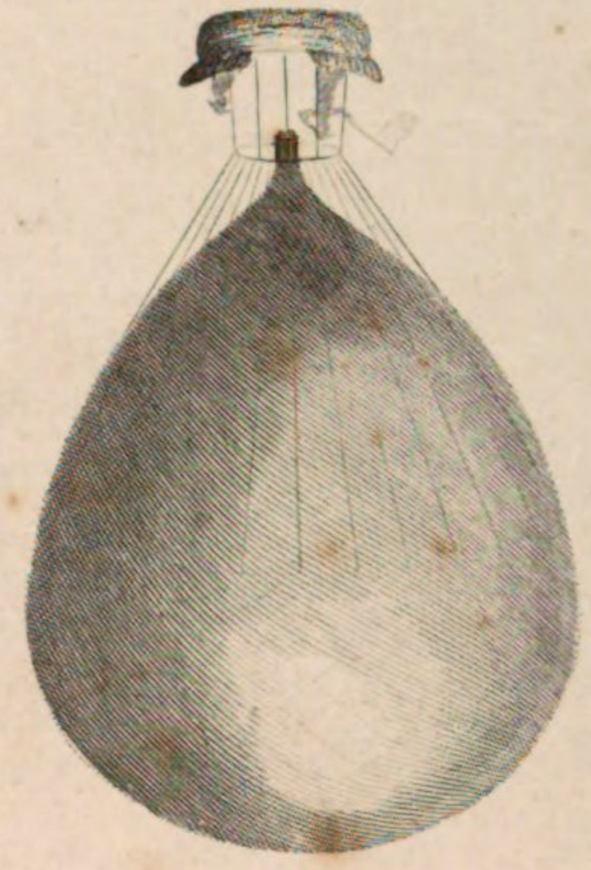

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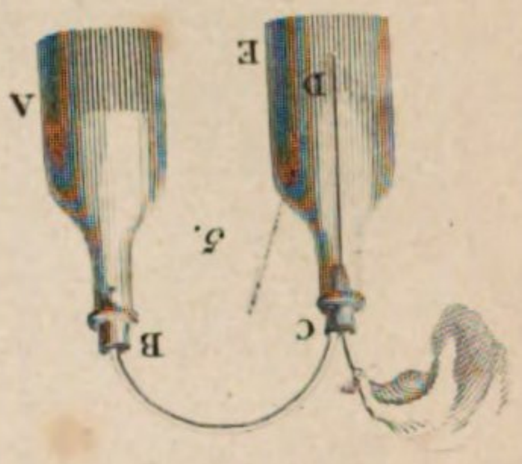

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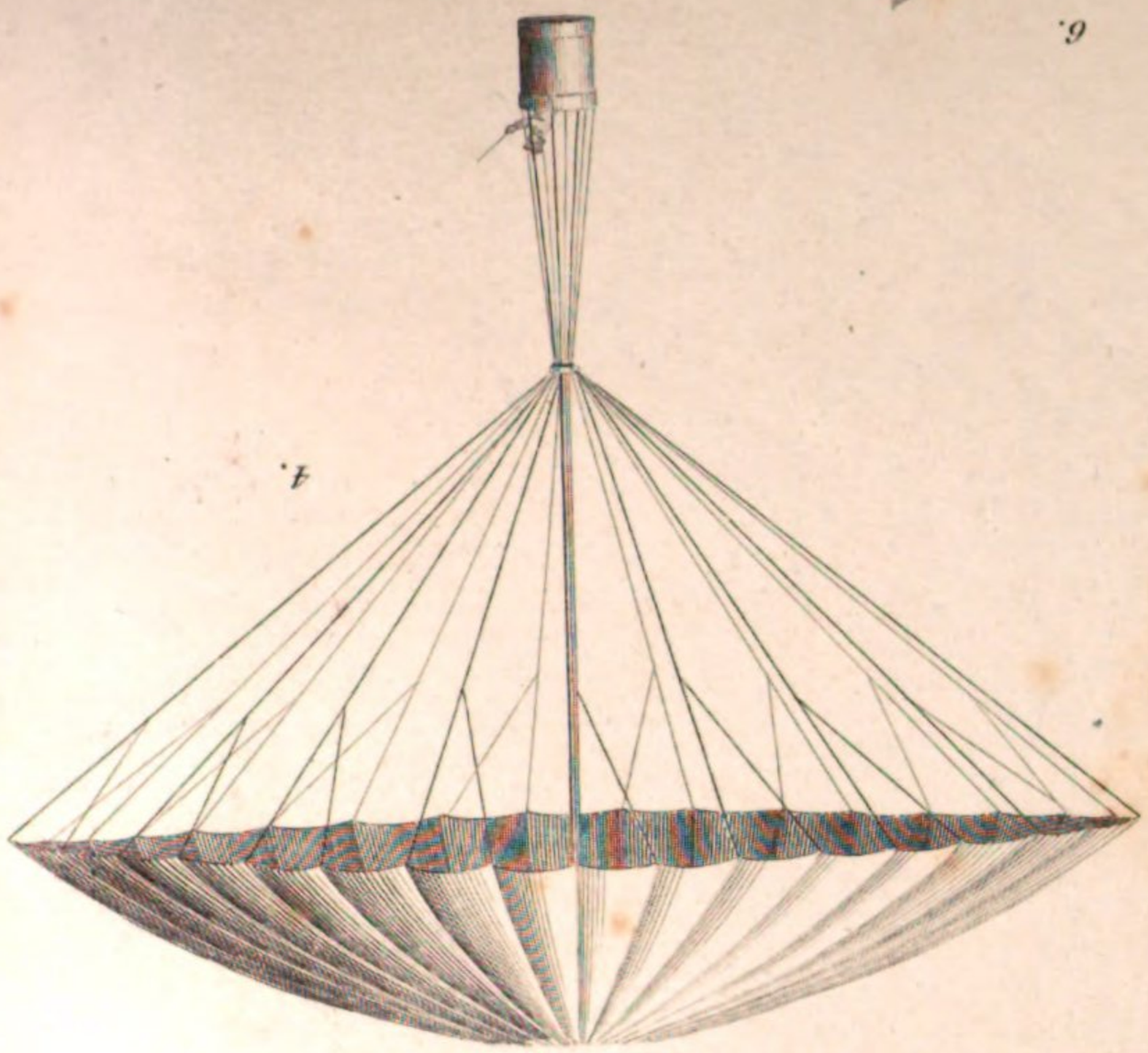

4.

Parachute open

3.

Parachute

which proceeded from the edge of the parachute, terminated in a common joining, from which shorter ropes proceeded, to the extremities of which a circular basket was fastened, and in this basket Mr. Garnerin placed himself. Now the single rope, which has been said above to proceed from the balloon, passed through a hole in the centre of the parachute, also through certain tin tubes, which were placed one after the other in the place of the handle or stick of an umbrella, and was lastly fastened to the basket; so that when the balloon was in the air, by cutting the end of this rope next to the basket, the parachute, with the basket, would be separated from the balloon, and, in falling downwards, would be naturally opened by the resistance of the air. The use of the tin tubes was to let the rope slip off with greater certainty, and to prevent its being entangled with any of the other ropes, as also to keep the parachute at a distance from the basket.

The balloon began to be filled at about two o'clock. There were 36 casks filled with iron filings and diluted sulphuric acid, for the production of the hydrogen gas. These communicated with three other casks or general receivers, to each of which was fixed a tube that emptied itself into the main tube attached to the balloon.

At six, the balloon being quite full of gas, and the parachute, &c. being attached to it, Mr. Garnerin placed himself in the basket, and ascended majestically amidst the acclamations of innumerable spectators. The weather was the clearest and pleasantest imaginable; the wind was gentle and about west by south; in consequence of which Mr. Garnerin went in the direction of about east by north. In about eight minutes time, the balloon and parachute had ascended to an immense height, and Mr. Garnerin, in the basket, could scarcely be perceived. While every spectator was contemplating the grand sight before them, Mr. Garnerin cut the rope, and in an instant he was separated from the balloon, trusting his safety to the parachute.

At first, viz. before the parachute opened, he fell with great velocity; but as soon as the parachute was expanded, which took place a few moments after, the descent became very gentle and gradual. In this descent a remarkable circumstance was observed, namely, that the parachute with the appendage of cords and basket, soon began to vibrate like the pendulum of a clock, and the vibrations were so great, that more than once the parachute, and the basket with Mr. Garnerin, seemed to be on the same level, or quite horizontal, which appeared extremely dangerous: however, the extent of the vibrations diminished as he came pretty near the ground. On coming to the earth, Mr. Garnerin experienced some pretty strong shocks, and when he came out of the basket, he was much discomposed; but he soon recovered his spirits, and remained without any material hurt.

As soon as the parachute was separated from the balloon, the latter ascended with great rapidity, and, being of an oval form, turned itself with its longer axis into an horizontal position.

We shall conclude this article with a description of the several figures on the plate, to which we have before occasionally referred. Figure 1 represents a balloon D F, suspended by means of the poles G and H, and the cord, for the purpose of being filled with gas. It is kept steady and held down whilst filling by ropes, which are readily disengaged. A, A, are two tubs about three feet in diameter, and two feet deep, inverted in larger tubs, B, B, full of water. At the bottom of each of the inverted tubs there is a hole, to which is inserted a tin tube; to these the silken tubes of the balloon are tied. Each of the tubs, B, is surrounded by several strong casks, so regulated in number and capacity, as to be less than half full when the materials are equally distributed. In the top of these casks are two holes; to one of which is adapted a tin tube, formed so as to pass over the edge of the tub B, and through the water, and to terminate with its aperture under the inverted tub A. The other hole, which serves for supplying the cask with materials, is stopped with a wooden plug. When the balloon is to be filled, the common air is first to be expelled, then the silken tubes are fastened round the tin ones; the iron filings are to be put into the casks, then the water, and lastly the sulphuric acid. The balloon will speedily be inflated by the hydrogen gas, and support itself without the aid of the rope G H. As the filling advances, a net is adjusted about it, the cords proceeding from the net are fastened to the hoop M N, the boat I K is suspended from the hoop, and whatever is wanted for the voyage is deposited in the boat. When the balloon is sufficiently full, the silken tubes are separated from the tin tubes, their extremities are tied, and they are placed in the boat. When the aeronauts are seated in the boat, the ropes that held the balloon down are slipped off, and the machine ascends in the air as in figure 2. In figure 3, is a representation of a part of M. Garnerin's balloon in its ascent, to which is attached the parachute, in its contracted state, and below is the car. Figure 4 shews the manner in which M. Garnerin descended in the car by means of the expanded parachute, after he had detached it from the balloon. In figure 5 is represented an apparatus as described by Mr. Cavallo, for filling balloons of the size of two or three feet in diameter with inflammable air, after passing it through water. A is a bottle with the ingredients; B C D a tube fastened in the neck at B, and passing through C, the cork of the other bottle, in which there is a hole made to receive the tube, and to this the balloon is tied. Thus the inflammable air coming out of the tube D, will pass first through the water of the bottle E, and then into the balloon. Two small casks may be used instead of the bottles A and E.

To obtain the gas from the coarser kind of materials, the following apparatus may be recommended. Let a vessel be made of iron in the shape of a Florence flask (figure 6). Put the substance into this vessel, so as to fill about three-fourths of its cavity. Lute a tube of brass to the neck C of the vessel, and let the end D of the tube be shaped as in the figure, so that going into the water H I, it may terminate under a sort of inverted vessel, E F, to the upper aperture of which the balloon G is adapted. If now the part A B of the vessel is put into the fire, and made red-hot, the inflammable air produced will come out of the tube C D, and passing through the water will at last enter into the balloon G.

AIR-GUN. See PNEUMATICS.

AIR-JACKET, a sort of jacket made of leather, in which are several bags, or bladders, composed of the same materials, communicating with each other. These are filled with air through a leather tube, having a brass stop-cock accurately ground at the extremity, by which means the air blown in through the tube is confined to the bladders. The jacket must be wet before the air is blown into the bags, as otherwise it will immediately escape through the pores of the leather. By the help of these bladders, which are placed near the breast, the person is supported in the water, without making any effort to swim.

AIR-PIPES, an invention for drawing foul air out of ships, or any other close places, by means of fire. These pipes were first discovered by a Mr. Sutton, a brewer in London; and from him have got the name of *Sutton's Air-pipes*. The principle on which their operation depends, is no other than that air is necessary for the support of fire; and, if it has not access from the places most adjacent, will not fail to come from those that are more remote. Thus, in a common furnace, the air enters through the ash-hole; but if this is closed up, and a hole made in the side of a furnace, the air will rush in with great violence through that hole. If a tube of any length whatever is inserted in this hole, the air will rush through the tube into the fire, and of consequence there will be a continued circulation of air in that place where the extremity of the tube is laid. Mr. Sutton's contrivance then amounts to this. As, in every ship of any bulk, there is already provided a copper or boiling-place proportionable to the size of the vessel; it is proposed to clear the bad air by means of the fire already used under the coppers or boiling-places for the necessary uses of the ship. It is well known, that, under every such copper or boiler, there are placed two holes, separated by a grate; the first of which is for the fire, and the other for the ashes falling from it; and that there is also a flue from the fire-place upward, by which the smoke of the fire is discharged at some convenient place of the ship. It is also well known, that the fire once lighted in these fire-places, is only preserved by the constant draught of air through these two holes and flue; and that if the holes are closely stopped up, the fire, though burning ever so briskly before, is immediately put out. But if, after shutting up these holes, another hole is opened, communicating with any other room or airy place, and with the fire, it is clear the fire must burn as before, there being a like draught of air through it as there was before the stopping up of the first holes. It is therefore proposed, that, in order to clear the holds of ships of the bad air contained in them, the two holes abovementioned, the fire-place and ash-place, be both closed up with substantial and tight iron doors, and a copper or leaden pipe, of sufficient size, be laid from the hold into the ash-place, for the draught of air to come in that way to feed the fire. And thus it seems plain, from what has been already said, that there will be, from the hold, a constant discharge of the air; and consequently, that air, so discharged, must be as constantly supplied by fresh air down the hatches or such other communications as are opened into the hold. And if into this principal pipe so laid into the hold, other pipes are let in, communicating respectively either with the well or

lower decks, it must follow, that part of the air consumed in feeding the fire, must be respectively drawn out of all such places to which the communication shall be so made.

AIR-PUMP. See PNEUMATICS.

AIR SHAFTS, among miners, denote holes or apertures let down from the open air to meet the adits, and furnish fresh air. Sir Robert Murray describes a method, used in the coal mines at Liege, of working mines without air shafts. When the miners at Mendip have sunk a groove, they will not be at the charge of an air shaft till they come at ore; and for the supply of air have boxes of elm exactly closed, of about six inches in the clear, by which they carry it down about 20 fathoms. They cut a trench at a little distance from the top of the groove, covering it with turf and rods disposed to receive the pipe, which they contrive to come in sideways to their groove, four feet from the top, which carries down the air to a great depth. When they come at ore, and need an air shaft, they sink it four or five fathoms distant, according to the convenience of the breadth, and of the same fashion with the groove, to draw as well ore as air.

AIR THREADS, in natural history, a name given to the long filaments so frequently seen in autumn floating about in the air. These threads are the work of spiders, especially of that species called the long-legged field spider. See ARANEA.

AIR TRUNK, is a contrivance by Dr. Hales to prevent the stagnation of putrid effluvia in jails and other places where a great number of people are crowded together, in a small space. It consists only of a long square trunk, open at both ends; one of which is inserted into the ceiling of the room, the air of which is required to be kept pure; and the other extends a good way beyond the roof. The putrid effluvia, therefore, being lighter than the pure air of the atmosphere, ascend, or are forced by it, through the trunk, and carried clear away. The reason why vapours of this kind ascend more swiftly through a long trunk than a short one, is, that the pressure of fluids is always according to their different depth, without regard to the diameter of their basis, or of the vessel which contains them; and, upon this principle, a gallon of water may be made to split a strong cask. When the column of putrid effluvia is long and narrow, the difference between the column of atmosphere pressing on the upper end of the trunk, and that which presses on the lower end, is much greater than if the column of putrid effluvia was short and wide, and consequently the ascent is much swifter. One pan of a single pair of scales, which was two inches in diameter, being held within one of these trunks over the house of commons, the force of the ascending air made it rise so as to require four grains to restore the equilibrium, and this when there was no person in the house; but when it was full, no less than 12 grains were requisite to restore the equilibrium.

AIR VESSELS are spiral ducts in the leaves, &c. of plants, supposed to be analogous to the lungs of animals, in supplying the different parts of a plant with air. See PHYSIOLOGY of PLANTS.

AITONIA, (so named in honour of Mr. Aiton, his majesty's gardener at Kew) a genus of the class and order monodelphia octandria. The essential character is, style 1, cal. four-parted, cor. four-petalled; berry dry, quadrangular, one-celled, many seeded.

There is but one species, a shrub found at the Cape of Good Hope. The segments of the calyx and the petals are red, the fruit is also red and large. It must be kept in a good green-house, or a moderate stove.

AJUGA, BUGLE, a genus of the gymnospermia order, and didynamia class of plants; and in the natural method ranking under the 42d order, Asperifoliæ. The characters are, the calyx is a short perianthium, monophyllous and persistent; the corolla is monopetalous and grinning; the stamina consist of four erect subulated filaments; the antheræ are dimidiated; the pistillum has a four-cleft germen, a filiform stylus, and two slender stigmata: there is no pericarpium; the calyx converging, and containing the seeds in its bosom: the seeds are four and oblong. There are six species, the principal of which are:

1. AJUGA GENEVENSIS, with woolly leaves and hairy cups, a native of Switzerland, and of the southern parts of Europe.

2. AJUGA ORIENTALIS, with inverted flowers, is a native of the East.

3. AJUGA PYRAMIDALIS, or mountain bugle, with a square pyramidal spike and blue flowers, a native of Sweden, Germany, Switzerland and England.

4. AJUGA REPTANS, common or pasture bugle, with creeping suckers, and blue, red, or white blossoms, a native of the southern parts of Europe, and is met with in woods and moist places in many parts of Britain. The roots are astringent, and strike a black colour with vitriol of iron.

AJUTAGE, or ADJUTAGE, a sort of tube, fitted to the mouth, or aperture of the vessel, through which the water of a fountain is to be played, and by it determined into different figures. It is indeed chiefly the diversity in the ajutages that constitutes the different kinds of fountains. And hence, by having several adjutages to be supplied occasionally, one fountain comes to have the effect of many. See HYDRAULICS.

AIZOON, a genus of the pentagynia order, and icosandria class of plants, and in the natural method ranking under the 13th order, succulentæ. The characters are: the calyx is a single-leaved perianthium, divided into five segments, and persistent: there is no corolla: the stamina consist of very numerous capillary filaments; the antheræ are simple: the pistillum has a five-cornered germen above, with five simple styli; and the stigmata are simple: the pericarpium is a bellied, retuse, five-cornered capsule, having five cells and five valves: the seeds are many and globular. There are ten species, of which

1. AIZOON CANARIENSE, a native of the Canary islands;

2. AIZOON HISPANICUM, a native of Spain; and,

3. AIZOON PANICULATUM, a native of the Cape of Good Hope; are the principal. They may all be raised in this country in hot-beds; but they are not remarkable either for beauty or any other property.

AKOND, an officer of justice in Persia, who takes cognizance of the causes of orphans and widows, of contracts and other civil concerns. He is the head of the school of law, and gives lectures to all the subaltern officers. He has his deputies in all the courts of the kingdom, who, with the second *sadra*, make all contracts.

AL, an Arabic particle prefixed to words, and signifying much the same with the English particle *the*: thus they say, alkermes, alkoran, &c. *i. e.* the kermes, the koran, &c.

ALA, in botany, is used for the hollow of a stalk, which either the leaf, or the pedicle of the leaf, makes with it; or it is that hollow turning, or sinus, placed between the stalk or branch of a plant and the leaf, whence a new offspring usually issues. Sometimes it is used for those parts of leaves otherwise called *lobes*, or *wings*.

ALABARDA, the name of a spear anciently used by the Helvetians and Germans.

ALABASTER, in natural history, a species of that genus of stones whose base is calcareous earth. It differs from marble in being combined, not with the aerial, but with sulphuric acid; therefore, when mixed with any acid, no effervescence appears. It is soluble in about 500 times its weight of water at the temperature of 60. It is fusible alone in a long continued porcelain heat, or by the blow-pipe. Specific gravity 1.87. Texture granular, with shining particles. In composition, and consequently in its chemical properties, it does not differ from gypsum, selenite, or plaster of Paris. The fineness and clearness of this stone render it in some measure transparent; whence it has been sometimes employed for windows. There is a church at Florence still illuminated, instead of panes of glass, by slabs of alabaster near 15 feet high, each of which forms a single window, through which the light is conveyed. The countries in Europe which abound most in alabaster are Germany, towards Coblentz; the province of Maconnois, in the neighbourhood of Cluni in France; Italy towards Rome, where that of Montaiout is particularly remarkable not only for its whiteness, but also for the size of its blocks, some of which are so large, that statues as big as the life may be easily cut out of them. A new manufacture of basso-relievos, from a singular species of factitious alabaster, was some time ago established by Mr. Letapie, at the baths of St-Philip in Tuscany. The stream at these baths deposits a peculiar kind of sand, which, when collected and condensed in the cavities of any body employed to oppose its current, acquires the nature, hardness, and colour, of alabaster, and assumes the forms of those cavities in which it is thus lodged. There are three species of alabaster, viz.

1. ALABASTER, THE SNOW WHITE SHINING, or lygdinum of the antients. 2. THE VARIEGATED, yellow and reddish. This species is the common alabaster of the antients. 3. THE YELLOWISH, or phengites of Pliny, is found in Greece, Germany, France, and Derbyshire in England. The alabasters are frequently used by statuaries for small statues, vases, and columns. After being calcined and mixed with water, they may be cast in any mould like plaster of Paris. See GYPSUM and MINERALOGY.

ALÆ, in anatomy, a term applied to the lobes of the liver, the cartilages of the nostril, and sometimes to the armpits.

ALÆ, in botany, (the plural of *Ala*,) is used to signify those petals of leaves of papilionaceous flowers, placed between those others which are called the *vexillum* and *carina*, and which form the top and bottom of

the flowers. Instances of flowers of this structure are seen in those of peas and beans, in which the top leaf or petal is the vexillum, the bottom the carina, and the side ones the alæ. Alæ is also applied to those extremely slender and membranaceous parts of some seeds which appear as wings placed on them; and likewise signifies those membranaceous expansions running along the stems of some plants, which are therefore called *alated stalks*.

ALAMODE, in commerce, a thin glossy black silk, chiefly used for women's hoods and men's mourning scarfs, commonly called mode.

ALARAF, in the Mahometan theology, the partition wall that separates heaven from hell.

ALARES, in antiquity, are supposed by some authors to have been a kind of militia or soldiers among the Romans; so called from *ala*, a wing, because of their lightness and swiftness in the combat. Others make them a people of Pannonia; but others, with more probability, take *alares* for an adjective, or epithet, and apply it to the Roman cavalry, because placed in two wings, or *alæ*, of the army; for which reason a body of horse was called *ala*.

ALASCANI, in church history, a sect of antilutherans, whose distinguishing tenet, besides their denying baptism, is said to have been this, that the words, *This is my body*, in the institution of the eucharist, are not to be understood of the bread, but of the whole action or celebration of the supper.

ALAUDA, Lark, in ornithology, a genus of birds of the order of passeres; the characters of which are, that the beak is cylindrical, subulate, and straight, bending towards the point; the mandibles are of equal size and opening downwards at their base; the tongue is bifid; and the hinder claw is straighter and longer than the toe.

1. A. arvensis, the skylark, the specific characters of which are, that the two outermost quills of its tail are white lengthwise externally, and the intermediate ones are ferruginous on the inside; the length is about seven inches. The males of this species are somewhat browner than the females; they have a black collar, and more white on the tail; their size is larger, and their aspect bolder; and they exclusively possess the faculty of singing. When the female is impregnated, she forms her nest between two clods of earth, and lines it with herbs and dry roots, being no less attentive to the concealment than to the structure of it. It sometimes builds its nest among corn and in high grass. Each female lays four or five eggs, which are greyish, with brown spots; and the period of her incubation is about 15 days. The young may be taken out of the nest when they are a fortnight old, and they are so hardy that they may be easily brought up. Some have said that she hatches three times in the year; but this must depend on the temperature of the climate. The parent is very tender of her young; and though she does not always cover them with her wings, she directs their motions, supplies their wants, and guards them from danger. The common food of the young sky-larks is worms, caterpillars, ant's-eggs, and even grasshoppers; and in maturity, they live chiefly on seeds, herbage, and all vegetable substances. Those birds, it is said, that are destined for singing, should be caught in October or November; and the males should, as much as possible, be selected: and when they are untractable they should be pinioned, lest they injure themselves by their violence against the roof of the cage. As they cannot cling by the toes, it is needless to place bars across their cage; but they should have clean sand at the bottom of the cage, that they may welter in it, and be relieved from the vermin which torment them.

The lark is found in all the inhabited parts of both continents, as far as the Cape of Good Hope; though Villault says that it is not found on the Gold coast; nor, according to Averroes, in Andalusia.

This bird, and the wood-lark, are the only birds which sing whilst they fly. The higher it soars, the more it strains its voice, and lowers it till it quite dies away in descending. When it ascends beyond our sight, its music is distinctly heard; and its song, which is full of swells and falls, and thus delightful for its variety, commences before the earliest dawn.

In a state of freedom, the lark begins its song early in the spring, which is its season of pairing, and continues to warble during the whole of the summer.

2. A. pratensis, the titlark, of which the specific characters are, that above it is greenish brown; its two outermost tail-quills are externally white, and it has a white line on its eyebrows. This bird is of an elegant slender shape, five inches and a half long; its bill is black; the back and head of a greenish brown, spotted with black; the throat and lower part of the belly are white; the breast yellow, marked with oblong spots of black; the tail is dusky: the exterior feather is varied by a bar of white, which runs across the end and takes in the whole outmost web; the claw on the hind toe is very long, and the feet yellowish. The male has in general more yellow than the female, on the throat, breast, legs, and feet. The tit-lark is found generally in meadows and low marshy grounds; and, like other larks, it makes its nest among the grass, and lays five or six eggs, which are roundish, of a dusky red colour, with many small spots. While the female hatches, the male sits on a neighbouring tree, and rises at times, singing and clapping his wings. It feeds chiefly on the worms and insects which it finds in new-ploughed lands; and it will live for a long time on no other food than small seeds. Like the wood-lark, it sits on trees; but it is flushed at the least noise, and shoots with a rapid flight: it has a very remarkable fine note, singing in all situations; on trees, on the ground, while it is sporting in the air, and particularly in its descent.

3. A. arborea, the wood-lark of English writers, is specifically characterised by a white annular belt, encircling its head. This bird is smaller than the sky-lark, and of a shorter thicker form; the colours of the plumage are paler; the first feather of the wing is shorter, than the second; the hind claw is very long and somewhat bent; it perches on trees; it haunts the uncultivated tracts near copses, without penetrating the woods, whence its name; its song resembles more the warble of the nightingale, or the whistling of the blackbird, than that of the sky-lark; its note being less sonorous and less varied, though not less sweet; and it is heard not only in the day but in the night, both when it flies and when it sits on a bough.

This bird builds on the ground, and forms its nest on the outside with moss, and on the inside with dried bents, lined with a few hairs, and conceals it with a turf; and the situation it selects is ground where the grass is rank, or become brown. It lays four or five eggs, which are dusky and blotched with deep brown; its fecundity is inferior to that of the sky-lark, and its numbers are not so great: it breeds earlier, since its young are sometimes flown in the middle of March, and therefore they pair in February, at which time, and not before, they part with their last year's brood; whereas the common lark does not hatch before the month of May. This is a very tender and delicate bird; so that it is impossible to rear the young taken out of the nest; but this is the case only in England and such cold climates, for in Italy they are removed from the nest, and reared at first like the nightingale, and afterwards fed upon panic and millet. The wood-lark feeds on beetles, caterpillars, and seeds: its tongue is forked; its stomach muscular and fleshy; and it has no craw, but a moderate dilatation of the lower part of the œsophagus; and its cæca are very small. It lives ten or twelve years. The males are distinguished from the females by their larger size; the crown of the head is also of a darker colour, and the hind nail longer; its breast is more spotted, and its great wing-quills edged with olive, which in the female is grey. The wood-lark mounts high, warbling its notes, and hovering in the air; it flies in flocks during the winter colds; it is found in Sweden and Italy, and is probably dispersed through the intervening countries, and consequently over the greatest part of Europe. It is also found in Siberia, as far as Kamtschatka, and in the island of Madeira.

4. A. campestris, the meadow-lark, is rather larger than the tit-lark, being six inches and a half in length. Its specific characters are, that its tail-quills are brown; the lower half, except two intermediate quills, white; the throat and breast yellow. According to Willughby, the meadow-lark differs from the other larks by the blackness of its bill and feet; he adds, that its bill is slender, straight, and pointed, and the corners of its mouth edged with yellow; that it has not, like the wood-lark, the first quills of the wings shorter than the succeeding; and that in the male the wings are rather darker than in the female. Though the males are hardly to be distinguished from the females by their external appearance, yet if another male is presented, shut up in a cage, they will instantly attack it as an enemy or a rival. This bird has a slenderer body than the sky-lark, and is distinguished from it by the shake of its tail, like that of the wagtail and tit-lark. It inhabits heaths and uncultivated tracts, and frequently the oat-stubble, after the corn is reaped, where birds of this species gather together in numerous flocks. In spring, the male perches to discover or woo his mate, and sometimes he mounts into the air, singing with all his might, and then descends quickly to pair on the ground. When a person approaches the nest, the female betrays her fears by her cries; whereas, other larks are silent unmoved, when danger is apprehended. They make their nest close to the ground, sometimes in furze-bushes, and form it of moss, lined with straw and horse-hair.

5. A. trivialis, is distinguished by brown tail-quills, the outermost half white, the second white at its wedge-like tip, with a double

whitish line on the wings. The German epithet *piep*, and the English *pippit* formed from the Latin *pipio*, which signifies to utter a feeble cry like chickens, alludes to the sibilous notes of this bird. Its cry, especially in winter, is like that of the grasshopper, but stronger and shriller, and it utters this, both when perched on the tallest branches among the bushes, and when it is on the wing. Its tones are soft, harmonious, and clear. This little bird builds its nest in solitary spots, concealed under a turf, and its young are frequently a prey to the adders. It lays five eggs, of a light grass-green colour, thinly sprinkled with deeper coloured specks. The grasshopper larks appear in England about the middle of September, and great numbers of them are caught in the environs of London.

6. A. cristata, is distinguished by black tail-quills, the two outermost white at their exterior edge, its head crested, and its feet black. Its length is about six inches and three quarters. It lives in the meadows and fields, on the sides of ditches and the backs of furrows: it is often seen at the margin of water, and on the high roads, rarely in the skirts of woods, perched on a tree, and sometimes on the tops of houses, and of abbeys, &c. This lark, though not so common as the sky-lark, is found in most parts of Europe, in Italy, France, Germany, Poland, Denmark, Russia, Scotland, and does not change its abode in winter. The song of the males is loud, and yet mellow and pleasant; and their warbling is usually accompanied with a quivering of the wings.

The crested lark is the only one that may be instructed; in a month it learns many airs perfectly, which it repeats without confusion, and retains nothing of its native warble; and in these particulars it is superior to the canary.

The other species are, the alauda rufa, capensis, calandra, alpestris, magna, minor, italica, ludoviciana, rubra, mosellana, malabarica, gingica, tartarica, mutabilis, nemorosa, undata, senegalensis, testacea, lusitana, africana, cinerea, Novæ Zeelandiæ, mongolica, sibirica, flava, obscura, most of them foreign birds. In all 33 species.

ALBARIUM OPUS, in the ancient building, the incrustation or covering of the roofs of houses with white plaster, made of mere lime. This is otherwise called *opus album*. It differs from *tectorium*, which is a common name given to all roofing or ceiling, including even that formed of lime and sand, or lime and marble; whereas albarium was restrained to that made of lime alone.

ALBATROSSE. See DIOMEDEA.

ALBE, a small piece of money, current in Germany, worth only a French sol and seven deniers.

ALBERNUO, a kind of camblet, brought from the Levant by the way of Marseilles.

ALBERTUS, a gold coin, worth about 14 French livres: it was coined during the administration of Albertus archduke of Austria.

ALBIGENSES, in church history, a party of reformers about Toulouse and the Albigeois in Languedoc, who sprung up in the twelfth century, and distinguished themselves by their opposition to the discipline and ceremonies of the church of Rome. This sect had their name, it is supposed, either because there were great numbers of them in the diocese of Albi, or because they were condemned by a council held in that city. In fact it does not appear that they were known by this name before the holding of that council. The albigenses were also called *albiani*, *albigesei*, *albii*, and *albanenses*, though some distinguish these last from them. The albigenses, by the truth of their doctrines, and their vigour and energy in propagating them, became so formidable, that the papists agreed upon a holy league or croisade against them. They were at first supported by Raimond, count of Toulouse. Pope Innocent III., desirous to put a stop to their progress, sent a legate into their country, which failing, he stirred up Philip Augustus, king of France, and the other princes and great men of the kingdom, to make war upon them. Upon this, the count of Toulouse, who had supported them, made his submission to the pope, and went over to the catholics; but soon after, finding himself plundered by the croisaders, he declared war against them, and was joined by the king of Arragon. His army was defeated at the siege of Muret, where he himself was killed, and the defeat followed by the surrender of the city of Toulouse, and the conquest of the greatest part of Languedoc and Provence. His son Raimond succeeded him; who agreed with the king and the pope to establish the inquisition in his estates, and to extirpate the Albigenses. In an assembly held at Milan, the archbishop of Toulouse drew up articles; agreeable to which the count made a most ample declaration against them, which he published at Toulouse in 1253. From this time the Albigenses dwindled by little and little, till the times of the reformation; when such of them as were left fell in with the Vaudois, and became conformable to the doctrine of Zuinglius and the discipline of Geneva.

ALBIGENSES is also a name sometimes given to the followers of Peter Vaud, or Waldo; and hence synonymous with Waldenses, or poor men of Lyons. In this sense the word is applied by Camerarius, Thuanus, and several other writers. The reason seems to be, that the two parties agreed in their opposition to the papal innovations and encroachments, though in many other respects different. The bishop of Meaux labours hard to support a distinction between the two sects, alleging, that the Albigenses were heretics and Manichees; whereas the Waldenses were only schismatics, not heretics, being sound as to articles of faith, and only separating from the church of Rome on account of forms and discipline. Dr. Allix endeavours to set aside the distinction; and shows, that both of them held the same opinions, and were equally condemned and held for heretics; and this not for points of faith, but for declaiming against the papal tyranny and idolatry, and holding the pope to be the antichrist; which last, according to the bishop of Meaux, constitutes little less than Manicheism. In this sense the Lollards and Wickliffites in England were not only Albigenses but Manichees.

ALBINOS, the name by which the Portuguese call the white Moors, who are looked upon by the negroes as monsters. They at a distance might be taken for Europeans; but, upon a near inspection, their white colour appears like that of persons affected with a leprosy. In Saussure's *Voyages dans les Alpes*, is the following account of two boys, at Chamouni, who have been called Albinos: "The elder, who was at the end of the year 1785 about twenty or one-and-twenty years of age, had a dull look, with lips somewhat thick, but nothing else in his features to distinguish him from other people. The other, who is two years younger, is rather a more agreeable figure: he is gay and sprightly, and seems not to want wit. But their eyes are not blue; the iris is of a very distinct rose-colour: the pupil too, when viewed in the light, seems decidedly red; which seems to demonstrate, that the interior membranes are deprived of the uvea, and of that black mucous matter that should line them. Their hair, their eye-brows, and eye-lashes, the down upon their skin, were all, in their infancy, of the most perfect milk-white colour, and very fine; but their hair is now of a reddish cast, and has grown pretty strong. I am therefore of opinion that we may consider these two lads as true albinos: for if they have not the thick lips and flat noses of the white negroes, it is because they are albinos of Europe not of Africa. This infirmity affects the eyes, the complexion, and the colour of the hair; it even diminishes the strength, but does not alter the conformation of the features. Besides, there are certainly in this malady various degrees: some may have less strength, and be less able to endure the light: but these circumstances in those of Chamouni are marked with characters sufficiently strong to entitle them to the unhappy advantage of being classed with that variety of the human species denominated albinos."

ALBORAK, amongst the Mahometan writers, the beast on which Mahomet rode in his journeys to heaven. The Arab commentators give many fables concerning this extraordinary vehicle. It is represented as of an intermediate shape and size between an ass and a mule. A place, it seems, was secured for it in paradise at the intercession of Mahomet; which, however, was in some measure extorted from the prophet by Alborak's refusing to let him mount him when the angel Gabriel was come to conduct him to heaven.

ALBUCA, a genus of the hexandria-monogynia class and order. The essential character is, corolla six petalled, inner ones difform, stamina three of the six castrated stigma, surrounded by six carps. There are eight species, rather tender, but may be kept in winter in a garden frame.

ALBUGINEA, in anatomy, the outermost coat or tegument of the eye, otherwise called *adnata* and *conjunctiva*.

ALBUGO, or LEUCOMA, is defined by physicians to be a distemper occasioned by a white opaque spot growing on the corner of the eye, and obstructing vision. See MEDICINE.

ALBULA, in ichthyology, a genus of fishes of the truttaceous kind, having no teeth. The principal species are,

1. Albula indica, a small fish resembling a herring, caught about the shores of the East Indies, and called by the Dutch the wit-fish.

2. Albula nobilis, a truttaceous fish caught in great plenty in the lakes of Germany and other places.

ALBULA, in natural history, mineral waters of an aluminous kind; hence endowed with an astringent quality, and of use in wounds.

ALBUMEN. The eggs of fowls contain two very different substances: a yellow oily-like matter, called the *yolk*, and a colourless glossy viscid liquid, distinguished by the name of *white*. This last is the substance which

chemists have agreed to denominate albumen. The white of an egg, however, is not pure albumen. It contains, combined with it, some soda and some sulphur: but as albumen is never found except combined with these bodies, and as no method is known of separating it without at the same time altering the properties of the albumen, chemists are obliged to examine it while in combination with these bodies.

Albumen dissolves readily in water, and the solution has the property of giving a green colour to vegetable blues, in consequence of the soda which it contains. When albumen is heated to the temperature of 165°, it coagulates into a white solid mass; the consistency of which, when other things are equal, depends, in some measure, on the time during which the heat was applied. The coagulated mass has precisely the same weight that it had while fluid. This property of coagulating when heated is characteristic of albumen, and distinguishes it from other bodies.

The taste of coagulated albumen is quite different from that of liquid albumen: its appearance, too, and its properties, are entirely changed; for it is no longer soluble, as before, either in hot or in cold water.

The coagulation of albumen takes place even though air is completely excluded; and even when air is present, there is no absorption of it, nor does albumen in coagulating change its volume. Acids have the property of coagulating albumen, as Scheele ascertained. Alcohol also produces, in some measure, the same effect. Heat, then, acids and alcohol, are the agents which may be employed to coagulate albumen.

Scheele and Fourcroy have ascribed the coagulation of albumen to the addition of a new substance. According to Scheele, caloric is the substance which is added. Fourcroy, on the contrary, affirms that it is oxygen.

Albumen then is capable of existing in two states; the one before it has been coagulated, and the other after it has undergone coagulation. Its properties are very different in each. It will be proper, therefore, to consider them separately.

1. Albumen, in its natural state or uncoagulated, is a glary liquid, having little taste, and no smell. When dried spontaneously, or in a low heat, it becomes a brittle transparent glassy-like substance, which, when spread thin upon plain surfaces, forms a varnish, and is accordingly employed by bookbinders for that purpose. When thus dried, it has a considerable resemblance to gum arabic, to which also its taste is similar. The white of an egg loses about 4-5ths of its weight in drying. It is still soluble in water, and forms the same glary liquid as before.

Uncoagulated albumen soon putrefies unless it is dried; in which state it does not undergo any change.

2. When albumen is coagulated either by heat, alcohol, or acids, it is an opaque substance of a pearl white colour, tough, and of a sweetish mucilaginous taste. It is no longer soluble in water, and is not nearly so susceptible of decomposition as uncoagulated albumen. Mr. Hatchett kept it for a month under water, and yet it did not become putrid. It is to the experiments of this ingenious chemist that we are indebted for almost every thing at present known relative to coagulated albumen. By drying it in the temperature of 212°, he converted it into a brittle hard yellow substance, semitransparent like horn.

These properties indicate sufficiently that coagulated albumen is a very different substance from uncoagulated albumen. During the coagulation its component parts must arrange themselves differently.

From the effects of nitric acid on albumen and its products, when subjected to destructive distillation, it has been concluded that it consists of carbon, hydrogen, azote, and oxygen, in unknown proportions. As it yields more azotic gas to nitric acid, it has been considered as containing more of that principle than gelatine. It is obvious, however, that it does not differ much from that body, as nitric acid spontaneously converts it into gelatine. Albumen forms the membranous parts of many shells, sponges, &c. It is, in short, one of the most important and general animal substances.

The property which albumen has of being coagulated by heat renders it a very useful substance for clarifying fluids. See Thompson's Chemistry.

ALBUMEN, vegetable. This substance was discovered by Fourcroy, who observed that the clarification of the expressed juices of antiscorbutic plants was effected by the spontaneous coagulation of their colouring matter, at the temperature of boiling water, on which account he was led to examine whether this property did not depend on the presence of albumen. He obtained the juice of two pounds of young cresses, and filtered it while cold through blotting paper, and thus separated the grosser parts of the colouring fecula; the liquor was still of a bright green, and upon being exposed in a broad shallow vessel to the air at the temperature of 80° Fahrenheit, in two hours it became turbid, and deposited green matter, becoming itself almost colourless; in this state it was exposed to the heat of boiling water, and in a few minutes there separated a quantity of whitish flocculent matter. Another portion of the same liquor exposed to the air, deposited, at the end of two days, a similar coagulum; and the same effect was produced on a third portion by the addition of sulphuric acid. This substance exhibited all the properties of animal albumen.

Albumen has since been found in the roots of various vegetables; also in wheat, and the farinaceous seeds; and in general in all the green and succulent plants. The acid pulp of fruits are totally destitute of this substance, but they abound with jelly; and it is supposed that, in all these cases, there is a conversion of albumen into jelly, by the gradual evolution of the acid, and fixation of oxygen.

ALBURNUM, the soft white substance found in trees between the liber, or inner bark, and the true wood, and which, in process of time, is itself converted into that substance. It is found in the largest quantities in trees which are vigorous. In an oak six inches in diameter this substance is nearly equal in bulk to the wood. In a trunk of one foot diameter, it is as one to three and a half; of two and a half feet diameter, as one to four and a half, &c. but these proportions vary according to the health and constitution of the trees. The alburnum is frequently gnawed in pieces by insects, which lodge in this substance, and are nourished from it.

ALCA, or AUK, in ornithology, a genus of the order of anseres. The beak of this genus is without teeth, short, convex, compressed, and frequently furrowed transversely: the inferior mandible is gibbous near the base; the feet have generally three toes. There are 12 species of the alca, of which the most remarkable are,

1. ALCA ALLE, the little auk, or black and white diver, with a smooth conical bill, a white streak on the belly and wings, and black feet. The size of this species exceeds not that of a blackbird. It is not very common in England. It seems to be most plentiful towards the north, being met with in various parts as far as Spitzbergen. It is common in Greenland, in company with the black-billed species; feeds on the same food; and lays two blueish eggs, larger than those of a pigeon. It flies quick, and dives well; and is always dipping its bill into the water, while swimming or at rest on the water. It grows fat in the stormy season, from the waves bringing plenty of crabs and small fish within its reach; but from its size it is less sought after than the others. In Greenland it is called the ice-bird, being the harbinger of ice. This species is sometimes seen of a pure white.

2. A. ARCTICA, known in England by the name of *puffin*. See Plate Nat. Hist. fig. 8. These birds are found upon several of the rocky coasts in England, in Ireland, North Britain, Iceland, and Greenland. They frequent Carolina in America during winter, and have been met with in Sandwich-sound, where the natives ornament the fore parts and collar of their seal-skin jacket with the beaks of them. On the coast of Kamtschatka, and the Kurile islands, the inhabitants wear the bills of the arctica about their necks, and their priests put them on with a proper ceremony, in order to procure good fortune. They arrive at their breeding places here about the first week in May, and endeavour to dislodge the rabbits to save the trouble of making holes for themselves. The female lays but one egg, and the young are hatched in the beginning of July, and about the middle of August they take their flight. The young that are late hatched, become the prey of falcons, &c. Notwithstanding their neglect of the young at this time, on every other occasion they are very attentive to them. They will suffer themselves to be taken by the hand, and use every means of defence in their power to save them; and if held by the wings, will tear their bodies, as if actuated by despair, and when released, instead of flying away, will hurry again into the burrow to their young.

3. ALCA CIRRHATA, so called by Dr. Pallas, or tufted auk, is somewhat bigger than the common puffin, and the colours much the same: the bill is an inch and three quarters in length, the same in depth at the base, and crossed with three furrows: over each eye arises a tuft of feathers four inches in length, which falls elegantly on each side of the neck, reaching almost to the back; and white as far as they are attached to the head, but afterwards of a fine buff yellow; the legs are of a bright red; the claws black. The female is principally distinguished by having the bill crossed only with two furrows instead of three. This species inhabits the shores of Kamtschatka, the Kurile islands, and those intervening between Kamtschatka and America. In man-

ners it greatly resembles the puffin; living all day at sea, but at no great distance from the rocks; it comes on shore at night; burrows a yard deep under ground, and makes a nest with feathers and sea plants; is monogamous, and lodges there the whole night with its mate. It lays one white egg in the end of May or beginning of June, which alone is thought fit to be eaten, the flesh of the bird itself being insipid and hard. It feeds on crabs, shrimps, and shell-fish, which last it forces from the rocks with its strong bill.

4. ALCA IMPENNIS, the northern penguin, or great auk, with a compressed bill, furrowed on each side, and an oval spot on each side of the eyes. According to Mr. Martin, this bird breeds on the isle of St. Kilda; appearing there the beginning of May, and retiring the middle of June. It lays one egg, which is six inches long, of a white colour; some are irregularly marked with purplish lines crossing each other: if the egg is taken away, it will not lay another that season. The length of this bird, to the end of its toes, is three feet: but its wings are so small, as to be useless for flight; the length, from the tip of the longest quillfeathers to the first joint, being only four inches and a quarter. This bird is observed by seamen never to wander beyond soundings; and according to its appearance they direct their measures, being then assured that land is not very remote. It walks ill; but dives well, and is taken in the manner used for the razor bill and puffin. The skin between the jaws is blown into a bladder, and used for the tlarts of the Greenlanders, as is also that of some other birds.

5. ALCA PICA, or black-billed auk, has the bill of the same form with the torda, but is entirely black. Mr. Pennant observes, that it is sometimes found on our coasts; but, according to Mr. Latham, it is in the winter season only, when the common sort has quitted them. They are said to be met with on the coast of Candia, and other parts of the Mediterranean.

6. ALCA PSITTACULA, or perroquet auk of Dr. Pallas, is about the size of the little auk. The bill is much compressed on the sides, in shape convex both above and below, and of a bright red colour: from the remote corner of each eye is a very slender tuft of fine white feathers, hanging down the neck. This species is found at Kamtschatka, in the isles towards Japan, and on the western shores of America. They are sometimes seen in flocks, but seldom far from land, except when driven by storms. During night they harbour in the crevices of rocks. About the middle of June they lay an egg, almost the size of a hen's, of a dirty white or yellowish colour, spotted with brown, upon the bare rock, or sand, for they make no nest. Like most of the tribe, they are stupid birds, as is evinced by the method of catching them. One of the natives places himself under a loose garment of fur, of a particular make, with large open sleeves, among the rocks at evening; when the birds, returning to their lodging places at dusk, run under the skirts, and up the arm holes, for shelter during the night, and thus become an easy prey. Their stupidity likewise appears from their flying aboard ships, mistaking them for roosting places.

7. ALCA TORDA, or the razor bill, with four furrows on the bill, and a white line on each side running from the bill to the eyes. These birds, in company with the guillemot, appear in our seas the beginning of February, but do not settle on their breeding places till they begin to lay, about the beginning of May. They inhabit the ledges of the highest rocks that impend over the sea, where they form a grotesque appearance; sitting close together, and in rows one above another. They properly lay but one egg apiece, of an extraordinary size for the bulk of the bird, being three inches long; it is either white, or of a pale sea green, irregularly spotted with black. If this egg is destroyed, both the auk and the guillemot will lay another: if that is taken, then a third: they make no nest, depositing their egg on the bare rock; and though such multitudes lay contiguous, by a wonderful instinct each distinguishes its own. What is also matter of great amazement, they fix their egg on the smooth rock with so exact a balance, as to secure it from rolling off; yet should it be removed, and then attempted to be replaced by the human hand, it is extremely difficult, if not impossible, to find its former equilibrium. According to Mr. Latham, it is by means of a cement that the bird fixes its egg.

ALCAIC, in antient poetry, a denomination given to several kinds of verse, from Alcæus, their inventor. 1. The first kind consists of five feet, viz. a spondee, or iambic; an iambic; a cæsura, and two dactyles; such is the following verse of Horace:

Eheu! | fuga|ces, | Postume, | Postume,
Labun|tur an|ni! | nec pie|tas moram.

2. The second kind consists of two dactyles and two trochees: as,

Afferet, | indom|tæque | morti.

3. Besides these two, which are called dactylic Alcaics, there is another styled simply Alcaic; consisting of an epitrite, two choriambus; and a bacchius: the following is of this species,

Cur timet fla|vum Tiberim | tangere, cur | olivum?

ALCAID, ALCAYDE, or ALCALDE, in the polity of the Moors, Spaniards, and Portuguese, a magistrate, or officer of justice, answering nearly to the office of the British justice of peace. The alcaid among the Moors is invested with the supreme jurisdiction, both in civil and criminal cases.

ALCANNA, in commerce, a cosmetic powder prepared from the leaves of the Egyptian privet. It is much used by the Turkish women to give a golden colour to their nails and hair. There is also an oil extracted from the berries of alcanna, and used in medicine as a quiescent.

ALCANTARA, *the knights of*, a military order of Spain, which took its name from the above mentioned city. They make a very considerable figure in the history of the expeditions against the Moors. After the expulsion of the Moors, and the taking of Granada, the sovereignty of the order of Alcantara and that of Calatrava was settled in the crown of Castile by Ferdinand and Isabella. In 1540 the knights of Alcantara sued for leave to marry, which was granted them.

ALCAVALA, in the Spanish finances, was at first a tax of 10 per cent. afterwards of 14 per cent. but is at present of only 6 per cent. upon the sale of every sort of property, whether moveable or immoveable; and it is repeated every time the property is sold. The levying of this tax requires a multitude of revenue officers sufficient to guard the transportation of goods, not only from one province to another, but from one shop to another. It is to the alcavala, accordingly, that Ulloa imputes the ruin of the manufactures of Spain.

ALCEA, the HOLLY-HOCK: a genus of the polyandria order, belonging to the monadelphia class of plants; and in the natural method ranking under the 37th order, columniferæ. The characters are: the calyx is a double perianthium, monophyllous and persistent; the exterior one six-cleft, the interior half five-cleft: the corolla consists of five petals, coalesced at the base, heart-shaped inversely, and expanding: the stamina consist of numerous filaments, coalesced below into a five-cornered cylinder, loose above, and inserted into the corolla; the antheræ are kidney-shaped: the pistillum has a roundish germen; a short cylindric stylus; and numerous bristly stigmata the length of the stylus: the pericarpium consists of many arilli, jointed into a verticillum about a columnar depressed receptacle: the seeds are solitary, reniform, and depressed. There are three species, the alcea ficifolia, rosea, and africana.

ALCEDO, or KINGSFISHER, in ornithology, a genus of the order of picæ. The alcedo has a long, straight, thick, triangular bill; with a fleshy, plain, short, flat tongue. Of this genus there are many species, with one or other of which almost every part of the world is furnished. Most of them frequent rivers, and live on fish, the singularity of catching which is admirable: sometimes hovering over the water, where a shoal of small fishes is seen playing near the surface; at other times waiting with attention, on some low branch hanging over the water, for the approach of a single fish which is so unlucky as to swim that way; in either case dropping like a stone, or rather darting with rapidity on its prey; when, seizing it crosswise in its bill, it retires to a resting place to feast on it; which it does piecemeal, bones and all, without reserve, afterwards bringing up the indigestible parts in pellets, like birds of prey. The wings of most of the genus are very short; yet the birds fly rapidly and with great strength. It may be remarked, that throughout this genus, blue, in different shades, is the most predominant colour. There are above 30 species of this genus, of which the following are the most remarkable, viz. See Plate Nat. Hist. fig. 9 and 10.

1. ALCEDO GALBULA, or green jacamar, is about the size a lark. The bill is black, of a square form, a little incurvated and sharp at the point; the plumage, in general, in the upper part of the body, is of a most brilliant green, glossed with copper and gold in different lights. This species is found both in Guiana and Brasil, in the moist woods, which it prefers to the more dry spots, for the sake of insects, on which it feeds. Though these birds are solitary, yet they are far from scarce, as many may be met with. They are said to have a short and agreeable note.

2. ALCEDO ISPIDA, or common kingsfisher, is not much larger than a swallow; its shape is clumsy; the bill disproportionably long, it is two inches from the base to the tip, the upper chap black, and the lower yellow. But the colours of this bird atone for its inelegant form: the crown of the head and the co-

verts of the wings are of a deep blackish green, spotted with bright azure; the back and tail are of the most resplendent azure; the whole under side of the body is orange coloured; a broad mark of the same passes from the bill beyond the eyes. From the diminutive size, the slender short legs, and the beautiful colours of this bird, no person would be led to suppose it one of the most rapacious little animals that skims the deep. M. D'Aubenton has kept these birds for several months, by means of small fish put into basons of water, on which they have fed; for on experiment they have refused all other kinds of nourishment.

3. ALCEDO PARADISEA, or paradise jacamar, is of the same size with the former, and has a similar bill; the throat, fore part of the neck, and under wing coverts, are white; the rest of the plumage is of a deep dull green, in some lights appearing almost black, in others with a slight gloss of violet and copper bronze. It inhabits Surinam; and like the galbula it feeds on insects; and sometimes frequents open places. It flies farther at a time, and perches on the tops of trees: it is frequently found with a companion, not being quite so solitary a bird as the other.

4. ALCEDO RUDIS, or Egyptian kingsfisher, is the size of the Royston crow. The bill is blackish, more than half an inch broad at the base, and two inches in length; the head, shoulders, and back, are brown, marked with oblong ferruginous spots; the throat is of a ferruginous white; the belly and thighs are whitish, marked with longitudinal broadish cinereous spots; the upper tail coverts quite white; the quills spotted with white on the inner webs, chiefly at the tips; the tail is ash-coloured; the legs are of a pale green; and the claws blackish. It inhabits lower Egypt, about Cairo; builds in sycamore and date trees; and feeds on frogs, insects, and small fish, which last it meets with in the fields when they are overflowed.

5. ALCEDO TAPARARA of Buffon is about the size of a starling: the hind part of the neck, the back, and scapulars, are of an elegant blue; the rump, and upper tail coverts bright beryl-blue; the under parts of the body are white; the wing coverts blue; and the legs red. Inhabits Cayenne and Guiana.

6. ALCEDO TORQUATA, or cinereous kingsfisher, is about the size of a magpie. The bill is three inches and a half long, and brown; the head is crested; the upper parts of the head and body are bluish ash; the under parts chesnut; the throat is whitish, descending down the neck, and passing behind like a collar, ending towards the back in a point; the under tail coverts are of a pale fulvous, transversely striated with black; lesser wing coverts varied with bluish, ash, black, and yellowish. It inhabits Martinico and Mexico.

ALCHEMILLA, or LADIES-MANTLE, a genus of the monogynia order, and tetandria class of plants; and in the natural method ranking under the 35th order, Senticosæ. The essential character is cal. 8 cleft, cor. none, seed one. There are 4 species, the principal are:

1. ALCHEMILLA ALPINA, or cinque-foil ladies-mantle. It is a native of the mountainous parts of Europe. Goats and cows eat it; horses, sheep, and swine, refuse it.

2. ALCHEMILLA MINOR, or least ladies-mantle. It grows naturally in Sweden, Lapland, and other cold countries.

3. ALCHEMILLA VULGARIS, or common ladies-mantle, with leaves plaited like a fan, and yellowish green blossoms. It grows naturally in pasture lands in this as in most other countries in Europe. The leaves discover to the taste a moderate astringency; and were formerly much esteemed in some female weaknesses, and in fluxes of the body. They are now rarely made use of, though both the leaves and roots might possibly be of service in cases where mild astringents are required.

ALCHEMY, (from *al*, the, Arab, and Χημια, chemistry,) that obsolete branch of chemistry which had for its principal objects the transmutation of metals into gold; the panacea, or universal remedy; an alkahest, or universal menstruum; an universal ferment; and many other things equally ridiculous.

ALCHORNIA, a genus of the dioecia monodelphia class and order. The essential character is, male, calyx three, five-leaved; cor. none: female, calyx five-toothed, cor. none, styli two parted, caps. berried, decorous. There is one species of which little seems to be known in this country.

ALCOHOL, or ALKOOL, in chemistry, is used for any highly rectified spirit. Alcohol is extremely light and inflammable, is a strong antiseptic, and therefore employed to preserve animal substances. See CHEMISTRY.

ALCOHOL, ardent spirit. The term alcohol is applied by modern chemists to the purely spiritous part of all liquors that have undergone the vinous fermentation. It is certain, that the method of procuring ardent spirits by distillation was known in the dark ages; and it is more than probable that it was practised in the north of Europe much earlier.

Ardent spirits, such as brandy, for instance, rum and whisky, consist almost entirely of three ingredients, water, alcohol, or spirit of wine, to which they owe their strength, and a small quantity of a peculiar oil, from which they derive their flavour.

When these spiritous liquors are distilled in a water bath, the first portion that comes over is a fine light transparent liquid, known in commerce by the name of rectified spirits, and commonly sold under the denomination of alcohol or spirit of wine. It is not however, as strong as possible, still containing a considerable portion of water. This water may be separated, and the alcohol obtained as pure as possible, by the following process: Saturate the spirit with a quantity of carbonat of potass, which has just immediately before been exposed for about half an hour in a crucible to a red heat, in order to deprive it of moisture. Carbonat of potass in this state has a strong attraction for water; it accordingly combines with the water of the spirit; and the solution of carbonat of potass thus formed sinks to the bottom of the vessel, and the alcohol, which is lighter, swims over it, and may easily be decanted off; or, what is perhaps better, the solution of potass may be drawn off from below it by means of a stop-cock placed at the bottom of the vessel. The alcohol, thus obtained, contains a little pure potass dissolved, which may be separated by distilling it in a water bath with a very small heat. The alcohol passes over, and leaves the potass behind. It is proper not to distil to dryness.

Alcohol is a transparent liquor, colourless like water, of a pleasant smell, and a strong penetrating agreeable taste. When swallowed it produces intoxication.

It is exceedingly fluid, and has never been frozen, though it has been exposed to a cold so great that the thermometer stood at —69°.

Its specific gravity, when pure, is only 0.800; but it is seldom obtained so low. The specific gravity of alcohol, as highly rectified as possible, is 0.820; that of the alcohol of commerce is seldom less than 0.8371. It is almost unnecessary to remark, that the diminution of specific gravity is always proportional to the purity of the alcohol.

Alcohol is exceedingly volatile, boiling at the temperature of 176°; in which heat it assumes the form of an elastic fluid, capable of resisting the pressure of the atmosphere, but which condenses again into alcohol when that temperature is reduced. In a vacuum it boils at 56°, and exhibits the same phenomena; so that was it not for the pressure of the atmosphere, alcohol would always exist in the form of an elastic fluid, as transparent and invisible as common air. It is exceedingly combustible; and when set on fire, it burns all away with a blue flame, without leaving any residuum. Boerhaave observed, that when the vapour which escapes during this combustion is collected in proper vessels, it it found to consist of nothing but water. Junker had made the same remark; and Dr. Black suspected, from his own observations, that the quantity of water obtained, if properly collected, exceeded the weight of the alcohol consumed. This observation was confirmed by Lavoisier; who found that the water produced during the combustion of alcohol exceeded the alcohol consumed by about 1-seventh part.

Different opinions were entertained by chemists about the nature of alcohol; but Lavoisier was the first who attempted to analyse it. From his experiments it follows, that 76.7083 grains of alcohol, consumed during the combustion, were composed of

22.849 carbon
6.030 hydrogen
47.830 water

76.7

Such were the consequences which Mr. Lavoisier drew from his analysis. He acknowledged, however, that there were two sources of uncertainty, which rendered his conclusions not altogether to be depended upon. The first was, that he had no method of determining the quantity of alcohol consumed, except by the difference of weight in the lamp before and after combustion; and that therefore a quantity might have evaporated without combustion, which, however, would be taken into the sum of the alcohol consumed. But this error could not have been great; for if a considerable quantity of alcohol had existed in the state of vapour in the vessel, an explosion would certainly have taken place. The other source of error was, that the quantity of water was not known by actual weight, but by calculation.

That alcohol contains oxygen, has been proved by a very ingenious set of experiments performed by Messrs. Fourcroy and Vauquelin. When equal parts of it and sulphuric acid are mixed together, the sulphuric acid suffers no change; but the alcohol

is decomposed, being partly converted into water and partly into æther. Now it is evident that the alcohol could not have been converted into water unless it had contained oxygen.

When alcohol, in the state of vapour, is made to pass through a red hot porcelain tube, it is decomposed completely. Carbureted hydrogen gas and carbonic acid gas are disengaged; water passes into the receiver, and on its inner surface are deposited a number of small brilliant crystals, which Vauquelin ascertained to be a concrete volatile oil. The inside of the volatile tube is coated with charcoal in the state of a fine black. This experiment was first made by Priestley; but it was afterwards repeated with more care, and the nature of the products ascertained by the Dutch chemists.

Alcohol has a strong affinity for water, and is miscible with it in every proportion. The specific gravity varies according to the proportion of the two liquids combined; but, as happens in almost all combinations, the specific gravity is always greater than the mean of the two liquids; consequently there is a mutual penetration: and as this penetration or condensation varies also with the proportions, it is evident that the specific gravity of different mixtures of alcohol and water can only be ascertained by experiment. As the spiritous liquors of commerce are merely mixtures of alcohol and water in different proportions, and as their strength can only be ascertained with precision by means of their specific gravity, it becomes a point of very great importance to determine with precision the proportion of alcohol contained in a spirit of a given specific gravity: and as the specific gravity varies with the temperature, it is necessary to make an allowance for that likewise.

The importance of this object, both for the purposes of revenue and commerce, induced the British government to employ Sir Charles Blagden to institute a very minute and accurate series of experiments. An account of these was published by Blagden in the Philosophical Transactions for 1790; and a set of tables, exhibiting the result of them, was drawn up by Mr. Gilpin, who had performed the experiments, and published in the Philosophical Transactions for 1794.

The following little table, constructed from Dr. Thomson's experiments, will enable the reader to ascertain the proportion of real alcohol and water in mixtures. Suppose alcohol at 0.800 to be pure; then alcohol of

0.813 is composed of 100 alcohol + 2 water.
0.818 . . . . . 100 + 4
0.825 . . . . . 100 + 7.53 or 93 + 7.

Alcohol has no action upon sulphur while solid; but when these two bodies are brought together both in the state of vapour, they combine and form a reddish sulphuret, which exhales the odour of sulphurated hydrogen gas. This compound contains about 60 parts of alcohol and one part of sulphur. The sulphur is precipitated by water. Alcohol dissolves also a little phosphorus when assisted by heat. This phosphorized alcohol exhales the odour of phosphurated hydrogen gas. When a little of it is dropt into a glass of water, a flame instantly makes its appearance, and waves beautifully on the surface of the water. This phenomenon, which is occasioned by the emission of a little phosphurated hydrogen gas, can only be observed when the experiment is performed in a dark room.

Alcohol has no action upon charcoal, hydrogen gas, azotic gas, the metals, nor upon any of the metallic oxides.

Alcohol dissolves the fixed alkalies very readily, and forms with them a reddish coloured acrid solution. It is from this solution only that these alkalies can be obtained in a state of purity. When heat is applied to it, the alcohol is partly decomposed; but the nature of the products has not been accurately ascertained. Ammonia also combines with alcohol with the assistance of heat: but at a temperature somewhat below the boiling point of alcohol, the ammonia flies off in the state of gas, carrying with it, however, a little alcohol in solution.

None of the earths are acted upon by alcohol. It absorbs about its own weight of nitrous gas, which cannot afterwards be expelled by heat.

Sulphuric acid, nitric acid, and oxymuriatic acid, decompose alcohol; but all the other acids are soluble in it, except the metallic acids, phosphoric acid, and perhaps also prussic acid.

Alcohol is capable of dissolving a great many saline bodies. A considerable number of these, with the quantities soluble, is exhibited in the following tables:

1. *Substances dissolved in large quantities.*

Names of the substances.	Temperature.	240 parts of alcohol dissolve
Oxysulphat of iron . . .		
Nitrat of cobalt	54.5	240 parts
copper	54.5	240
alumina	54.5	240
lime		300
magnesia . . .	180.5	694
Muriat of zinc	54.5	240
alumina . . .	54.5	240
magnesia . . .	180.5	1313
iron	180.5	240
copper	180.5	240
Acetat of lead	113	
copper		
Nitrat of zinc decomposed		
iron decomposed		
bismuth decomposed		

2. *Substances dissolved in small quantities.*

Names of the substances.	240 parts of alcohol, at the boiling temperature, dissolve
Muriat of lime	240 parts
Nitrat of ammonia	214
Oxymuriat of mercury . . .	212
Succinic acid	177
Acetat of soda	112
Nitrat of silver	100
Refined sugar	59
Boracic acid	48
Nitrat of soda	23
Acetat of copper	18
Muriat of ammonia	17
Arseniat of potass	9
Superoxalat of potass	7
Nitrat of potass	5
Muriat of potass	5
Arseniat of soda	4
White oxide of arsenic . . .	3
Tartrat of potass	1
Nitrat of lead	
Carbonat of ammonia	

3. *Substances insoluble in alcohol.*

Sugar of milk	Sulphat of potass
Borax	soda
Tartar	magnesia
Alum	Sulphite of soda
Sulphat of ammonia	Tartrite of soda and
lime	potass
barytes	Nitrat of mercury
iron	Muriat of lead
copper	silver
silver	Common salt
mercury	Carbonat of potass
zinc	soda

These experiments were made chiefly by Macquer and Wenzel. The alcohol employed by Macquer was of the specific gravity 0.840. Wenzel does not give the density of his alcohol; but as he compares it with that of Macquer, we may suppose it nearly of the same strength. As the solubility of salts depends upon the strength of the alcohol employed, the experiments of these chemists must be considered as defective, because they have confined themselves to one particular density. This defect is in part supplied by the following very valuable table of Mr. Kirwan's, constructed from his own experiments.

Solubility of salts in 100 *parts of alcohol of different densities.*

Salts.	Alcohol of				
	0.900	0.872	0.848	0.834	0.817
Sulphat of soda	0.	0.	0.	0.	0.
Sulphat of magnesia	1.	1.	0.	0.	0.
Nitrat of potass	2.76	1.		0.	0.
Nitrat of soda	10.5	6.		0.38	0.
Muriat of potass	4.62	1.66		0.38	0.
Muriat of soda	5.8	3.67		0.5	
Muriat of ammonia	6.5	4.75		1.5	
Muriat of magnesia, dried at 120°	21.25		23.75	36.25	50.
Muriat of barytes	1.		0.29	0.185	0.09
Ditto crystallized	1.56		0.43	0.32	0.06
Acetat of lime	2.4		4.12	4.75	4.88

When alcohol, containing certain saline bodies in solution, is set on fire, its flame is often tinged of different colours according to the body. Thus nitrat of strontian tinges it purple; boracic acid and cupreous salts tinge it green; muriat of lime gives it a red colour; nitre and oxymuriat of mercury a yellow colour.

The affinities of alcohol are but imperfectly known. Those stated by Bergman are water, æther, volatile oil, alkaline sulphurets.

ALCOHOL is also used for a very fine, impalpable powder, which women in the east make use of. Dr. Shaw, in his Travels, speaking of the women in Barbary, says, that none of these ladies think themselves completely dressed until they have tinged their hair and edges of their eye-lids with *al-ka-hol*, the powder of lead ore. From this impalpable powder the name was transferred to other subtile powders, and afterwards to spirit of wine, exalted to its highest purity and perfection.

ALCOR, in astronomy, a small star adjoining to the large bright one in the middle of the tail of ursa major. The word is Arabic. It is a proverb among the Arabians, applied to one who pretends to see small things, but overlooks much greater: Thou canst see Alcor, and yet not see the full moon.

ALCYONIUM, in zoology, a genus of zoophytes, the characters of which are, that the animal grows in the form of a plant: the stem or root is fixed, fleshy, gelatinous spongy, or coriaceous, with a cellular epidermis, penetrated with stellated pores, and shooting out tentaculated oviparous hydræ. There are 28 species, as A. *arboreum*, with woody stem, obtuse branches, and pores in the form of pimples, found in Norway, in the white and Indian seas, sometimes of the human height. A. *digitatum*, stemless, oblong, coriaceous, and rugose, called also dead man's hand, &c. &c. See Plate Nat. Hist. fig. 11.

ALDEBARAN, in astronomy, a star of the first magnitude, called in English the Bull's-eye, being the eye of the constellation Taurus. Long. 6° 32′ 9″ of Gemini. Lat. 5° 29′ 40″ S.

ALDER, in botany. See BETULA.

ALDERMAN, among our Saxon ancestors, was a degree of nobility answering to earl or count at present. It ranked inferior to atheling, but superior to thane. Alderman was also used, in the time of king Edgar, for a justice or judge. In modern British policy, it implies a magistrate subordinate to the mayor of a city or town corporate. The number of these magistrates is not limited, but is greater or less according to the magnitude of the place. In London they are twenty-six; each having one of the wards of the city committed to his care. This office is for life. When one dies or resigns, a wardmote is called within three days, who elect another, and return him to the court of aldermen, who are obliged to admit him to supply the vacancy. All the aldermen are justices of the peace by a charter of 15 Geo. II. The aldermen of London, &c. are exempted from serving inferior offices; nor can they be put upon assizes, or serve on juries, so long as they continue in office.

ALDROVANDA, in botany, a genus of the pentandria class and pentagynia order of plants; of which there is but one species. The calyx is divided into five parts; the petals are five, and the capsule has five valves, with ten seeds. It is a native of Italy and the Indies; and has no English name.

ALE, a fermented liquor obtained from an infusion of malt, differing from beer chiefly in having a less proportion of hops. See BREWING.

This liquor, the natural substitute of wine in such countries as could not produce the grape, was originally made in Egypt. The natives of Spain also, the inhabitants of France, and the aborigines of Britain, all used an infusion of barley for their ordinary liquor; and it was called by the various names of *cælia* and *ceria* in the first country, *cerevisia* in the second, and *curmi* in the last, all literally importing only the strong water.

The method in which the ancient Britons, and other Celtic nations, made their ale, is thus described by Isidorus and Orosius: "The grain is steeped in water and made to germinate, by which its spirits are excited and set at liberty; it is then dried and ground; after which it is infused in a certain quantity of water, which being fermented, becomes a pleasant, warming, strengthening, and intoxicating liquor."

There are various sorts of ale known in Britain, particularly pale and brown: the former is brewed from malt slightly dried, and is esteemed more viscid than the latter, which is made from malt more highly dried or roasted. In Staffordshire they have a secret of fining ale in a very short time.

Ale is flatulent; and hence sometimes produces colics, and the cholera morbus: it is acescent; but it does not produce calcareous diseases, as has been asserted. If malt liquor, of any degree of strength, is become flat and tarnish, as it is used, it should be drawn out of the cask into a jug, in which as many drams of powdered chalk is put as there are to be pints of liquor: thus a new fermentation will be raised, a sprightly taste will be restored to the liquor, and its acidity will be destroyed. Tart liquors of this kind are apt to produce a dysury, strangury, or a gonorrhœa; in which cases a small quantity of brandy may be taken.

The consumption of ale in these kingdoms is incredible. It was computed thirty years ago at the value of 4,000,000*l.* yearly, including Great Britain and Ireland. The duties on ale and beer make a principal branch of the revenue in Britain. They were first imposed by the 12th of Car. II. and have been continued by several subsequent acts of parliament to first Geo. III. which lays an additional duty of 3d. per barrel. In the whole, the brewer of ale and beer for sale shall pay 8s. for every barrel of either, above 6s. a barrel; and for every barrel of 6s. or under, the sum of 1s. 4d. Additional duties were laid on in 1803.

ALE GILL, is that in which the dried leaves of gill or ground-ivy have been infused. It is esteemed abstersive and vulnerary, and consequently good in disorders of the breast and obstructions of the viscera.

ALECONNER, an officer in the city of London, whose business it is to inspect the measures of public-houses. Four of them are chosen or re-chosen annually by the common-hall; and whatever might be their use formerly, their places are now regarded only as sinecures for decayed citizens. They are the same as ale-tasters, which see.

ALEHOUSES must be licensed by justices of the peace, who take recognizances of the persons licensed, and of their sureties, viz. 10*l.* each that they will not suffer unlawful gaming nor other disorderly practices in their houses. Every person, excepting those who sell ale in fairs, neglecting to procure a licence, is liable to a penalty of 40s. for the first offence, 4*l.* for the second, and 6*l.* for the third, with all costs. The licence is granted on the 1st September, or within twenty days after, at a general meeting of the justices for the division to which he belongs, upon his producing a certificate to his character, unless, by living in a city or town corporate, this last circumstance is dispensed with, and continues in force for one year only. Alehouse-keepers selling ale in short measure, are liable to a penalty not exceeding 40s. and not less than 10s., and likewise to a fine of 10s. for permitting tippling, &c. By the 29th Geo. II. c. 12. persons keeping alehouses in Scotland shall be licensed as in England, and the justices there shall meet annually to license alehouses; on each of which licences a fee of 1s. is payable to the clerk of the peace.

ALE-TASTER, an officer appointed in every court leet, and sworn to look to the assize and the goodness of bread and ale, or beer, within the precincts of that lordship. *Cowell.*

ALECTORIA, a stone said to be formed in the gall-bladders of old cocks, to which the antients ascribed many fabulous virtues. This is otherwise called *alectorius lapis* and *alectorolithos*, in English the *cock-stone*. Modern naturalists hold the alectorius lapis to be not generated in, but swallowed down into, the stomach or gizzard of cocks and capons. It is known that many fowls swallow pebbles, which are supposed to be of service in trituration and digestion.

A-LEE, in the sea language, a term only used when the wind, crossing or flanking the line of a ship's course, presses upon the masts and sails so as to make her incline to one side, which is called the lee-side: hence, when the helm is moved over to this side, it is said to be *a-lee* or *hard-a-lee*.

ALEGER, an inferior sort of vinegar, made of ale or malt liquor instead of wine.

ALEMBICK, a vessel formerly used in distilling. They were usually made of glass or copper. The bottom, which contained the subject for distillation, was called, from its shape, the cucurbit; the upper part, which received and condensed the steam, was called the head, the beak being fitted into the neck of a receiver. Retorts, and the common worm-still, are now more generally employed.

ALETRIS, in botany, a genus of the monogynia order and hexandria class of plants; and in the natural method ranking under the tenth order, coronariæ. The characters are: the corolla is monopetalous, funnel-shaped, hexangular, much corrugated, semiquinquefid, and persistent; the stamina consist of six subulated filaments, the length of the corolla, and inserted into the base of the divisions of the corolla; the antheræ are oblong and erect: the pistillum has an ovate germen; the stylus subulated, and the length of the stamina; the stigma is trifid: the pericarpium is an ovated capsule, triquetrous, pointed, and trilocular: the seeds are nume-

rous. There are eight species, among which are, 1. Aletris capensis, a native of the Cape of Good Hope. It is with us a stove-plant. The flower is pink. 2. Aletris farinosa, a native of North America. This, though the most hardy plant of the genus, requires to be sheltered under a frame. The flowers appear in June or July, of a whitish green colour. 3. Aletris fragrans, a native of Africa, and, when placed in a stove, produces fine spikes of white flowers in March or April. 4. Aletris hyacinthoides, or Guinea aloe, produces likewise white flowers when kept in proper warmth by a stove, in the month of July. 5. Aletris hyacinthoides, the Ceylon aloe, is with us also a stove-plant.

ALEXANDRIAN *manuscript*, a famous copy of the New Testament. This MS. is now preserved in the British Museum. It was sent as a present to king Charles I. from Cyrillus Lucaris, patriarch of Constantinople, by sir Thomas Rowe, ambassador from England to the Grand Signior, about the year 1628. Cyrillus brought it with him from Alexandria, where probably it was written. In a schedule annexed to it, he gives this account: That it was written, as tradition informed him, by Thecla, a noble Egyptian lady, about 1300 years ago, not long after the council of Nice. But this high antiquity, and the authority of the tradition to which the patriarch refers, have been disputed; nor are the most accurate biblical writers agreed about its age. Grabe thinks that it might have been written before the end of the fourth century; others are of opinion that it was not written till near the end of the fifth century, or somewhat later. A fac-simile was published by the late Dr. Warde.

ALEXANDRINE, a kind of verse borrowed from the French, first used in a poem called Alexander. They consist, among the French, of twelve and thirteen syllables, in alternate couplets; and, among us, of twelve. They are well characterized by Pope:

Then, at the last, an only couplet fraught
With some unmeaning thing they call a thought,
A needless *Alexandrine* ends the song,
That, like a wounded snake, drags its slow length along. *Essay on Criticism.*

ALEXIPHARMICS, in antient medicine, were properly remedies for expelling or preventing the ill effects of poison; but some having imagined that the animal spirits, in acute distempers, were affected by a malignant poison, the term has been understood to mean medicines adapted to expel this poison, by the cutaneous pores, in the form of sweat. In this sense alexipharmics are the same as sudorifics.

ALFECCA, in astronomy, the star otherwise called Alfeta and Lucida coronæ.

ALGÆ, Flags, one of the seven families, or natural tribes, into which the whole vegetable kingdom is divided by Linnæus, in his Philosophia Botanica. They are defined to be plants, whose root, leaf, and stem, are all one. Under this description are comprehended all the sea-weeds, and some other aquatic plants. In the sexual system they constitute the third order of the twenty-fourth class *cryptogamia*, and the fifty-seventh order in Linnæus's Fragments of a Natural Method.

ALGAROT, or Algarel, in chemistry, an Arabic term for an emetic powder, prepared from regulus of antimony, dissolved in acids, and separated by repeated lotions in warm water.

ALGEBRA, a general method of resolving mathematical problems by means of equations: or, it is a method of performing the calculations of all sorts of quantities by means of general signs or characters. At first, numbers and things were expressed by their names at full length; but afterwards these were abridged, and the initials of the words used instead of them; and, as the art advanced farther, the letters of the alphabet came to be employed as general representations of all kinds of quantities; and other marks were gradually introduced to express the operations and combinations, so as to entitle it to different appellations.

It has been called *specious* arithmetic by Vieta, on account of the species or letters of the alphabet, which he brought into general use; and by Sir Isaac Newton it was denominated universal arithmetic, from the manner in which it performs all arithmetical operations by general symbols, or indeterminate quantities.

Some authors define algebra to be the art of resolving mathematical problems: but this is the idea of analysis, or the analytic art in general, rather than of algebra, which is only one particular species of it.

Indeed algebra properly consists of two parts: first, the method of calculating magnitudes or quantities, as represented by letters or other characters; and secondly, the manner of applying these calculations in the solution of problems.

In algebra, as applied to the resolution of problems, the first business is to translate the problem out of the common into the algebraic language, by expressing all the conditions and quantities, both known and unknown, by their proper characters, arranged in an equation, or several equations if necessary, and treating the unknown quantity, whether it be number or line, or any other thing, in the same way as if it were a known one: this forms the composition. Then the resolution, or analytic part, is the disentangling the unknown quantity from the several others with which it is connected, so as to retain it alone on one side of the eduation, while all the known quantities are collected on the other side, and so giving the value of the unknown one. And as this disentangling of the quantity sought is performed by the converse of the operations by which it is connected with the others, taking them always backwards in the contrary order, it hence becomes a species of the analytic art, and is called the modern analysis, in contradistinction to the antient analysis, which chiefly respected geometry and its applications.

There have arisen great controversies and sharp disputes among authors concerning the history of the progress and improvements of algebra, arising partly from the partiality and prejudices which are natural to all nations, and partly from the want of a closer examination of the works of the older authors on this subject. From these causes it has happened that the improvements made by the writers of one nation have been ascribed to those of another; and the discoveries of an earlier author to some one of much later date. Add to this also, that the peculiar methods of many authors have been described so little in detail, that our information derived from such histories is but very imperfect, and amounting only to some general and vague ideas of the true state of the arts.

It is highly probable that the Indians or Arabians first invented the noble art; for it may be reasonably supposed that the antient Greeks were ignorant of it, since Pappus, in his mathematical collections, in which he enumerates their analysis, makes mention of nothing like it: and he besides speaks of a local problem, begun by Euclid, and continued by Apollonius, which none of them could fully resolve, a circumstance that could not have occurred had they been acquainted with algebra.

Diophantus was the first Greek writer on algebra, who published thirteen books about the year 800, though only six of them were translated into Latin in the year 1575. This algebra of Diophantus only extends to the solution of arithmetical indeterminate problems. Before this translation of Diophantus came out, Lucas de Burgo, a friar, published at Venice, in the year 1494, an Italian Treatise on Algebra. This author refers to others who had preceded him, and from whom he had learned the art; but their writings have not come down to us. He also assumes, that algebra came originally from the Arabs, and never mentions Diophantus, which makes it highly probable that his work was not even then known in Europe. Burgo's Treatise goes no farther than quadratic equations. He was succeeded by Stifelius, who was a good author, but did not advance the science. After him came Scipio Ferreus, Cardan, Tartagilla, and some others, who proceeded to the solution of cubic equations.

In 1590, Vieta introduced his specious arithmetic, to which we have already alluded, which consists in denoting the quantities, both known and unknown, by symbols or letters. To Vieta we are indebted for the method of extracting the roots of equations by approximation, which has been since greatly improved by Raphson, Halley, Maclaurin, Simpson, and others.

Vieta was followed by Oughtred and Harriot: the former invented several compendious characters to show the sums, differences, rectangles, squares, cubes, &c. of any given numbers; the latter left behind him his Analysis, which is highly esteemed at this day. In 1657, Des Cartes published his geometry, in which he made use of the literal calculus, and the algebraic rules of Harriot: he applied his method to the higher geometry, explaining the nature of curves by equations, and adding the constructions of cubic, biquadratic, and other higher equations.

The elements of the art were compiled and published by Kersey, in 1671, in which specious arithmetic, and the nature of equations, are largely explained and illustrated by a variety of examples. Sir Isaac Newton's Arithmetica Universalis was published in 1707, which abounds with useful and important instruction; and since his time we have had a great number of excellent treatises on the subject, from almost any of which the science may with very little difficulty be learned.

Algebra, as has been already observed, is called an Universal Arithmetic, and it proceeds by operations and rules similar to those in common arithmetic, founded upon the same principles. This, however, is no argument against its usefulness or evidence; since arithmetic is not to be the less valued that it is common, and is allowed to be one of the most clear and evident of the sciences. But as a number of symbols are admitted into this science, being necessary for giving it that extent and generality which is its greatest excellence; the import of those symbols is to be clearly stated, that no obscurity or error may arise from the frequent use and complication of them. Thus,

The relation of equality is expressed by the sign $=$; thus to express that the quantity represented by a is equal to that which is represented by b, we write $a = b$. But if we would express that a is greater than b, we write $a > b$; and if we would express algebraically that a is less than b, we write $a < b$.

Quantity is what is made up of parts, or is capable of being greater or less. It is increased by Addition, and diminished by Subtraction; which are therefore the two primary operations that relate to quantity. Hence it is, that any quantity may be supposed to enter into algebraic computations two different ways which have *contrary* effects; either as an increment, or as a decrement; that is, as a quantity to be added, or as a quantity to be subtracted. The sign $+$ (plus) is the mark of Addition, and the sign $-$ (minus) of Subtraction. Thus the quantity being represented by a, or $+a$ imports that a is to be added, or represents an increment; but $-a$ imports that a is to be subtracted and represents a decrement. When several such quantities are joined, the signs serve to shew which are to be added, and which are to be subtracted. Thus $+a+b$ denotes the quantity that arises when a and b are both considered as increments, and therefore expresses the sum of a and b. But $+a-b$ denotes the quantity that arises when from the quantity a the quantity b is subtracted; and expresses the excess of a above b. When a is greater than b, then $a-b$ is itself an increment; when $a=b$, then $a-b=0$; and when a is less than b, then $a-b$ is itself a decrement.

As Addition and Subtraction are opposite, or an increment is opposite to a decrement, there is an analogous opposition between the affections of quantities that are considered in the mathematical sciences. As between excess and defect; between the value of effects or money due to a man, and money due by him; a line drawn towards the right and a line drawn to the left; gravity and levity; elevation above the horizon and depression below it. When two quantities equal in respect of magnitude, but of those opposite kinds, are joined together, and conceived to take place in the same subject, they destroy each other's effect, and their amount is nothing. Thus 100*l.* due to a man, and 100*l.* due by him, balance each other; and in estimating his stock may be both neglected.

A quantity that is to be added is likewise called a positive quantity; and a quantity to be subtracted is said to be negative: they are equally real, but opposite to each other, so as to take away each other's effect, in any operation, when they are equal as to quantity. Thus $3-3=0$, and $a-a=0$. But though $+a$ and $-a$ are equal as to quantity, we do not suppose in Algebra that $+a=-a$; because to infer equality in this science, they must not only be equal as to quantity, but of the same quality, that in every operation the one may have the same effect as the other. A decrement may be equal to an increment; but it has in all operations a contrary effect. It is on account of this contrariety that a negative quantity is said to be less than nothing, because it is opposite to the positive, and diminishes it when joined to it, whereas the addition of 0 has no effect. But a negative is to be considered no less as a real quantity than the positive. Quantities that have no sign prefixed to them are understood to be positive.

The number prefixed to a letter is called the numeral co-efficient, and shews how often the quantity represented by the letter is to be taken. Thus $2a$ imports that the quantity represented by a is to be taken twice; $3a$ that it is to be taken thrice, and so on. When no number is prefixed, unit is understood to be the co-efficient. Thus 1 is the co-efficient of a or of b.

Quantities are said to be like or similar, that are represented by the same letter, or letters equally repeated. Thus, $+3a$ and $-5a$ are like; but a and b, or a and aa, are unlike.

A quantity is said to consist of as many terms as there are parts joined by the signs $+$ or $-$; thus $a+b$ consists of two terms, and is called a binomial; $a+b+c$ consists of three terms, and is called a trinomial. These are called compound quantities: a simple quantity consists of one term only, as $+a$, or $+ab$, or $+abc$.

Of Addition.

Case I. To add quantities that are like and have like signs.

Rule. Add together the co-efficients, to their sum prefix the common sign, and subjoin the common letter or letters.

EXAMPLES.

To	$+5a$	to $-6b$	to $a+b$
Add	$+4a$	add $-2b$	add $3a+5b$
Sum	$+9a$	Sum $-8b$	Sum $4a+6b$

To $3a-4x$
add $5a-8x$
Sum $8a-12x$

Case II. To add quantities that are like but have unlike signs.

Rule. Subtract the lesser co-efficient from the greater, prefix the sign of the greater to the remainder, and subjoin the common letter or letters.

EXAMPLES.

To	$-4a$	$+5b-6c$
Add	$+7a$	$-3b+8c$
Sum	$+3a$	$2b+2c$

To	$a+6x-5y+8$	$2a-2b$
Add	$-5a-4x+4y-3$	$-2a+2b$
Sum	$-4a+2x-y+5$	$0\ .\ .\ 0$

This rule is easily deduced from the nature of positive and negative quantities.

If there are more than two quantities to be added together, first add the positive together into one sum, and then the negative (by Case I). Then add these two sums together (by Case II).

$+8abx$
$-7abx$
$+10abx$
$-12abx$

Sum of the positive $+18abx$
Sum of the negative $-19abx$
Sum of all $-abx$

Case III. To add quantities that are unlike.

Rule. Set them all down one after another, with their signs and co-efficients prefixed.

EXAMPLES.

To	$+2a$	$+3a$
Add	$+3b$	$-4x$
Sum	$2a+3b$	$3a-4x$

To $4a+4b+3c$
Add $-4x-4y+3z$
Sum $4a+4b+3c-4x-4y+3z$

Of Subtraction.

General Rule. Change the signs of the quantity to be subtracted into their contrary signs, and then add it so changed to the quantity from which it was to be subtracted (by the preceding rules): the sum arising by this addition is the remainder. For, to subtract any quantity, either positive or negative, is the same as to add the opposite kind.

EXAMPLES.

From	$+5a$	$8x-7b$
Subtract	$+3a$	$3a+4b$
Remainder	$5a-3a$, or $2a$	$5a-11b$

From	$2a-3x+5y-6$
Subtract	$6a+4x+5y+4$
Remainder	$-4a-7x \quad 0-10$

It is evident, that to subtract or take away a decrement is the same as adding an equal increment. If we take away $-b$ from $a-b$, there remains a; and if we add $+b$ to $a-b$, the sum is likewise a. In general, the subtraction of a negative quantity is equivalent to adding its positive value.

Of Multiplication.

In Multiplication the general Rule for the signs is, That when the signs of the factors are like (i. e. both $+$, or both $-$) the sign of the product is $+$; but when the signs of the factors are unlike, the sign of the product is $-$.

Case I. When any positive quantity, $+a$, is multiplied by any positive number, $+n$, the meaning is, that $+a$ is to be taken as many times as there are units in n; and the product is evidently na.

Case II. When $-a$ is multiplied by n, then $-a$ is to be taken as often as there are units in n, and the product must be $-na$.

Case III. Multiplication by a positive number implies a repeated addition: but multiplication by a negative implies a repeated subtraction. And when $+a$ is to be multiplied by $-n$, the meaning is, that $+a$ is to be subtracted as often as there are units in n. Therefore the product is negative, being $-na$.

Case IV. When $-a$ is to be multiplied by $-n$, then $-a$ is to be subtracted as often as there are units in n; but to subtract $-a$ is equivalent to adding $+a$, consequently the product is $+na$.

The IId and IVth Cases may be illustrated in the following manner.

By the definitions, $+a-a=0$; therefore, if we multiply $+a-a$ by n, the product must vanish or be 0, because the factor $a-a$ is 0. The first term of the product is $+na$ (by Case I.) Therefore the second term of the product must be $-na$, which destroys $+na$; so that the whole product must be $+na-na=0$. Therefore $-a$ multiplied by $+n$ gives $-na$.

In like manner, if we multiply $+a-a$ by $-n$, the first term of the product being $-na$, the latter term of the product must be $+na$, because the two together must destroy each other, or their amount be 0, since one of the factors (viz. $a-a$) is 0. Therefore $-a$ multiplied by $-n$ must give $+na$.

In this general doctrine the multiplicator is always considered as a number. A quantity of any kind may be multiplied by a number; but

a pound is not to be multiplied by a pound, or a debt by a debt, or a line by a line. We shall hereafter consider the analogy that there is betwixt rectangles in geometry and a product of two factors.

If the quantities to be multiplied are simple quantities, find the sign of the product by the last rule; after it place the product of the co-efficients, and then set down all the letters after one another, as in one word.

EXAMPLES.

Mult.	$+a$	$-2a$	$6x$
By	$+b$	$+4b$	$-5a$
Prod.	$+ab$	$-8ab$	$-30ax$

Mult.	$-8x$	$+3ab$
By	$-4a$	$-5ac$
Prod.	$+32ax$	$-15aabc$

To multiply compound quantities, you must multiply every part of the multiplicand by all the parts of the multiplier taken one after another, and then collect all the products into one sum: that sum shall be the product required.

EXAMPLES.

Mult.	$a+b$	$2a-3b$
By	$a+b$	$4a+5b$
Prod.	$aa+ab$ $+ab+bb$	$8aa-12ab$ $+10ab-15bb$
Sum	$aa+2ab+bb$	$8aa-2ab-15bb$

Mult.	$2a-4b$	$xx-ax$
By	$2a+4b$	$x+a$
Prod.	$4aa-8ab$ $+8ab-16bb$	$xxx-axx$ $+axx-aax$
Sum	$4aa \,..\, 0. -16bb$	$xxx \,..\, 0. -aax$

Mult. $aa+ab+bb$
By $a-b$

Prod. $aaa+aab+abb$
$-aab-abb-bbb$

Sum $aaa \ldots 0 \ldots . 0 . -bbb$

Products that arise from the multiplication of two, three, or more quantities, as abc, are said to be of two, three, or more dimensions; and those quantities are called factors or roots.

If all the factors are equal, then these products are called powers; as aa, or aaa, are powers of a. Powers are expressed sometimes by placing above the root to the right hand a figure expressing the number of factors that produce them. Thus,

a	is called the	1st	power of the	a
aa		2d	root a, and	a^2
aaa		3d	is shortly	a^3
$aaaa$		4th	expressed	a^4
$aaaaa$		5th	thus,	a^5

These figures which express the number of factors that produce powers, are called their indices or exponents; thus 2 is the index of a^2. And powers of the same root are multiplied by adding their exponents. Thus $a^2 \times a^3 = a^5$. $a^4 \times a^3 = a^7$. $a^3 \times a = a^4$.

Sometimes it is useful, not actually to multiply compound quantities, but to set them down with the sign of multiplication ($\times$) between them, drawing a line over each of the compound factors. Thus $\overline{a+b} \times \overline{a-b}$ expresses the product of $a+b$ multiplied by $a-b$.

Of Division.

The same rule for the signs is to be observed in Division as in Multiplication; that is, if the signs of the dividend and divisor are like, the sign of the quotient must be $+$; if they are unlike, the sign of the quotient must be $-$. This will be easily deduced from the rule in Multiplication, if you consider that the quotient must be such a quantity as, multiplied by the divisor, shall give the dividend.

The general rule in Division is, to place the dividend above a small line, and the divisor under it, expunging any letters that may be found in all the quantities of the dividend and divisor, and dividing the co-efficients of all the terms by any common measure. Thus, when you divide $10ab+15ac$ by $20ad$, expunging a out of all the terms, and dividing all the co-efficients by 5, the quotient is $\frac{2b+3c}{4d}$; and

$2b) ab+bb \left(\frac{a+b}{2}.$

$12ab) 30ax-54ay \left(\frac{5x-9y}{2b}.$

$4aa) 8ab+6ac \left(\frac{4b+3c}{2a}.$

And $2bc) 5abc \left(\frac{5a}{2}.$

Powers of the same root are divided by subtracting their exponents, as they are multiplied by adding them. Thus, if you divide a^5 by a^2, the quotient is a^{5-2}, or a^3. And b^4 divided by b^4, gives b^{4-4}, or b^2; and $a^7 b^5$ divided by $a^2 b^3$, gives $a^5 b^2$ for the quotient.

If the quantity to be divided is compound, then you must range its parts according to the dimensions of some one of its letters, as in the following example. In the dividend $a^2+2ab+b^2$, they are ranged according to the dimensions of a, the quantity a^2, where a is of two dimensions, being placed first, $2ab$, where it is of one dimension, next, and b^2, where a is not at all, being placed last. The divisor must be ranged according to the dimensions of the same letters; then you are to divide the first term of the dividend by the first term of the divisor, and to set down the quotient, which in this example is a; then multiply this quotient by the whole divisor, and subtract the product from the dividend, and the remainder shall give a new dividend, which in this example is $ab+b^2$, thus,

$a+b) a^2+2ab+b^2 (a+b$
a^2+ab
$ab+b^2$
$ab+b^2$
0 0

Divide the first term of this new dividend by the first term of the divisor, and set down the quotient (which in this example is b) with its proper sign. Then multiply the whole divisor by this part of the quotient, and subtract the product from the new dividend; and if there is no remainder, the division is finished. If there is a remainder, you are to proceed after the same manner till no remainder is left, or till it appears that there will be always a remainder.

Some examples will illustrate this operation.

EXAMPLE I.

$a+b) a^2-b^2 (a-b$
a^2+ab
$-ab-b^2$
$-ab-b^2$
0 0

EXAMPLE II.

$a-b) aaa-3aab+3abb-bbb (aa-2ab+bb$
$aaa-aab$
$-2aab+3abb-bbb$
$-2aab+2abb$
$abb-bbb$
$abb-bbb$
0 0

EXAMPLE III.

$a-b) aaa-bbb (aa+ab+bb$
$aaa-aab$
$aab-bbb$
$aab-abb$
$abb-bbb$
$abb-bbb$
0 0

EXAMPLE IV.

$3a-6) 6aaaa-96 (2aaa+4aa+8a+16$
$6aaaa-12aaa$
$12aaa-96$
$12aaa-24aa$
$24aa-96$
$24aa-48a$
$48a-96$
$48a-96$
0 0

It often happens that the operation may be continued without end, and then you have an infinite series for the quotient; and by comparing the first three or four terms, you may find what law the terms observe; by which means, without any more division, you may continue the quotient as far as you please. Thus, in dividing 1 by $1-a$, you find the quotient to be $1+a+aa+aaa+aaaa+$ &c. which series can be continued as far as you please, by adding the powers of a.

The operation is thus:

$1-a) 1 (1+a+aa+aaa,$ &c.
$1-a$
$+a$
$+a-aa$
$+aa$
$+aa-aaa$
$+aaa$
$+aaa-aaaa$
$+aaaa,$ &c.

Another Example:

$a+x) aa+xx (a-x+\frac{2xx}{a}-\frac{2x^3}{a^2}+\frac{2x^4}{a^3}-$ &c.
$aa+ax$
$-ax+xx$
$-ax-xx$
$+2xx$
$+2xx+\frac{2x^3}{a}$
$-\frac{2x^3}{a}$
$-\frac{2x^3}{a}-\frac{2x^4}{a^2}$
$+\frac{2x^4}{a^2},$ &c.

In this last example the signs are alternately $+$ and $-$, the co-efficient is constantly 2 after the first two terms, and the letters are the powers of x and a; so that the quotient may be continued as far as you please without any more division.

But in division, after you come to a remainder of one term, as $2xx$ in the last example, it is commonly set down with the divisor under it, after the other terms, and these together give

the quotient. Thus, the quotient in the last example is found to be $a - x + \frac{2x^2}{a+x}$. And $bb + ab$, divided by $b - a$, gives for the quotient $b + \frac{2ab}{b-a}$.

Note. The sign $\div$ placed between any two quantities, expresses the quotient of the former divided by the latter. Thus $\overline{a+b} \div \overline{a-x}$ is the quotient of $a+b$ divided by $a-x$.

Of Fractions.

In the preceding page it was said, that the quotient of any quantity a divided by b, is expressed by placing a above a small line, and b under it, thus, $\frac{a}{b}$. These quotients are also called fractions; and the dividend or quantity placed above the line is called the numerator of the fraction, and the divisor or quantity placed under the line is called the denominator. Thus, $\frac{2}{3}$ expresses the quotient of 2 divided by 3; and 2 is the numerator and 3 the denominator of the fraction.

If the numerator of a fraction is equal to the denominator, then the fraction is equal to unity. Thus, $\frac{a}{a}$, and $\frac{b}{b}$, are equal to unit. If the numerator is greater than the denominator, then the fraction is greater than unit. In both these cases, the fraction is called improper. But if the numerator is less than the denominator, then the fraction is less than unit, and is called proper. Thus $\frac{5}{3}$ is an improper fraction; but $\frac{3}{4}$ and $\frac{2}{3}$ are proper fractions. A mixt quantity is that whereof one part is an integer, and the other a fraction; as $3\frac{4}{5}$, and $5\frac{2}{3}$, and $a + \frac{a^2}{b}$.

Prob. I. *To reduce a Mixt Quantity to an Improper Fraction.*

Rule. Multiply the part that is an integer by the denominator of the fractional part; and to the product add the numerator; under their sum place the former denominator.

Thus $2\frac{1}{5}$, reduced to an improper fraction, gives $\frac{13}{5}$; $a + \frac{a^2}{b} = \frac{ab+a^2}{b}$; and $a - x + \frac{a^2-ax}{x} = \frac{a^2-x^2}{x}$.

Prob. II. *To reduce an Improper Fraction to a Mixt Quantity.*

Rule. Divide the numerator of the fraction by the denominator, and the quotient shall give the integral part; the remainder set over the denominator shall be the fractional part.

Thus, $\frac{12}{5} = 2\frac{2}{5}$; $\frac{ab+a^2}{b} = a + \frac{a^2}{b}$; $\frac{ax+2xx}{a+x} = x + \frac{x^2}{a+x}$; $\frac{aa+xx}{a-x} = a + x + \frac{2xx}{a-x}$.

Prob. III. *To reduce Fractions of different Denominators, to Fractions of equal Value that shall have the same Denominator.*

Rule. Multiply each numerator, separately taken, into all the denominators but its own, and the products shall give the new numerators. Then multiply all the denominators into one another, and the product shall give the common denominator. Thus,

The fractions $\frac{a}{b}$, $\frac{b}{c}$, $\frac{c}{d}$, are respectively equal to these fractions, $\frac{acd}{bcd}$, $\frac{bbd}{bcd}$, $\frac{ccb}{bcd}$, which have the same denominator bcd. And the fractions $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, are respectively equal to these $\frac{40}{60}$, $\frac{45}{60}$, $\frac{48}{60}$.

Prob. IV. *To Add and Subtract Fractions.*

Rule. Reduce them to a common denominator, and add or subtract the numerators; the sum or difference set over the common denominator, is the sum or remainder required.

Thus, $\frac{a}{b} + \frac{c}{d} + \frac{d}{e} = \frac{ade+bce+d^2b}{bde}$; $\frac{a}{b} - \frac{c}{d} = \frac{ad-bc}{bd}$; $\frac{2}{3} + \frac{3}{4} = \frac{8+9}{12} = \frac{17}{12} = 1\frac{5}{12}$; $\frac{3}{4} - \frac{2}{3} = \frac{9-8}{12} = \frac{1}{12}$; $\frac{4}{5} - \frac{3}{4} = \frac{16-15}{20} = \frac{1}{20}$; $\frac{x}{2} - \frac{x}{3} = \frac{3x-2x}{6} = \frac{x}{6}$.

Prob. V. *To Multiply Fractions.*

Rule. Multiply their numerators one into another to obtain the numerator of the product; and their denominators multiplied into one another, shall give the denominator of the product.

Thus, $\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$; $\frac{2}{3} \times \frac{4}{5} = \frac{8}{15}$; and $\frac{a+b}{c} \times \frac{a-b}{d} = \frac{a^2-b^2}{cd}$.

If a mixt quantity is to be multiplied, first reduce it to the form of a fraction (by Prob. I.). And if an integer is to be multiplied by a fraction, you may reduce it to the form of a fraction by placing unit under it.

EXAMPLES.

$5\frac{2}{3} \times \frac{3}{4} = \frac{17}{3} \times \frac{3}{4} = \frac{51}{12}$; $9 \times \frac{2}{3} = \frac{9}{1} \times \frac{2}{3} = \frac{18}{3} = 6$; $b + \frac{bx}{a} \times \frac{a}{x} = \frac{ba+bx}{a} \times \frac{a}{x} = \frac{a^2b+abx}{ax} = \frac{ab+bx}{x} = b + \frac{ab}{x}$.

Prob. VI. *To Divide Fractions.*

Rule. Multiply the numerator of the dividend by the denominator of the divisor, their product shall give the numerator of the quotient. Then multiply the denominator of the dividend by the numerator of the divisor, and their product shall give the denominator. Thus

$\frac{4}{5}) \frac{2}{3} (\frac{10}{12}$; $\frac{3}{7}) \frac{5}{8} (\frac{35}{24}$; $\frac{c}{d}) \frac{a}{b} (\frac{ad}{cb}$; $\frac{a+b}{a-b}) \frac{a-b}{a} (\frac{a^2-2ab+b^2}{a^2+ab}$.

These last four Rules are easily demonstrated from the definition of a fraction.

1. It is obvious that the fractions $\frac{a}{b}$, $\frac{c}{d}$, $\frac{e}{f}$, are respectively equal to $\frac{adf}{bdf}$, $\frac{cbf}{dbf}$, $\frac{ebd}{fbd}$; since, if you divide adf by bdf, the quotient will be the same as of a divided by b; and cbf divided by dbf, gives the same quotient as c divided by d; and ebd divided by fbd, the same quotient as e divided by f.

2. Fractions reduced to the same denominator are added by adding their numerators and subscribing the common denominator. I say $\frac{a}{b} + \frac{c}{b} = \frac{a+c}{b}$. For, call $\frac{a}{b} = m$, and $\frac{c}{b} = n$, and it will be $a = mb$, $c = nb$, and $mb + nb = a + c$, and $m + n = \frac{a+c}{b}$; that is, $\frac{a}{b} + \frac{c}{b} = \frac{a+c}{b}$. After the same manner, $\frac{a}{b} - \frac{c}{b} = m - n = \frac{a-c}{b}$.

3. I say, $\frac{a}{b} \times \frac{c}{d}$ $(= m \times n) = \frac{ac}{bd}$; for $bm = a$, $dn = c$; and $bdmn = ac$, and $mn = \frac{ac}{bd}$; that is, $\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$.

4. I say, $\frac{a}{b}$ divided by $\frac{c}{d}$, or $\frac{m}{n}$, gives $\frac{ad}{cb}$; for $mb = a$, and $mbd = ad$; $nd = c$, and $nbd = cb$; therefore $\frac{mbd}{nbd} = \frac{ad}{cb}$; that is, $\frac{m}{n} = \frac{ad}{cb}$.

Prob. VII. *To find the greatest common Measure of two Numbers; that is, the greatest Number that can divide them both without a Remainder.*

Rule. First divide the greater number by the lesser, and if there is no remainder, the lesser number is the greatest common divisor required. If there is a remainder, divide your last divisor by it; and thus proceed continually dividing the last divisor by its remainder, till there is no remainder left, and then the last divisor is the greatest common measure required. Thus, the greatest common measure of 45 and 63 is 9; and the greatest common measure of 256 and 48 is 16.

```
45) 63 (1        48) 256 (5
    45               240
    --               ---
    18) 45 (2        16) 48 (3
        36               48
        --               --
         9) 18 (2         0
            18
            --
             0
```

Much after the same manner the greatest common measure of Algebraic quantities is discovered; only the remainders that arise in the operation are to be divided by their simple divisors, and the quantities are always to be ranged according to the dimensions of the same letter.

Thus, to find the greatest common measure of $a^2 - b^2$ and $a^2 - 2ab + b^2$;

$a^2 - b^2) a^2 - 2ab + b^2 (1$
$a^2 - b^2$

$-2ab + 2b^2$ remainder,

which divided by $-2b$ is reduced to

$a - b) a^2 - b^2 (a + b$
$a^2 - b^2$

0 0

Therefore $a - b$ is the greatest common measure required.

The ground of this operation is, that any quantity that measures the divisor and the remainder (if there is any) must also measure the dividend; because the dividend is equal to the sum of the divisor multiplied into the quotient, and of the remainder added together. Thus, in the last example, $a - b$ measures the divisor $a^2 - b^2$, and the remainder $-2ab + 2b$; it must therefore likewise measure their sum $a^2 - 2ab + b^2$. You must observe in this operation, to make that the dividend which has the highest powers of the letter according to which the quantities are ranged.

Prob. VIII. *To reduce any Fraction to its lowest Terms.*

Rule. Find the greatest common measure of the numerator and denominator; divide them by that common measure, and place the quo-

tients in their room, and you shall have a fraction equivalent to the given fraction expressed in the least terms. Thus,

$\frac{25bc}{25bc}) \frac{75abc}{125bcx} = \frac{3a}{5x}$; $\frac{156aa + 156ab}{572aa - 572ab} = \frac{3a + 3b}{11a - 11b}$; $\frac{a^2 - b^2}{a^2 - 2ab + b^2} = \frac{a + b}{a - b}$; $\frac{a^3 - b^2a}{a^2 + 2ab + b^2} = \frac{a^2 - ba}{a + b}$; $\frac{a^4 - b^4}{a^3 - a^2b^2} = \frac{a^2 + b^2}{a^2}$.

When unit is the greatest common measure of the numbers and quantities, then the fraction is already in its lowest terms. Thus, $\frac{3ab}{5dc}$ cannot be reduced lower.

And numbers, whose greatest common measure is unit, are said to be prime to one another.

If it is required to reduce a given fraction to a fraction equal to it that shall have a given denominator, you must multiply the numerator by the given denominator, and divide the product by the former denominator, the quotient, set over the given denominator, is the fraction required. Thus $\frac{a}{b}$ being given, and it being required to reduce it to an equal fraction whose denominator shall be c; find the quotient of ac divided by b, and it shall be the numerator of the fraction required.

Of the Involution of Quantities.

The products arising from the continual multiplication of the same quantity, were before called the powers of that quantity. Thus a, a^2, a^3, a^4, &c. are the powers of a; and ab, a^2b^2, a^3b^3, a^4b^4, &c. are the powers of ab. And the rule given for the multiplication of powers of the same quantity was, to "Add the exponents, and make their sum the exponent of the product." Thus $a^4 \times a^5 = a^9$; and $a^3b^3 \times a^6b^2 = a^9b^5$. In the above place you have the rule for dividing powers of the same quantity, which is, "To subtract the exponents, and make the difference the exponent of the quotient."

Thus, $\frac{a^6}{a^4} = a^{6-4} = a^2$; and $\frac{a^5b^3}{a^4b} = a^{5-4}b^{3-1} = ab^2$.

If you divide a lesser power by a greater, the exponent of the quotient must, by this rule, be negative. Thus, $\frac{a^4}{a^6} = a^{4-6} = a^{-2}$. But $\frac{a^4}{a^6} = \frac{1}{a^2}$; and hence $\frac{1}{a^2}$ is expressed also by a^2 with a negative exponent, or a^{-2}.

It is also obvious, that $\frac{a}{a} = a^{1-1} = a^0$; but $\frac{a}{a} = 1$, and therefore $a^0 = 1$. After the same manner, $\frac{1}{a} = \frac{a^0}{a} = a^{0-1} = a^{-1}$; $\frac{1}{aa} = \frac{a^0}{a^2} = a^{0-2} = a^{-2}$; $\frac{1}{aaa} = a^{0-3} = a^{-3}$; so that the quantities a, 1, $\frac{1}{a}$, $\frac{1}{a^2}$, $\frac{1}{a^3}$, $\frac{1}{a^4}$, &c. may be expressed thus, a^1, a^0, a^{-1}, a^{-2}, a^{-3}, a^{-4}, &c. Those are called the negative powers of a, which have negative exponents; but they are at the same time positive powers of $\frac{1}{a}$, or a^{-1}.

Negative powers (as well as positive) are multiplied by adding, and divided by subtracting, their exponents. Thus the product of a^{-2} (or $\frac{1}{a^2}$) multiplied by a^{-3} (or $\frac{1}{a^3}$) is a^{-2-3} $= a^{-5}$ (or $\frac{1}{a^5}$); also $a^{-6} \times a^4 = a^{-6+4}$ $= a^{-2}$ (or $\frac{1}{a^2}$); and $a^{-3} \times a^3 = a^0 = 1$.

And, in general, any positive power of a multiplied by a negative power of a of an equal exponent, gives unit for the product; for the positive and negative exponents destroy each other, and the product gives a^0, which is equal to unit.

Likewise $\frac{a^{-5}}{a^{-2}} = a^{-5+2} = a^{-3} = \frac{1}{a^3}$; and $\frac{a^{-2}}{a^{-5}} = a^{-2+5} = a^3$. But also, $\frac{a^{-2}}{a^{-5}}$ $= \frac{a^{-2}}{a^{-2} \times a^{-3}} = \frac{1}{a^{-3}}$; therefore $\frac{1}{a^{-3}} = a^3$. And, in general, "any quantity placed in the denominator of a fraction, may be transposed to the numerator, if the sign of its exponent be changed." Thus $\frac{1}{a^3} = a^{-3}$, and $\frac{1}{a^{-3}} = a^3$.

The quantity a^m expresses any power of a in general; the exponent (m) being undetermined; and a^{-m} expresses $\frac{1}{a^m}$, or a negative power of a of an equal exponent: and $a^m \times a^{-m} = a^{m-m} = a^0 = 1$ is their product. a^n expresses any other power of a; $a^m \times a^n = a^{m+n}$ is the product of the powers a^m and a^n, and a^{m-n} is their quotient.

To raise any simple quantity to its second, third, or fourth power, is to add its exponent twice, thrice, or four times to itself; therefore the second power of any quantity is had by doubling its exponent, and the third by trebling its exponent; and, in general, the power expressed by m of any quantity is had by multiplying the exponent by m, as is obvious from the multiplication of powers. Thus the second

$a + b$ = Root.
$\times\ a + b$
$a^2 + ab$
$+ ab + b^2$
$a^2 + 2ab + b^2$ = the Square, or 2d Power.
$\times\ a + b$
$a^3 + 2a^2b + ab^2$
$+ a^2b + 2ab^2 + b^3$
$a^3 + 3a^2b + 3ab^2 + b^3$ = Cube, or 3d Power.
$\times\ a + b$
$a^4 + 3a^3b + 3a^2b^2 + ab^3$
$+ a^3b + 3a^2b^2 + 3ab^3 + b^4$
$a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$ = Biquadrate, or 4th Power.
$\times\ a + b$
$a^5 + 4a^4b + 6a^3b^2 + 4a^2b^3 + ab^4$
$+ a^4b + 4a^3b^2 + 6a^2b^3 + 4ab^4 + b^5$
$a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + b^5$ = 5th Power.
$\times\ a + b$
$a^6 + 5a^5b + 10a^4b^2 + 10a^3b^3 + 5a^2b^4 + ab^5$
$+ a^5b + 5a^4b^2 + 10a^3b^3 + 10a^2b^4 + 5ab^5 + b^6$
$a^6 + 6a^5b + 15a^4b^2 + 20a^3b^3 + 15a^2b^4 + 6ab^5 + b^6$ = 6th Power, &c.

If the powers of $a - b$ are required, they will be found the same as the preceding, only the terms in which the exponent of b is an odd number will be found negative; "because an odd number of multiplications of a negative produces a negative." Thus, the cube of $a - b$ will be found to be $a^3 - 3a^2b + 3ab^2 - b^3$; where the 2d and 4th terms are negative, the exponent of b being an odd number in these terms. In general, "the terms of any power of $a - b$ are positive and negative by turns."

It is to be observed, that "in the first term of any power of $a \mp b$, the quantity a has the exponent of the power required; that in the following terms, the exponents of a decrease gradually by the same difference, (viz. unit); and that in the last terms it is never found. The powers of b are in the contrary order; it is not found in the first term, but its exponent in the second term is unit, in the 3d term its exponent is 2; and thus its exponent increases, till in the last term it becomes equal to the exponent of the power required."

power or square of a is $a^{2 \times 1} = a^2$; its third power or cube is $a^{3 \times 1} = a^3$; and the mth power of a is $a^{m \times 1} = a^m$. Also, the square of a^4 is $a^{2 \times 4} = a^8$; the cube of a^4 is $a^{3 \times 4} = a^{12}$; and the mth power of a^4 is $a^{4 \times m}$. The square of abc is $a^2b^2c^2$, the cube is $a^3b^3c^3$, the mth power $a^mb^mc^m$.

The raising of quantities to any power is called Involution; and any simple quantity is involved by multiplying the exponent by that of the power required, as in the preceding examples.

The co-efficient must also be raised to the same power by a continual multiplication of itself by itself, as often as unit is contained in the exponent of the power required. Thus the cube of $3ab$ is $3 \times 3 \times 3 \times a^3b^3 = 27a^3b^3$.

As to the signs, When the quantity to be involved is positive, it is obvious that all its powers must be positive. And when the quantity to be involved is negative, yet all its powers whose exponents are even numbers must be positive; for any number of multiplications of a negative, if the number is even, gives a positive; since $- \times - = +$, therefore $- \times - \times - \times - = + \times + = +$; and $- \times - \times - \times - \times - = + \times + \times + = +$.

The power then only can be negative when its exponent is an odd number, though the quantity to be involved be negative. The powers of $-a$ are $-a$, $+a^2$, $-a^3$, $+a^4$, $-a^5$, &c. Those whose exponents are 2, 4, 6, &c. are positive; but those whose exponents are 1, 3, 5, &c. are negative.

The involution of compound quantities is a more difficult operation. The powers of any binomial $a + b$ are found by a continual multiplication of it by itself, as follows.

As the exponents of a thus decrease, and at the same time those of b increase, "the sum of their exponents is always the same, and is equal to the exponent of the power required." Thus in the 6th power of $a+b$, viz. $a^6+6a^5b+15a^4b^2+20a^3b^3+15a^2b^4+6ab^5+b^6$, the exponents of a decrease in this order, 6, 5, 4, 3, 2, 1, 0; and those of b increase in the contrary order, 0, 1, 2, 3, 4, 5, 6. And the sum of their exponents in any term is always 6.

To find the co-efficient of any term, the co-efficient of the preceding term being known; you are to "divide the co-efficient of the preceding term by the exponent of b in the given term, and to multiply the quotient by the exponent of a in the same term, increased by unit." Thus to find the co-efficients of the terms of the 6th power of $a+b$, you find the terms are a^6, a^5b, a^4b^2, a^3b^3, a^2b^4, ab^5, b^6; and you know the co-efficient of the first term is unit, therefore, according to the Rule, the co-efficient of the second term will be

$$\frac{1}{1}\times\overline{5+1}=6;$$

that of the third term will be

$$\frac{6}{2}\times\overline{4+1}=3\times 5=15;$$

that of the fourth term will be

$$\frac{15}{3}\times\overline{3+1}=5\times 4=20;$$ and those of the following terms will be 15, 6, 1, agreeable to the preceding table.

In general, if $a+b$ is to be raised to any power m, the terms, without their co-efficients, will be, a^m, $a^{m-1}b$, $a^{m-2}b^2$, $a^{m-3}b^3$, $a^{m-4}b^4$, $a^{m-5}b^5$, &c. continued till the exponent of b becomes equal to m.

The co-efficients of the respective terms, according to the last Rule, will be

$$1,\ m,\ m\times\frac{m-1}{2},\ m\times\frac{m-1}{2}\times\frac{m-2}{3},$$
$$m\times\frac{m-1}{2}\times\frac{m-2}{3}\times\frac{m-3}{4},$$
$$m\times\frac{m-1}{2}\times\frac{m-2}{3}\times\frac{m-3}{4}\times\frac{m-4}{5},$$

&c. continued until you have one co-efficient more than there are units in m.

It follows therefore by these last Rules, that

$$\overline{a+b}^m=a^m+ma^{m-1}b+m\times\frac{m-1}{2}\times a^{m-2}b^2+m\times\frac{m-1}{2}\times\frac{m-2}{3}\times a^{m-3}b^3+$$
$$m\times\frac{m-1}{2}\times\frac{m-2}{3}\times\frac{m-3}{4}\times a^{m-4}b^4+,$$

&c. which is the general Theorem for raising a quantity consisting of two terms to any power m.

If a quantity consisting of three, or more terms is to be involved, "you may distinguish it into two parts, considering it as a Binomial, and raise it to any power by the preceding Rules; and then by the same rules you may substitute instead of the powers of these compound parts their values." Thus,

$$\overline{a+b+c}^2=\overline{\overline{a+b}+c}^2=\overline{a+b}^2+2c\times\overline{a+b}+c^2=a^2+2ab+b^2+2ac+2bc+c^2.$$

And $\overline{a+b+c}^3=\overline{a+b}^3+3c\times\overline{a+b}^2+3c^2\times\overline{a+b}+c^3=a^3+3a^2b+3ab^2+b^3+3a^2c+6abc+3b^2c+3ac^2+3bc^2+c^3.$

In these examples, $a+b+c$, is considered as composed of the compound part $a+b$ and the simple part c; and then the powers of $a+b$ are formed by the preceding rules, and substituted for $\overline{a+b}^2$ and $\overline{a+b}^3$.

Of Evolution.

The reverse of Involution, or the resolving of powers into their roots, is called Evolution. The roots of single quantities are easily extracted by dividing their exponents by the number that denominates the root required. Thus, the square root of a^8 is $a^{\frac{8}{2}}=a^4$; and the square root of $a^4b^8c^2$ is a^2b^4c. The cube root of a^6b^3 is $a^{\frac{6}{3}}b^{\frac{3}{3}}=a^2b$; and the cube root of $x^9y^6z^{12}$ is $x^3y^2z^4$. The ground of this rule is obvious from the rule for Involution. The powers of any root are found by multiplying its exponent by the index that denominates the power; and therefore, when any power is given, the root must be found by dividing the exponent of the given power by the number that denominates the kind of root that is required.

It appears from what was said of Involution, that "any power that has a positive sign, may have either a positive or negative root, if the root is denominated by any even number." Thus the square root of $+a^2$ may be $+a$, or $-a$, because $+a\times+a$, or $-a\times-a$ gives $+a^2$ for the product.

But if a power have a negative sign, "no root of it denominated by an even number can be assigned," since there is no quantity that multiplied into itself an even number of times can give a negative product. Thus the square root of $-a^2$ cannot be assigned, and is what we call an "impossible or imaginary quantity."

But if the root to be extracted is denominated by an odd number, then shall the sign of the root be the same as the sign of the given number whose root is required. Thus the cube root of $-a^3$ is $-a$, and the cube root of $-a^6b^3$ is $-a^2b$.

If the number that denominates the root required is a divisor of the exponent of the given power, then shall the root be only a "lower power of the same quantity." As the cube root of a^{12} is a^4, the number 3 that denominates the cube root being a divisor of 12.

But if the number that denominates what sort of root is required is not a divisor of the exponent of the given power, "then the root required shall have a fraction for its exponent." Thus the square root of a^3 is $a^{\frac{3}{2}}$; the cube root of a^5 is $a^{\frac{5}{3}}$, and the square root of a itself is $a^{\frac{1}{2}}$.

These powers that have fractional exponents are called "imperfect powers or surds;" and are otherwise expressed by placing the given power within the radical sign $\sqrt{\ }$, and placing above the radical sign the number that denominates what kind of root is required. Thus

$a^{\frac{3}{2}}=\sqrt[2]{a^3}$, $a^{\frac{5}{3}}=\sqrt[3]{a^5}$; and $\overline{a^{\frac{m}{n}}}=\sqrt[n]{a^m}$. In numbers the square root of 2 is expressed by $\sqrt[2]{2}$, and the cube root of 4 by $\sqrt[3]{4}$.

These imperfect powers or surds are "multiplied and divided, as other powers, by adding and subtracting their exponents." Thus,

$$a^{\frac{1}{2}}\times a^{\frac{5}{2}}=a^{\frac{6}{2}}=a^3;$$
$$a^{\frac{2}{3}}\times a^{\frac{3}{4}}=a^{\frac{2}{3}+\frac{3}{4}}=a^{\frac{17}{12}}=\sqrt[12]{a^{17}};$$
$$\text{and }\frac{a^{\frac{7}{2}}}{a^{\frac{3}{2}}}=a^{\frac{7-3}{2}}=a^{\frac{4}{2}}=a^2.$$

They are involved likewise, and evolved after the same manner as perfect powers. Thus the square of $a^{\frac{3}{2}}$ is $a^{\frac{3}{2}\times\frac{3}{2}}=a^3$; the cube of $a^{\frac{2}{5}}$ is $a^{\frac{2}{5}\times\frac{2}{5}}=a^{\frac{6}{5}}$. The square root of $a^{\frac{2}{3}}$ is $a^{\frac{2}{2\times 2}}=a^{\frac{1}{3}}$, the cube root of $a^{\frac{3}{4}}$ is $a^{\frac{1}{4}}$.

The square root of any compound quantity, as $a^2+2ab+b^2$ is discovered after this manner. "First, take care to dispose the terms according to the dimensions of the alphabet, as in Division; then find the square root of the first term aa, which gives a for the first member of the root. Then subtract its square from the proposed quantity, and divide the first term of the remainder ($2ab+b^2$) by the double of that member, viz. $2a$, and the quotient b is the second member of the root. Add this second member to the double of the first, and multiply their sum ($2a+b$) by the second member b, and subtract the product ($2ab+b^2$) from the foresaid remainder ($2ab+b^2$), and if nothing remains, then the square root is obtained; and in this example it is found to be $a+b$.

The manner of the operation is thus:

$$a^2+2ab+b^2\ (a+b$$
$$a^2$$
$$2a+b)\ 2ab+b^2$$
$$\times\ b)\ 2ab+b^2$$
$$0\ .\ 0$$

But if there had been a remainder, you must have divided it by the double of the sum of the two parts already found, and the quotient would have given the third member of the root.

Thus, if the quantity proposed had been $a^2+2ab+2ac+b^2+2bc+c^2$, after proceeding as above, you would have found the remainder $2ac+2bc+c^2$, which divided by $2a+2b$ gives c to be annexed to $a+b$ as the third member of the root. Then adding c to $2a+2b$, and multiplying their sum $2a+2b+c$ by c, subtract the product $2ac+2bc+c^2$ from the foresaid remainder: and since nothing now remains, you conclude that $a+b+c$ is the square root required.

The operation is thus:

$$a^2+2ab+2ac+b^2+2bc+c^2\ (a+b+c$$
$$a^2$$
$$2a+b)\ 2ab+2ac+b^2+2bc+c^2$$
$$\times\ b)\ 2ab+b^2$$
$$2a+2b+c)\ 2ac+2bc+c^2$$
$$\times\ c)\ 2ac+2bc+c^2$$
$$0\ .\ 0\ .\ 0$$

Another Example.

$$xx-ax+\tfrac{1}{4}aa\ (x-\tfrac{1}{2}a.$$
$$xx$$
$$2x-\tfrac{1}{2}a)\ -ax+\tfrac{1}{4}aa$$
$$\times\ -\tfrac{1}{2}a)\ -ax+\tfrac{1}{4}aa$$
$$0\ .\ 0$$

In general, to extract any root out of any given quantity, "First range that quantity according to the dimensions of its letters, and extract the said root out of the first term, and that shall be the first member of the root required. Then raise this root to a dimension lower by unit than the number that denominates the root required, and multiply the power that arises by that number itself; divide the second term of the given quantity by the product, and the quotient shall give the second member of the root required."

Thus, to extract the root of the 5th power out of $a^5+5a^4b+10a^3b^2+10a^2b^3+5ab^4+b^5$, I find that the root of the 5th power out of a^5 gives a, which I raise to the 4th power, and multiplying by 5, the product is $5a^4$; then dividing the second term of the given quantity $5a^4b$ by $5a^4$, I find b to be the second member; and raising $a+b$ to the 5th power, and subtracting it, there being no remainder, I conclude that $a+b$ is the root required. If the root has three members, the third is found after the same manner from the first two considered as one member, as the second member was found from the first; which may be easily understood from what was said of extracting the square root.

In extracting roots it will often happen that the exact root cannot be found in finite terms; thus the square root of a^2+x^2 is found to be

$$a+\frac{x^2}{2a}-\frac{x^4}{8a^3}+\frac{x^6}{16a^5}-\frac{5x^8}{128a^7}+,\ \&c.$$

The operation is thus:

$$a^2 + x^2 \left(a + \frac{x^2}{2a} - \frac{x^4}{8a^3} + \frac{x^6}{16a^5} -, \&c.\right.$$

$$\underline{a^2}$$

$$2a + \frac{x^2}{2a}) + x^2$$

$$\times \frac{x^2}{2a}) = x^2 + \frac{x^4}{4a^2}$$

$$\overline{2a + \frac{x^2}{a} - \frac{x^4}{8a^3})} - \frac{x^4}{4a^2}$$

$$\times -\frac{x^4}{8a^3}) = -\frac{x^4}{4a^2} - \frac{x^6}{8a^4} + \frac{x^8}{64a^6}$$

$$+ \frac{x^6}{8a^4} - \frac{x^8}{64a^6}, \&c.$$

After the same manner, the cube root of $a^3 + x^3$ will be found to be

$$a + \frac{x^3}{3a^2} - \frac{x^6}{9a^5} + \frac{5x^9}{81a^8} - \frac{10x^{12}}{243a^{11}} +, \&c.$$

"The general theorem which we gave for the involution of binomials, will serve also for their evolution;" because, to extract any root of a given quantity, is the same thing as to raise that quantity to a power whose exponent is a fraction that has its denominator equal to the number that expresses what kind of root is to be extracted. Thus, to extract the square root of $a + b$ is to raise $a + b$ to a power whose exponent is $\frac{1}{2}$. Now, since $\overline{a + b}^m = a^m + m \times a^{m-1} b + m \times \frac{m-1}{2} a^{m-2} b^2 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times a^{m-3} b^3$, &c.

Supposing $m = \frac{1}{2}$, you will find

$$\overline{a + b}^{\frac{1}{2}} = a^{\frac{1}{2}} + \frac{1}{2} \times a^{-\frac{1}{2}} b + \frac{1}{2} \times -\frac{1}{4} \times a^{-\frac{3}{2}} b^2 + \frac{1}{2} \times -\frac{1}{4} \times -\frac{1}{2} a^{-\frac{5}{2}} b^3, \&c.$$

$$= a^{\frac{1}{2}} + \frac{b}{2a^{\frac{1}{2}}} - \frac{b^2}{8a^{\frac{3}{2}}} + \frac{b^3}{16a^{\frac{5}{2}}} -, \&c.$$

And after this manner you will find that $\overline{a^2 + x^2}^{\frac{1}{2}} = a + \frac{x^2}{2a} - \frac{x^4}{8a^3} + \frac{x^6}{16a^5} -$, &c. as before.

Of Proportion.

When quantities of the same kind are compared, it may be considered either how much the one is greater than the other, and what is their difference; or, it may be considered how many times the one is contained in the other, or, more generally, what is their quotient. The first relation of quantities is expressed by their arithmetical ratio; the second by their geometrical ratio. That term whose ratio is enquired into is called the Antecedent, and that with which it is compared is called the Consequent.

When of four quantities, the difference betwixt the first and second is equal to the difference betwixt the third and fourth, those quantities are called Arithmetical Proportionals; as the numbers 3, 7, 12, 16; and the quantities a, $a + b$, e, $e + b$. But quantities form a series in Arithmetical Proportion, when they "increase or decrease by the same constant difference;" as these, a, $a + b$, $a + 2b$, $a + 3b$, $a + 4b$, &c. x, $x - b$, $x - 2b$, &c. or the numbers 1, 2, 3, 4, 5, &c. and 10, 7, 4, 1, -2, -5, -8, &c.

In four quantities arithmetically proportional, "the sum of the extremes is equal to the sum of the mean terms." Thus, a, $a + b$, e, $e + b$, are arithmetical proportionals, and the sum of the extremes $(a + e + b)$ is equal to the sum of the mean terms $(a + b + e)$. Hence, to find the fourth quantity arithmetically proportional to any three given quantities; "add the second and third, and from their sum subtract the first term, the remainder shall give the fourth arithmetical proportional required."

In a series of arithmetical proportionals, "the sum of the first and last terms is equal to the sum of any two terms equally distant from the extremes." If the first terms are a, $a + b$, $a + 2b$, &c. and the last term x, the last term but one will be $x - b$, the last but two $x - 2b$, the last but three $x - 3b$, &c. So that the first half of the terms, having those that are equally distant from the last term set under them, will stand thus:

$$a,\ a + b,\ a + 2b,\ a + 3b,\ a + 4b, \&c.$$
$$x,\ x - b,\ x - 2b,\ x - 3b,\ x - 4b,$$

$$\overline{a + x},\ \overline{a + x},\ \overline{a + x},\ \overline{a + x},\ \overline{a + x}, \&c.$$

And it is plain that if each term be added to the term above it, the sum will be $a + x$, equal to the sum of the first term a, and the last term x. From which it is plain, that "the sum of all the terms of an arithmetical progression is equal to the sum of the first and last taken half as often as there are terms," that is, the sum of an arithmetical progression is equal to the sum of the first and last terms multiplied by half the number of terms. Thus, in the preceding series, if n be the number of terms, the sum of all the terms will be $\overline{a + x} \times \frac{n}{2}$.

The common difference of the terms being b, and b not being found in the first term, it is plain that "its co-efficient in any term will be equal to the number of terms that precede that term." Therefore, in the last term x, you must have $\overline{n - 1} \times b$, so that x must be equal to $a + \overline{n - 1} \times b$. And the sum of all the terms being $\overline{a + x} \times \frac{n}{2}$, it will also be equal to $\frac{2an + n^2 b - nb}{2}$, or to $a + \frac{nb - b}{2} \times n$. Thus, for example, the series $1 + 2 + 3 + 4 + 5$, &c. continued to a hundred, must be equal to $\frac{2 \times 100 + 10000 - 100}{2} = 5050$.

If a series have (0) nothing for its first term, then "its sum shall be equal to half the product of the last term multiplied by the number of terms." For then, a being $= 0$, the sum of the terms, which is in general $\overline{a + x} \times \frac{n}{2}$, will in this case be $\frac{nx}{2}$. From which it is evident, that "the sum of any number of arithmetical proportionals beginning from nothing, is equal to half the sum of as many terms each equal to the greatest term." Thus,

$$\frac{0 + 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9}{9 + 9 + 9 + 9 + 9 + 9 + 9 + 9 + 9 + 9} = \frac{}{2}$$

$$= \frac{10 \times 9}{2} = 45.$$

"If of four quantities the quotient of the first and second be equal to the quotient of the third and fourth, then those quantities are said to be in geometrical proportion." Such are the numbers 2, 6, 4, 12; and the quantities a, ar, b, br; which are expressed after this manner;

$$2 : 6 :: 4 : 12.$$
$$a : ar :: b : br.$$

And you read them by saying, As 2 is to 6, so is 4 to 12; or as a is to ar, so is b to br.

In four quantities geometrically proportional, "the product of the extremes is equal to the product of the middle terms." Thus, $a \times br = ar \times b$. And, if it is required to find a fourth proportional to any three given quantities, "multiply the second by the third, and divide their product by the first, the quotient shall give the fourth proportional required." Thus, to find a fourth proportional to a, ar, and b, I multiply ar by b, and divide the product arb by the first term a, the quotient br is the fourth proportional required.

When a series of quantities increase by one common multiplicator, or decrease by one common divisor, they are said to be in "geometrical proportion continued."

As, a, ar, ar^2, ar^3, ar^4, ar^5, &c. or,

$$a,\ \frac{a}{r},\ \frac{a}{r^2},\ \frac{a}{r^3},\ \frac{a}{r^4},\ \frac{a}{r^5}, \&c.$$

The common multiplier or divisor is called their "common ratio."

In such a series, "the product of the first and last is always equal to the product of the second and last but one, or to the product of any two terms equally remote from the extremes." In the series a, ar, ar^2, ar^3, &c. if y be the last term, then shall the four last terms of the series be y, $\frac{y}{r}$, $\frac{y}{r^2}$, $\frac{y}{r^3}$; now it is plain that $a \times y =$

$$ar \times \frac{y}{r} = ar^2 \times \frac{y}{r^2} = ar^3 \times \frac{y}{r^3}, \&c.$$

"The sum of a series of geometrical proportionals wanting the first term, is equal to the sum of all but the last term multiplied by the common ratio."

For $ar + ar^2 + ar^3$, &c. $+ \frac{y}{r^3} + \frac{y}{r^2} + \frac{y}{r} + y =$

$$\overline{r \times a + ar + ar^2, \&c. + \frac{y}{r^4} + \frac{y}{r^3} + \frac{y}{r^2} + \frac{y}{r}}.$$

Therefore, if s be the sum of the series, $s - a$ will be equal to $\overline{s - y} \times r$; that is, $s - a = sr - yr$, or $sr - s = yr - a$, and $s = \frac{yr - a}{r - 1}$.*

Since the exponent of r is always increasing from the second term, if the number of terms be n, in the last term its exponent will be $n - 1$. Therefore $y = ar^{n-1}$; and $yr = ar^{n-1+1} = ar^n$; and $s = \left(\frac{yr - a}{r - 1}\right) = \frac{ar^n - a}{r - 1}$. So that having the first term of the series, the number of the terms, and the common ratio, you may easily find the sum of all the terms.

If it is a decreasing series, whose sum is to be found, as of $y + \frac{y}{r} + \frac{y}{r^2} + \frac{y}{r^3}$, &c. $+ ar^3 + ar^2 + ar + a$, and the number of the terms be supposed infinite, then shall a, the last term, be equal to nothing. For, because n, and consequently r^{n-1}, is infinite, $a = \frac{y}{r^{n-1}} = 0$.

The sum of such a series $s = \frac{yr}{r - 1}$; which is a finite sum, though the number of terms be infinite. Thus,

$$1 + \tfrac{1}{2} + \tfrac{1}{4} + \tfrac{1}{8} + \tfrac{1}{16} +, \&c. = \frac{1 \times 2}{2 - 1} = 2.$$

and $1 + \frac{1}{3} + \frac{1}{9} + \frac{1}{27} + \frac{1}{81} +$ &c. $= \frac{1 \times 3}{3 - 1} = \frac{3}{2}$.

Of Equations.

Definit. 1. An equation is a proposition asserting the quality of two quantities, and is expressed by placing the sign $=$ between them.

Definit. 2. Equations containing only one unknown quantity and its powers, are divided into orders, according to the highest power of the unknown quantity to be found in any of its terms.

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* See the Rules under the next general head.

If the highest power of the unknown quantity in any term be the { 1st, 2d, 3d, &c. } The equation is called { Simple, Quadrat, Cubic, &c. }

But the exponents of the unknown quantities are supposed to be integers, and the equation is supposed to be cleared of fractions, in which the unknown quantity, or any of its powers, enter the denominators. Thus, $x + a = \frac{3x - b}{c}$ is a simple equation; $3x - \frac{5}{2x} = 12$, when cleared of the fraction by multiplying both sides by $2x$, becomes $6x^2 - 5 = 24x$ a quadratic; $x^3 - 2x^4 = x^5 - 20$ is an equation of the sixth order, &c.

To resolve an equation is to find the value of the unknown term in known terms.

Of Simple Equations, and their Resolutions.

Rule 1. Any quantity may be transposed from one side of an equation to the other, by changing its sign.

Thus, if $3x - 10 = 2x + 5$
Then, $3x - 2x = 10 + 5$ or $x = 15$
Thus also, $5x + b = a + 2x$
By transp. $3x = a - b$.

For equal quantities are thus added to or subtracted from both sides.

Corol. The signs of all the terms of an equation may be changed into the contrary signs, and it will continue to be true.

Rule 2. Any quantity by which the unknown quantity is multiplied may be taken away, by dividing all the other quantities of the equation by it.

Thus, if $ax = b$
$$x = \frac{b}{a}$$
Also, if $mx + nb = am$
$$x + \frac{nb}{m} = a.$$

For if equal quantities are divided by the same quantity, the quotients are equal.

Rule 3. If a term of an equation is fractional, its denominator may be taken away by multiplying all the other terms by it.

Thus, if $\frac{x}{a} = b + c$ Also, if $a - \frac{b}{x} = c$
$x = ab + ac$ $ax - b = cx$
And by trans. $ax - cx = b$
And by div. $x = \frac{b}{a - c}$.

For, if all the terms of the equation are multiplied by the same quantity, the quantities on each side will be equal.

Corol. If any quantity be found on both sides of the equation, with the same sign, it may be taken away from both.

Also, if all the terms in the equation are multiplied or divided by the same quantity, it may be taken out of them all.

EXAMPLE.

If $3x + a = a + b$, then $3x = b$.
If $2ax + 3ab = ma + a^2$, then $2x + 3b = m + a$.
If $\frac{x}{3} - \frac{4}{3} = \frac{16}{3}$, then $x - 4 = 16$.

By these rules the unknown term may be separated from the known, and the equation is resolved.

Examples of Simple Equations resolved by these Rules.

If $3x + 5 = x + 9$
$2x = 4$
$x = \frac{4}{2} = 2$.

If $5x - \frac{5x}{2} + 12 = \frac{4x}{3} + 26$
$5x - \frac{5x}{2} - \frac{4x}{3} = 26 - 12 = 14$
$30x - 15x - 8x = 84$.
Or $7x = 84$
$x = \frac{84}{7} = 12$.

If $\frac{5}{x} + \frac{9}{4} = 16$
$\frac{20}{x} + 9 = 64$
$20 + 9x = 64x$
$20 = 64x - 9x = 55x$
$x = \frac{20}{55} = \frac{4}{11}$.

Solution of Questions producing Simple Equations.

General Rule. The unknown quantities in the question proposed must be expressed by letters, and the relations of the known and unknown quantities contained in it, or the conditions of it, as they are called, must be expressed by equations. These equations being resolved, give the answer to the question.

For example, if the question is concerning two numbers, they may be called x and y, and the conditions from which they are to be investigated must be expressible by equations.

Thus, if it be required that the sum of two numbers sought be 60, that condition is expressed thus: $x + y = 60$

If their difference must be 24, then $x - y = 24$
If their product is 1640, then $xy = 1640$
If their quotient must be 6, then $\frac{x}{y} = 6$.

Case I. When there is only one unknown quantity to be found.

Rule. An equation involving the unknown quantity must be deduced from the question; and it is obvious, that, when there is only one unknown quantity, there must be only one independent equation contained in the question; for any other would be unnecessary, and might be contradictory to the former.

Ex. 1. To find a number, to which if there be added a half, a third part, and a fourth part of itself, the sum will be 50.

Let it be z: then half of it is $\frac{z}{2}$, a third of it is $\frac{z}{3}$, &c.

Therefore, $z + \frac{z}{2} + \frac{z}{3} + \frac{z}{4} = 50$
$24z + 12z + 8z + 6z = 1200$
$50z = 1200$
$z = 24$.

Case II. When there are two unknown quantities.

Rule. Two independent equations involving the two unknown quantities, must be derived from the question. A value of one of the unknown quantities must be derived from each of the equations; and these two values being put equal to each other, a new equation will arise, involving only one unknown quantity.

Ex. 2. Two persons, A and B, were talking of their ages; says A to B, Seven years ago I was just three times as old as you were, and seven years hence I shall be just twice as old as you will be. I demand their present ages.

Let the ages of A and B be x and y, then seven years ago their ages were $x - 7$ and $y - 7$; and seven years hence they will be $x + y$ and $y + 7$;

therefore $x - 7 = \overline{y - 7} \times 3 = 3y - 21$
$x + 7 = y + 7 \times 2 = 2y + 14$
$x = 3y - 21 + 7 = 3y - 14$
$x = 2y + 14 - 7 = 2y + 7$
Therefore $3y - 14 = 2y + 7$
$y = 21$, and
$x = 49$.

Ex. 3. A gentleman distributing money among some poor people, found he wanted 10*s.* to be able to give 5*s.* to each; therefore he gives each 4*s.* only, and finds he has 5*s.* left.—To find the number of shillings and poor people.

If any question such as this, in which there are two quantities sought, can be resolved by means of one letter, the solution is in general more simple than when two are employed. There must be, however, two independent conditions; one of which is used in the notation of one of the unknown quantities, and the other gives an equation.

Let the number of poor be z, then the number of shillings will be $5z - 10$, and also $4z + 5$; therefore, $5z - 10 = 4z + 5$
$z = 15$, equal the number of poor, of course the number of shillings is 65.

Case III. When there are three or more unknown quantities.

Rule. When there are three unknown quantities, there must be three independent equations arising from the question; and from each of these a value of one of the unknown quantities must be obtained. By comparing these three values, two equations will arise, involving only two unknown quantities; and in like manner may the rule be extended to such questions as contain four or more unknown quantities.—Hence it may be inferred, that when just as many independent equations may be derived from a question as there are unknown quantities in it, these quantities may be found by the resolution of equations.

Ex. 4. To find three numbers, so that the first with half the other two, the second with one-third of the other two, and the third with one-fourth of the other two, may each be equal to 34.

Let the numbers be x, y, z, and the equations will be

$x + \frac{y + z}{2} = 34$

$y + \frac{x + z}{3} = 34$

$z + \frac{x + y}{4} = 34$; then, by the first equation

$x = \frac{68 - y - z}{2}$; and by the second

$x = 102 - 3y - z$; and by the third

$x = 136 - 4z - y$; therefore

$\frac{68 - y - z}{2} = 102 - 3y - z$

$y = \frac{136 - z}{5}$; and by the two latter equations

$y = \frac{3z - 34}{2}$, therefore,

$\frac{3z - 34}{2} = \frac{136 - z}{5}$
$15z - 170 = 272 - 2z$
$17z = 442$, or $z = 26$
$y = 22$, and $x = 10$.

On many occasions, by particular contrivances, the operations by the preceding rules may be much abridged. This, however, must be left to the skill and practice of the learner. A few examples are the following.

1. It is often easy to employ fewer letters than there are unknown quantities, by expressing some of them from a simple relation to others contained in the conditions of the question.

2. Sometimes it is convenient to express by letters, not the unknown quantities themselves, but some other quantities connected with them, as their sum, difference, &c. from which they may be easily derived.

3. In the operation, also, circumstances will suggest a more easy road than that pointed out by the general rules. Two of the original equations may be added together, or may be subtracted; sometimes they must be previously multiplied by some quantity, to render such addition or subtraction effectual, in exterminating one of the unknown quantities, or otherwise promoting the solution. Substitutions may be made of the values of quantities, in place of quantities themselves; and various other such contrivances may be used, which will render the solution much less complicated.

General Solution of Problems.

In the solutions of the questions in the preceding part, the given quantities (being numbers) disappear in the last conclusion, so that no general rules for like cases can be deduced from them. But if letters are used to denote the known quantities, as well as the unknown, a general solution may be obtained, because, during the whole course of the operation, they retain their original form. Hence also the connection of the quantities will appear in such a manner as to discover the necessary limitations of the data, when there are any, which is necessary to the perfect solution of a problem.

Ex. 1. To find two numbers, of which the sum and difference are given.

Let s be the sum given, and d the given difference. Also, let x and y be the two numbers sought.

$$x + y = s$$
$$x - y = d$$
$$\text{Whence } \begin{cases} x = s - y \\ x = d + y \end{cases}$$
$$d + y = s - y$$
$$2y = s - d$$
$$y = \frac{s-d}{2}$$
$$\text{And } x = \frac{s+d}{2}.$$

Thus, let the given sum be 100, and the difference 24.

$$\text{Then } x = \left(\frac{s+d}{2} = \frac{124}{2} =\right) 62$$
$$\text{and } y = \left(\frac{s-d}{2} = \frac{76}{2} =\right) 38.$$

Equations are either pure or adfected.

Def. 1. A pure equation is that in which only one power of the unknown quantity is found.

2. An adfected equation is that in which different powers of the unknown quantity are found in the several terms. Thus,

$a^2 + ax^2 = b^3$, $ax^2 - b^2 = m^2 + x^2$, are pure equations.

$x^2 - ax = b^2$, $x^3 + x^2 = 17$, are adfected equations.

Solution of Pure Equations.

Rule. Make the power of the unknown quantity to stand alone by the rules formerly given, and then extract the root of the same denomination out of both sides, which will give the value of the unknown quantity.

Examples.

If $a^2 + ax^2 = b^3$

$$ax^2 = b^3 - a^2$$
$$x^2 = \frac{b^3 - a^2}{a}$$
$$x = \sqrt{\frac{b^3 - a^2}{a}}$$

$ax^m - b = x - c$

$$ax^m - x^m = b - c$$
$$x^m = \frac{b-c}{a-1}$$
$$x = \sqrt[m]{\frac{b-c}{a-1}}$$

Solution of Adfected Quadratic Equations.

An adfected quadratic equation (commonly called a quadratic) involves the unknown quantity itself, and also its square:

Rule 1. Transpose all the terms involving the unknown quantity to one side, and the known terms to the other; and so that the term containing the square of the unknown quantity may be positive.

2. If the square of the unknown quantity is multiplied by any co-efficient, all the terms of the equation are to be divided by it, so that the co-efficient of the square of the unknown quantity may be 1.

3. Add to both sides the square of half the co-efficient of the unknown quantity, and the side of the equation involving the unknown quantity will be a complete square.

4. Extract the square root from both sides of the equation, and by transposing the above-mentioned half co-efficient, a value of the unknown quantity is obtained in known terms.

The reason of this rule is manifest from the composition of the square of a binomial, for it consists of the squares of the two parts, and twice the product of the two parts.

The different forms of quadratic equations, expressed in general terms, being reduced by the first and second parts of the rule, are these:

1. $x^2 + ax = b^2$
2. $x^2 - ax = b^2$
3. $x^2 - ax = -b^2$

Case 1. $x^2 + ax = b^2$

$$x^2 + ax + \frac{a^2}{4} = b^2 + \frac{a^2}{4}$$
$$x + \frac{a}{2} = \pm\sqrt{b^2 + \frac{a^2}{4}}$$
$$x = \pm\sqrt{b^2 + \frac{a^2}{4}} - \frac{a}{2}$$

Case 2. $x^2 - ax = b^2$

$$x^2 - ax + \frac{a^2}{4} = b^2 + \frac{a^2}{4}$$
$$x - \frac{a}{2} = \pm\sqrt{b^2 + \frac{a^2}{4}}$$
$$x = \frac{a}{2} \pm \sqrt{b^2 + \frac{a^2}{4}}$$

Case 3. $x^2 - ax = -b^2$

$$x^2 - a^2 + \frac{a^2}{4} = \frac{a^2}{4} - b^2$$
$$x - \frac{a}{2} = \pm\sqrt{\frac{a^2}{4} - b^2}$$
$$x = \frac{a}{2} \pm \sqrt{\frac{a^2}{4} - b^2}.$$

1. Every quadratic equation will have two roots, except such of the third form whose roots become impossible.

2. In the two first forms, one of the roots must be positive, and the other negative.

3. In the third form, if $\frac{a^2}{4}$, or the square of half of the co-efficient of the unknown quantity, be greater than b^2, the known quantity, the two roots will be positive. If $\frac{a^2}{4}$ be equal to b^2, the two roots become equal; but if $\frac{a^2}{4}$ is less than b^2, the quantity under the radical sign becomes negative, and the two roots are impossible.

4. If the equation express the relation of magnitudes abstractly considered, where a contrariety cannot be supposed to take place, the negative roots cannot be of use, or rather there are no such roots; for then a negative quantity by itself is unintelligible, and therefore the square root of a positive quantity must be positive only.

Solution of Questions producing Quadratic Equations.

The expression of the conditions of the question by equations, or the stating of it, and the reduction likewise of these equations, till we arrive at a quadratic equation, involving only one unknown quantity and its square, are effected by the same rules which were given for the solution of simple equations.

Ex. 1. One lays out a certain sum of money in goods, which he sold again for 24*l.* and gained as much per cent. as the goods cost him: I demand what they cost him?

If the money laid out be y

The gain will be $24 - y$

$$\text{But this gain is } (y : 24 - y :: 100) \begin{cases} \frac{2400 - 100y}{y} \text{ per cent.} \end{cases}$$
$$\text{Therefore by question } \begin{cases} y = \frac{2400 - 100y}{y} \end{cases}$$
$$\text{And by mult. and tr. } y^2 + 100y = 2400$$
$$\text{Completing the square } \begin{cases} y^2 + 100y + 50^2 = 2400 \\ + 2500 = 4900 \end{cases}$$
$$\text{Extract the root } y + 50 = \pm\sqrt{4900} = 70$$
$$\text{Trans. } y = \pm 70 - 50 = 20, \text{ or } -120.$$

The answer is 20*l.* which succeeds. The other root, -120, has no place in this example, a negative number being here unintelligible.

To find two numbers whose sum is 100, and whose product is 2059.

Ex. 2. Let the given sum $100 = a$, the product $2059 = b$, and let one of the numbers sought be x, the other will be $a - x$. Their product is $ax - x^2$.

Therefore $ax - x^2 = b$, or $x^2 - ax = -b$

Compl. the sq. $x^2 - ax + \frac{a^2}{4} = \frac{a^2}{4} - b$

Ext. $\sqrt{\ }$ $x - \frac{a}{2} = \pm\sqrt{\frac{a^2}{4} - b}$

Transp. $x = \frac{a}{2} \pm \sqrt{\frac{a^2}{4} - b}$

$$\text{And the other number } \begin{cases} a - x = \frac{a}{2} \mp \sqrt{\frac{a^2}{4} - b}. \end{cases}$$

By inserting numbers, $x = 71$ or 29, and $a - x = 29$ or 71, so that the two numbers sought are 71 and 29.

Here it is to be observed, that b must not be greater than $\frac{a^2}{4}$, else the roots of the equation would be impossible; that is, the given product must not be greater than the square of half the given sum of the numbers sought. This limitation can easily be shewn from other principles; for the greatest possible product of two parts into which any number may be divided, is, when each of them is a half of it. If b be equal to $\frac{a^2}{4}$, there is only one solution, and $x = \frac{a}{2}$, also $a - x = \frac{a}{2}$.

Of Indeterminate Problems.

It may be observed, that if there are more unknown quantities in a question than equations, by which their relations are expressed, it is indetermined. In other circumstances, such problems are resolved by various methods, not to be comprehended in general rules.

Ex. 1. To divide a given square number into two parts, each of which shall be a square number.

There are two quantities sought in this ques-

tion, and there is only one equation expressing their relation; but it is required also that they may be rational, which circumstance cannot be expressed by an equation: another condition therefore must be assumed, in such a manner as to obtain a solution in rational numbers.

Let the given square be a^2; let one of the squares sought be x^2, the other is $a^2 - x^2$. Let $rx - a$ also be a side of the last square, therefore

$$r^2x^2 - 2rxa + a^2 = a^2 - x^2$$

By transp. $\quad r^2x^2 + x^2 = 2rxa$

Divide by x $\quad r^2x + x = 2ra$

Therefore $\quad x = \frac{2ra}{r^2+1}$

And $rx - a = \frac{2r^2a}{r^2+1} - a = \frac{r^2-1}{r^2+1}a$.

Let r therefore be assumed at pleasure, and $\frac{2ra}{r^2+1}, \frac{r^2-1}{r^2+1}a$, which must always be rational, will be the sides of the two squares required.

Thus, if $a^2 = 100$; then, if $r = 3$, the sides of the two squares are 6 and 8, for $36 + 64 = 100$.

Also, let $a^2 = 64$. Then, if $r = 2$, the sides of the squares are $\frac{32}{5}$ and $\frac{24}{5}$; and $\frac{1024}{25} + \frac{576}{25} = \frac{1600}{25} = 64$.

The reason of the assumption of $rx - a$ as a side of the square $a^2 - x^2$, is, that being squared and put equal to this last, the equation manifestly will be simple, and the root of such an equation is always rational.

Ex. 2. To find two square numbers whose difference is given.

Let x^2 and y^2 be the square numbers, and a their difference.

Put $\frac{z+v}{2} = x$, and $\frac{z-v}{2} = y$

$$\frac{z^2 + 2zv + v^2}{4} = x^2$$

$$\frac{z^2 - 2zv - v^2}{4} = y^2$$

$$zv = x^2 - y^2 = a.$$

If x and y are required only to be rational, then take v at pleasure, and $x = \frac{a}{v}$, whence x and y are known.

But if x and y are required to be whole numbers, take for z and v any two factors that produce a, and are both even or both odd numbers. And this is possible only where a is either an odd number greater than 1, or a number divisible by 4.

Then $\frac{z+v}{2}$ and $\frac{z-v}{2}$ are the numbers sought.

For the product of two odd numbers is odd, and that of two even numbers is divisible by 4. Also if z and v are both odd or both even, $\frac{z+v}{2}$ and $\frac{z-v}{2}$ must be integers.

Ex. 1. If $a = 27$, take $v = 1$, then $z = 27$; and the squares are 196 and 169. Or z may be 6, and $v = 3$, and then the squares are 36 and 9.

2. If $a = 12$, take $v = 2$, and $z = 6$; and the squares are 16 and 4.

Of the Origin and Composition of Equations; and of the Signs and Co-efficients of their Terms.

The higher orders of equations, and their general affections, are best investigated by considering their origin from the combination of inferior equations.

In this general method, all the terms of any equation are brought to one side, and the equation is expressed by making them equal to 0. Therefore, if a root of the equation be inserted instead of (x) the unknown quantity, the positive terms will be equal to the negative, and the whole must be equal to 0.

Def. When any equation is put into this form, the term in which (x) the unknown quantity is of the highest power is made the first, that in which the index of x is less by 1 is the second, and so on, till the last into which the unknown quantity does not enter, and which is called the absolute term.

Prop. I. If any number of equations be multiplied together, an equation will be produced, of which the dimension is equal to the sum of the dimensions of the equations multiplied.

If any number of simple equations be multiplied together, as $x - a = 0$, $x - b = 0$, $x - c = 0$, &c. the product will be an equation of a dimension, containing as many units as there are simple equations. In like manner, if higher equations are multiplied together, as a cubic and a quadratic, one of the fifth order is produced, and so on.

Conversely. An equation of any dimension is considered as compounded either of simple equations, or of other such that the sum of their dimensions is equal to the dimension of the given one. By the resolution of equations these inferior equations are discovered, and by investigating the component simple equations, the roots of any higher equation are found.

Cor. 1. An equation admits of as many solutions, or has as many roots, as there are simple equations which compose it.

Cor. 2. And conversely no equation can have more roots than it has dimensions.

Cor. 3. Imaginary or impossible roots must enter an equation by pairs; for they arise from quadratics, in which both the roots are such. And an equation of an even dimension may have all its roots, or any even number of them, impossible; but an equation of an odd dimension must at least have one possible root.

Cor. 4. The roots are either positive or negative, according as the roots of the simple equations, from which they are produced, are positive or negative.

Cor. 5. When one root of an equation is discovered, one of the simple equations is found, from which the given one is compounded. The given equation, therefore, being divided by this simple equation, will give an equation of a dimension lower by 1.

Prop. II. To explain the general properties of the signs and co-efficients of the terms of an equation.

Let $x - a = 0$, $x - b = 0$, $x - c = 0$, $x - d = 0$, &c. be simple equations, of which the roots are any positive quantities $+a$, $+b$, $+c$, $+d$, &c. and let $x + m = 0$, $x + n = 0$, &c. be simple equations, of which the roots are any negative quantities $-m$, $-n$, and let any number of these equations be multiplied together, as in the following table:

$$x - a = 0$$
$$\times\ x - b = 0$$
$$= x^2 - ax - bx + ab = 0, \text{ a Quadratic.}$$
$$\times\ x - c = 0$$
$$= x^3 - (a+b+c)x^2 + (ab+ac+bc)x - abc = 0, \text{ a Cubic.}$$
$$\times\ x - m = 0$$
$$= x^4 - (a+b+c+m)x^3 + (ab+ac+bc-am-bm-cm)x^2 - (abc-abm-acm-bcm)x + abcm = 0, \text{ a Biquadratic.}$$

&c.

From this table it is plain,

1. That in a complete equation the number of terms is always greater by unit than the dimension of the equation.

2. The co-efficient of the first term is 1.

The co-efficient of the second term is the sum of all the roots (a, b, c, m, &c.) with their signs changed.

The co-efficient of the third term is the sum of all the products that can be made by multiplying any two of the roots together.

The co-efficient of the fourth term is the sum of all the products which can be made by multiplying together any three of the roots with their signs changed; and so of others.

The last term is the product of all the roots, with their signs changed.

3. From induction it appears, that in any equation (the terms being regularly arranged as in the preceding example) there are as many positive roots as there are changes in the signs of the terms from + to −, and from − to +; and the remaining roots are negative. The rule also may be demonstrated.

Note. The impossible roots in this rule are supposed to be either positive or negative.

Cor. If a term of an equation is wanting, the positive and negative parts of its co-efficient must then be equal. If there is no absolute term, some of the roots $= 0$, and the equation may be depressed by dividing all the terms by the lowest power of the unknown quantity in any of them. In this case also, $x - 0 = 0$, $x - 0 = 0$, &c. may be considered as so many of the component simple equations, by which the given equation being divided, it will be depressed so many degrees.

Of the Transformation of Equations.

Prop. I. The affirmative roots of an equation become negative, and the negative become affirmative, by changing the signs of the alternate terms, beginning with the second.

Thus the roots of the equation $x^4 - x^3 - 19x^2 + 49x - 30 = 0$, are $+1$, $+2$, $+3$, -5, whereas the roots of the equation $x^4 + x^3 - 19x^2 - 49x - 30 = 0$, are -1, -2, -3, $+5$.

The reason of this is derived from the composition of the co-efficients of these terms, which consist of combinations of odd numbers of the roots, as explained in the preceding head.

Prop. II. An equation may be transformed into another that shall have its roots greater or less than the roots of the given equation by some given difference.

Let e be the given difference; then $y = x \pm e$, and $x = y \mp e$; and if for x and its powers in the given equation, $y \mp e$ and its powers be inserted, a new equation will arise, in which the unknown quantity is y, and its value will be $x \pm e$.

Let the equation proposed be $x^3 - px^2 + qx - r = 0$, of which the roots must be diminished by e. By inserting for x and its powers $y + e$ and its powers, the equation required is,

$$\left.\begin{matrix} y^3 + 3y^2 + 3e^2y + e^3 \\ - py^2 - 2pey - pe^2 \\ + qy + qe \\ - r \end{matrix}\right\} = 0.$$

Cor. 1. The use of this transformation is to take away the second, or any other intermediate term; for as the co-efficients of all the terms of the transformed equation, except the first, involve the powers of e, and known quantities only, by putting the co-efficient of any term equal to 0, and resolving that equation, a value of e may be determined, which being substituted, will make that term to vanish.

Thus let the co-efficient $3e - p = 0$, and $e = \frac{1}{3}p$, which being substituted for e, the new equation will want the second term. And universally the co-efficient of the first term of an

equation of n dimensions being 1, the second term may be taken away, by supposing $x = y \pm \frac{1}{n}p$.

Cor. 2. The second term may be taken away by the solution of a simple equation, the third by the solution of a quadratic, and so on.

Prop. III. An equation may be transformed into another, of which the roots shall be equal to the roots of the given equation, multiplied or divided by a given quantity.

Let $y = xe$, or $y = \frac{x}{e}$.

Then substitute for x and its powers, $\frac{y}{e}$ or ye and its powers, and the new equation will have the property required.

Cor. 1. An equation, in which the co-efficient of the first term is any known quantity, as a, may thus be transformed into another, in which the co-efficient of the first term shall be unit. Thus, let the equation be $ax^3 - px^2 + qx - r = 0$.

Suppose $y = ax$, or $x = \frac{y}{a}$, and for x and its powers insert $\frac{y}{a}$ and its powers, and the equation becomes $\frac{y^3}{a^2} - \frac{py^2}{a^2} + \frac{qy}{a} - r = 0$, or $y^3 - py^2 + qay - a^2r = 0$.

Cor. 2. If there are fractions in an equation, they may be taken away, by multiplying the equation by the denominators, and by this proposition the equation may then be transformed into another, without fractions, in which the co-efficient of the first term is 1. In like manner may a surd co-efficient be taken away in certain cases.

Cor. 3. Hence also, if the co-efficient of the second term of a cubic equation is not divisible by 3, the fractions thence arising in the transformed equation wanting the second term, may be taken away by the preceding corollary. But the second term also may be taken away, so that there shall be no such fractions in the transformed equation, by supposing $x = \frac{z \mp p}{3}$, $\pm p$ being the co-efficient of the second term of the given equation. And if the equation $ax^3 - px^2 + qx - r = 0$ be given, in which p is not divisible by 3, by supposing $x = \frac{z + p}{3a}$, the transformed equation reduced is $z^3 - \overline{3p^2 + 9aq} \times z - 2p^3 + 9apq - 7a^2r = 0$; wanting the second term, having 1 for the co-efficient of the first term, and the co-efficients of the other terms being all integers, the co-efficients of the given equation being also supposed integers.

General Corollary to Prop. I, II, III.

If the roots of any of these transformed equations be found by any method, the roots of the original equation, from which they were derived, will easily be found from the simple equations expressing their relation. Thus, if 8 is found to be a root of the transformed equation $z^3 + 23z - 696 = 0$. Since $x = \frac{z+2}{5}$, the corresponding root of the given equation $5x^3 - 6x^2 + 7x - 30 = 0$, must be $\frac{8+2}{5} = 2$.

It is to be observed also, that the reasoning in Prop. II. and III, and the Corollaries, may be extended to any order of equations, though in them it is applied chiefly to cubics.

From the preceding principles and operations, rules may be derived for resolving equations of all orders.

ALGENEB, a fixed star of the second magnitude, on the right shoulder of the constellation Perseus.

ALGOL, the name of a fixed star of the second magnitude, in the constellation Perseus, otherwise called Medusa's head.

This star has been subject to singular variations, appearing at different times of different magnitudes, from the fourth to the second, which is its usual appearance. It has been conjectured that the cause of this variation is owing either to the interposition of a large body revolving round Algol, or to some motion of its own, in consequence of which part of its body, covered with spots, is periodically turned towards the earth. The period of variation is said to be 2d. 20h. 49′ 2″.

ALGOMEIZA, a name given to the star Procyon.

ALGOR, among medical writers, a term used to denote an unusual coldness or chilness in any part of the body.

ALGORAB, a fixed star of the third magnitude, in the right wing of Corvus.

ALGUAZIL, in the Spanish policy, an officer whose business it is to see the decrees of a judge executed.

ALHABOR, among the Arabians, is the star which we call Sirius.

ALHIRTO, a fixed star of the third magnitude, in the constellation Capricorn. It is sometimes called *rostrum gallinæ*. Near this star, in the year 1600, appeared a new star, which lasted 21 years, and then disappeared again.

ALIAS, in law, a second or farther writ issued from the courts of Westminster after a *capias*, &c. has been sued out without effect.

ALIAS DICTUS, the legal description of a person known by two or more names.

ALIBI, denotes the absence of the accused from the place where he is charged to have committed the crime.

ALIDES, among the Mahomedans, a designation given to the descendants of Ali; between whom and the Ommiades there was a warm dispute about the kaliphate.

ALIEN, in law, a person born in a strange country, not within the king's allegiance, in contradistinction from a denizen, or a natural subject. See DENIZEN.

An alien is incapable of inheriting lands in England, till naturalized by an act of parliament. No alien is entitled to vote in the choice of members of parliament, nor can enjoy an office, or be returned on any jury, unless where an alien is party in a cause; and then the inquest of jurors shall be one half natives and the other aliens.

The issue of an English woman, by an alien, born abroad, is an alien in law. But if an Englishman, living beyond sea, marry a wife there, and have children born abroad, they are denizens, and shall be heirs to their father.

Aliens can have no heirs, strictly so called, because they have not in them any heritable blood; yet natural-born subjects may inherit as heirs to their ancestors, even though their ancestors were aliens.

If an alien is made a denizen by letters patent, and then purchases lands, his son before his denization shall not inherit; but a son born afterwards may inherit, even though the elder brother be living. *Blacks.*

Every foreign seaman serving on board an English ship two years in time of war is naturalized.

Masters of ships arriving from foreign parts are to give notice at every port of the number and names of all foreigners on board, under a penalty of 10*l.* for each alien whose name is omitted; 33 Geo. III. c. 4. And by the 42d Geo. III. c. 22, commonly called the alien bill, his majesty may issue a proclamation ordering aliens out of the kingdom, and in case of disobedience, the alien for the first offence shall suffer imprisonment for one month, and for twelve months for a second offence, being liable to transportation for life for the third. Secretaries of state may grant warrants for conducting such aliens out of the kingdom as they apprehend will not pay due obedience to the proclamation.

ALIEN-DUTY, an impost laid on all goods imported by aliens, over and above the customs paid for such goods imported by British and on British bottoms.

ALIEN-PRIORIES, a kind of inferior monasteries, formerly very numerous in England, and so called from their belonging to foreign abbies.

ALIENABLE, denotes something that may be alienated.

All estates are alienable, except those in tail and for life: a bond too, with condition not to alien, is said to be good.

ALIENATION, in law, denotes the act of making over a man's property in lands, tenements, &c. to another person.

To *alien* or *alienate* in fee, is to sell or convey the fee simple of lands, &c.

ALIENATION, in mortmain, is making over lands, tenements, &c. to a body politic, or to a religious house, for which the king's licence must first be obtained, otherwise the lands, &c. alienated, will be forfeited. See MORTMAIN.

Alienation of crown lands is always supposed to be made under a faculty of perpetual redemption.

A perpetual copy-hold is also a kind of alienation.

ALIENATION, in Roman antiquity, was used for a father's discarding a son in his own life-time.

ALIENATION-*office*, is that to which are carried all writs of covenants and entry upon which fines are levied, in order to have fines for alienation set upon them.

ALIMENT, among physicians, denotes whatever is capable of nourishing the human body. Aliment is either animal or vegetable, of an attenuating or incrassating nature; and with respect to the taste, is sweet, fat, acid, astringent, salsuginous, bitter, and acrid.

ALIMENTARY DUCT, a name by which some call the intestines, on account of the food passing through them. See ANATOMY.

Alimentary duct is sometimes also used for the thoracic duct.

ALIMENTARY CHILDREN, in Roman antiquity, an appellation given to those educated in houses not unlike our hospitals, erected for that purpose. There were likewise alimentary girls, who owed their maintenance to the bounty of several empresses, as the boys did theirs to that of the emperors.

ALIMENTARY LAW, among the same people, that whereby children were obliged to maintain their aged parents.

ALIMONY, in law, denotes the maintenance sued for by a wife, in case of separation from her husband, wherein she is neither chargeable with elopement nor adultery.

Anciently this was recoverable only in the spiritual courts, but at present may be obtained in chancery.

ALIPILARIUS, or ALIPILUS, in Roman

antiquity, a servant belonging to the baths, whose business it was, by means of waxen plasters, and an instrument called volsella, to take off the hairs from the arm-pits, and even arms, legs, &c. this being deemed a point of cleanliness.

ALIQUANT *parts*, in arithmetic, those which will not divide or measure the whole number exactly. Thus, 7 is an aliquant part of 16, for twice 7 wants 2 of 16, and three times 7 exceeds 16 by 5.

ALIQUOT *part*, is such part of a number as will divide and measure it exactly, without any remainder. For instance, 2 is an aliquot part of 4, 3 of 9, and 4 of 16.

To find all the aliquot parts of a number, divide it by its least divisor, and the quotient by its least divisor, until you get a quotient not farther divisible, and you will have all the prime divisors or aliquot parts of that number. Thus, 60 divided by 2, gives the quotient 30, which divided by 2 gives 15, and 15 divided by 3 gives the indivisible quotient 5. Hence the prime aliquot parts are 1, 2, 3, 5; and by multiplying any two or three of these together, you will find the compound aliquot parts, viz. 4, 6, 10, 12, 15, 20, 30.

Aliquot parts must not be confounded with commensurable ones; for though the former are all commensurable, yet these are not always aliquot parts: thus 4 is commensurable with 6, but is not an aliquot part of it.

ALISMA, water-plantain, a genus of plants of the class and order hexandria polygynia. The essential character is calyx three-leaved; petals three; seeds several.

There are nine species, most of which may be found in England. They are inhabitants of watry places, bogs, &c.

ALKAHEST, or ALCAHEST, among the old chemists, denotes an universal menstruum capable of resolving all bodies into their first matter, or *ens primum;* and that without suffering any change or diminution by so doing.

Van Helmont assures us in the most positive manner, that he himself was master of such a menstruum. But, in this enlightened period, when chemical research has been extended farther than it ever was before, the notion is deservedly ridiculed.

ALKALESCENT denotes a substance slightly alkaline, or in which alkali is beginning to be formed, and to predominate. See the next article.

ALKALI. This word is of Arabian origin, and was introduced into chemistry after it had been applied to the plant which still retains the name of *kali*. When this plant is burnt, the ashes washed in water, and the water evaporated to dryness, a white substance remains, which is called alkali. This, however, may be obtained from other substances besides the kali: and the word alkali is now applied to all bodies which possess, 1, a caustic taste; 2, the properties of being volatilized by heat; 3, of being capable of combining with acids; 4, of being soluble in water, even when combined with carbonic acid; and, 5, capable of converting vegetable blues to green.

The alkalies at present known are three in number: 1, potass; 2, soda; 3, ammonia. The two first are called fixed alkalies; they require a red heat to volatilize them: the last is called volatile alkali, because it readily assumes a gaseous form, and consequently is dissipated with a moderate degree of heat.

Alkalies readily unite with sulphur, forming compounds which have the property of absorbing the oxygen from the atmosphere, and when moistened, of giving out a peculiar and very fetid gas. These compounds were formerly called alkaline hepars or livers; but according to the modern nomenclature, they are denominated sulphurets. The alkalies have a very powerful action on almost all vegetable and animal matters, producing speedy disorganization, and reducing them to a pulp. With oils they form a compound known by the name of soap. They unite with all the acids, and produce neutral salts, of various degrees of solubility; in which, when the contents are mutually saturated, the distinguishing properties of both acid and alkali are neutralized, and no longer to be perceived. From their affinity to acids, alkalies decompose the acid solutions of all metals and most earths. See CHEMISTRY.

ALKALINE *earths*, are those earths which agree with alkali in the property of solubility in water to a certain extent; of changing blue and red vegetable colours to green; of absorbing carbonic acid; and of possessing those acrid qualities that distinguish the alkalies. Magnesia, lime, barytes, and strontian, are deemed alkaline earths; but the former is very imperfectly so, being scarcely more soluble in water than silex. Barytes and strontian approach nearer to an alkali than lime, in being largely soluble in water.

ALKALINE *salts*. See MATERIA MEDICA.

ALKEKENGI, *winter cherry*. See PHYSALIS.

ALKERMES, in pharmacy, a compound cordial confection, made of various ingredients, as rose-water, sugar, cinnamon, aloeswood, &c.; but the principal one is kermes. It is now disused.

ALKORAN, or ALCORAN, [from the Arabic particle *al*, and *coran*, or *koran*, derived from the verb *craoa* or *karoa*, to read; signifying *the reading*, or rather *that which ought to be read*,] the scripture or bible of the Mahometans; containing the revelations and doctrines of their pretended prophet.

The alkoran is divided into 114 larger portions of very unequal length, which we call chapters, but the Arabians *sowar*, in the singular *sura;* a word rarely used on any other occasion, and properly signifying a row, or a regular series. These chapters are not, in the manuscript copies, distinguished by their numerical order, but by particular titles, which are taken sometimes from a peculiar subject treated of, or person mentioned in them, usually from the first word of note. Some chapters have two or more titles, occasioned by the difference of the copies. Some of them being pretended to have been revealed at Mecca, and others at Medina, the noting this difference makes a part of the title. Every chapter is divided into smaller portions, of very unequal length also, which we customarily call verses; but the Arabic word is *ayat*, signifying signs or wonders. Besides these unequal divisions, the Mahometans have also divided their koran into 60 equal portions, each subdivided into four equal parts. But the koran is more usually divided into 30 sections only, each of twice the length of the former, and in like manner subdivided into four parts. These divisions are for the use of the readers of the koran in the royal temples, or in the adjoining chapels, where the emperors and great men are interred.

There are 29 chapters of the koran which have this peculiarity, that they begin with certain letters of the alphabet, some with a single one, others with more. These letters the Mahometans believe to be the peculiar mark of the koran, and to conceal several profound mysteries; the certain understanding of which the more intelligent confess has not been communicated to any mortal, their prophet only excepted.

The koran is universally allowed to be written with the utmost elegance and purity of language, in the dialect of the tribe of Koreish, the most noble and polite of all the Arabians, but with some mixture, though very rarely, of other dialects; and it is confessedly the standard of the Arabic tongue.

The great doctrine of the koran is the unity of God; to restore which Mahomet pretended was the chief object of his mission: that there never was, nor ever can be, more than one true orthodox religion; that, though the particular laws or ceremonies are only temporary, and subject to alteration, according to the divine direction, yet the substance of it being eternal truth, is not liable to change, but continues immutably the same; and that, whenever this religion became neglected or corrupted in essentials, God had the goodness to re-inform and re-admonish mankind thereof by several prophets, of whom Moses and Jesus were the most distinguished, till the appearance of Mahomet, who is their seal, and no other to be expected after him.

The most excellent moral in the whole alcoran is that in the chapter *al alraf*, viz. "Shew mercy, do good to all, and dispute not with the ignorant;" or, as Mr. Sale renders it, Use indulgence, command that which is just, and withdraw far from the ignorant. Mahomet, according to the authors of the *Keschaf*, having begged of the angel Gabriel a more ample explication of this passage, received it in the following terms: "Seek him who turns thee out, give to him who takes from thee, pardon him who injures thee; for God will have you plant in your souls the roots of his chief perfections." It is easy to see that this commentary is borrowed from the gospel.

The caliph Hassan, son of Ali, being at table, a slave let fall a dish of meat reeking hot, which scalded him severely. The slave fell on his knees, rehearsing these words of the alcoran: "Paradise is for those who restrain their anger." "I am not angry with thee," answered the caliph. "And for those who forgive offences against them," continues the slave. "I forgive thee thine," replies the caliph. "But above all, for those who return good for evil," adds the slave. "I set thee at liberty," rejoined the caliph; "and I give thee ten dinars."

It is the common opinion that Mahomet, assisted by one Sergius, a monk, composed this book; but the Mussulmans believe it as an article of their faith, that the prophet, who they say was an illiterate man, had no concern in inditing it; but that it was given him by God, who, to that end, made use of the ministry of the angel Gabriel; that, however, it was communicated to him by little

and little, a verse at a time, and in different places, during the course of 23 years. "And hence, say they, proceed that disorder and confusion visible in the work;" which, in truth, are so great, that all their doctors have never been able to adjust them. The alkoran, while Mahomet lived, was only kept in loose sheets: his successor Abubeker, first collected them into a volume, and committed the keeping of it to Haphsa, the widow of Mahomet, in order to be consulted as an original; and there being much diversity between the several copies already dispersed throughout the provinces, Othman successor of Abubeker procured a great number of copies to be taken from that of Haphsa; at the same time suppressing all the others not conformable to the original.

ALKUSSA, a name given by the Swedes to a fish which they also call a *lake*. It is a species of the Silurus.

ALL *in the wind*, a phrase which expresses the state of the ship's sails when they are parallel to the direction of the wind.

ALL hands hoay! the phrase by which a ship's company are summoned upon deck.

ALLAMANDA, a genus of the pentandria monogynia class and order. The corolla is monopetalous and funnel-shaped; and the essential character is: cor. contorted; caps. lens-shaped, erect, echinate, one-celled, two-valved, many-seeded. There is only one species, the A. cathartica. It grows wild in Guiana. The leaves are cathartic, whence the specific name; and are used at Surinam in the cholic.

ALLANTOIS, or ALLANTOIDES, in comparative anatomy, a vesicle investing the fœtus of several animals, as cows, sheep, goats, &c. and filled with an urinous liquor conveyed thither from the urachus. See COMPARATIVE ANATOMY.

ALLAY, the same with alloy.

ALLEGATA, in Roman antiquity, a kind of subscription used by the emperors, importing the writings to be verified.

ALLEGATION, in law, signifies the producing instruments or deeds, to authorise or justify something.

ALLEGEAS, a stuff manufactured in the East Indies. There are two sorts; one of cotton, and the other of herbs, which is spun like flax or hemp.

ALLEGIANCE, in law, denotes the obedience which every subject owes to his lawful sovereign.

ALLEGIANCE, oath of, in the British policy, is that taken in acknowledgment of the king, as a temporal prince; as the oath of supremacy acknowledges him for the supreme head of the church.

This oath may be tendered to all persons above the age of twelve years, whether natives, denizens, or aliens, either in the court leet of the manor, or in the sheriff's court. It is a necessary preliminary to the holding of any office of trust under the crown.

ALLEGORY, in literature, a figure of rhetoric; also a mode of writing, wherein something else is signified, than the words in their literal meaning express. An allegory may be considered as a series or chain of metaphors, continued through a great part of a discourse. For example, when the prophets represent the Hebrews under the allegory of a vine planted, cultivated, and watered by the hand of God, which instead of producing good fruit, brings forth verjuice and sour grapes.

Allegories have entered into most religions: the Hebrew abounds with them, and it is well known that some philosophers of the Gentile world, undertaking to give a rational account of the many horrid absurdities which the poets had introduced into their religion, found it necessary to maintain that these fictions contained mysteries, and signified something very different from what they seemed to express. Hence came the word allegory, or a discourse that in its natural sense, αλλο αγοβευει, signifies some other thing than what seems intended to be meant. See RHETORIC.

ALLEGRO, in music, an Italian word denoting that the part is to be played in a sprightly, brisk, lively, and gay manner.

ALLELENGYON, in antiquity, a tax paid by the rich for the poor, when absent in the army.

ALLEMAND, a sort of grave solemn music, with good measure and a slow movement. It is also a kind of dance very common in Germany and Switzerland.

ALLERION, or ALERION, in heraldry, a sort of eagle without beak or feet, having nothing perfect but the wings.

They differ from martlets in this, that their wings are expanded, whereas those of the martlet are close; and denote imperialists vanquished and disarmed, for which reason they are more common in French than in German coats of arms.

ALLEVEURE, the smallest copper coin that is struck in Sweden. It is about 2¼d. of English money.

ALLEY, in perspective, that which, in order to have a greater appearance of length, is made wider at the entrance than at the termination.

ALLIANCE, in the civil and canon law, the relation contracted between two persons or two families by marriage.

An alliance is thus contracted between the husband and his wife's relations, between the wife and her husband's relations, but not between the relations of the husband and wife.

ALLIANCE is also used for a treaty entered into by sovereign princes and states, for their mutual safety and defence.

In this sense, alliances may be distinguished into such as are offensive, whereby the contracting parties oblige themselves jointly to attack some other power; and into defensive, whereby they bind themselves to support and defend each other, in case they are attacked by others. Under this head too may be ranked treaties of subsidy, which are well known to the English nation.

ALLIGATI, in antiquity, the basest and worst kind of slaves. The Romans had three kinds, or orders of slaves; the first employed in the management of their estates; the second in the menial or lower functions of the family; the third called *alligati*, these were kept in chains and dungeons.

ALLIGATION, in arithmetic, is the rule of mixture, which teaches to compound several species of ingredients or commodities together, according to any intent or design proposed, and is either medial or alternate. See ARITHMETIC.

ALLIGATOR, in zoology, the smaller kind of crocodiles. See LACERTA.

ALLIOTH, a star in the tail of the greater bear, much employed for finding the latitude at sea.

The word is also written *alliot* or *aliot*, denoting a horse. The Arabs give this name to each of the three stars in the tail of the Great Bear, on account of their appearing like three horses, ranged for the drawing of the waggon, represented by four stars, called Charles's wain.

ALLITERATION, a figure or decoration of language, chiefly used in poetry, and consisting in the repetition of the same letter or letters at certain intervals, whence its name is derived; thus in Lucretius:

——— Adverso *f*labra *f*eruntur
*F*lumine.

And in Shakspeare,

*H*ad my sweet *H*arry *h*ad but *h*alf their numbers,
This day might I, *h*anging on *H*otspur's neck,
*H*ave talked.

ALLIONIA, a genus of plants of the class and order tetandria monogynia. The corolla is one-petalled and funnel-shaped; and the essential character is cal. common, oblong, simple, three-flowered; proper obsolete, superior: corollures irregular: recept. naked. There are two species, both natives of South America.

ALLIUM, GARLICK, in botany, a genus of plants, of the hexandria monogynia class and order. The corolla is six-petalled, and the essential character is cor. six-parted, spreading: spathe many-flowered: umbel heaped: caps. superior.

This is a very extensive genus of plants, comprehending the A. porrum or leek, the A. cepa or onion, with all their varieties (among which the A. canadense, or Canada tree-onion, which bears excellent eatable onions on the top of the stalk, is most remarkable) the eschalot or shallot, the common garlick, the rocambole (which resembles the tree onion in bearing the garlick at the top of the stem as well as at the root), the Moly's, and a considerable tribe of flowering ornamental garlicks. There are in all 45 species. The A. ursinum or ransoms, is a most disagreeable weed, on which if cows feed, their butter is not eatable. The A. descendens and triquetrum are very ornamental; the latter is treated as a greenhouse plant. Garlick is used in many preparations in medicine and farriery.

ALLOCATIONE FACIENDA is a writ directed to the lord treasurer, or barons of the exchequer, commanding them to allow an accountant such sums as he has lawfully expended in the execution of his office.

ALLOCATO COMITATU, a new writ of exigent allowed, before any other county-court held, on a former not being complied with.

ALLODIAL, an epithet given to an inheritance held without any acknowledgment to a lord or superior, in opposition to feudal.

Allodial lands are free lands, for which neither fees, rents, nor services, are due.

ALLODIUM *nobile*, that which had also civil and criminal jurisdiction annexed to it; in opposition to *allodium villanum*, which had no such jurisdiction.

ALLONGE, in fencing, denotes a thrust or pass at the adversary.

ALLOPHYLUS, a genus of the octandria monogynia class and order, and of the natural order of guttiferæ. The essential character is cal. four-leaved, leaflets orbiculate, two smaller; pet. four less than the calyx; germ. twin; stigma quadrifid. There are 5 species; all trees but one, which is a shrub. They are natives of the East and West Indies.

ALLOTTING, or ALLOTMENT *of goods*, in commerce, is the dividing a ship's cargo into several parts, which are to be purchased by several persons, whose names being written upon as many slips of paper, are applied by an indifferent person to the several lots; by which means the goods are divided without partiality, each man having the parcel upon which his name is fixed.

ALLOTMENTS *of land*, are such portions of ground as are granted to claimants on the division and inclosure of commons and waste lands, and which are generally proportionate to the extent of the right which they enjoy upon them.

ALLOWANCES, at the custom-house, to goods rated by weight, are two, viz. draught and tare.

ALLOY, or ALLAY, a proportion of a baser metal mixed with a finer one. Thus all gold coin has an alloy of silver and copper, as silver coin has of copper alone; the proportion in the former case, for standard gold, being two carats of alloy in a pound troy of gold; and in the latter, eighteen pennyweight of alloy for a pound troy of silver.

According as gold or silver has more or less alloy than that mentioned above, it is said to be coarser or finer than the standard. It ought, however, to be remarked, that the coin of different nations varies greatly in this respect; some using a larger, and others a less proportion of alloy, the original intention of which was to give the coin a due degree of hardness.

ALLUME'E, in heraldry, a term applied to the eyes of a bear, or other beast, when they are drawn sparkling and red.

ALLUSION, in rhetoric, a figure by which something is applied to, or understood of another, on account of some similitude between them. An allusion to words is trifling and low, making what we commonly call a pun. Allusions, however, to some apophthegm, remarkable event, or generally received custom, are not only extremely pleasing, but approved by the best writers, antient as well as modern.

ALLUVIAL *Limestone*, a sort of stone found in many districts, supposed to have been formed in the earliest ages of the world by the desposition of calcareous matters held in the state of solution in water.

ALLUVION, among civilians, denotes the gradual increase of land along the seashore, or on the banks of rivers. This, when slow and imperceptible, is deemed a lawful means of acquisition; but when a considerable portion of land is torn away at once, by the violence of the current, and joined to a neighbouring estate, it may be claimed by the king. 2 Black. 262.

ALMADIE, a kind of canoe or small vessel, about four fathom long, usually made of bark, and used by the negroes of Africa.

ALMADIE is also the name of a kind of long boats, fitted out at Calicut, which are eighty feet in length, and six or seven in breadth. They are exceedingly swift, and are otherwise called *cathuri*.

ALMAGRA, in natural history, the name of a fine deep-red ochre, with a faint admixture of purple, used both in painting and medicine, being an excellent astringent. It is the same with what the antients called *sil atticum*.

ALMANAC, a table containing the calendar of days and months, the rising and setting of the sun, the age of the moon, &c.

The first thing to be done in the construction of almanacs is to compute the sun's and moon's place for each day of the year, or it may be taken from some ephemerides and entered in the almanac; next, find the dominical letter, and, by means thereof, distribute the calendar into weeks: then, having computed the time of Easter by it, fix the other moveable feasts; adding the immoveable ones, the rising and setting of each luminary, the length of day and night, the aspects of the planets, the phases of the moon, and the sun's entrance into the cardinal points of the ecliptic, i. e. the two equinoxes and solstices.

These are the principal contents of almanacks; besides which there are others of a political nature, and consequently different in different countries, as the birth-days and coronation of princes, tables of interest, &c.

ALMANAC, *nautical*, and *astronomical ephemeris*, is a kind of national almanac, published annually, by anticipation, under the direction of the commissioners of longitude. It contains among other things, the distances of the moon from the sun and fixed stars, for every three hours of apparent time, adapted to the meridian of Greenwich; by comparing which with the distances carefully observed at sea, the mariner may readily infer his longitude to a degree of exactness, that is found sufficient for most nautical purposes.

ALMARIC HERESY, one broached in France, in 1209, the distinguishing tenet of which was, that no Christian could be saved unless he believed himself to be a member of Christ.

ALME, singing and dancing girls in Egypt, who can occasionally chaunt unpremeditated verse. They derive their name from having received a better education than other women, and they form a celebrated society in the country. The qualifications for admission are, a good voice, a knowledge of the language and of the rules of poetry, and an ability to compose and sing couplets on the spot, adapted to the occasion.

ALMEHRAB, in the Mahometan customs, a nich in the mosques, pointing towards the kebla, or temple of Mecca, to which they are obliged to bow in praying.

ALMEISAR, a celebrated game among the ancient Arabs, performed by a kind of casting lots with arrows, forbidden by Mahomet, on account of the frequent quarrels occasioned by it.

ALMENE, in commerce, a weight of two pounds, used to weigh saffron in several parts of the continent of the East Indies.

ALMENDINE, ALMANDINE, or ALBANDINE, a kind of ruby, but softer and lighter than the oriental ruby.

ALMERICANS, followers of the Almaric heresy, which see.

ALMOND-TREE, see AMYGDALUS.

ALMOND, in commerce, a measure by which the Portuguse sell their oil: twenty-six almonds make a pipe.

ALMOND-FURNACE, among refiners, that in which the slags of litharge, left in refining silver, are reduced to lead again, by the help of charcoal.

ALMOND is also a name given to a species of rock-crystal, which lapidaries use in adorning branch-candlesticks, &c. on account of the resemblance they bear to the fruit of the same name.

ALMONER, an officer appointed to distribute alms to the poor.

The lord almoner, or lord high almoner of England, is an ecclesiastical officer, usually a bishop, who has the forfeiture of all deodands, and the goods of all felos-de-se, which he is to distribute among the poor.

By virtue of an ancient custom, the lord almoner may give the first dish from the king's table, to whatever poor person he pleases; or, in lieu of it, an alms in money.

The parishioners, also, of the parishes adjacent to the king's place of residence, nominate twenty-four poor men, to whom the lord almoner distributes four pence a day in money, bread, and small beer.

ALMONER is sometimes also used for a deacon of a church, a chaplain, or even a legatee.

ALMONER is also used for a person who left alms to the poor, by his last will. It is sometimes used for a legatee: in this sense the same person cannot be both almoner and heir.

ALMS, a general term for what is given out of charity to the poor.

In the early ages of christianity, the alms of the charitable were divided into four parts, one of which was allotted to the bishop, another to the priests, and another to the deacons and sub-deacons, which made their whole subsistence; the fourth part was employed in relieving the poor, and in repairing the churches.

ALMS also denotes lands or other effects left to churches, or religious houses, on condition of praying for the soul of the donor. Hence,

ALMS *free*, was that which is liable to no rent or service.

ALMS *reasonable*, was a certain portion of the estates of intestate persons, allotted to the poor.

ALMUCANTARS, in astronomy, are the same with respect to the azimuths and horizon, that the parallels of latitude are with regard to the meridians and equator.

ALMUTAZAPHUS, a magistrate of Aragon, whose office it was to inspect measures and weights, and search houses for stolen goods.

ALNAGE, or AULNAGE, in the English polity, the measuring of woollen manufactures, with an aul or ell, and the other functions of the alnager.

Alnage was at first intended as a proof of the goodness of the commodity, and therefore a seal was invented as a signal, that the commodity was made according to the statute. But now that these seals may be bought and affixed to whatever commodity the buyer pleases, our rivals have acquired an opportunity of supplanting our trade with foreign nations, to the great prejudice of our woollen manufactures.

ALNAGER, see article above.

There were three officers relating to the alnage, namely, a searcher, measurer, and alnager; all which were antiently comprized in the alnager; the office is now abolished.

ALNUDE, a measure of liquids, the same with almond.

ALOA, in Grecian antiquity, a festival kept in honour of Ceres by the husbandmen, and supposed to resemble our harvest-home.

ALOE, in botany, a genus of plants with a liliaceous flower, consisting of only one tubular petal, divided into six deep segments at the edge: its fruit is an oblong capsule, divided into three cells, and containing a number of angulated seeds. It is one of the hexandria monogynia class and order of Linnæus. See Plate Nat. Hist. fig. 12.

Several species of this exotic plant are cultivated in the gardens of the curious, where they afford a very pleasing variety, as well by the odd shape of their leaves as by the different spots with which they are variegated. The essential character is, cor. erect with an expanded mouth, and a nectareous base; filaments inserted into the receptacle.

Some aloes are arborescent, or divided into a number of branches, like trees; others are very small, growing close to the ground. There are in all 14 species, with a great number of varieties. It is from two varieties of one of the tree aloes, or A. arborescens, the medicine of that name is produced. The hepatic aloe is from a variety called the Barbadoes aloe, though it grows in most of the West India islands; the succotrine, from the aloe of that name, or sweet aloe. We are, however, of opinion, that an extract having the same properties might be prepared from most of the other species. The partridge-breasted or variegata, and the mitriformis, are the most elegant in their foliage. But the humilis produces, in our opinion, the largest and handsomest flowers. It is a native of the Cape of Good Hope. Most of the species are best treated as greenhouse plants; and like all other succulent plants, must be sparingly watered, especially in winter.

ALOE or ALOES, in pharmacy, the inspissated juice of the aloe, prepared in the following manner: from the leaves fresh cut, is drained or pressed a juice, the thinner and purer part of which is poured off, and set in the sun to evaporate to a hard yellowish substance or extract.

This extract is famous for its purgative virtues, being frequently given in the form of a tincture in wine, which is called *hiera picra*; in a solid form called pil. de rufi, &c. &c. and in the popular quack medicine, called Anderson's Scotch Pills.

ALOE *rosata*, a preparation of succotrine aloes, which being dissolved in the juice of roses, or violets, and exposed to the sun, or put upon a slow fire, thickens to a consistency proper for making pills.

Aloes is accounted an excellent purging medicine, especially to cold constitutions, a good stomatic, and, applied outwardly, is serviceable in cicatrizing wounds.

ALOEDARY, among antient physicians, a purging medicine, the chief ingredient of which was aloes. It is also used for a history of the class of plants, under the denomination of aloes.

ALOFT, a sea term, synonymous with "up in the tops," "at the mast-head," or any-where about the higher rigging.

ALOGIANS, in church-history, a sect of antient heretics, who denied that Jesus Christ was the logos or eternal word; and consequently rejected the gospel of St. John, as spurious.

ALOGOTROPHIA, among physicians, denotes an unequal nutrition, or growth in some part of the body, as is the case in the rickets.

ALONG *side*, in sea language, expresses side by side, or joined to a ship, wharf, &c.

ALONG *shore*, a phrase expressing along the coast, or a course which is in sight of and nearly parallel to the shore.

ALONG, *lying*, the state of a ship that is pressed down sideways, by the weight of the sail.

ALOOF, in the sea-language, a word of command to the man at the helm, to keep the ship near the wind, when sailing upon a quarter-wind.

ALOPECIA, in medicine, denotes a falling off of the hair, occasioned either by a defect of nourishment, or by a bad state of the humours.

Some make a distinction between the *alopecia* and *defluvium capillorum*: as in the former, certain spots are left entirely bald; whereas, in the latter, the hair only grows excessively thin. They likewise distinguish it from the *ophiasis*, as the baldness in this last creeps in spiral lines about the head, like the windings of a serpent. The intention of cure, however, seems to be much the same in them all, viz. to supply proper nourishment, where that is wanting; and to correct the bad qualities of the humours, where these are in fault.

ALOPECURUS, FOX-TAIL-GRASS, in botany, a distinct genus of plants, the flower of which consists of only one hollow valve, with a long awn or beard inserted on its back part, near the base: it is one of the triandria digynia of Linnæus. The essential character is, calyx two-valved; corolla one-valved.

There are seven species. The A. pratensis, or meadow fox-tail, is esteemed by some farmers, but in our opinion its value has been overrated. The A. arvensis, or field fox-tail, is a smaller plant of the same description, and flowers early; but it is even less valuable than the preceding, and we believe is never cultivated.

ALOUCHI, a sweet scented gum, which runs from the tree that produces white cinnamon.

ALPHABET, in matters of literature, the natural or accustomed series of the several letters of a language.

All the alphabets extant are charged by bishop Wilkins with great irregularities, with respect both to order, number, power, figure, &c.

As to the order, it appears (says he) inartificial, precarious, and confused, as the vowels and consonants are not reduced into classes, with such order of precedence and subsequence as their natures will bear. Of this imperfection the Greek alphabet, which is one of the least defective, is far from being free: for instance, the Greeks should have separated the consonants from the vowels; after the vowels they should have placed the diphthongs, and then the consonants; whereas, in fact, the order is so perverted that we find the ο the fifteenth letter, in order of the alphabet, and the ω, or long o, the twenty-fourth and last; the ε the fifth, and the η the seventh.

With respect to number they are both redundant and deficient; redundant, by alloting the same sound to several letters, as in the Latin *c* and *k*, *f* and *ph*; or by reckoning double letters among the simple elements of speech, as in the Greek ξ and ψ, the Latin *q* or *cu*, *x* or *ex*, and the *j* consonant; deficient in many respects, particularly with regard to vowels, of which seven or eight kinds are commonly used, though the Latin alphabet takes notice only of five. Add to this, that the difference among them, with regard to long and short, is not sufficiently provided against.

The powers again are not more exempt from confusion; the vowels, for instance, are generally acknowledged to have each of them several different sounds; and among the consonants we need only bring as evidence of their different pronunciation, the letter *c* in the word *circa*, and *g* in the word *negligence*. Hence it happens, that some words are differently written, though pronounced in the same manner, as *cessio* and *sessio*; and others are different in pronunciation which are the same in writing, as *give*, *dare*, and *give*, *vinculum*.

Finally, the figures are but ill-concerted, there being nothing in the characters of the vowels answerable to the different degrees of apertion; nor in the consonants analogous to their agreements or disagreements.

Alphabets of different nations vary in the number of their constituent letters. The English alphabet contains twenty-four letters, to which if *j* and *v* consonant are added, the sum will be twenty-six; the French twenty-three; the Hebrew, Chaldee, Syriac, and Samaritan twenty-two each; the Arabic twenty-eight; the Persian thirty-one; the Turkish thirty-three; the Georgian thirty-six; the Coptic thirty-two; the Muscovite forty-three; the Greek twenty-four; the Latin twenty-two; the Sclavonic twenty-seven; the Dutch twenty-six; the Spanish twenty-seven; the Italian twenty; the Ethiopic, as well as Tartarian, two hundred and two; the Indian of Bengal twenty-one; the Baramos nineteen; the Chinese, properly speaking, have no alphabet, except we call their whole language their alphabet; their letters are words, or rather hieroglyphics, and amount to about 80,000.

If alphabets had been constructed by able persons, after a full examination of the subject, they would not have been filled with such contradictions between the manner of writing and reading, as we have shewn above, nor with those imperfections that evidently appear in the alphabets of every nation. Mr. Lodowic, however, and bishop Wilkins, have endeavoured to obviate all these, in their universal alphabets or characters.

ALPHERATZ, a fixed star of the third magnitude, in Aquarius.

ALPHONSIN, in surgery, an instrument for extracting bullets out of gun-shot wounds.

This instrument derives its name from the inventor, Alphonsus Ferrier, a physician of Naples. It consists of three branches, which are closed by a ring. When closed and introduced into the wound, the operator draws back the ring towards the handle, upon which the branches opening take hold of the ball; and then the ring is pushed from the haft, by which means the branches grasp the ball so firmly as to extract the ball from the wound. See SURGERY.

ALPINIA, a genus of the monandria monogynia class and order. The corolla is monopetalous and tubulose; and the essential character is, calyx three-toothed, equal, tubulose; corolla three-parted, equal; nect. two-lipped, the lower lip spreading.

There is but one species, called after Pros-

per Alpinus, a famous botanist. It is a native of the West Indies. It is with us treated as a stove aquatic.

ALQUIER, a liquid measure used in Portugal to measure oil, two of which make an almond.

ALQUIFORE is a sort of mineral lead, very heavy, easily reduced to powder, and difficult to fuse. The potters use it to give their works a green varnish. It is found in Cornwall, and called potter's ore. It contains probably some mixture of cobalt.

ABEAMECH, in astronomy, the name of a star of the first magnitude, otherwise called arcturus.

ALSINE, CHICKWEED, the name of a genus of plants, of the class and order of pentandria trigynia. The corolla is five equal petals, which, with the five-leaved calyx and a capsule one-celled, three-valved, form the essential character. Happily for gardeners there are but three species of this vile weed, and but one in England. This however, though an annual, affords sufficient trouble. It appears to be of no use whatever, though it is called chickweed, from the notion that chickens feed on it, which must be when they can get nothing else.

ALSIRAT, in the Mahometan theology, denotes a bridge laid over the middle of hell, the passage or path whereof is sharper than the edge of a sword; over which, however, every soul must pass at the day of judgment, when the wicked will tumble headlong into hell, whereas the good will fly over it.

ALSTONIA, a genus of the polyandria monogynia class and order. The corolla is shorter than the calyx; and the essential character is, corolla one-petalled, eight or ten cleft; the clefts alternated. There is only one species, a shrub of South America, the leaves of which are said to have the taste of tea.

ALSTROEMERIA, a genus of plants of the hexandria monogynia class and order, and of the natural order of lilia. The essential character is, corolla six petals, subbilabiate; the two lower petals tubulose at the base; stamina bending down.

There are six species, all natives of South America. They are cultivated here as ornamental plants. The A. pelegrina and ligtu are the most beautiful and the most common. The former will bear to be treated as a greenhouse plant, and some assert that it thrives best even in a garden frame.

ALTAR-THANE, in our old law books, an appellation given to the priest, or parson of a parish, to whom the altarage belonged.

ALTARAGE, among ecclesiastical writers, denotes the profits arising to a priest on account of the altar, as well as the offerings themselves made upon it.

ALTERANTS, or ALTERATIVE *medicines*, in pharmacy, such medicines as are supposed to correct the bad qualities of the blood and other animal fluids, without occasioning any sensible evacuation.

ALTERN BASE, in trigonometry, a term used in contradistinction to the true base. Thus, in oblique triangles, the true base is either the sum of the sides, and then the difference of the sides is called the altern base; or the true base is the difference of the sides, and then the sum of the sides is called the altern base.

ALTERNATE, in heraldry, is said in respect of the situation of the quarters.

Thus the first and fourth quarters, and the second and third, are usually of the same nature, and are called alternate quarters.

ALTERNATE, such a disposition of the leaves of a plant, that the first on one side of a branch stands higher than the first on the other side, the second the same, and so on to the top.

ALTERNATE *allegation*. See ARITHMETIC.

ALTERNATE *angles*. See GEOMETRY.

ALTHÆA, MARSH-MALLOW, a genus of plants, with a double calyx, the exterior one being divided into nine segments; the fruit consists of numerous capsules, each containing a single seed. It belongs to the monadelphia polyandria class of Linnæus. The essential character is, calyx double, outer nine-cleft; arils many, one-seeded.

There are seven species, of which the A. officinalis, or common marsh-mallow, is well known. It was formerly supposed to possess many medical virtues, but is now scarcely used in any preparation whatever. The flowers and seed are nearly the same with those of the malva, or mallow.

ALTIN, in commerce, a kind of money current in Muscovy, worth three copics.

ALTITUDE, in geometry, one of the three dimensions of body; being the same with what is otherwise called height.

ALTITUDE *of a figure*. is the nearest distance of its vertex from its base, or the length of a perpendicular let fall from the vertex to the base.

ALTITUDE, in optics, is the height of an object above a line, drawn parallel to the horizon from the eye of the observer, or the angle subtended between a line drawn through the eye parallel to the horizon, and a visual ray emitted from an object to the eye. See OPTICS.

ALTITUDE *of the eye*, in perspective, is its perpendicular height above the geometrical plane.

ALTITUDE *of a star, &c.* in astronomy, is an arch of a vertical circle, intercepted between the star and the horizon.

This altitude is either true or apparent, according as it is reckoned from the rational or sensible horizon, and the difference between these is what is called by astronomers the parallax of altitude.

The true altitudes of the sun and fixed stars differ but little from their apparent altitudes, because of their great distance from the earth, and the smallness of the earth's semi-diameter compared with it. The quantity of refraction is different at different altitudes, and the parallax is different, according to the distance of celestial objects; in the fixed stars it is too small to be observed with any degree of certainty: that of the sun is about $8\frac{2}{3}$ sec. and that of the moon 52 min.

Sailors commonly take the altitude of stars with a quadrant, but as this method is liable to an error of six, seven, or more minutes, from the motion of the ship, as well as the coarseness of their instruments, Mr. Parent has given a new way of finding their altitudes, by means of a common watch. His method is this: having observed the difference of time between the rising of two stars, the right ascension and declination of which are known from astronomical tables, in the Nautical Almanac, it will be easy to distinguish that part of the difference which arises from that different position, from that arising from the obliquity of the sphere. Now this last is precisely the altitude of the pole of the place of observation; for as to the way the ship may have made between the rising of the two stars, it is so small as to be safely overlooked, or at most estimated in the common way of reckoning.

The ship changing place between the two observations, renders this method liable to some objection; but the small alteration either of the ship's longitude or latitude will make no sensible error, and if she happens to have run a good distance between the observations, it is easy reckoning how much it is, and accordingly allowingfor it. See NAVIGATION.

ALTITUDE, *accessible*, &c. See TRIGONOMETRY. See also GNOMON, PIN, QUADRANT, &c.

ALTITUDE *refraction of*, is an arc of a vertical circle, by which the altitude of a heavenly body is increased by means of refraction. This is different at different altitudes, being nothing at the zenith, and greatest at the horizon.

ALTITUDE, *parallax of*, the difference between the true and apparent place of a star: it diminishes the altitude of the star, or increases its distance from the zenith.

ALTITUDE *of motion*, according to Dr. Wallis, is its measure estimated in the line of direction of the moving force.

ALTITUDE, *determinative*, that whence a heavy body falling, acquires a certain velocity by its natural acceleration.

ALTO-RELIEVO. See RELIEVO.

ALTO RIPIENO, in music, the tenor of the great chorus which sings or plays only now and then in some particular places.

ALVARID, in the history of Spain, a kind of magistrate or judge, differing very little from the alcaid.

ALVARISTS, a branch of thomists, so called from Alvares their leader; who asserted sufficient grace, instead of the efficacious grace of the antient thomists.

ALUDE, a kind of sheep's leather, one side of which has the wool on.

ALUDELS, in chemistry, are earthen pots ranged one above another, for retaining the products which ascend in the process of sublimation.

The lowest aludel is fitted to a pot, placed in the furnace, in which is the matter to be sublimed; and at top is a close head to retain the sublimates which ascend highest.

ALVEARIUM, among anatomists, denotes the hollow of the auricle, or outer ear.

ALVEHEZIT, denotes, among Arabian writers, what we call falling-stars.

ALVEOLATE, in botany, a term used in the same sense as *honey-combed*, to express something that is furrowed by oblong depressions.

ALVEOLUS, in anatomy, the socket-like cavity in the jaws, wherein each of the teeth is fixed.

ALVEOLUS, in the history of fossils, a marine body, not known at present in its recent state, but frequently found fossile.

The alveoli are of a conic shape, and composed of a number of cells, like so many beehives, jointed into one another, with a pipe of communication, like that of the nautilus. They are sometimes met with entire, but more frequently truncated, or with their smaller ends broken off.

ALULA notha, bastard or spurious wing, in ornithology, is a kind of appendage to the true and principal wing, placed near its

outer extremity, at the base of the primary quill-feathers, and consists of from three to five small feathers of the quill kind.

ALUM, a neutral salt, the base of which is alumina, argil, or clay, combined with sulphuric acid.

ALUM, *ores of*, include all those minerals which either contain alum ready formed, or are capable of yielding this salt by manufacture: they may be divided (1.) into the *saline*, all the species of which are almost wholly soluble in water; (2.) the *earthy saline*, the soluble particles of which are diffused through a large proportion of earth; (3.) the earthy, which containing no alum, but the materials of it, are insoluble, and destitute of that sweetish astringent taste which characterises the two former.

There are four varieties of alum, which are all triple salts; two neutral, and two in the state of super salts. These varieties Dr. Thomson distinguishes by the following names:

1. Sulphate of alumina and potash.
2. Sulphate of alumina and ammonia.
3. Supersulphate of alumina and potash.
4. Supersulphate of alumina and ammonia.

The two last of these varieties are usually confounded under the name of alum; the two first have been called *alum saturated with earths*, or *aluminated alum*.

We owe the discovery of alum to the Asiatics, and it continued to be imported from the East till the fifteenth century, when a number of alum-works were established in Italy. In the sixteenth century it was manufactured in other parts of the continent; and during the reign of queen Elizabeth an alum-work was established in England.

The composition of alum has been but lately understood with accuracy. It has, indeed, been long known that sulphuric acid is one of the ingredients, and it was equally certain that alumina is another. But these are incapable of forming alum. The addition of potash, or of ammonia, or of some substance containing these alkalis, is almost always necessary; and where these additions are not wanted, the earth from which the alum is obtained contains already a quantity of potash. Hence it appears that alum is properly a triple salt, composed of sulphuric acid, alumina, and potash or ammonia united.

Alum crystallizes in regular octahedrons, consisting of two four-sided pyramids applied base to base, the sides are equilateral triangles. Its taste is sweetish, and very astringent. It always reddens vegetable blues: its specific gravity is 2.711 nearly. At the temperature of 60 degrees, it is soluble in from 15 to 20 parts of water, and three-fourths of its weight in boiling water. When exposed to the air it efflouresces slightly. When exposed to a gentle heat it undergoes the watery fusion. A very strong heat causes it to swell and foam, and to lose 44 per cent. of its weight, consisting chiefly of water of crystallization; what remains is called calcined or burnt alum, and is sometimes used as a corrosive. By a still more violent heat, the greater part of the acid may be driven off.

There are three varieties of alum in commerce (1.) the *supersulphate of alumina and potash*; (2.) *supersulphate of alumina and ammonia*; and (3.) a mixture of these two, which contains both potash and ammonia. This is the most common, because the manufacturers of alum use both urine and muriate of potash to crystallize their alum. The first variety is composed of

49	Sulphate of alumina
7	Sulphate of potash
44	water
100.	

Crystallized alum contains,

17.66	acid
12.00	base
70.34	water
100.	

Burnt alum contains,

36.25	acid
63.75	base
100.	

When an unusual quantity of potash is added to alum liquor, the salt loses its usual form, and crystallizes in cubes; this is called *cubic* alum, and contains an excess of alkali; and when the potash is still farther increased, the salt loses the property of crystallizing, and falls down in flakes: it then consists of sulphate of potash combined with a small proportion of alumina.

All the varieties of alum are capable of combining with an additional dose of alumina, and forming perfectly neutral compounds.

Alum is of great importance as a mordant in dying; it is used also in the manufacture of leather, it is employed by calico-printers, engravers, &c. and it is used in medicine, in preserving animal substances from putrefaction, and in preventing wood from taking fire.

If three parts of alum, and one of flour or sugar be melted together in an iron ladle, and the mixture dried till it becomes blackish and ceases to swell; if it be then pounded small, put into a glass phial, and placed in a sand-bath till a blue flame issues from the mouth of the phial, and after burning a minute or two be allowed to cool, a substance is obtained called Homberg's phosphorus, which has the property of catching fire when exposed to the open air, especially if it be moist.—See Thomson's Chemistry, vol. ii.

ALUM, *native*, or *fossile* ALUM, that formed by nature, without the assistance of art.

There are still mines of native alum in the island of Chio, consisting of a kind of vaults, or apartments, crusted over with alum, which may be regarded as exfoliations from the rocks.

ALUM, *plumose*, or *plume* ALUM, a kind of natural alum, composed of a sort of threads, or fibres, resembling feathers; whence it has its name.

ALUM, *prepared*, or *purified* ALUM, that which is dissolved in hot rain-water, and afterwards made to crystallize, by evaporating the water.

ALUM, *Roman*, a sort of rock alum, of a reddish colour, made in the country near Rome.

ALUM, *saccharine*, is a composition of common alum with rose-water, and clarified by the whites of eggs, which being boiled to the consistence of a paste, is formed in the shape of a sugarloaf; hence it obtained its name: it is used as a cosmetic.

ALUMINA, derives its name from alum, of which it is the base. It is the argillaceous part of common clay, or, in other words, pure argil or clay, free from all impurities. It is smooth and unctuous to the touch, when pure, diffusible in water, and adhering to the tongue. Its specific gravity is 200. Its bulk is diminished by great heat, and its hardness may be so increased by baking as to enable it to strike fire with steel. It forms a difficult combination with the acids. With the sulphuric it makes sulphate of alumina; but its crystallization is difficult, both with the nitre and muriatic. It has a powerful attraction for lime. The most intense heat is not able to melt it alone, but it is easily fusible when lime or an alkali is added to it. By its mixture with water and silex it acquires great solidity.

ALUMINOUS WATERS, those impregnated, either naturally or artificially, with the virtues of alum.

Of the former kind is the spa at Scarborough represented to be; and of the latter, the *aqua aluminosa* of the shops.

ALUNGU is a name given by the people of Malabar to an animal resembling a large lizard, except as to head and tail, which are both pointed. It is of the species of the manis of Linnæus, and belongs to the family of ant-eaters; which have no teeth, but a round tongue, with which they catch ants.

ALURNUS, a genus of insects of the order of coleoptera, with filiform antennæ, six short feelers, and a horny arched jaw. Three species of them are found at the Cape of Good Hope, viz. a. grossus, femoratus, and dentipes. See Plate Nat. Hist. fig. 13.

ALWAIDID, a sect of Mahometans, who believe all great crimes to be unpardonable.

ALYSSUM, or ALYSSON, *madwort*, in botany, a genus of the tetradynamia siliculosa class and order, of the natural order of siliquosæ and cruciferæ of Jussieu. The flower is of the cruciform kind, and consists of four petals; the fruit is a small roundish capsule, divided into two cells, in which are contained a number of small roundish seeds. The essential character is, the shorter filaments marked with a toothlet; the silicle emarginate.

There are 17 species. The A. palimifolium, or sweet alysum, is an annual plant, chiefly cultivated in gardens for its fragrance. The yellow alysson is also very ornamental, and is perennial.

AMA, among ecclesiastical writers, denotes a vessel in which wine or water were kept for the service of the eucharist.

AMA is sometimes also used for a wine measure, as a pipe, &c.

AMABYR, or AMVABYR, a barbarous custom which formerly prevailed in Wales and some other parts of the kingdom; being a certain fine, or sum of money, paid to the lord, upon marrying a maid within his manor.

AMADOW, a kind of black match, tinder, or touchwood, which comes from Germany. It is made from spungy excrescences, which often grow on old trees, especially oaks, ash, or firs. This substance being boiled in common water, and afterwards dried and well beaten, is then put into a strong ley prepared with salt-petre, after which it is again put to dry in an oven, when it is fit for use.

AMADOWRY, a kind of cotton, which comes from Alexandria, by way of Marseilles.

AMAIN, or AMAYNE, in the sea language, a term importing to lower something

at once. Thus, to strike amain is to lower, or let fall the top-sails.

AMALGAM, a mass of mercury united and incorporated with some other metal.

Amalgams grow soft with heat and hard with cold; and the metals amalgamated with mercury, assume a consistence harder or softer, in proportion to the quantity of mercury employed in the amalgam.

Amalgams are used either to render a metal fit to be extended on some works, as in gilding; or else to reduce the metal into a very subtile powder.

Thus gilders, to lay gold on any other metal, dissolve it in hot mercury; which done, they apply the solution on the body to be gilt, then setting it over the coals, the mercury evaporates, and leaves the gold adhering to the body like a crust.

The amalgams of gold, silver, tin, lead, zinc, bismuth, and copper, are all white; and when the proportion of the quantity of the other metal to that of mercury is considerable, they form a kind of paste.

AMALGAMATION, in chemistry, the operation of making an amalgam, or of mixing quicksilver with some metal, is performed by fusing, or at least igniting the metal, and in this state adding a proportion of mercury to it; upon which they mutually attract and incorporate with each other.

Of all metals, gold unites with mercury with the greatest facility; next to that, silver; then lead, tin, and every metal, except iron and copper, the last of which incorporates with quicksilver with great difficulty, and the former scarcely at all.

The amalgam of gold is thus made: take a dram of gold, beat it into very thin plates, and upon these, heated in a crucible red-hot, pour an ounce of quicksilver; stir the matter with an iron rod, and when it begins to fume, cast it into an earthen pan filled with water, and it will coagulate and become tractable. Gold will retain about thrice its weight of mercury.

To make an amalgam of lead: melt clean lead in an iron ladle, add to it an equal weight of melted mercury, stir them together with an iron rod, then let them cool, and you will have an uniform mass of a silver colour, somewhat hard, but growing softer and softer by trituration. Put this mass into a glass mortar, grind it, and mix with it any quantity of mercury at pleasure, and it will unite with it, as salt with water.

The amalgam of tin is made exactly in the same manner, and this also may be diluted by the addition of mercury.

To have an amalgam of copper, take a solution of pure copper, made in aquafortis, so strong that the aquafortis could dissolve no more of the metal; dilute the solution with twelve times its quantity of water; heat the liquor, and put into it polished plates of iron, and the copper will be precipitated in a powder to the bottom, while the iron will be dissolved: proceed thus till all the copper is fallen, pour off the liquor, wash the powder with hot water, till it becomes perfectly insipid; then dry the powder, and grind it in a glass mortar with an equal weight of hot quicksilver, and they will unite into an amalgam, which will also receive a further addition of mercury. An amalgam of copper in any other way is very difficult to make.

Pure silver precipitated from aquafortis, may in the same manner be made into an amalgam.

From these operations we may perceive that the making of amalgams is the foundation of the art of gilding, both in gold and silver, and that metals by that art may be mixed, confounded, and secretly concealed among one another.

Amalgams are also used in electricity; the rubber being always prepared by laying on it a small quantity of amalgam, which is in general made of zinc, triturated with tallow. See ELECTRICITY. An amalgam of tin and mercury is used for looking-glasses. In this case, the glass-plate is laid on an even board, on which is spread very evenly some tin-foil, and on the tin-foil is spread quicksilver: the glass is then laid on the quicksilver, and a number of leaden weights, covered with baize or flannel, are laid upon the glass; in this state it remains several days, till the tin and quicksilver, in the state of amalgam, adhere firmly to the glass, by means of which it acquires the power of reflection.

AMAN, a sort of blue cotton cloth, which comes from the Levant by the way of Aleppo.

AMARANTA, or AMARANTE, an order of knighthood, instituted in 1653, by Christina queen of Sweden, in memory of a masquerade, in which she had assumed that name, which signifies unfading, or immortal.

AMARANTHUS, in botany, the name of a genus of plants, sometimes called prince's feather, the flower of which is rosaceous, and its fruit an oval or roundish capsule, containing only one large seed of a roundish compressed shape. The characters are: the male calyx is a five or three leaved perianthium, erect, coloured, and persistent: there is no corolla: the stamina consist of five or three erect capillary filaments, the length of the calyx; the antheræ are oblong and versatile: the female calyx the same as the male, and no corolla: the pistillum has an ovate germen; the styli are three, short and subulated; the stigmata simple and persistent: the pericarpium is an ovate capsule, three-beaked, unilocular, and cut round: the seed is one, globular, compressed, and large. Of this there are 29 species; the most remarkable of which are:

Amaranthus bicolor, melancholicus, or two-coloured amaranthus. This greatly resembles the tricolor in its manner of growth; but the leaves have only two colours, which are an obscure purple, and a bright crimson. These are so splendid, as to set off each other, and when the plants are vigorous, make a fine appearance. Amaranthus maximus, or tree-like amaranthus, grows with a strong stem to the height of seven or eight feet. Amaranthus oleraceus, with obtuse indented leaves. This has no beauty; but it is used by the Indians as a substitute for cabbage. Amaranthus tricolor, or three-coloured amaranthus. This has been long cultivated in gardens on account of the beauty of its variegated leaves, which are green, yellow, and red, very elegantly mixed. The amaranths are all annual.

AMARYLLIS, a genus of the hexandria monogynia class and order, of the natural order of lilia, which in its flower it resembles. The essential character is corolla hexapetaloid, irregular; filaments inserted into the throat of the tube, bending down, unequal in proportion or direction. There are 29 species, all of them highly ornamental, but only one, the A. lutea, perfectly hardy in this country. The A. regina, the vittata, the jacobea, belladonna, and Guernsey lily, are well known in the stoves and green-houses of the curious in plants. To describe them is impossible, but no flowers are more beautiful.

AMASONIA, a genus of the didynamia angiospermia class and order. The corolla is one-petalled: and the essential character is corolla tubulous; limb small, quinquefid: the seed is a nut, ovate and one-celled. We know of but one species, the erecta, a native of Surinam. The stem is herbaceous, and grows to the height of three feet.

AMAUROSIS, among physicians, a distemper of the eye otherwise called *gutta serena*.

AMAUSA, a name given by chemists to the pastes used in counterfeiting gems.

AMAZONS, an antient nation of women, inhabiting that part of Lesser Asia, now called Amasia.

The Amazons are said to have killed all their male children, and to have cut off the right breasts of their females, to fit them for martial exercises. The existence, however, of such a nation is controverted by the most judicious authors, particularly Mr. Bryant, and defended by others, particularly Mr. Petit, a French physician, who has published a dissertation on the subject, wherein are several curious inquiries concerning their arms, dress, &c.

We also read of Scythian Amazons, of German Amazons, of Lybian Amazons, and Amazons of America, living on the banks of the great river which bears their name, who are represented as governed by a queen, no men being permitted to live among them; only, at a certain season, those of the neighbouring nations are suffered to visit them. The Amazons of Lybia are famous for their wars with another female nation, called Gorgons. The whole of these stories appear to us little better than fabulous.

AMAZONE, a very fine antique statue, in Parian marble, in the gallery of antiques at Paris. There is also a beautiful statue of the queen of the Amazons at Wilton, represented in a warlike attitude, which was executed by Cleomenes.

AMBE, among surgeons, an instrument for reducing dislocated bones, consisting of a horizontal lever, moved by a hinge, upon a vertical standard or foot.

AMBE, among anatomists, a term used for the superficial jutting out of a bone.

AMBER is a bituminous concrete, of a yellow or brown colour, and more or less transparent. In its colour, however, there is considerable variety; some pieces being clear and transparent, some opaque and whitish, some dark coloured; the most valued specimens are of a pale yellow colour. On being slightly rubbed, it acquires electric powers. Only a small portion of it is dissolved by spirit of wine. It affords the most remarkable phenomena when exposed to heat. Being rubbed, the odour of it that exhales resembles the aromatic resinous substances, and is increased. In a greater heat it acquires a brown colour, emits some steams, and undergoes a state of fusion. It then becomes quite

dark and opaque, and is employed in this state in the composition of some varnishes. In burning it emits very penetrating vapours, burns with a greyish flame, and leaves a coaly residuum.

When this substance is distilled, the empyreumatic oil produced is mostly thick, and of a blackish colour, and has a heavy, penetrating odour. When it is repeatedly distilled it becomes more fluid and transparent, and can be rendered quite limpid; in which state it is said to resemble the finer kinds of petrolea, particularly the naphtha. It is then termed rectified oil of amber.

The origin of amber has been much disputed, whether it is originally a fossil, or is produced from vegetable matter. The only reason to imagine it is entirely a fossil body is, that it is found at some depth below the surface under certain strata. The greatest part that we have comes from the Baltic. A considerable quantity is found floating on the sea on these coasts, being washed out of the soil by the agitation of the waves, when they penetrate through different strata, first through one containing fossil wood, variously compacted together; under this a stratum of vitriolic minerals; below this the amber is found dispersed in various sizes; but when it is examined, we find manifest proofs of its having been produced originally at the surface of the earth; parts of vegetables, and even insects, being occasionally found in it.

Amber is used for trinkets, particularly in Turkey and the East; but the finest specimens are in the cabinet of the king of Prussia.

AMBERGRIS resembles amber in several chemical qualities. It is a light ash-coloured body found on the sea-shores in the East Indies. It is opaque, and of a granulated structure. It has a light agreeable odour; melts with a gentle heat, without suffering any change; and, if farther heated in close vessels, it gives an oil like that of amber. It also dissolves in spirit of wine, by means of heat, and is used in the composition of perfumes. It is not affected by acids.

The origin of this substance is uncertain. It appears to be somewhat similar to that of amber. It is found in masses, from one to a hundred ounces. The greatest quantity is found floating in the Indian ocean; but we also meet with it in our own and in the northern seas. It is found likewise adhering to the rocks, and in the stomachs of the most voracious fishes; these animals swallowing at particular times every thing they happen to meet with. It has been particularly found in the intestines of the cachalot whale, and most commonly in sickly fish, whence it is supposed either the cause or effect of disease. We often find it in relicts of animal and vegetable substances, the bones and beaks of birds, and insects; and as it resembles bees-wax, melting like it, it would appear that it has been originally bees-wax, which having been buried under the surface of the earth, or having floated a long time on the ocean, has undergone a considerable change; and we know the amazing quantity of bees-wax and honey that is sometimes collected by bees in their wild state, as in America. In old trees quantities have been found, sufficient for filling several hogsheads; and in rocks and caves along the sea-shore, quantities may be gathered together; and by being buried, or by floating on the water, they may undergo a change, so as to be converted into this substance.

AMBIDEXTER, a person who can use both hands with the same facility, and for the same purposes, that the generality of people do their right hands.

Was it not for education, some think that all mankind would be ambidexters; and, in fact, we frequently find nurses obliged to be at a good deal of pains before they can bring children to forego the use of their left hands. It is perhaps a pity that any of the gifts of nature should be thus rendered in a great measure useless, as there are many occasions in life which require the equal use of both hands: such are the operations of bleeding in the left arm, left ancle, &c.

AMBIDEXTER, among lawyers, a juror or embracer, who accepts money of both parties for giving his verdict; an offence for which he is liable to be imprisoned, for ever excluded from a jury, and to pay ten times the sum he accepted of.

AMBIGENAL HYPERBOLA, a name given by sir Isaac Newton to one of the triple hyperbolas of the second order, having one of its infinite legs falling within an angle formed by the asymptotes, and the other falling without. See CONIC SECTION.

AMBIGUITY, in rhetoric and grammar, a defect of language, whereby words are rendered equivocal.

AMBIT, in geometry, is the same with what is otherwise called the perimeter of a figure.

AMBITUS, whence our word *ambition*, in Roman antiquity, the offering for some magistracy or office, and formally going round the city to solicit the interest and vote of the people.

On these occasions it was not only usual to solicit the interest of their friends and others, with whom they were personally acquainted; but the candidates, being attended by persons of an extensive acquaintance, who suggested to them the names of the citizens, and thence called *nomenclatores*, or *interpretes*, made application to all they met. This method of suing for offices was deemed allowable, and therefore never prohibited by law; but to restrain all undue influence, whether by bribery, or by exhibiting games, shews, and the like, many laws were enacted, and severe fines imposed.

AMBITUS, in music, a name sometimes appropriated to signify the particular extent of each tone, or modification of grave and acute.

AMBLE, in horsemanship, a peculiar pace by which a horse's two legs of the same side move at the same time.

Many methods have been proposed to bring a young horse to amble: some try it by new-ploughed fields; some endeavour to bring him to amble from the gallop; and many use weights: some attempt to procure an amble in hand, ere they mount his back; others, by the help of hind shoes, made on purpose; others, by folding fine soft lists about the gambrels of the horse; and others by the tramel.

All these methods, however, are attended with great danger to the horse; and the best way is to try with the hand, by a gentle deliberate racking of the horse, by helping him in the weak part of the mouth with a smooth, big, and full snaffle, and correcting him first on one side, then on the other, with the calves of the legs, and sometimes with a spur.

AMBLYGON, in geometry, denotes an obtuse-angled triangle, or a triangle, one of whose angles consists of more than ninety degrees.

AMBO, or AMBON, in ecclesiastical antiquity, a kind of pulpit, or reading-desk, where that part of the divine service called the gradual was performed.

AMBROSE, or *St.* AMBROSE *in the wood*, an order of religious, who use the Ambrosian office, and wear an image of that saint engraven on a little plate: in other respects they conform to the rule of the Augustins.

AMBROSIA, the name of a distinct genus of plants, with flosculous flowers, composed of several small infundibuliform floscules, divided into five segments; these, however, are barren; the fruit, which in some measure resembles a club, growing on other parts of the plant.

This genus belongs to the monoecia pentandria class of Linnæus. The characters are: the male flowers are compound: the common calyx is a single-leaved perianthium, the length of the florets; the compound corolla is uniform, tubular, flat, and hemispherical: the proper is monopetalous, funnel-shaped, and quinquefid: the stamina consist of five very small filaments; the antheræ are erect, parallel, and pointed: the pistillum has a filiform stylus, the length of the stamina; the stigma, orbicular and membraneous: the receptaculum is naked.—Female flowers below the male ones, on the same plant, doubled: the calyx is a single-leaved perianthum, entire (with the belly quinquedentated), one-flowered, and persistent: there is no corolla: the pistillum has an ovate germen in the bottom of the calyx; a filiform stylus, the length of the calyx; and two long bristly stigmata: the pericarpium is an ovate unilocular nut: the seed is single and roundish. Of this genus five species are enumerated; one of which is perennial, and may be propagated either by cuttings or by seeds. The plants are moderately hardy, so may be exposed to the open air in the summer; and in winter may be sheltered in a common green-house with myrtles, and other hardy exotic plants.

AMBROSIAN OFFICE, in church history, a particular formula of worship in the church of Milan, which takes its name from St. Ambrose, who instituted that office in the fourth century. Each church originally had its particular office; and when the pope in aftertimes took upon him to impose the Roman office upon all the western churches, that of Milan sheltered itself under the name and authority of St. Ambrose, from which time the Ambrosian ritual has prevailed in contradistinction from the Roman ritual.

AMBROSIAN *chant*, in ecclesiastical music, differs very little, if at all, from the Gregorian chant.

AMBROSIN, a coin formerly struck by the dukes of Milan, representing St. Ambrose on horseback, with a whip in his right-hand.

AMBROSINIA, a genus of the class and order of gynandria polyandria. The essential character is: spathe one-leaved, separated by a partition; stamina on the inner, pistils on the outer side of it. We know of but one species, a native of Sicily. It requires

the protection of a green-house in this country.

AMBRY, a place in which are deposited all utensils necessary for house-keeping.

In the antient abbies and priories, there was an office under this denomination, wherein were laid up all charities for the poor.

AMBUBAJÆ, in Roman antiquity, were immodest women who came from Syria to Rome, where they lived by prostitution, and by playing on the flute: the word is derived from the Syriac *abbub*, which signifies a flute; although others make it come from *am* and *Baiæ*, because these prostitutes often retired to Baiæ. According to Cruquius, these women used likewise to sell paint for ornamenting the face, &c.

AMBULANT, the name of brokers, or exchange-agents, who have not been sworn before magistrates. They transact brokerage business, but their testimony is not admitted in the courts of justice.

AMBULATION, in surgery, a term given to the spreading of a gangrene or mortification.

AMBULATORY, a term applied to such courts as were not fixed, but removed sometimes to one place, sometimes to another: thus the court of parliament and court of king's bench were formerly ambulatory.

AMBULATORY WILL is such a will as can be at any time revoked before the person's death.

AMBULIA, a genus of the didynimia angiospermia class and order. It grows in Malabar, has an aromatic smell, and is administered in cases of fever in the form of a decoction.

AMBURBIUM, in Roman antiquity, a procession made by the Romans round the city and pomærium, in which they led a victim, and afterwards sacrificed it, in order to avert some calamity that threatened the city.

AMBURY, or ANBURY, among farriers, denotes a tumour, wart, or swelling, which is soft to the touch and full of blood. See FARRIERY.

AMBUSTA, a term used in surgery for a solution of continuity, caused by the application of heated substances.

AME, a musical term used by the French to denote feeling and expression.

AMEDIANS, in church history, a congregation of religious in Italy, so called from their professing themselves *amantes deum*, lovers of God; or rather, *amati deo*, beloved of God.

AMELLUS, *starwort*, a genus of the polygamia superflua order, belonging to the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ-oppositifoliæ. The characters are: the common calyx is imbricated and roundish: the compound corolla is radiated; the hermaphrodite corollets numerous in the disk; the female numerous in the ray: proper corolla of the hermaphrodites are tubular and quinquefid; of the females, tongued, loose, and two or three toothed: the stamina in the hermaphrodites consist of five short capillary filaments; the antheræ cylindric and tubular: the pistillum has an ovate germen, a filiform stylus the length of the stamina, and two filiform stigmata: there is no pericarpium, but the calyx unchanged: the seeds are ovate and solitary; the pappus is hairy; the receptaculum chaffy. Of this there are two species, viz. Amellus lynchnitis, with one flower on each footstalk. This is a native of the Cape of Good Hope, and a perennial plant. The amellus umbellatus, with flowers growing in umbels, is a native of Jamaica, and is extremely tender.

AMEN, in the scriptural language, a solemn formula, or conclusion to all prayer, signifying *so be it*.

The term amen is hebrew, being derived from the verb aman, i. e. to be true, faithful, &c. so that, strictly speaking, it signifies truth; and, used adverbially, as is frequently done in the gospels, truly or verily. Sometimes it is repeated twice together, and then it stands for the superlative, as Amen, amen, dico vobis.

AMEND, or AMENDE, in the French customs, a pecuniary punishment imposed by a judge for any crime, false prosecution, or groundless appeal.

Amende honorable, an infamous kind of punishment inflicted in France upon traitors, parricides, or sacrilegious persons, in the following manner: the offender being delivered into the hands of the hangman, his shirt is stripped off, and a rope put about his neck, and a taper in his hand; then he is led into court, where he must beg pardon of God, the king, the court, and his country. Sometimes the punishment ends here, but sometimes it is only a prelude to death, or banishment to the galleys.

AMENDMENT, in law, the correction of an error committed in a process, which may be amended after judgment, unless the error lies in giving judgment, for in that case it is not amendable, but the party must bring a writ of error.

A bill may be amended on the file at any time before the plea is pleaded, but not afterwards, without motion and leave of the court.

AMENDMENT *of a bill*, in parliament, is some alteration made in the first draught of it. We even read of amendments of amendments. However, it is to be observed, that all amendments ought to be made in the house, whence the thing to be amended originally proceeded.

AMENDMENT, in husbandry, is used for the enriching land by laying manure on it.

AMENTACEOUS, in botany, an appellation given to such flowers as have an aggregate of summits hanging down in form of a rope, or cat's-tail, which is called an amentum or catkin.

AMENTUM, in Roman antiquity, a thong tied about the middle of a javelin or dart, and fastened to the fore-finger, in order to recover the weapon as soon as it was discharged. The antients made great use of the amentum, thinking it helped to inforce the blow. Amentum also denotes a latchet that bound their sandals.

AMERCEMENT, or AMERCIAMENT, in law, a pecuniary punishment imposed upon offenders at the mercy of the court.

Amercements differ from fines, the latter being certain punishments growing expressly from some statute, whereas the former are imposed in proportion to the fault. Besides, fines are assessed by the court, but amercements by the country.

A court of record only can fine, all others can only amerce.

Sheriffs are amerciable for the faults of their officers, and clerks of the peace may be amerced in the king's-bench for gross faults in indictments removed to that court.

A town is subject to amercement for the escape of a murderer in the day-time; and if the town is walled, it is subject to amercement whether the escape happens by day or night.

The statute of Magna Charta ordains that a freeman is not to be amerced for a small fault, but in proportion to the offence, by his peers and equals.

AMERICA, one of the four grand divisions of the earth. See GEOGRAPHY.

AMERIMNUM, a genus of the diadelphia decandria class and order, of the natural order of the papilionaceæ or leguminosæ. The essential character is: calyx two-lipped; legume compressed, leafy, two-valved, gaping; seeds few and solitary. There are two species: the one a shrub; and the other, A. ebenus, a tree which rises to 14 feet high, with a very thick stem. It is common in the West Indies, where the wood is cut and sent to England under the name of ebony.

AMETHYST, *amethystus*, in the history of precious stones, a gem of a purple colour, which seems compounded of a strong blue and a deep red; and according as either of these prevails, affording different tinges of purple, sometimes approaching to violet, and sometimes even fading to a pale rose-colour.

The amethyst on analysis is found, according to Rose, to contain

97.50	silica
0.25	alumina
0.50	oxyde of iron and manganese
98.25	

Though the amethyst is generally of a purple colour, it is nevertheless sometimes found naturally colourless, and may at any time be easily made so by putting it into the fire; in which pellucid or colourless state, it so well imitates the diamond, that its want of hardness seems the only way of distinguishing it.

Some derive the name amethyst from its colour, which resembles wine mixed with water; whilst others, with more probability, think it got its name from its supposed virtue of preventing drunkenness; an opinion which, however imaginary, prevailed to that degree among the antients, that it was usual for great drinkers to wear it about their necks.

Be this at it will, the amethyst is scarcely inferior to any of the gems in the beauty of its colour; and in its purest state is of the same hardness, and at least of equal value, with the ruby and sapphire. It is found of various sizes, from that of a small vetch, to an inch and a half in diameter, and often to much more than that in length. Its shape is extremely various, sometimes roundish, sometimes oblong, and at others flatted, at least on one side; but its most common appearance is in a crystalliform figure, consisting of a thick column, composed of four planes, and terminated by a flat and short pyramid, of the same number of sides; or else, of a thinner and longer hexangular column, and sometimes of a long pyramid without any column. It makes the gayest figure in the last of these states, but is hardest and most valuable in the roundish and pebble-like form.

The amethyst is found in the East and West Indies, and in several parts of Europe;

the oriental ones, at least some of the finer specimens, being so hard and bright as to equal any of the coloured gems in value. However, by far the greater number of amethysts fall infinitely short of these, as all the European ones, and not a few of those brought from the East and West Indies, are very little harder than common crystal.

AMETHYST, in heraldry, a term for the purple colour in the coat of a nobleman, in use with those who blazon by precious stones instead of metals and colours. This in a gentleman's escutcheon is called Purpure, and in those of sovereign princes Mercury.

AMETHYSTEA, a genus of the diandria monogynia class and order, of the natural order of verticillatæ and labiatæ. The characters are: the calyx consists of a single-leaved perianthium, bell-shaped, angular, semiquinquefid, and persistent: the corolla is monopetalous; the border quinquepartite, the lowest division more expanding: the stamina consist of two slender filaments approximated: the antheræ are simple and roundish: the pistillum has a four-cleft germen; stylus, the size of the stamina; stigmata two, acute: no corolla: the seeds four, gibbous, and shorter than the calyx. There is only one known species: it is a native of Siberia. It is an annual plant, with an upright stalk, which rises about a foot high. Towards the top it puts forth two or three small lateral branches, garnished with small trifid leaves, sawed on their edges, of a very dark green colour. The flowers appear in June or July, and are produced in small umbels at the extremities of the branches. They are of a fine blue colour, as are also the upper part of the branches, and the leaves immediately under the umbel, so that they make a fine appearance. The seeds of the amethystea should be sown in autumn, as they are apt to remain a whole year in the ground.

AMETHYSTINE, a term applied to a kind of purple garment dyed of the hue of amethyst. This colour is a medium between the tyrian and hyacinthine.

AMIABLE, or AMICABLE *numbers*, such as are mutually equal to the sum of one another's aliquot parts, as the numbers 284 and 220. Thus the aliquot parts of 220, are 1, 2, 4, 5, 10, 11, 20, 22, 44, 55, 110, and these added together are equal to 284; and the aliquot parts of 284, are 1, 2, 4, 71, 142, and these added together are equal to 220.

Van Schouten was the first who gave this name to such numbers, of which it is easily apprehended, there are but very few at least to be set down and manageable by us; for 284 and 220 are the two least, and the two next greater are 18416 and 17296; the third pair of numbers are 9363584 and 9437056.

AMIANTHUS, a fibrose, flexile, and elastic mineral substance, composed of short and abrupt filaments.

There are several species of amianthi; that of a greyish green colour, with short, abrupt, and interwoven filaments, is the same with the plumose alum of the shops.

The properties of the amianthus are very wonderful. They will neither give fire with steel, nor ferment with aquafortis; and if thrown into the fire, will endure the most extreme heat without the least injury to their texture. Amianthus threads are sometimes used as perpetual wicks for lamps; they require occasional cleaning from the soot; and by great heat they are apt to run together in a state of semifusion, so as to prevent the due supply of oil. The amianthus and all the varieties of asbestos, are classed by Mr. Kirwan among the magnesian earths, as they contain about a fifth part of that substance. See ASBESTOS and MINERALOGY.

AMICABLE BENCHES, in Roman antiquity, were, according to Pitiscus, lower and less honourable seats allotted for the inferior judges, who, upon being admitted of the emperor's council, were dignified by him with the title *amici*.

AMICTUS, among ecclesiastical writers, the uppermost garment anciently worn by the clergy; the other five being the alba, singulum, stola, manipulus, and planeta. The amictus was a linen garment, of a square figure, covering the head, neck, and shoulders, and buckled, or clasped, before the breast. It is still worn by the religious abroad.

AMICULUM, in Roman antiquity, a woman's upper garment, which differed from the palla, as we learn from Livy; but in what that difference consisted we are at a loss to know, unless that it was shorter than the palla. The amiculum was worn both by matrons and courtezans.

AMICUS CURIÆ, a law term, to denote a by-stander, who informs the court of a matter in law that is doubtful or mistaken.

AMIESTIES, cotton cloths, which come from the East Indies.

AMIRANTE, in the Spanish polity, a great officer of state, answering to our lord-high-admiral.

AMITTERE LEGEM TERRÆ, among lawyers, a phrase importing the loss of the liberty of swearing in any court. The punishment of a champion overcome or yielding in battle, of jurors found guilty in a writ of attaint, and of a person outlawed.

AMMAN, or AMMANT, in the German and Belgic policy, a judge who has the cognizance of civil causes.

AMMANT is also used among the French for a public notary, or officer who draws up instruments and deeds.

AMMANNIA, in botany, the name of a genus of plants, belonging to the tetrandria monogynia class and order of Linnæus; the flower of which is composed of four oval patent petals, growing within the cup; and its fruit is a roundish capsule covered by the cup, and containing four cells; and this description forms its essential character. There are seven species, all of which seem to be annual, and being natives of hot climates most of them require protection in this country.

AMMI, *bishop's weed*, in botany, a genus of umbelliferous plants, belonging to the pentandria digynia class and order of Linnæus; the flower of which is rosaceous and composed of heart-like petals; and its fruit is a small roundish and striated capsule, containing two striated seeds, convex on one side. There are three species, all annual.

AMMOCHRYSOS, in natural history, the name of a stone common in Germany, being a species of mica, with gold-coloured spangles. Reduced to powder, it is used to strew over writing.

AMMODYTES, the name of a genus of fishes, of which only a single species has hitherto been discovered. The head is compressed, narrower than the body; upper lip doubled, lower jaw narrow and pointed; teeth sharp; gill membrane of seven rays; body long square; tail-fin distinct. It inhabits the sandy shores of the northern seas, and it takes its name from its quality of diving into, or burying itself under the sand. It is usually from nine to twelve inches in length. It is silvery white, and greenish on the back.

AMMONIA, or VOLATILE ALKALI, is distinguished from the fixed alkalis by a very sharp irritating pungent smell, and by its great volatility.

Ammonia may be procured by the following process:

1. Put into a retort a mixture of three parts of quick lime and one part of sal ammoniac in powder. Plunge the beak of the retort below the mouth of a glass jar filled with mercury, and standing inverted in a bason of mercury. Apply the heat of a lamp to the retort; a gas comes over, which displaces the mercury and fills the jar. This gas is ammonia. It was known by the name of volatile alkali; it was also called hartshorn, because it was often obtained by distilling the horn of the hart; spirit of urine, because it may be obtained by the same process from urine; and spirit of sal ammoniac, because it may be obtained from that salt. Dr. Black first pointed out the difference between ammonia and carbonat of ammonia, or ammonia combined with carbonic acid; and Dr. Priestley discovered the method of obtaining it in a state of purity, by the process already described.

2. Ammonia in the state of gas is transparent and colourless like air; its taste is acrid and caustic like that of the fixed alkalies, but not nearly so strong, nor does it, like them, corrode those animal bodies to which it is applied: its smell is remarkably pungent, though not unpleasant when sufficiently diluted. Its use as a stimulant to prevent fainting is well known.

Animals cannot breathe it without death. When a lighted candle is let down into this gas, it goes out three or four times successively; but at each time the flame is considerably enlarged by the addition of another flame of a pale yellow colour, and at last this flame descends from the top of the vessel to the bottom.

Its specific gravity is 0.000732. Its weight is to that of common air as 3 to 5.

When exposed to a cold of —45° it is condensed into a liquid, which again assumes the gaseous form when the temperature is raised. When passed through a red hot tube of porcelain or glass, it is totally decomposed and converted into hydrogen and azotic gas. That this experiment may succeed, the diameter of the tube must not be too great.

3. It combines very rapidly with water. When a piece of ice is brought into contact with this gas, it melts and absorbs the ammonia, while at the same time its temperature is diminished. Cold water absorbs this gas almost instantaneously, and at the same time heat is evolved, and the specific gravity of the water is diminished. Water is capable of absorbing and condensing more than a third of its weight of ammoniacal gas. The specific gravity of the saturated solution is 0.9054. It is in this state that ammonia is usually employed by chemists. The term ammonia, indeed, almost always means this liquid solution of ammonia in water. When heated to the temperature of about 130°, the ammo-

nia separates under the form of gas. When exposed to the temperature of —46° it crystallizes; and when suddenly cooled down to —68°, it assumes the appearance of a thick jelly, and has scarcely any smell.

It follows from the experiments of Mr. Davy, that a saturated solution of ammonia is composed of

74.63 water
25.37 ammonia

100.00

The following table, drawn up by the same ingenious chemist, exhibits the proportion of water and ammonia contained in 100 parts of liquid ammonia of different specific gravities.

Specific grav.	Ammonia.	Water.
0.9054	25.37	74.63
0.9166	22.07	77.93
0.9255	19.54	80.46
0.9326	17.52	82.48
0.9385	15.88	84.12
0.9435	14.53	85.47
0.9476	13.46	86.54
0.9513	12.40	87.60
0.9545	11.56	88.44
0.9573	10.82	89.18
0.9597	10.17	89.83
0.9619	9.60	90.40
0.9684	9.50	90.50
0.9639	9.09	90.91
0.9713	7.17	92.83

4. Ammoniacal gas is not altered by light; but when electric sparks are made to pass through it, the bulk of the gas is considerably increased, and it is converted into hydrogen gas and azotic gas. Hence it follows, that it is composed of hydrogen and azote. By this process Berthollet converted 1.7 cubic inches of ammoniacal gas into 3.3 cubic inches.

5. This gas has no effect upon oxygen gas while cold; but when a mixture of the two gases is made to pass through a red hot porcelain tube, a detonation takes place, water is formed, and azotic gas emitted. Hence we see that ammonia is partly combustible. Its hydrogen combines with the oxygen, and forms water, while the azote makes its escape in the form of a gas. If the proportion of oxygen gas is considerable, nitric acid is also formed in consequence of the combination of the azote with the superabundant oxygen. The same decomposition and detonation take place if common air is used instead of oxygen gas.

6. Sulphur is the only one of the simple combustibles that combines with ammonia. Hydrogen produces no change upon it whatever; but phosphorus and charcoal act with considerable effect in high temperatures.

It combines with sulphur in the state of vapour, and forms a sulphuret which decomposes water, and forms hydrogenated sulphuret of ammonia, known formerly by the name of fuming liquor of Boyle, because it was first described by that philosopher. It is commonly prepared by distilling a mixture of five parts of sal ammoniac, five parts of sulphur, and six of quicklime. It is a liquid of a red or rather deep orange colour, and exhales a fetid odour in consequence of an excess of ammonia which it contains. Its nature was first pointed out by Berthollet.

Phosphorus produces no change on ammoniacal gas while cold; but when this gas is made to pass through phosphorus in a red hot porcelain tube, it is decomposed, and phosphureted hydrogen gas, and phosphureted azotic gas, are formed.

Charcoal absorbs ammoniacal gas, but does not alter its properties while cold. But when the gas is made to pass through red hot charcoal, part of the charcoal combines with it, and forms a substance known by the name of prussic acid.

7. Ammonia is not acted on by azote; but it combines rapidly with muriatic acid, the two gases concreting into the solid salt called muriat of ammonia.

8. Ammonia does not combine with the metals; but it changes some of them into oxides, and then dissolves them. The oxidizement is evidently in consequence of the decomposition of part of the water with which the ammonia is combined; for hydrogen gas is emitted during the solution. Copper and zinc are oxidized by the action of ammonia: as are also tin and iron, though only superficially. Scarcely any of the other metals are altered by its action.

Liquid ammonia is capable of dissolving the oxides of copper, iron, tin, nickel, zinc, bismuth, and cobalt. When digested upon the oxides of mercury, lead, or manganese, it is decomposed, water is formed by the union of the hydrogen of the ammonia with the oxygen of the oxides, and azotic gas is emitted. If a considerable heat is applied, nitric acid is formed at the same time with water. Several other oxides are also partly deoxidized when ammonia is poured into their solutions in acids. The ammoniacal solution of the peroxide of copper is of a fine blue colour, and, according to Sage, capable of crystallizing. When heat is applied, the ammonia is partly driven off, and partly decomposed, by the combination of its hydrogen with the oxygen of the oxide.

9. Ammonia combines readily with the peroxides of gold and silver, and forms with them two compounds, formerly known by the names of fulminating gold and fulminating silver; because, when heated or rubbed, they explode with great violence. It combines also with the red oxide of mercury.

10. The affinities of ammonia are the same with those of the fixed alkalies.

11. As ammonia has the property of detonating with nitre, chemists had unanimously agreed that it contained phlogiston. Scheele first demonstrated, that when it is decomposed by means of the oxides of manganese, arsenic, or gold, azotic gas is set at liberty, while the oxide is reduced. Hence he concluded, that it was composed of azote and phlogiston; and Bergman coincided with him in opinion. Dr. Priestley discovered, that when electric explosions are made to pass through this gas, its bulk is gradually augmented to thrice the space which it formerly occupied; and a quantity of hydrogen gas is produced. The same ingenious philosopher applied heat to the red oxides of mercury and lead confined in ammoniacal gas. The oxides were reduced, water was evolved, the ammoniacal gas disappeared, and instead of it, there was found a quantity of azotic gas. These experiments, and those of Scheele, led to the conclusion, that ammonia is composed of azote and hydrogen; a conclusion which was fully established by the experiments of Berthollet, published in the Memoirs of the French Academy for 1785. This acute philosopher repeated the experiments of Scheele and Priestley, and applied to them the theory of Mr. Lavoisier, and added also several very decisive ones of his own. The most important of these is the mutual decomposition of ammonia and oxy-muriatic acid. When solutions of these bodies in water are mixed together, an effervescence takes place, azote is disengaged, a quantity of water formed, and the oxy-muriatic acid is converted into common muriatic acid. Now the substances mixed were ammonia and oxy-muriatic acid, which is composed of oxygen and muriatic acid; the products were, muriatic acid, azote, and water, which is composed of oxygen and hydrogen. The oxygen of the water was furnished by the acid; the other products must have been furnished by the ammonia, which had disappeared. Ammonia, therefore, must be composed of azote and hydrogen. It follows from Mr. Berthollet's experiments, that ammonia is composed of 121 parts of azote and 29 of hydrogen. According to Dr. Austin, it is composed of 121 parts of azote and 32 of hydrogen. Hence 100 parts of ammonia are composed of about 80 parts of azote and 20 of hydrogen. The experiments of Berthollet have been still farther confirmed by those made more lately by Mr. Davy.

AMMONIA, *liquid*, is formed by the solution of ammoniacal gas in water, which takes place very rapidly.

AMMONIAC, or *Gum*-AMMONIACUM, in the materia medica, a gum, or more properly a gum-resin, extracted from an umbelliferous plant, growing in some parts of Africa and Asia. It is brought to us in drops or granules, and sometimes in large masses, composed of a number of these granules connected together by other matter of the same kind.

The best ammoniac is always most free from dross, of a yellowish colour without and white within, of a bitterish taste and castor smell.

AMMONIAC, *sal*. See *Muriate of Ammonia*, in CHEMISTRY.

AMMONIACAL gas, an elastic fluid, as transparent as air, but little more than half as heavy. Its smell and taste are sharp and caustic. It destroys animal and vegetable life, and extinguishes flame. The electric spark separates it into its constituent principles, hydrogen and azotic gas. On being mixed with acid gases, clouds are produced by the formation of neutral ammonial salts.

AMMONIACAL preparations. See PHARMACY.

AMMONITÆ, in natural history, the same with the cornua ammonis, or snake-stones.

AMMOSCHISTA, a genus of stones of a laminated structure, and splitting only horizontally, or into flat plates.

AMMUNITION, a general term for all warlike provisions, but more especially powder, ball, &c.

Ammunition, arms, utensils of war, gunpowder, imported without licence from his majesty, are, by the laws of England, forfeited and triple the value.

And again, such licence obtained, except for furnishing his majesty's public stores, is to be void, and the offender to incur a præmunire, and be disabled from holding any office from the crown.

AMMUNITION BREAD, SHOES, &c. such as are served out to the soldiers of an army or garrison.

AMNIOS, a thin pellucid membrane, which surrounds the fœtus. See ANATOMY and PHYSIOLOGY.

AMOEBŒUM, a poem, or other composition, in which two parties speak alternately in the same number of verses, but so as that he who answers, either goes beyond or contradicts the other; such are the third and seventh Eclogues of Virgil.

AMOGABARI, antient Spanish soldiery greatly celebrated for bravery.

AMOGLOSSUS, a name of a peculiar kind of flat fish, something resembling a soal, and called also a lantern.

AMOK, a term used as a catch-word among the slaves in Batavia; who, when they consider themselves as aggrieved, sally forth, shouting out *amok, amok*, and murder all they meet.

AMOMUM, a genus of the *monondria monogynia* class and order. The characters are: the calyx is an obscure three-toothed perianthium, above: the corolla is monopetalous, the tubes short, the limbus tripartite; the stamina is an oblong filament, with the anthera adjoining; the pistillum has a roundish germen, beneath; the style is filiform, the stigma obtuse; the pericarpium is leathery, subovate, trigonous, trilocular, and three-valved; the seeds are numerous. Of this genus there are 12 species, the principal of which are,

1. Amomum Zinziber, or common ginger, a native of the East, and also of some parts of the West Indies; where it grows naturally without culture. The roots are jointed, and spread in the ground: they put out many green reed-like stalks in the spring, which rise to the height of two feet and a half, with narrow leaves. The flower stems rise by the side of these, immediately from the root; these are naked, ending with an oblong scaly spike. From each of these scales is produced a single blue flower, whose petals are but little lower than the squamous covering. All the species are tender, and require a stove to preserve them in this country. They are easily propagated by parting the roots in the spring.

2. Amomum Zerumbet, or wild ginger, also a native of India. The roots are larger than those of the common ginger, but are jointed in the same manner. The stalks grow from 3 to near 4 feet high, with oblong leaves placed alternately. The flower-stems arise immediately from the root: these are terminated by oblong, blunt, scaly heads; out of each scale is produced a single white flower, whose petals extend a considerable length beyond the scaly covering.

3. Amomum Cardamomum, or cardamom, is a native of India, but is little known in this country except by its seeds, which are used in medicine. Of this there is a variety, with smaller fruit, which makes the distinction into cardamomum majus and minus.

4. Amomum Grana Paradisi, is likewise a native of the East Indies. The fruit containing the grains of paradise is about the size of a fig, divided into 3 cells, in each of which are contained two small seeds like cardamoms. They are somewhat more grateful, and considerably more pungent, than cardamoms.

The dried roots of the 1st species are of great use in the kitchen, as well as in medicine. They furnish a considerable export from some of the American islands. The green roots, preserved as a sweetmeat, are preferable to every other. The Indians mix them with their rice, which is their common food, to correct its natural insipidity. Ginger is a very useful spice in cold flatulent colics, and in laxity and debility of the intestines; it does not heat so much as those of the pepper kind, but its effects are much more durable. The cardamoms and grains of paradise have the same medicinal qualities with ginger.

AMOMUM, in the materia medica, a name given to the seed of an aromatic plant, esteemed a powerful diuretic, and aperient; and consequently thought good in nephritic cases, obstructions of the viscera, and suppression of the menses. It is now disused.

AMOPHILA, a name proposed for a new genus of hymenopterous insects, with beak conic, inflected, concealing a bifid, retractile, tubular tongue.

AMORPHA, in botany, a genus of plants, belonging to the diadelphia decandria class and order of Linnæus; the flower of which consists of one petal vertically ovated, hollow and erect; and the fruit is a lupulated pod, of a compressed form, and covered with tubercles, in which are contained two seeds, of an oblong kidney-like shape. The essential character is: standard of the corolla ovate, concave: wings none, cal. none. We know of but one species, a very elegant shrub, vulgarly called bastard indigo, as formerly in Carolina a coarse sort of indigo was made from the young shoots. With us it is perfectly hardy.

AMORTIZATION, in law, the alienation of lands or tenements to a corporation or fraternity and their successors.

Amortization also denotes the privilege of taking lands, &c. in mortmain, for which purpose the king's consent must first be obtained. This licence is granted upon paying to the king and the superior a certain sum to indemnify them for several incidental dues, which in the common way would have fallen to them, but by the amortization are cut off.

AMPELIS, in zoology, the chatterer, a genus of birds belonging to the order of passeres; the distinguishing characters of which are, that the tongue is furnished with a rim or margin all round, and the bill is conical and straight. There are 7 species, all natives of foreign countries, except the garrulus, which is a native both of Europe and the West Indies. In the former, the native country of these birds is Bohemia; whence they wander over the rest of Europe, and were once superstitiously considered as presages of a pestilence. They appear annually about Edinburgh in February, and feed on the berries of the mountain-ash. They also appear as far S. as Northumberland; and, like the fieldfare, make the berries of the white thorn their food. It is but by accident that they ever appear farther south. They are gregarious; feed on grapes, where vineyards are cultivated; are easily tamed, and are esteemed delicious food. This species is about the size of the blackbird; the bill is short, thick, and black; on the head is a sharp-pointed crest reclining backwards; the lower part of the tail is black, the end of a rich yellow; the quill feathers are black, the three first tipt with white, the six next have half an inch of their exterior margin edged with fine yellow, the interior with white. But what distinguishes this from all other birds, are the thorny appendages from the tips of seven of the secondary feathers, of the colour and gloss of the best red wax. See Plate, Nat. Hist. fig. 15,* 16*.

AMPELITES, Cannel-coal, in natural history, a solid, dry, opake fossil, very hard, not fusible, but easily inflammable, and burning with a bright, vivid, white flame. This mineral is found in Lancashire, and in different parts of Scotland, where it is known by the name of *Parrot coal*. Colour black; structure sometimes slaty. It burns like a candle, and lasts but a short time. It does not cake, and leaves a stony or sooty residuum.

A specimen of Lancashire cannel coal, analysed by Mr. Kirwan, contained

75.20 charcoal
21.68 maltha
3.10 alumina and silica

99.98

Cannel coal is susceptible of polish, and, like jet, is frequently wrought into snuff-boxes, and other trinkets.

AMPHERES, in antiquity, a kind of vessels, wherein the rowers plied two oars at the same time, one with the right hand, and the other with the left.

AMPHIARTHROSIS, in anatomy, a term under which some comprehend all those junctures of the bones, which have a manifest motion, and which differ from the several articulations of the diarthrosis either in regard to their figure or motion.

AMPHIBIA, the third class of animals in the Linnæan system, including those which possess, in a certain degree, the power of respiration, and are thereby enabled to live either in water or on land. This class is subdivided into four orders, viz. 1st. Amphibia reptiles, 2d. Amphibia serpentes, 3d. Amphibia nantes, and 4th. Amphibia meantes. The distinguishing characters of this class are these; they have either naked or scaly bodies, and sharp-pointed fore-teeth, but without grinders, or *dentes molares*: to which add, that they have no radiated fins. The class includes the tortoise, the frog kind, and the lizard and serpent kinds: 289 species.

Anatomists observe, that the lungs of amphibious animals are so formed, that though respiration is necessary to them, yet it is not requisite to be performed at short intervals. Hence it is, that they can remain a long time under water without being suffocated, and many of them even a considerable part of their lives.

AMPHIBIOUS, a term descriptive of the class *Amphibia*: it also applies, however, to the otter, seal, beaver, and some animals of the other classes, who live on the land, and occasionally go into the water in search of prey.

Most of the *amphibious* animals of this description have peculiar provisions in their structure to fit them for their mode of living, particularly in the heart, lungs, foramen ovale, &c. There are two very curious and important disquisitions by Dr. Parsons on this subject, in the 56 vol. of the Phil. Trans. the substance of which is as follows. Dr. Parsons classes amphibious animals under two divisions: 1. Such as enjoy their chief functions by land, but occasionally go into the water. 2. Such as chiefly inhabit the water, but occasionally go on shore.

Of the first he particularly considers the phocæ or seal tribe; and endeavours to show, that none of them can live chiefly in the water, but that their chief enjoyment of the functions of life is on shore. These animals, he observes, are really quadrupeds; but as their chief food is fish, they are under the necessity of going out to sea to hunt their prey, and to great distances from shore; taking care that, however great the distance, rocks or small islands are at hand, as resting-places when they are tired, or when their bodies become too much macerated in the water. He proceeds: It is well known, that the only essential difference (as to the general structure of the heart) between amphibious and mere land animals, or such as never go into the water, is, that in the former the oval hole remains always open. Now, in such as are without this hole, if they were to be immersed in water but for a little time, respiration would cease, and the animal must die. There are three necessary and principal uses of respiration in all land animals, and in those kinds that are counted amphibious. The first is, that of promoting the circulation of the blood through the whole body and extremities. In real fishes, the force of the heart is alone capable of sending the blood to every part, as they are not furnished with limbs or extremities; which, being so remote from the heart, have need of such assistance, otherwise the circulation would be very languid in these parts. Thus we see, that in persons subject to asthmatic complaints, the circulation grows languid, the legs grow cold and œdematous, and other parts suffer by the defect in respiration. A second use of breathing is, that, in inspiration, the variety of particles, of different qualities, which float always in the air, might be drawn into the lungs, to be insinuated into the mass of blood, being highly necessary to contemperate and cool the agitated mass, and to contribute refined pabulum to the finer parts of it, which, meeting with the daily supply of chyle, serves to assimilate and more intimately mix the mass, and render its constitution the fitter for supporting the life of the animal. Therefore it is, that valetudinarians, by changing foul or unwholesome air for a free, good, open air, often recover from lingering diseases. A third principal use of respiration is, to promote the exhibition of voice in animals; which all those that live on the land do according to their specific natures. From these considerations it appears, that the phocæ of every kind are under an absolute necessity of making the land their principal residence. But there is another very convincing argument why they reside on shore the greatest part of their time, viz. that the flesh of these creatures is analogous to that of other land animals; and therefore, by over-long maceration, added to the fatigue of their chasing their prey, they would suffer such a relaxation as would destroy them. It is well known, that animals which have lain long under water, are reduced to a very lax and even putrid state; and the phoca must bask in the air on shore. Let us now examine by what power these animals are capable of remaining longer under water than land animals. All these have the oval hole open between the right and left auricles of the heart, and in many the canalis arteriosus also; and while the phoca remains under water, which he may continue an hour or two, more or less, his respiration is stopped; and the blood, not finding the passage through the pulmonary artery free, rushes through the arterial canal, being a short passage to the aorta, and thence to every part of the body, maintaining the circulation; but upon rising to come ashore, the blood finds its passage again through the lungs the moment he respires. Thus the fœtus in utero, during its confinement, having the lungs compressed, and consequently the pulmonary arteries and veins impervious, has the circulation of the blood carried on through the oval hole and the arterial canal. Now so far the phoca in the water, and the fœtus in utero, are analogous; but they differ in other material circumstances. One is, that the fœtus having never respired, remains sufficiently nourished by the maternal blood circulating through him, and continues to grow till the time of his birth, without any want of respiration, during nine months confinement; the phoca, having respired the moment of his birth, cannot live very long without it, for the reasons given before; and this hole and canal would be closed in them, as it is in land animals, if the dam did not, soon after the birth of the cub, carry him so very frequently into the water to teach him; by which practice these passages are kept open during life, otherwise they would not be capable of attaining the food designed for them by Providence. Another difference is, that the phocæ, as was said before, would be relaxed by maceration in remaining too long in the water; whereas the fœtus in utero suffers no injury from continuing its full number of months in the fluid it swims in: the reason is, that water is a powerful solvent, and penetrates the pores of the skins of land animals, and in time can dissolve them; whereas the *liquor amnii* is an insipid soft fluid, impregnated with particles more or less mucilaginous, and utterly incapable of making the least alteration in the cutis of the fœtus. Otters, beavers, and some kinds of rats, go occasionally into the water for their prey, but cannot remain very long under water. "I have often gone to shoot otters (says our author), and watched all their motions: I have seen one of them go softly from a bank into the river, and dive down; and in about two minutes rise, at 10 or 15 yards from the place he went in, with a middling salmon in his mouth, which he brought on shore: I shot him, and saved the fish whole." Now, as all fœtuses have these passages open, if a whelp of a true water-spaniel was, immediately after its birth, served as the phoca does her cubs, and immersed in water, to stop respiration for a little time every day, it is probable that the hole and canal would be kept open, and the dog be made capable of remaining as long under water as the phoca. Frogs, how capable soever of remaining in the water, yet cannot avoid living on land, for they respire; and if a frog is thrown into a river, he makes to the shore as fast as he can. The lizard kind, such as may be called water lizards, are all obliged to come to land, in order to deposit their eggs, to rest, and to sleep. Even the crocodiles, who dwell much in rivers, sleep and lay their eggs on shore; and, while in the water, are compelled to rise to the surface to breathe; yet, from the texture of his scaly covering, he is capable of remaining in the water longer by far than any species of the phoca, whose skin is analogous to that of a horse or cow. The hippopotamus who wades into the lakes or rivers, is a quadruped, and remains under the water a considerable time; yet his chief residence is upon land, and he must come on shore for respiration. The testudo, or sea tortoise, though he goes out to sea, and is often found far from land, yet being a respiring animal, cannot remain long under water. He has indeed a power of rendering himself specifically heavier or lighter than the water, and therefore can let himself down to avoid an enemy or a storm: yet he is under a necessity of rising frequently to breathe, for reasons given before; and his most usual situation, while at sea, is upon the surface of the water, feeding upon the various substances that float in great abundance every where about him. These animals sleep securely upon the surface, but not under water, and can remain longer at sea than any other of this class, except the crocodile, because, as it is with the latter, his covering is not in danger of being too much macerated.

The second division of amphibious animals, according to Dr. Parsons, comprehends such as chiefly inhabit the waters, but occasionally go on shore. These are but of two kinds; the eels, and water serpents, or snakes of every kind. It is their form that qualifies them for loco-motion on the land, and they know their way back to the water at will; for by their structure they have a strong peristaltic motion, by which they can go forward at a pretty good rate; whereas all other kinds of fish, whether vertical or horizontal, are incapable of a voluntary loco-motion on shore; and therefore, as soon as such fish are brought out of the water, after having flounced a while, they lie motionless, and soon die. Let us now examine into the reason why these vermicular fish, the eel and serpent kinds, can live a considerable time on land, and the vertical and horizontal kinds die almost immediately when taken out of the water: and, in this research, we shall come to know what analogy there is between land animals and those of the waters. All land animals have lungs, and can live no longer than while these are inflated by the ambient air, and alternately compressed for its expulsion; that is, while respiration is duly carried on, by a regular inspiration and exspiration of air. In like manner, the fish in general have, instead of lungs, gills or bronchiæ: and as, in land animals, the lungs have a larger portion of the mass of blood circulating through them, which must be stopped if the air has not a free ingress and egress into and from them; so, in fish, there is a great number of blood vessels that pass through the bronchiæ, and a great portion of their blood circulates through them, which must in like manner be totally stopped, if the bronchiæ are not perpetually wet with water. So that, as the air is to the lungs in land animals, a constant assistant to the circulation; so is the water to the bronchiæ of those of the rivers and seas: for when these are out of the water, the bronchiæ very soon grow crisp and dry, the blood-vessels are shrunk, and the blood is obstructed in its passage; so, when the former are immersed in water, or otherwise prevented from having respiration, the circulation ceases, and the animal dies. Again, as land-animals would be destroyed by too much maceration in water, so fishes would, on the other hand, be ruined by too much exsiccation; the latter being, from their general structure and consti-

tution, made fit to bear and live in the water; the former, by their constitution and form, to breathe and dwell in the air. But it may be asked, why eels and water-snakes are capable of living longer in the air than the other kinds of fish? This is answered, by considering the providential care of the great Creator for these and every one of his creatures; for since they were capable of loco-motion by their form, which they need not be if they were never to go on shore, it seemed necessary that they should be rendered capable of living a considerable time on shore, otherwise their locomotion would be in vain. How is this provided for? Why, in a most convenient manner; for this order of fishes have their bronchiæ well covered from the external drying air: they are also furnished with a slimy mucus, which hinders their becoming crisp and dry for many hours; and their very skins always emit a mucous liquor, which keeps them supple and moist for a long time; whereas the bronchiæ of other kinds of fish are much exposed to the air, and want the slimy matter to keep them moist. Now, if any of these, when brought out of the water, were laid in a vessel without water, they might be preserved alive a considerable time, by only keeping the gills and surface of the skin constantly wet, even without any water to swim in.

Some kinds of insects, and some birds, are amphibious. The term has been applied to men who have the faculty of living long under water. The divers employed in the pearl fisheries possess this power in an eminent degree.

AMPHIBOLOGY, in grammar and rhetoric, a term used to denote a phrase susceptible of two different interpretations.

AMHIBRACHYS, in antient poety, the name of a foot consisting of three syllables, whereof that in the middle is long, and the other two short.

AMPHICTYONS, in Grecian antiquity, an assembly composed of deputies from the different states of Greece, and resembling, in some measure, the diet of the German empire.

The amphictyons met regularly at Delphi, twice a year, viz. in spring and autumn, and decided all differences between any of the Grecian states, their determinations being held sacred and inviolable.

AMPHIMACER, in antient poetry, a foot consisting of three syllables, whereof the first and last are long, and that in the middle short.

AMPHIMASCALOS, a tunic, or coat, worn by the Greeks, with two short sleeves, so as to cover part of the arm to the elbow. The coats of freemen were *amphimascalos*, those of slaves had only one.

AMPHIBOLES, the principal magistrates of Syracuse, in Sicily, called archons at Athens.

AMPHIPPII, in Grecian antiquity, soldiers, who in war used two horses without saddles, and were dextrous enough to leap from one to the other.

AMPHIPRORÆ, in the naval affairs of the antients, vessels with a prow at each end. They were used chiefly in rapid rivers and narrow channels, where it was not easy to tack about.

AMPHISBÆNA, in zoology, a genus of serpent so called, because it moves with either end forward. The body of the amphisbæna has a number of circular annuli, surrounding it from the head to the extremity of the tail; so that it seems composed of a number of narrow and somewhat rounded rings applied close to one another, and having deep furrows between them.

Only two species of this genus have hitherto been discovered, the white and the black. The white is from 15 to 18 inches long; it is found preying on insects, worms, &c. It is harmless, but on handling it, the skin becomes affected with a slight itching, accompanied with small pustules. The other is rarely so large, and is equally harmless. The skin of the amphisbæna is strong and tenacious, and of a smooth glossy surface; and it is probable that they are enabled with facility to perforate the ground in the manner of earth worms, in order to obtain occasional supplies of food. See Nat. Hist. fig. 14*.

AMPHISCII, among geographers, a name applied to the people who inhabit the torrid zone.

Amphiscii, as the word imports, have their shadows one part of the year towards the north, and at the other towards the south, according to the sun's place in the ecliptic. They are also called Ascii.

AMPHITAPA, in antiquity, a garment frizzed or shagged on both sides, which was laid under persons going to sleep.

AMPHITHEATRE, in antiquity, a spacious edifice built either round or oval, with a number of rising seats, upon which the people used to sit and behold the combats of gladiators, of wild beasts, and other sports.

Amphitheatres were at first only of wood, and it was not till the reign of Augustus, that Statilius Taurus built one for the first time of stone. The lowest part was of an oval figure, and called arena, because, for the conveniency of the combatants, it was usually strewed with sand; and round the arena were vaults styled *caveæ*, in which were confined the wild beasts appointed for the shews. Above the caveæ was erected a large circular peristyle podium, adorned with columns. This was the place of the emperors, senators, and other persons of distinction. The rows of benches were above the podium. Their figure was circular, and they were entered by avenues, at the end of which were gates, called vomitoriæ. The most perfect remains we now have of antient amphitheatres are that of Vespasian, called the coliseum, that at Verona in Italy, and that at Nismes in Languedoc.

AMPHORA, in antiquity, a liquid measure in use among the Greeks and Romans. The Roman amphora contained forty-eight sextaries, and was equal to about seven gallons one pint, English wine-measure; and the Grecian, or attic amphora, contained one-third more.

AMPHORA, was a dry measure, likewise in use among the Romans, and contained three bushels.

AMPHORA, among the Venetians, the largest measure used for liquids. It contains four bigorzas, the bigorza being four quarts, the quart four sachies, and each sachie four leras; but by wholesale the amphora is 14 quarts, and the bigorza three quarts and a half.

AMPHORARIUM *vinum*, wine that is drawn into pitchers, distinguished from cask wine. The Romans had a method of keeping wine in amphoræ for many years to ripen, by fastening the lids down with pitch or gypsum, and placing them either under ground, or in the smoke.

AMPHOTEROPLON, a kind of naval insurance, where insurers run the risk both in the going out, and return of the vessel.

AMPHOTIDES, in antiquity, a kind of armour or covering for the ears, worn by the antient pugilists, to prevent their adversaries from laying hold of this part.

AMPLIATION, in Roman antiquity, was the deferring to pass sentence in certain causes. This the judge did, by pronouncing the word *amplius*; or by writing the letters N. L. for *non liquet*; thereby signifying, that as the cause was not clear, it would be necessary to bring farther evidence.

AMPLITUDE, an arch of the horizon intercepted between the east or west point, and the centre of the sun, or a planet at its rising and setting, and so is either north and south, or ortive and occasive.

The sun's amplitude, either rising or setting, is found by the globes, by bringing the sun's place to the horizon, either on the east or west side, and the degrees from the east point, either north or south, are the amplitude required. To find the amplitude trigonometrically, say, as the cosine of the latitude: radius:: sine of the present declination: sine of the amplitude. This problem is useful in navigation, to find the variations of the compass.

AMPLITUDE *Magnetical*, the different rising or setting of the sun, from the east or west points of the compass. It is found by observing the sun, at his rising and setting, by an amplitude-compass.

AMPLITUDE *of the range of a projectile*, the horizontal line, subtending the path in which the projectile moved.

AMPULLA, in antiquity, a round big-bellied vessel, which the antients used in their baths, to contain oil for anointing their bodies. Ampulla was also a cup made of glass, and sometimes of leather, for drinking out of at table.

AMPUTATION, the cutting off a limb, or other part of the body. See SURGERY.

AMPYX, among the ancients, a kind of golden chain, which served to bind the hair of the horses on the forehead. The term was afterwards used to denote a fillet which formed part of their dress; this was frequently encircled with gold and precious stones.

AMSDORFIANS, a sect of protestants, in the 16th century, who took their name from Amsdorf, their leader.

They maintained, that good works were not only unprofitable, but even opposite and pernicious to salvation.

AMULET, a charm or preservative against mischief, witchcraft, or diseases.

Amulets were made of stone, metal, simples, animals, and in a word, of every thing which fancy or caprice suggested; and sometimes they consisted of words, characters, and sentences, ranged in a particular order, and engraved upon wood, &c. and worn about the neck, or some other part of the body.

At other times they were neither written nor engraved, but prepared with many superstitious ceremonies, great regard being usually paid to the influence of the stars. The Arabians have given to this species of amulet the name of talisman.

All nations have been fond of amulets: the Jews were extremely superstitious in the use of them to expel diseases: and the Misna forbids them, unless received from an approved man, who had cured at least three persons before, by the same means.

Even amongst the Christians of the early times, amulets were made of the wood of the

cross, or ribbands with a text of scripture written in them, as preservatives against diseases; and therefore the council of Laodicea forbids ecclesiastics to make such amulets, and orders all such as wore them to be cast out of the church.

AMUSETTE, an instrument of war, mounted like a cannon, and fired off like a musket.

AMY, in law, the next friend or relation to be intrusted for an infant.

AMYGLADOIDES *lapis*, in natural history, a fossile body, resembling the kernel of an almond in shape, being the petrified spine of a species of *echinus marinus*, or sea urchin.

AMYGDALUS, the Almond and Peach: a genus of the monogynia order, belonging to the icosandria class of plants; and in the natural method, ranking under the order pomaceæ. The characters are: the calyx is a single-leaved perianthium beneath, tubular, and quinquefid: the corolla consists of five oblong petals, which are inserted into the calyx: the stamina of 30 slender erect filaments, half the length of the corolla, and inserted into the calyx; the antheræ are simple: the pistillum has a round villous germen above; a simple stylus, the length of the stamina; and the stigma headed: the pericarpium is a large roundish villous drupa, with a longitudinal furrow: the seed is an ovate compressed not perforated in the pores. The nut of the almond is covered with a dry skin, that of the peach and nectarine with a soft pulp. The nectarine again is smooth, the peach downy.

There are 7 species with innumerable varieties, the principal of which are:

1. Amygdalus communis, or common almond, a native of Africa, grows to near 20 feet high. The white flowering almond is a variety of this species, and is cultivated for the sake of the flowers and the fruit, though the flowers are inferior to the red.

2. Amygdalus nana, the dwarf almond is a native of Asia Minor. Of this shrub there are two varieties, the single and the double. Both grow to about four or five feet high, and are in the first esteem as flowering shrubs.

3. Amygdalus Persica, or the Peach, is said to be a native of Europe; but of what place is not known. Cultivation has produced many varieties of this fruit; of which the following are the most esteemed:

1. Admirable. 2. Beautiful Chevreuse. 3. Bellegarde. 4. Bloody Peach. 5. Bourdine. 6. Catharine. 7. Chancellor. 8. Early Purple. 9. Great French Mignon. 10. Late Admirable. 11. Late Purple. 12. Malta. 13. Monstrous Pavy. 14. Montauban. 15. Nivette. 16. Old Newington. 17. Persique. 18. Portugal. 19. Rambouillet. 20. Red Magdalen. 21. Red Nutmeg. 22. Rossanna. 23. Royal. 24. Small Miguon. 25. Smith's Newington. 26. Venus's Nipple. 27. Vineuse. 28. White Magdalen. 29. White Nutmeg. 30. Yellow Alberge. 31. Noblesse. 32. Double Montagne.

4. Amygdalus nuci-Persica, or the Nectarine. Of this many varieties are now cultivated; and the following are some of the most esteemed.

1. Elruge. 2. Golden. 3. Italian. 4. Murrey. 5. Newington. 6. Roman. 7. Scarlet. 8. Temple's. 9. Clermont's. 10. Fairchild's early.

The good kinds of all these species are propagated by budding or inoculation. They will thrive and bear against any wall but one with a north aspect, but the best aspect is south. In the pruning, care must be taken to leave enough of the young bearing wood, and not lay in the branches too close, or to cross each other.

AMYRIS, a genus of the octandria monogynia class and order, and of the natural order of terebintaceæ. The calyx is a small single-leaved perianthium, four-toothed and persistent: the corolla consists of four oblong petals, concave and expanding: the stamina consist of eight erect subulated filaments: the antheræ are oblong, erect, and the length of the corolla: the pistillum has an ovate germen above; a thickish stylus the length of the stamina; and a four-cornered stigma: the pericarpium is a round drupaceous berry: the seed is a globular glossy nut. There are nine species: the most remarkable are:

1. Amyris balsamifera, or rose-wood, is found on gravelly hills in Jamaica and others of the West India islands. It rises to a considerable height, and the trunks are remarkable for having large protuberances on them. The leaves are laurel-shaped; the small blue flowers are on a branched spike; and the berries are small and black.

2. Amyris elemifera, or shrub which bears the gum elemi, a native of South America. It grows to the height of about six feet.

3. Amyris Gileadensis, or opobalsamum, is an evergreen shrub, growing spontaneously in Arabia Felix, from whence the opobalsam, or balm of Gilead, is procured.

4. Amyris toxifera, or poison wood, is a small tree, with a smooth light coloured bark. From the trunk of this tree distils a liquid as black as ink. Birds seed on the fruit; particularly one called the purple grosbeak, on the mucilage that covers the stone. It grows usually on rocks, in Providence, Ilathera, and others of the Bahama islands.

AMZEL, in ornithology, the name of a bird of the merula or blackbird kind, of which there are two species; the ring amzel or merula torquata, and the merula montana, called simply the amzel. The ring amzel is a little larger than the common blackbird. Its back is of a dusky blackish brown, and its throat and breast are beautifully variegated with spots and streaks of white; and the lower part of the throat is adorned with a fine broad white ring, whence the bird has its name. This ring is of a lunated shape, the points ending at the sides of the neck. The wings and tail are blackish, but in the female variegated with white. This bird feeds on insects and berries, and is common about the peak of Derbyshire, where it is called the Rock Ouzel.

AN JOUR and WASTE, in law, signifies a forfeiture of lands for a year and a day to the king, by persons committing petit treason and felony, and afterwards the land falls to the lord.

ANA, among physicians, denotes an equal quantity of the ingredients which immediately precede it in prescriptions: it is written by abbreviation ā or āā; thus, ℞. *thur. myrrh. alum.* āā, i ℈: that is, take frankincense, myrrh, and alum, each a scruple.

ANA, in matters of literature, a Latin termination added to the titles of several books in other languages.

They are collections of the conversation and memorable sayings of men of wit and learning: the Scaligeriana was the first book that appeared with a title in ana, and was afterwards followed by the Perroniana, Thuana, Naudæana, Menagiana, and even by Arlequiniana, in ridicule of all books in ana.

ANABAPTISTS, in church-history, a sect of protestants, which sprung up in Germany, in 1521, immediately after the rise of lutheranism. At first, they preached up an entire freedom from all subjection to the civil as well as ecclesiastical power; but the tenet from whence they take their name, and which they still maintain, is their re-baptizing all new converts to their sect, and condemning infant-baptism.

Great troubles were occasioned in Germany by this sect; but of all places where they prevailed, none suffered so much by them as the town of Munster. The anabaptists, however, of Holland and Friezland disapproved the seditious behaviour of their brethren of Munster: and, at present, though this sect still subsists as well in Britain as abroad, yet they no longer pretend to be divinely inspired, they no longer oppose magistrates, nor preach up a community of goods, &c.

The anabaptists support their principal doctrine upon those words of our Saviour, "He that believeth, and is baptized, shall be saved." Now, as adults, or grown persons, are alone capable of believing, they argue, that none but adults are fit to be baptized. This doctrine is opposed by alleging the contrary practice of the primitive church, as well as from scripture, which tells us, that children are capable of the kingdom of heaven, and at the same time assures that, "except a man be baptized, he cannot enter into the kingdom of God."

ANABATA, a cope or sacerdotal vest, to cover the back and shoulders of the priest.

ANABATHRA, in antiquity, a kind of stones erected by the sides of highways, to assist travellers to mount their horses.

ANABIBAZON, in astronomy, a name given to the northern node of the moon, or dragon's head.

ANABLEPS, in ichthyology, a genus of malacopterygious fishes, with six bones in the branchiostege membrane, and only two small fins at the extremity of the back. Of this genus there is only one known species. It inhabits the sea shore of Surinam.

ANABOLÆUM, or ANABOLE, in antiquity, a kind of great or upper coat, worn over the tunica.

ANABOLEUS, in antiquity, an appellation given to grooms of the stable, or equerries, who assisted their masters in mounting their horses.

As the antients had no stirrups, or instruments that are now in use for mounting a horse, they either jumped upon his back, or were aided in mounting by anabolei.

ANACALYPTERIA, in antiquity, festivals among the Greeks on the day that the bride was permitted to lay aside her veil, and appear in public. The word is derived from a verb which signifies to uncover.

ANACAMPTERIA, in ecclesiastical antiquity, a kind of little edifices adjacent to

the churches, designed for the entertainment of strangers and poor persons.

ANACARDIUM, or CASHEW-NUT TREE: a genus of the monogynia order, belonging to the decandria class of plants; and in the natural method ranking under the 12th order, holoraceæ. The characters are: the calyx is divided into five parts, the divisions ovate and deciduous: the corolla consists of five reflected petals, twice the length of the calyx: the stamina consists of ten capillary filaments shorter than the calyx, one of them castrated; the antheræ are small and roundish: the pistillum has a roundish germen; the stylus is subulated, inflected, and the length of the corolla; the stigma oblique: there is no pericarpium; the receptaculum is very large and fleshy: the seed is a large kidney-shaped nut, placed above the receptaculum. Only one species is known, viz.

Anacardium occidentale. It grows naturally in the West Indies, and arrives at the height of 20 feet in those places of which it is a native. The fruit of this tree is as large as an orange; and is full of an acid juice, which is frequently made use of in making punch. To the apex of this fruit grows a nut, of the size and shape of a hare's kidney, but it is much larger at the end which is next to the fruit than at the other. The shell is very hard; and the kernel which is sweet and pleasant, is covered with a thin film. Between this and the shell is lodged a thick, blackish, inflammable liquor, of such a caustic nature in the fresh nuts, that if the lips chance to touch it, blisters will immediately follow. The kernels are eaten raw, roasted, or pickled. The caustic liquor just mentioned is esteemed an excellent cosmetic with the West India young ladies, but they must certainly suffer a great deal of pain in its application. The milky juice of this tree will stain linen of a good black, which cannot be washed out. This plant is easily raised from the nuts, which should be planted each in a separate pot filled with light sandy earth, and plunged into a good hot-bed of tanner's bark; they must also be kept from moisture till the plants come up, otherwise the nuts are apt to rot. If the nuts are fresh, the plants will come up in about a month; and in two months more they will be four or five inches high, with large leaves: from which quick progress many people have been deceived, imagining they would continue the like quick growth afterwards; but with all the care that can be taken, they never come to any kind of perfection even in our best stoves. See Plate Nat. Hist. fig. 14.

ANACHORET, in church-history, denotes a hermit, or solitary monk, who retires from the society of mankind into some desert, with a view to avoid the temptations of the world, and to be more at leisure for meditation and prayer.

ANACHORITA, a name given to the cells of recluses; by the antient canons, no anachorita could be erected without the consent of the bishop.

ANACRHONISM, in matters of literature, an error with respect to chronology, whereby an event is placed earlier than it really happened. Such is that of Virgil, who placed Dido in Africa at the time of Æneas, though in reality, she did not come here till 300 years after the taking of Troy.

ANACLASTICS, anaclastica, that part of optics, which considers the refraction of light.

ANACLASTIC *glasses*, a low kind of phials, which have the property of being flexible, and emitting a vehement noise, by the application of the human breath. They are made of a fine glass, with flat bellies resembling inverted funnels, with bottoms almost as thin as the skin of an onion. The bottom which is convex, by the action of inspiration will be drawn in with a prodigious crack, and from convex becomes concave; on the contrary, by expiring or breathing gently into them, the bottom returns to its place with the same noise.

ANACLETICUM, among the ancients, a particular blast of the trumpet, by which the feafulr and flying soldiers were rallied and recalled to the combat.

ANACREONTIC VERSE, in antient poetry, a kind of verse, so called from its being much used by the poet Anacreon. It consists of three feet and a half, usually spondees and iambuses, and sometimes anapests; such is that of Horace,

Lydia dic per omnes.

ANACYCLUS, a genus of the syngenesia polygamia class and order. The essential character is, recept. chaffy: down emarginate: seeds solitary with membranous wings. There are 4 species, all annuals, and somewhat resembling the chrysanthemum in the flower, foliage, and habits.

ANADEMA, in antiquity, denotes the fillet which the kings of Persia wore round their head. Anadema denotes also a kind of ornament which women wore on their heads like a garland.

ANADIPLOSIS, in rhetoric and poetry, a repetition of the last word of a line, or clause of a sentence, in the beginning of the next: thus,

Pierides, vos hæc facietis maxima Gallo:
Gallo, cujus amor, &c.
Et matutinis accredula vocibus instat,
Vocibus instat, & assiduas jacit ore querelas.

Among physicians, the renewal of a cold fit, in a semitertian fever, before the fit is entirely ended.

ANADROMOUS, among ichthyologists, a name given to all fish which, at stated seasons, go from the fresh waters into the sea, and afterwards return back again. Such are the salmon, and some other truttaceous fishes.

ANÆDEIA, in Grecian antiquity, a stool whereon the accused person was placed to make his defence.

ANAGALLIS, in botany, a genus of plants belonging to the pentandria monogynia class and order. The essential character is cor. rotale; caps. opening horizontally. There are 7 species. The A. arvensis, or common pimpernil, is a beautiful little scarlet flower well known in our fields, and called the poor man's weather-glass, from its property of opening in fair weather, and shutting up on the approach of rain. There are some foreign species with larger flowers, cultivated in our gardens; particularly the A. fruticosa, a beautiful flower, figured in Curtis's Magazine, vol. 21. p. 331.

ANAGLYPHICE, the art of embossing.

ANAGNOSTA, or ANAGNOSTES, in antiquity, a kind of literary servant, retained in the families of persons of distinction, whose chief business was to read to them during meals, or at any other time when they were at leisure.

ANAGRAM, a transposition of the letters of some name, whereby a new word is formed, either to the advantage or disadvantage of the person or thing to which the name belongs: thus, from Galenus is formed Angelus: from James, Simea; and so of others. A miserable species of false wit.

ANAGROS, in commerce, a measure for grain used in some cities of Spain, particularly at Seville. Forty-six anagros make about 10¼ quarters of London.

ANAGYRIS, BEAN-TREFOIL, in botany, a genus of plants with papilionaceous flowers, the vexillum of which is shorter than any of the other petals, and its fruit an oblong pod, containing kidney-like seeds: to this is to be added, that three leaves stand on every petal. It belongs to the decandria monogynia class and order of Linnæus. There are three species.

ANALEMMA, in geometry, a projection of the sphere on the plane of the meridian, orthographically made by straight lines and ellipses, the eye being supposed at an infinite distance, and in the east or west points of the horizon.

ANALEMMA denotes likewise an instrument of brass or wood, upon which this kind of projection is drawn, with an horizon and cursor fitted to it, wherein the solstitial colure, and all circles parallel to it, will be concentric circles; all circles oblique to the eye, will be ellipses; and all circles whose planes pass through the eye, will be right lines.

The use of this instrument is to shew the common astronomical problems, which it will do, though not very exactly, unless it be very large.

ANALEPTICS, in pharmacy, restorative medicines.

ANALGISTA, among civilians, denotes a tutor who is not obliged to give an account of his conduct.

ANALOGY, in literature, a certain relation and agreement between two or more things, which in other respects are entirely different: thus the foot of a mountain bears an analogy to the foot of an animal, although they are two very different things.

There is likewise an analogy between beings that have some conformity or resemblance to one another: for example, between animals and plants, and between metals and vegetables; but the analogy is still stronger between two different species of certain animals.

Analogy enters much into all our reasoning, and serves to explain and illustrate but not to demonstrate. Reasoning by analogy, however, may sometimes induce to error: thus, the analogy between the constellation called Leo, and the animal of that name, has given room to some astrologers to imagine that children born under that constellation were inspired with a martial spirit.

ANALOGY, in botany, is a term that has been used to denote the resemblance which plants bear to each other, with regard to their medical properties and uses.

ANALOGY, among geometricians, denotes a similitude of ratios.

ANALYSIS, among logicians, is a method of tracing things backward to their source, and of resolving knowledge into its original principles.

It is also called the method of resolution, and stands opposed to the synthetic method, or method of composition.

The art of this method consists chiefly in combining our perceptions, and classing them together with address; and in contriving a proper expression of our thought, so as to represent their several divisions, classes, and relations. This is clearly seen in the manner of computing by figures in arithmetic, but more particularly in the symbols applied in resolving algebraical problems.

ANALYSIS, among mathematicians, the art of discovering the truth or falsehood of a proposition, or its possibility and impossibility. This is done by supposing the proposition, such as it is, true; and examining what follows from thence, until we arrive at some evident truth, or some impossibility, of which the first proposition is a necessary consequence; and from thence establish the truth or impossibility of that proposition.

The analysis of the antient geometricians consisted in the application of the propositions of Euclid, Apollonius, &c. till they arrived, proceeding step by step, at the truth required. That of the moderns, though not so elegant, must, however, be allowed more ready and general. By this last, geometrical demonstrations are wonderfully abriged, a number of truths are frequently expressed by a single line, and whole sciences may sometimes be learned in a few minutes, which otherwise would be scarcely attained in many years.

Analysis is divided, with regard to its object, into that of finites and infinites.

Analysis of finite quantities, is that which is called specious arithmetic.

Analysis of infinites, is the same with fluxions.

ANALYSIS, in chemistry, the reduction of a mixed body into its principles. This is the chief object of chemistry, and is effected by means of heat and mixture.

ANALYSIS of powers, is the operation of resolving them into their roots, otherwise called evolution. See ALGEBRA.

ANAMORPHOSIS, in perspective and painting, a monstrous projection, or representation of an image on a plane or curve surface, which beheld at a proper distance, shall appear regular and in proportion. See OPTICS.

ANANAS, the trivial name of a species of the pine apple. See BROMELIA.

ANANCITIS, in antiquity, a kind of figured stone, otherwise called synochitis, celebrated for its magical virtue, of raising the shadows, umbræ, of the infernal gods.

ANAPÆST, anapestus, in antient poetry, a foot consisting of two short syllables and one long. It is just the reverse of the dactyle.

ANAPHORA, in antient astronomy, an ascension of the twelve signs of the zodiac from the east, by the daily course of the heavens.

ANAPHORA, in rhetoric, the repetition of the same word or words in the beginning of a sentence or verse: thus Virgil;

Pan etiam Arcadia mecum se judice certet,
Pan etiam Arcadia dicat se judice victum.

ANAPHORA, among antient physicians, denotes the throwing up of purulent matter by the mouth.

ANAPLASIS, among antient physicians, the replacing of a fractured bone in the same situation it obtained before it was broken.

ANAPLEROSIS, among surgeons, expresses the restoring deficiencies; and in this sense is the same with prosthesis.

ANAPLEROTICS, in pharmacy, such medicines as promote the growth of flesh in wounds and ulcers.

ANARRHICHAS, the name of a genus of malacopterygious fishes, called by other writers lupus-marinus, the sea-wolf. See Plate Nat. Hist. fig. 15.

ANAS, in zoology, a genus of birds of the order of anseres, according to Linnæus, the beak of which is convex, with an obtuse point, and the whole verge furnished with transverse lamellose teeth; the tongue is obtuse and ciliated. The nostrils are small and oval; the toes are four in number, three tare placed before, one behind, and the middle one is the longest: See Plate Nat. Hist. fig. 16. There are a great many species of this genus, amounting to at least 98, besides many varieties. The most noted species are:

1. Anas Aborea, or black-billed whistling duck of Edwards. It is a native of America, and makes a kind of whistling noise.

2. Anas acuta, pin-tail, or sea-pheasant of Ray. These birds, it is said, are found in great abundance in Connaught in Ireland, in the month of February only; and are much esteemed for their delicacy.

3. Anas Americana, American wigeon, is rather bigger than our wigeon. It inhabits North America, from Carolina to Hudson's Bay; but is no where a common bird.

4. Anas Anser, the goose. Of this species there are several varieties, of which we shall only mention two: the anser ferus, or wild goose, and the anser mansuetus, or tame goose.

5. Anas bernicla is of a brown colour, with the head, neck, and breast, black; and a white collar. These birds, like the bernacles, frequent our coasts in winter; and are particularly plenty, at times, on those of Holland and Ireland, where they are taken in nets placed across the rivers.

6. Anas boschas, common wild duck, or mallard. They abound particularly in Lincolnshire, the great magazine of wild-fowl in this kingdom; where prodigious numbers are taken annually in the decoys.

7. Anas Canadensis, is found during the summer in Hudson's-bay, and parts beyond; also in Greenland; and, in the summer months, in various parts of North America, as far as Carolina. This species is now pretty common, in a tame state, both on the continent and in England, where they are thought a great ornament to the pieces of water in many gentlemen's seats.

8. Anas Candida, the snow goose, the general colour of whose plumage is snow white, except the first ten quills, which are black with white shafts; they are very numerous at Hudson's-bay; they visit the Severn in May, and stay a fortnight; but go farther north to breed.

9. Anas Casarca, or ruddy goose, is found in all the southern parts of Russia and Siberia in plenty. In winter it migrates into India, and returns northward in spring. They have been attempted to be domesticated, by rearing the young under tame ducks; but without success, as they make their escape the first opportunity. The flesh is thought very delicate.

10. Anas Clangula, or golden eye of Ray, is not unfrequent on our sea coast in winter, and appears in small flocks; but passes to the north in spring, in order to breed.

11. Anas Clypeata, or shoveler of Ray, is sometimes met with in England, though not very commonly. It is said they appear in France in February, and that some of them stay during summer.

12. Anas Creca, or common teal, is frequent in the London markets, along with the wild duck. It is found to the north as high as Iceland.

13. Annas cursor, the race-horse or logger-head goose, inhabits the Falkland Islands, Staaten Land, &c. They are mostly seen in pairs, though sometimes in large flocks. From the shortness of the wings they are unable to fly; but in the water they seem to run, at least they swim, with the assistance of the legs used as oars, at an incredible rate.

14. Anas cygnoides, is the swan goose of Ray, from Guinea, and there is likewise a variety of this species of a less size, called the goose of Muscovy. They are sufficiently common in Britain, and readily mix with the common goose; the breeds uniting as freely, and continuing to produce as certainly, as if no such mixture had taken place.

15. Anas cygnus, or the swan. Of this species there are several varieties, of which we shall only mention two, viz. the ferus and the mansuetus.

16. Anas Erythropus, or laughing goose of Edwards, is a native of Europe and America. These visit the fens during winter, in small flocks; and disappear by the middle of March.

17. Anas fabalis, the bean goose, arrives in Lincolnshire in autumn, and retreats to the north of Europe in May. It is called the bean-goose, from the likeness of the nail of the bill to a horse-bean.

18. Anas ferina, pochard, or red-headed wigeon of Ray, frequents the fens in the winter season, and is brought up to the London markets sometimes in considerable numbers, where they are known by the name of Dun Birds, and are esteemed excellent eating.

19. Anas filigula, or tufted duck of Ray, in the winter months is not unfrequent in England; it is common also throughout the Russian empire, going northward to breed.

20. Anas fusca, the brown, or velvet duck, frequents Hudson's-bay in summer, where it breeds. It feeds on grass, and retires south in winter; when it is frequently seen as far south as New York. It is now and then seen on the coasts of England.

21. Anas galericulata, or Chinese teal of Edwards. This most singular and elegant species is a native of China and Japan, where it is kept by the inhabitants for the sake of its beauty. See Plate, Nat. Hist. fig. 17.

22. Anas glacialis, or long-tailed duck, breeds in the most northern parts of the world; and only visits our coasts in the severest winters.

23. Anas histrionica, or dusky spotted duck of Edwards, inhabits from Carolina to Greenland. In winter it seeks the open sea, flies high and swiftly, and is very clamorous.

24. Anas magna, the great goose, is of a very large size, weighing near 25 or 30 Rus-

sian pounds. It is found in the east of Siberia, from the Lena to Kamtschatka.

25. Anas maula, or scaup duck, is less than the common duck. These birds are said to take their name from feeding on scaup, or broken shell-fish. They differ infinitely in colours, so that in a flock of forty or fifty there are not two alike.

26. Anas mersa, or Ural duck of Pallas, is somewhat bigger than the common teal. It is not seen on the ground, as from the situation of its legs it is unable to walk; but it swims very well and quick.

27. Anas minuta, or little white and brown duck of Edwards. This and the former, according to Latham, are found both on the old and new continents.

28. Anas mollissima, or eider duck, is double the size of the common duck. This species is found in the Western Isles of Scotland, and on the Farn Isles; but in greater numbers in Norway, Iceland, and Greenland; whence a vast quantity of the down, known by the name of eider or edder, which these birds furnish, is annually imported. Its remakrably light, elastic, and warm qualities, make it highly esteemed for coverlets. This down is produced from the breast of the birds in the breeding season. It lays its eggs among the stones or plants near the shore; and prepares a soft bed for them, by plucking the down from its own breast. The natives watch the opportunity, and take away both eggs and nest: the duck lays again, and repeats the plucking of its breast: if she is robbed after that, she will still lay; but the drakes must supply the down, as her stock is now exhausted: but if her eggs are taken a third time, she wholly deserts the place.

29. Anas Moschata, or Muscovy duck of Ray, has a naked papillous face, and is a native of India. This species is pretty common in a domesticated state in almost every nation. The male will not unfrequently associate and produce a mongrel breed with the common duck. The name arises from their exhaling a musky odour, which proceeds from the gland placed on the rump in common with other birds.

30. Anas nigra, the black goose, or scoter, is totally black, and has a gibbosity at the base of the bill. It is the lesser black diver of Ray, and measures in length 22 inches. These birds are found on the northern coasts of England and those of Scotland in the winter season; but no where so common as on the French coasts, where they are sometimes seen in prodigious numbers. Their chief food is a glossy bivalve shell, near an inch long, called by the French vaimeaux. See Plate, Nat. Hist. fig. 18.

31. Anas querquedula, garganey, or first teal of Aldrovandus. In many places it is called the summer teal.

32. Anas ruficolis, or red-breasted goose. This most elegant of geese is found to breed from the mouth of the Ob, along the coasts of the Icy Sea, to that of the Lena.

33. Anas spectabilis, is common in Greenland, where the flesh is accounted excellent. It produces a down as valuable as the eider; and the skins sewed together make very warm garments.

34. Anas sponsa, or summer duck of Catesby, is a most elegant species. It inhabits Mexico, and some of the West India isles, migrating in the summer season as far north as 40 degrees, or a little beyond.

35. Anas strepera, or gad-wal, has the wings variegated with black, white, and red. It inhabits England in the winter months, and is also found at the same season in various parts of France and Italy.

36. Anas tadorna, or shieldrake, has a flat bill, a compressed forehead, a greenish black head, and the body is variegated with white. This species is found as far north as Iceland. It breeds in deserted rabbit-holes, or occupies them in the absence of the owners, who rather than make an attempt at dislodging the intruders, form others; though, in defect of ready-made quarters, these birds will frequently dig holes for themselves. They lay 15 or 16 roundish white eggs. This species, Mr. Latham informs us, may be hatched under a tame duck, and the young readily brought up; but are apt after a few years, to attempt the mastery over the rest of the poultry.

37. Anas tetrax, or campestris, is of the size of a pheasant, and of the nature of the bustard, having no hinder toe. It runs very swiftly, and sits on the ground as the duck does in the water, whence it has its name Anas.

ANASARCA, in medicine, a species of dropsy, wherein the skin appears puffed up and swelled, and yields to the impression of the fingers like dough. See MEDICINE.

ANASTATICA, in botany, the name of a genus of tetradynamious plants of the order siliculosa, called in English, the rose of Jericho: its flower consists of four roundish petals, disposed in the form of a cross; and its fruit is a short bilocular pod, containing in each cell a single roundish seed. Two species annual.

ANASTATICA, a species of vorticella, in the fifth order of vermes, infusoria. It is compound, with bell-shaped flowers, foot stalks scaly and rigid. This is the second species of clustering polypi described by Trembley.

ANASTOMASIS, or ANASTOMOSIS, in anatomy, the opening of the mouths of vessels, in order to discharge their contained fluids. It likewise denotes the communication of two vessels at their extremities; for example, the inosculation of a vein with a vein, of an artery with an artery, or of an artery with a vein.

ANASTOMATICS, in pharmacy, medicines supposed to have the power of opening the mouths of vessels, and promoting the circulation of the blood.

ANASTROPHE, in rhetoric and grammar, denotes the inversion of the natural order of the words: suchis Saxa per & scopulos, for Per saxa & scopulos.

ANATHEMA, among ecclesiastical writers, imports whatever is set apart, separated, or devoted; but is most usually meant to express the cutting off a person from the privileges of a society and communion with the faithful. The anathema differs from excommunication in the circumstance of being attended with curses and execrations.

Several councils have pronounced anathemas against such as they thought corrupted the purity of the faith.

There are two kinds of anathemas, the one judiciary, and the other abjuratory. The former can only be denounced by a council, a pope, or a bishop; the latter makes a part of the ceremony of abjuration, the convert being obliged to anathematise the heresy he abjures.

ANATHEMA, in Heathen antiquity, was an offering or present made to some deity, so called from its being hung up in the temple.

Whenever a person left off his employment, it was usual to dedicate the tools to the patron-deity of such a trade. Persons too who had escaped some imminent danger, as shipwreck and the like, or had met with any other remarkable instance of good fortune, seldom failed to testify their gratitude by some present of this kind.

ANATINUS, in conchology, a species of solen, found on the sandy shores of the Indian ocean. It is also a species of the mytillus common in the rivers of England, and known by the name of duck, or small horse-muscle.

ANATIS, a species of pediculus insect, that infests the wild duck. It is the name also of another creature that is found in the intestines of the velvet duck: and a species of arcaris, of the order intestina in the vermes class.

ANATOMY is the science which teaches us the internal conformation of the human body, both the solids and fluids of which are its particular objects.

The *solids* of the human body consist of,

1. Bones, which give support to the other parts of the body.

2. Cartilages, which are much softer than the bones, and also flexible and elastic.

3. Ligaments, which are more flexible still, and connect the ends of the bones to each other.

4. Membranes, or planes of minutely interwoven fibres.

5. Cellular substance, which is formed of membranes minutely interwoven with each other.

6. Muscles, which are soft and contractile bundles of fibres.

7. Tendons, which generally form the hard and inelastic terminations of muscles.

8. Viscera, which are portions of the body loosely contained in great cavities.

9. Glands, which separate various fluids from the blood.

10. Vessels, which are membranous canals dividing into branches and transmitting blood and other fluids.

11. Adipose substance, an animal oil contained in the cells of the cellular membrane.

12. The cerebral substance, which is of a peculiar nature.

13. Nerves, which are bundles of white cords connected by one end to the brain or spinal marrow, and thence expanded over every part of the body in order to receive impressions from external objects, or to produce muscular motion.

The *fluids* of the human body are,

1. Blood, which circulates through the vessels and nourishes the whole fabric.

2. Perspirable matter, excreted by the vessels of the skin.

3. Sebaceous matter, by the glands of the skin.

4. Urine, by the kidneys.

5. Ceruminous matter, secreted by the ceruminous glands of the external ear.

6. Tears, by the lachrymal glands.

7. Saliva, by the salival glands of the mouth, &c.

8. Mucus, by the mucous glands of the mouth, &c.

9. Pancreatic juice, by the pancreas.

10. Bile, by the liver.
11. Gastric juice, by the stomach.
12. Oil, by the vessels of the adipose membrane.
13. Synovia, by the synovial glands of the joints.
14. Seminal fluid, by the testes.
15. Milk, by the mammary glands.

Anatomy, therefore, from the names of the parts which it considers, is divided into

1. Osteogeny, which is the doctrine of the growth of the bones.
2. Osteology, or the doctrine of adult bones.
3. Chondrology, or the doctrine of cartilages.
4. Syndesmology, or the doctrine of ligaments.
5. Myology, or the doctrine of muscles.
6. Bursalogy, or the doctrine of the bursæ mucosæ.
7. Splanchnology, or the doctrine of the viscera.
8. Angiology, or the doctrine of the vessels.
9. Adenology, or the doctrine of the glands.
10. Neurology, or the doctrine of the nerves, &c. &c. &c.

OSTEOGONY.

Osteogeny treats of ossification, or the growth of bones.

It takes place in the flat bones of the head in the form of radii, which diverge from a common centre.—In the middle of the cylindrical bones, it takes place in the form of a flat ring, surrounding the internal, and surrounded by the external periosteum or membranes of the bone.—In irregular bones, it commences by a number of minute points.

OSTEOLOGY.

This division of anatomical science treats of the adult or full-grown bones.

It is at present taught in the medical schools of London, that bones consist of fibres and lamellæ. The doctrine is nevertheless a false one, for the celebrated Scarpa of Pavia has several years since demonstrated that a cellular, reticular, and vascular parenchyma constitutes the basis in which are secreted the earthy matters to which bones owe their solidity, and that consequently their intimate structure is the same with that of the soft parts of the body.

The long cylindrical or triangular bones consist of two epiphyses, which form their termination, and are internally spongy, and of a diaphysis or middle portion, which is placed between the two epiphyses, and is externally of a compact structure, and internally reticular, where its net-work supports the bags of the marrow. The broad or flat bones of the body are extremely irregular in their form.

The periosteum of bones is that membrane which covers them, gives attachment to their ligaments and muscles, and conducts to them vessels and nerves.

The marrow of bones is an oleaginous fluid contained within the membranous bags, occupying their cells; but its use is totally unknown.

Numerous bloodvessels pass into bones by small holes on their surface; and the minute manner in which these vessels are distributed is beautifully demonstrated by observing the red tinge which they assume in animals with whose food madder is mixed.

In considering the individual bones of the human body, it is proper to commence with those of the head, which are generally arranged into bones of the skull, and bones of the face. The bones of the skull are eight in number, namely, the os frontis, the two ossa parietalia, the os occipitis, the two ossa temporum, the os sphenoides, and the os ethmoides. The two last of these are said to be common to the head and face, because they constitute a part of both. We shall proceed to consider them in the order in which they are here enumerated.

The os frontis is placed in the fore part of the skull, and forms the brow and the upper part of the orbits of the eyes. It is convex externally, and concave internally, and has a serrated semicircular edge, which is turned upward, while its lower part is extremely irregular. It bears, in form, a great likeness to the shell of the common cockle. In children, and sometimes in women, it is divided down the middle by a longitudinal suture, or serrated junction.

The ossa parietalia form all the superior, and some of the lateral parts of the skull. They are convex externally, concave internally, and of an irregular quadrangular form. Their sides are anterior, posterior, superior, and inferior, which last is of a semicircular form. Their angles are posterior superior, posterior inferior, anterior superior, and anterior inferior; which last is produced into a process.

The os occipitis is situated in the lower and back part of the skull. It is convex externally, concave internally, and irregularly rhomboidal in its form.

The ossa temporum are situated at the lower part of the sides and base of the cranium, and are of a very irregular figure. Their upper part, named os squamosum, is externally smooth, and has a thin semicircular edge; their posterior part, called pars mammillaris, is thicker and less regular; and their inferior part becoming smaller, and extending horizontally inward and forward, obtains the name of os petrosum, from its excessive hardness.

The os sphenoides is situated in the middle of the base of the skull, and extends across it from one temple to the other. It is extremely irregular in its figure, and is divided into a body placed in the middle, two alæ on the sides, and two pterygoid processes projecting downward from the junction of the body and alæ.

The os ethmoides is placed in the middle of the forepart of the basis of the cranium. It consists of a cribriform portion, which is placed horizontally; a nasal portion, which, passing downward, contributes to separate the nares; two ossa turbinata, which are external to the last; the cells of the bone, which are placed still more externally; and the ossa plana, which are most external, and assist in the formation of the inner sides of the orbits.

These bones of the cranium are connected by certain sutures or serrated junctions: which are, the coronal, ascending over the forepart of the skull; the lambdoidal, placed at its posterior part; the sagittal, joining these two in the middle of the upper part of the skull; the squamous, which are placed on each side; and the sphenoidal and ethmoidal, surrounding the bones of the same name.

The bones of the face are fourteen in number; and of these

The ossa nasi constitute the arch of the nose.

The ossa lachrymalia are placed at the forepart of the inner edge of the orbits of the eyes.

The ossa malarum, of an irregular square form, constitute the prominences of the cheeks.

The ossa maxillaria superiora are of a very irregular form, constitute the upper jaw, and contain the sixteen upper teeth.

The ossa palati are also very irregular, and situated at the posterior part of the palate, nares, and orbit.

The ossa turbinata inferiora very much resemble those of the ethmoid bone.

The vomer is a thin plate of bone, which contributes to complete the septum narium, or division of the nares.

The maxilla inferior is, as its name indicates, the bone of the lower jaw, and contains the inferior sixteen teeth.

The teeth are thirty-two in number, internally composed of a bony substance, harder in its texture than common bone, and covered at their greater extremity with a cortex or enamel, which is much harder still. Externally each tooth consists of a head, a neck, or narrow place immediately below the head, and one or more fangs or roots, which are sunk in the jaws. They consist of three classes, viz. four incisores, the front teeth of each jaw; two cuspidati, placed on each side of the former; four bicuspides behind the last; and six molares behind these. The last of the molares, from the lateness of the period at which it makes its appearance, is termed dens sapientiæ.

The os hyoides, or bone of the tongue, resembles in form the Greek υ, whence its name. It consists of a body, two cornua, and two appendices.

The bones of the trunk consist of those of the spine, the pelvis, and the thorax.

The spine consists of twenty-four true or moveable, and five false or immoveable vertebræ, likewise denominated the os sacrum, and of one small bone named os coccygis. The true vertebræ consist of a body, a ring placed behind the body transmitting the spinal marrow, and of seven processes, four of which are articular, or serve to connect the vertebræ with each other; and three are for the purposes of muscular attachment: of these two are termed transverse, from their projecting laterally; and one spinous, from its forming the ridge or spine of the back. The true vertebræ are also divided into classes, from their situation in the cervix or neck, in the dorsum or back, and in the lumbar regions or loins. The first class is the cervical, including the first seven; the first of which is termed atlas, from its supporting the head; and the second dentatus, from its having a tooth-like process, which passes upwards into the former, and all of which have their transverse processes perforated by a hole for transmitting the vertebral arteries to the head. The second class is the dorsal, consisting of twelve, which are larger than the cervical, and are distinguished by having their sides and transverse processes depressed for connection with the ribs. The third class is the lumbar, consisting of five, which are larger

than any of the superior ones. The os sacrum resembles a pyramid reversed, somewhat concave internally and convex externally. It constitutes the posterior part of the pelvis, and in the young animal consists of five different portions, resembling considerably the true vertebræ, whence its name of false vertebræ. The os coccygis, in form, very much resembles the os sacrum, of which it is merely an appendix fixed to its lower part.

The pelvis, or inferior cavity of the trunk, in addition to the two bones last mentioned, consists of the two ossa innominata. These, in the young subject, are formed of three distinct bones, viz. the ossa ilium or haunch bones, which are placed at their upper part, the ossa pubis or share bones, which compose their fore part, and the ossa ischium which constitute their inferior part.

The thorax, or superior cavity of the trunk, in addition to the vertebræ, is formed anteriorly by a long narrow bone, named sternum, and laterally as well as in some measure anteriorly and posteriorly by the twenty-four ribs, which are long, narrow, and curved bones, attached by their heads or posterior ends to the vertebræ, and by their anterior cartilages either to the sternum or each other. The upper seven, from their being attached in the former way, are named true ribs; the inferior five are termed false.

The bones of the upper extremities are generally divided into those of the shoulder, arm, fore arm, and hand.

The shoulder consists of two bones, viz. the clavicula and the scapula. The clavicula or collar bone, is situated between the top of the sternum or breast-bone and the extremity of the shoulder, and sometimes resembles in form an italic *f*. The scapula is a triangular flat bone, which forms the greatest part of the shoulder. It is in some measure situated behind the upper part of the thorax. Its superior and inferior sides are denominated costæ; its posterior side is called its base.

The arm has only one bone, termed the os humeri, the upper part of which forms a round head, which is received by the scapula, and its lower part terminates in two condyles, giving attachment to muscles, and a trochlea or pulley between them, for articulation with the following bones:

The fore arm consists of two bones, viz. the radius and ulna, the latter of which is placed on the inside of the fore arm, and chiefly allows of flexion and extension, while at the same time it serves as an axis to the radius, which so revolves around it as to effect that which is called the supination and pronation of the hand.

The bones of the hand are divided into those of the carpus, metacarpus, fingers and thumb. The carpus consists of eight small irregular bones, named schaphoides, lunare, cuneiforme, and piziforme, which form the first row; and trapezium, trapezoides, magnum, and unciforme, which form the second. The metacarpus consists of four bones, having broad bases attached to the carpus, and round heads for articulation with the fingers. Each of the fingers, as well as the thumb, consists of three bones; all of which, except the terminating ones, possess a head and base tipped with cartilage for articulation with its fellows.

The bones of the lower extremities consist of those of the thigh, leg, and foot.

The thigh has only one bone, termed os femoris, the upper part of which forms a round head, received by a cup-like cavity, called acetabulum, of the os innominatum. Below this is the neck of the bone, and at its base two protuberances called trochanters, into which are fixed the muscles which rotate the thigh. The back of the bone is marked by a rough line which divides into two at its lower part, and terminates in the condyles of the bone; which inferiorly are joined to the tibia, a bone of the leg, and laterally give attachment to various muscles.

The bones of the leg are three in number, viz. the patella or knee-pan, a small round bone, requiring no particular description; the tibia, which is superiorly large, has a triangular body, and terminates inferiorly in the malleolus internus, or inner ankle; and the fibula, a long triangular bone, placed on the outside of the leg, articulated above to the tibia, and below terminating in the malleolus externus or outer ankle.

The bones of the foot are divided into those of the tarsus, metatarsus, and toes. The tarsus consists of seven bones, named astragalus, os calcis, naviculare, cuboides, cuneiforme externum, medium, and internum. The metatarsus is composed of five bones, having broad bases and round heads. The phalanges of the toes are three in number: each of their bones are shorter than those of the finger, and the great toe possesses only two.

CHONDROLOGY.

Under this head it is only necessary to state that, in the recent subject, all the articular surfaces of bones are covered by cartilage. Interarticular cartilages are also placed in some of them, as in the joint of the lower jaw, of the clavicle and sternum, of the knee, &c.

SYNDESMOLOGY.

Capsular ligaments surround all the joints, but those which possess the hinge-like motion have also lateral ligaments to render them firm, and to prevent their moving from side to side, while those possessing motion in every direction have generally ligaments internal to the capsular, as the round ligament of the hip-joint, the beginning of the bicipital tendon in the shoulder, the perpendicular ligament of the processus dentatus, &c.

BURSALOGY.

The mucous bags, called bursæ mucosæ, are placed wherever tendons pass over each other, or over any solid part, and serve the purpose of lubricating these tendons.

MYOLOGY.

Of the muscles of the teguments of the cranium.

The skin that covers the cranium is moved by a single broad digastric muscle, and one small pair.

1. The occipito-frontalis arises from the transverse protuberant ridge of the os occipitis; thence it comes straight forwards by a broad thin tendon, which covers the upper part of the cranium at each side; when it comes as far forwards as the hair of the front, it becomes fleshy, and descends to be inserted into the orbicularis palpebrarum of each side. Its use is to pull the skin of the head backwards.

2. The corrugator supercilii arises from the internal angular process of the os frontis, and is inserted into the inner and inferior fleshy part of the occipito-frontalis muscle. Its use is to draw the eyebrow of that side towards the other.

Of the muscles of the ear.

The muscles of the ear may be divided into three classes, viz. the common, proper, and internal. The common move the whole ear, the proper only affect the particular parts of it to which they are connected, and the internal the small bones within the tympanum.

The common muscles are,

1. The attollens aurem arises from the tendon of the occipito-frontalis, and is inserted into the upper part of the ear, opposite to the antihelix. Its use is to draw the ear upwards.

2. The anterior auris arise near the posterior part of the zygoma, and is inserted into a small eminence on the back of the helix. Its use is to draw this eminence a little forwards and upwards.

3. The retrahentes auris arises from the root of the mastoid process, and are inserted into that part of the back of the ear which is opposite to the septum conchæ. Their use is to draw the ear back.

The proper muscles are,

1. The helicis major arises from the acute process of the helix, and is inserted a little above. Its use is to depress that part from which it arises.

2. The helicis minor arises from the inferior and anterior part of the helix, and is inserted into the crus of the helix near its fissure. Its use is to contract the fissure.

3. The tragicus arises from the root of the tragus, and is inserted into the point of the tragus. Its use is to pull the point of the tragus a little forwards.

4. The antitragicus arises from the internal part of the antitragus, and is inserted into the tip of the antitragus. Its use is to turn the tip of the antitragus outwards.

5. The transversus auris arises from the prominent part of the concha on the dorsum of the ear; and is inserted opposite into the contiguous part of the antihelix. Its use is to draw the parts to which it is connected towards each other.

The muscles of the internal ear are three:

1. The laxator tympani arises from the spinous process of the sphenoid bone, and passes through the fissura glasseri to be inserted into the long process of the malleus. Its use is to draw the malleus obliquely forwards.

2. The tensor tympani arises from the cartilaginous extremity of the eustachian tube, and spinous process of the sphenoid bone, from thence running backwards through its osseous semicanal, it is inserted into the posterior part of the handle of the malleus. Its use is to pull the malleus and membrana tympani inwards.

3. The stapedius arises from a little cavern in the posterior part of the tympanum, and is inserted into the posterior part of the head of the stapes. Its use is to draw the stapes obliquely upwards.

Of the muscles of the eye-lids.

The palpebræ, or eye-lids, have one muscle

common to both, and the upper eye-lid one proper to itself.

1. The orbicularis palpebrarum arises from the outer edge of the orbitar process of the superior maxillary bone, and from a tendon near the inner angle of the eye; then surrounding the eye, and covering the eye-lids, it is inserted into the nasal process of the superior maxillary bone. Its use is to shut the eye.

2. The levator palpebræ superioris arises from the upper part of the foramen opticum, and is inserted into the tarsus of the upper eye-lid. Its use is to open the eye.

Muscles of the eye-ball.

The muscles which move the globe of the eye are six, viz. four straight and two oblique.

The four straight muscles very much resemble each other, and arise from the bottom of the orbit around the foramen opticum of the sphenoid bone. They are inserted at the fore part of the globe of the eye into the anterior part of the tunica selerotica, and under the tunica adnata, at opposite sides, which indicates both their names and use; so that they scarcely require any further description, but to name them singly. They are the levator oculi, depressor oculi, adductor oculi, and abductor oculi.

The oblique muscles are two:

1. The obliquus superior, or trochlearis, arises from the edge of the foramen opticum at the bottom of the orbit, between the levator and adductor; hence it runs through a cartilaginous trochlea on the inside of the internal angular process of the os frontis, and is inserted into the tunica sclerotica, between the attollens and optic nerve. Its use is to roll the globe of the eye, and to turn the pupil downwards and outwards.

2. The obliquus inferior arises from the outer edge of the orbitar process of the superior maxillary bone, and is inserted into the selerotica, between the abductor and optic nerve. Its use is to oppose the superior.

Of the muscle of the nose.

There is only one muscle on each side that can be called proper to the nose, though it is affected by several muscles of the face.

The compressor naris arises from the root of the ala nasi externally, and is inserted slightly into the anterior extremity of the os nasi. Its use is to compress the ala towards the septum nasi.

Muscles of the mouth and lips.

The mouth has nine pair of muscles, which are inserted into the lips, and a common one formed by the termination of these, viz. three above, three below, three outwards, and the common muscle surrounding the mouth.

The three above are,

1. The levator anguli oris arises from a hollow of the superior maxillary bone, and is inserted into the angle of the mouth. Its use is to draw the corner of the mouth upwards.

2. The levator labii superioris alæque nasi arises by two origins; the first from the external part of the orbitar process of the superior maxillary bone; the second from the nasal process of the superior maxillary bone. The first and shortest portion is inserted into the upper lip and orbicularis labiorum; the second and longest into the upper lip and outer part of the ala nasi. Its use is to raise the upper lip and ala nasi towards the orbit, and a little outwards.

3. The depressor labii superioris alæque nasi arises anteriorly from the os maxillare superius, and is inserted into the upper lip and root of the ala nasi. Its use is to draw the upper lip and ala nasi downwards and backwards.

The three below are,

1. The depressor anguli oris arises from the lower edge of the maxilla inferior, and is inserted into the angle of the mouth. Its use is to pull down the corner of the mouth.

2. The depressor labii inferioris arises from the inferior part of the lower jaw, and is inserted into the edge of the under lip. Its use is to pull the under lip and skin of the chin downward and outward.

3. The levator labii inferioris arises anteriorly from the lower jaw, and is inserted into the under lip and skin of the chin. Its use is to pull the parts into which it is inserted upward.

The three outward are,

1. The buccinator arises from the lower jaw, as far back as the last dens molaris and root of the coronoid process; from the upper jaw, between the last dens molaris and pterygoid process of the sphenoid bone; and is inserted into the angle of the mouth. Its use is to draw the angle of the mouth backward, and to contract its cavity.

2. The zygomaticus major arises from the os malæ, near the zygomatic suture, and is inserted into the angle of the mouth. Its use is to draw the corner of the mouth upward and outward.

3. The zygomaticus minor arises above the origin of the former, and is inserted near the corner of the mouth. Its use is to draw the corner of the mouth outward and upward.

The common muscle is,

The orbicularis oris. This muscle is, in a great measure, formed by the muscles that move the lips, and surrounds the mouth like a sphincter. Its use is to shut the mouth.

Muscles of the lower jaw.

The lower jaw has four pair of muscles for its elevation or lateral motions, viz. two which are seen on the side of the face, and two concealed by the angle of the jaw.

1. The temporalis arises from a semicircular ridge of the parietal bone, and from all the temporal fossa of the cranium, and is inserted into the coronoid process of the lower jaw. Its use is to pull the lower jaw upwards.

2. The masseter arises from the inferior and interior part of the zygoma, and is inserted into the outside of the angle of the lower jaw. Its use is to pull the lower to the upper jaw.

3. The pterygoideus internus arises from the pterygoid fossa, and is inserted into the angle of the lower jaw internally. Its use is to draw the jaw upwards and toward the opposite side.

4. The pterygoideus externus arises chiefly from the outer side of the external pterygoid process, and is inserted into the fore part of the condyloid process. Its use is to pull the lower jaw forwards, and to the opposite side.

The muscles which appear about the anterior part of the neck.

On the side of the neck are two muscles or layers:

1. The musculus cutaneus vulgo platysma myoides arises from the cellular substance that covers the upper parts of the deltoid and pectoral muscles, and is inserted into the integuments covering the side of the lower jaw. Its use is to corrugate the integuments to which it is attached.

2. The sterno-cleido mastoideus arises by two distinct origins; the anterior from the top of the sternum; the posterior from the upper and anterior part of the clavicle; both unite to be inserted into the mastoid process. Its use is to turn the head to one side, and bend it forward.

Muscles situated between the lower jaw and os hyoides.

There are four layers before, and two muscles at the side. The four layers are,

1. The digastricus arises from the fossa at the root of the mastoid process of the temporal bone, becomes tendinous, runs through the stylo-hyoides, is fixed by a ligament to the os hyoides, and then runs forwards and is inserted into a roughness at the inferior edge of the chin. Its use is to open the mouth, or to elevate the larynx, &c.

2. The mylo-hyoideus arises from all the inside of the lower jaw, and is inserted into the basis of the os hyoides. Its use is to pull the os hyoides forwards, upwards, and laterally.

3. The genio-hyoideus arises from the middle of the lower jaw internally, and is inserted into the basis of the os hyoides. Its use is to draw this bone forward to the chin.

4. The genio-hyo-glossus arises from the inside of the middle of the lower jaw, and is inserted into all the length of the tongue, and base of the os hyoides. Its use is, according to the direction of its fibres, to depress the tongue, or to draw the os hyoides forward.

The two muscles at the side are,

1. The hyo-glossus arises from the base, cornu, and appendix of the os hyoides, and is inserted into the side of the tongue. Its use is to pull the tongue inward and downward.

2. The lingualis arises from the root of the tongue laterally, and is inserted into the tip of the tongue. Its use is to contract the substance of the tongue.

Muscles situated between the os hyoides and trunk.

These may be divided into two layers. The first layer consists of two muscles:

1. The sterno-hyodeus arises, thin and fleshy, from about the cartilaginous extremity of the first rib, and is inserted into the base of the os hyoides. Its use is to pull the os hyoides downwards.

2. The omo-hyoideus arises from the superior costa of the scapula, near the semilunar nitch, and is inserted into the base of the os hyoides. Its use is to pull the os hyoides obliquely downwards.

The second layer consists of three muscles:

1. The sterno-thyroideus arises from the inner edge of the uppermost bone of the sternum, and is inserted into the rough line at the inferior edge of the thyroid cartilage. Its use is to draw the larynx downward.

2. Thyreo-hyoideus arises from the rough line opposite to the former, and is inserted into part of the basis, and almost all the cornu

of the os hyoides. Its use is to pull the os hyoides downward, or the thyroid cartilage upward.

3. The crico-thyroideus arises from the side and fore part of the cricoid cartilage, and is inserted by two portions; the first into the lower part of the thyroid cartilage; the second into its inferior cornu. Its use is to pull forward and depress the thyroid, or to elevate and draw backward the cricoid cartilage.

Muscles situated between the lower jaw and os hyoides laterally.

They are five in number. Three proceed from the styloid process of the temporal bone, from which they have half of their names; and two from the pterygoid process of the sphenoid bone.

The three from the styloid process are,

1. The stylo-glossus arises chiefly from the styloid process, and is inserted into the root, side and tip of the tongue. Its use is to draw the tongue laterally and backward.

2. The stylo-hyoideus arises from the inferior part of the styloid process, and is inserted into the os hyoides between its base and cornu. Its use is to pull the os hyoides to one side and a little upward.

3. The stylo-pharyngeus arises from the root of the styloid process, and is inserted into the side of the pharynx and back of the thyroid cartilage.

The two from the pterygoid process are,

1. The circumflexus, or tensor palati, arises chiefly from the spinous process of the sphenoid bone, then runs over the hook of the internal pterygoid process, and spreads into a broad membrane, which is inserted into the velum pendulum palati. Its use is to stretch the velum.

2. The levator palati arises chiefly from the extremity of the pars petrosa of the temporal bone, and is inserted into the velum pendulum palati. Its use is to draw the velum upward and backward.

Muscles situated about the entry to the fauces.

There are two on each side, and a single one in the middle.

The two on each side are,

1. The constrictor isthmi faucium arises from the side of the tongue: thence running upwards before the amygdala, it is inserted into the middle of the velum pendulum palati. Its use is to draw the velum towards the root of the tongue.

2. The palato-pharyngeus arises chiefly from the middle of the velum pendulum palati, thence passing within the posterior arch behind the amygdala; it is inserted into the edge of the upper and back part of the thyroid cartilage. Its use is to draw the uvula and velum downward and backward.

The one in the middle is,

The azygos uvulæ arises from the extremity of the suture, which joins the palate bones, and is inserted into the tip of the uvula. Its use is to raise the uvula upwards and forwards.

Muscles situated on the posterior part of the pharynx.

Of these there are three pair.

1. The constrictor pharyngis inferior arises from the side of the thyroid, and from the cricoid cartilage, and is inserted into the white line on the middle of the pharynx. Its use is to compress that part of the pharynx which it covers.

2. The constrictor pharyngis medius arises chiefly from the appendix and cornu of the os hyoides, and is inserted into the middle of the cuneiform process of the os occipitis, and is joined to its fellow at a white line in the middle back part of the pharynx. Its use is to compress that part of the pharynx which it covers.

3. The constrictor pharyngis superior arises above from the cuneiform process of the os occipitis lower down, from the pterygoid process of the sphenoid bone, and from the upper and under jaw, near the last dentes molares. It is inserted into a white line in the middle of the pharynx. Its use is to compress the upper part of the pharynx.

Muscles situated about the glottis.

They consist generally of four pair of small muscles, and a single one.

1. The cryco-arytænoideus posticus arises in the back part of the cricoid cartilage, and is inserted into the posterior part of the base of the arytenoid cartilage. Its use is to open the rima glottidis.

2. The crico-arytænoideus lateralis arises from the cricoid cartilage laterally, and is inserted into the side of the base of the arytenoid cartilage. Its use is to open the rima glottidis.

3. The thyreo-arytænoideus arises from the under and back part of the middle of the thyroid cartilage, and is inserted into the arytenoid cartilage, higher up than the crico-arytænoideus lateralis. Its use is to pull the arytenoid cartilage forward.

4. The arytænoideus obliquus arises from the base of one arytenoid cartilage and crossing its fellow, is inserted near the tip of the other. When both act, they pull the arytenoid cartilages towards each other.

The single muscle is,

The arytænoideus transversus arises from the side of one arytenoid cartilage, and is inserted in the same manner into the other. Its use is to shut the rima glottidis.

Besides these there are a few disgregated muscular fibres on each side, which, from their general direction, are named the thyreo-epiglottidei, and arytæno-epiglottidei.

Muscles situated in the fore part of the abdomen.

These consist of three broad layers on each side; always a long one, and generally also a short one, on each side the linea alba.

The three layers are,

1. The obliquus descendens externus arises by eight heads from the lower edges of an equal number of inferior ribs at a little distance from their cartilages, and is inserted into the whole length of the linea alba, and into the anterior extremity of the os ilium. Its use is to support and compress the abdomen, and to bend the loins.

2. The obliquus ascendens internus arises from all the spine of the ilium, from the os sacrum, the three undermost lumbar vertebræ, and from Poupart's ligament. It is inserted into the cartilago ensiformis, and into the cartilages of the seventh and those of all the false ribs. Its use is to assist the former, but to bend the trunk in an opposite direction.

3. The transversalis arises from the inner part of the cartilages of the seven lower ribs, from the spine of the os ilium internally, and from the tendon of the external oblique muscle. It is inserted into the cartilago ensiformis, and into the whole length of the linea alba. Its use is to compress the abdominal viscera.

The long muscle in the middle is

The rectus abdominis, which arises from the symphysis pubis, and is inserted into the cartilages of the three inferior true ribs. Its use is to compress the fore part of the belly, and to bend the loins.

The short muscle in the middle is the pyramidalis arising along with the rectus, and inserted into the linea alba, half-way between the os pubis and umbilicus. Its use seems to be to assist the rectus.

Muscles about the male organs of generation.

Each of the testes has one muscle.

The cremaster arises from the lower part of the internal oblique, and after having pierced the ring of the external, descends upon the spermatic chord, and is inserted into the tunica vaginalis of the testis. Its use is to elevate that gland.

The penis has three pairs of muscles.

1. The erector penis arises from the tuberosity of the ischium, and is inserted into the membrane covering the corpora cavernosa penis. Its use is to compress the crus penis.

2. The accelerator urinæ, or ejaculator seminis, arises from the sphincter ani and membranous part of the urethra, and from the crus penis. It is inserted into a line in the middle of the bulb. Its use is to drive the urine or semen forward.

3. Transversus perinei arises from the tough fatty membrane covering the tuberosity of the ischium, and is chiefly inserted into the accelerator urinæ. Its use is to dilate the bulb.

There is often a fourth muscle named

4. Transversus perinei alter, which arises behind the former, runs more forward, and is inserted into the fore part of the accelerator urinæ. Its use is to assist the former.

Muscles of the anus.

The anus has a single muscle, and one pair. The single muscle is

The sphincter ani, which arises from the skin and fat surrounding the verge of the anus, and is inserted, before, into the perineum, acceleratbres urinæ, and transversi perinei; behind, into the extremity of the os coccygis. Its use is to close the anus.

The levator ani arises extensively within the pelvis, and is inserted into the sphincter ani, &c. Its chief use is to draw the rectum upward.

Muscles of the female organs of generation.

The clitoris has one pair.

The erector clitoridis arises internally from the crus of the ischium, and is inserted into the crus and body of the clitoris. Its use is to draw the clitoris downward and backward.

The vagina has one pair.

The sphincter vaginæ arises from the sphincter ani, and from the back of the vagina, and is inserted into the crus and body of the clitoris. Its use is to contract the mouth of the vagina.

The transversus perinei, sphincter ani, and

levator ani, in the female almost precisely resemble the same muscles in the male.

Muscles situated within the pelvis.

Of these there are two pairs.

1. Obturator internus arises from the internal circumference of the thyroid foramen, and is inserted into the top of the trochanter major. Its use is to roll the os femoris obliquely outward.

2. The coccygeus arises from the spinous process of the os ischium, and is inserted into the end of the sacrum, and into the os coccygis. Its use is to move the os coccygis forward.

Muscles situated within the cavity of the abdomen.

They consist of a single muscle and four pairs.

The diaphragm is a broad thin muscle forming a septum between the thorax and abdomen, concave below and convex above. It is commonly divided into two portions.

1. The superior or greater muscle of the diaphragm arises from the cartilago ensiformis, from the cartilages of the seventh and all the inferior ribs, and is inserted into a tendon situated in the middle of the septum.

2. The inferior or lesser muscle of the diaphragm arises from the second, third, and fourth lumbar vertebræ, by eight heads; of which two in the middle, called its crura, are the longest: and is inserted into the posterior part of the middle tendon. Its chief use is as a principal agent in respiration.

The four pairs are,

1. The quadratus lumborum arises from the posterior part of the spine of the ilium, and is inserted into the transverse processes of the lumbar vertebræ, into the last rib, and into the last dorsal vertebra. Its use is to move the loins to one side.

2. Psoas parvus arises from the sides of the two upper lumbar vertebræ, and is inserted into the brim of the pelvis. Its use is to assist the psoas magnus in bending the loins.

3. Psoas magnus arises from the side of the body and transverse process of the last dorsal vertebra, and in the same manner from all the lumbar. It is inserted into the trochanter minor. Its use is to bend the thigh.

4. The iliacus internus arises from the transverse process of the last vertebra of the loins, from the crista, and from the hollow part of the ilium. It is inserted along with the former. Its use is to assist the psoas.

Muscles on the fore part of the thorax.

These consist of two layers, and the first layer of one muscle.

The pectoralis major arises from the extremities of the fifth and sixth ribs, from almost all the sternum, and from half the anterior part of the clavicle. It is inserted into the outside of the groove of the biceps. Its use is to move the arm forward and upward.

The second layer consists of three muscles.

1. The subclavius arises from the cartilage of the first rib, and is inserted into the inferior part of the clavicle. Its use is to pull the clavicle downward and forward.

2. The pectoralis minor arises from the upper edge of the third, fourth, and fifth ribs, near their cartilages, and is inserted into the coracoid process of the scapula. Its use is to bring the scapula forward and downward.

3. The serratus magnus arises from the nine superior ribs, and is inserted into the whole base of the scapula internally. Its use is to move that bone forward.

Muscles placed between the ribs.

These are the intercostales externi et interni, which, arising in two layers from the lower edge of one rib, are inserted into the upper edge of another, and whose use is to approximate the ribs.

The muscles within the thorax are one pair.

The triangularis, or sterno-costalis, arises from the cartilago ensiformis laterally, and from the inferior part of the edge of the middle bone of the sternum. It is inserted into the lower edge of the cartilages of the third, fourth, and fifth ribs. Its use is to depress these cartilages.

Muscles on the fore part of the neck, close to the vertebræ.

They consist of one layer, formed by four muscles.

1. Longus colli arises from the three superior laterally, and from the transverse process of the third, fourth, fifth, and sixth cervical. It is inserted into the fore part of the vertebræ of the neck. Its use is to bend the neck.

2. The rectus capitis internus major arises from the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and is inserted into the cuneiform process of the os occipitis. Its use is to bend the head forward.

3. Rectus capitis internus major arises from the body of the atlas, and is inserted into the condyloid process of the os occipitis. Its use is to nod the head forward.

4. The rectus capitis lateralis arises from the tip of the transverse process of the atlas, and is inserted into the os occipitis external to the foramen magnum. Its use is to bend the head to one side.

On the side of the neck,

1. Scalenus anticus arises from the fourth, fifth, and sixth transverse processes of the neck, and is inserted into the upper side of the first rib.

2. Scalenus medius arises from the transverse processes of the cervical vertebræ, and is inserted into the first rib.

3. Scalenus posticus arises from the fifth and sixth transverse processes of the cervical vertebræ, and is inserted into the upper edge of the second rib. The use of the three scaleni is to bend the neck to one side, or to elevate the ribs and dilate the thorax.

Muscles situated on the back of the trunk.

The following muscles are described as they appear on dissection.

1. The trapezius, seu cucularis, arises from the protuberance of the os occipitis, and from the rough line that extends from it towards the temporal bone, runs down along the nape of the neck, where it seems to arise from its fellow; arises also from the spinous processes of the two inferior cervical, and from those of all the dorsal vertebræ. It is inserted into the posterior half of the clavicle, into the acromion, and into almost all the spine of the scapula. Its use is to move the scapula according to the three different directions of its fibres.

2. The latissimus dorsi arises from the back of the spine of the ilium, from all the spinous processes of the sacrum and lumbar vertebræ, and from the seven inferior ones of the vertebræ of the back: also from the extremities of the three or four inferior ribs. It is inserted into the inner edge of the groove of the tendon of the biceps. Its use is to pull the arm backward and downward, and to roll the os humeri.

3. The serratus posticus inferior arises from the spinal processes of the two inferior dorsal vertebræ, and from the three superior lumbar. It is inserted into the lower edges of the four inferior ribs. Its use is to depress the ribs into which it is inserted.

4. The rhomboideus is divided into two portions. 1. The rhomboideus major, which arises from the spinous processes of the five superior vertebræ of the back, and is inserted into all the basis of the scapula below its spine. Its use is to draw the scapula obliquely upwards and directly inwards. 2. Rhomboideus minor, which arises from the spinous processes of the three inferior vertebræ of the neck, and from the ligamentum nuchæ. It is inserted into the base of the scapula, opposite to its spine. Its use is to assist the former.

5. The serratus superior posticus, arises from the spinous processes of the three last vertebræ of the neck, and the two uppermost of the back. It is inserted into the second, third, fourth, and fifth ribs. Its use is to elevate the ribs and dilate the thorax.

6. The levator scapulæ arises from the transverse processes of the five superior vertebræ of the neck. It is inserted fleshy into the superior angle of the scapula. Its use is to pull the scapula upwards and forwards.

On the neck,

1. The splenius arises from the four superior spinous processes of the vertebræ of the back, from the five inferior of the neck, and adheres to the ligamentum nuchæ. It is inserted into the five superior transverse processes of the cervical vertebræ, into the back of the mastoid process, and into the os occipitis. Its use is to bring the head backward laterally.

2. The complexus arises from the transverse processes of the seven superior vertebræ of the back, and four inferior of the neck; it also receives a slip from the spinous process of the first vertebra of the back. It is inserted into the protuberance of the os occipitis, and into part of its transverse ridge. Its use is to draw the head backwards laterally.

3. The trachelo-mastoideus arises from the transverse processes of the three uppermost dorsal and five lowermost cervical vertebræ. It is inserted into the back of the mastoid process. Its use is to assist the complexus.

4. The transversalis colli arises from the transverse processes of the five uppermost vertebræ of the back. It is inserted into the transverse processes of all the cervical vertebræ, except the first and the last. Its use is to turn the neck obliquely backward, and to one side.

5. The rectus capitis posticus major arises from the spinous process of the dentata. It is inserted into the os occipitis. Its use is to pull the head backwards.

6. The rectus capitis posticus minor arises from the back part of the atlas. It is in-

serted behind the foramen magnum. Its use is to assist the rectus major.

7. The obliquus capitis superior arises from the transverse process of the atlas. It is inserted into the os occipitis, behind the back of the mastoid process. Its use is to draw the head backwards.

8. The obliquus capitis inferior arises from the spinous process of the dentata, and is inserted into the transverse process of the atlas. Its use is to rotate the head.

On the back near to the spine:

1. The sacro-lumbalis arises in common with the longissimus dorsi, inserted into the curve of all the ribs. Its use is to pull the ribs down, and assist to erect the trunk of the body.

2. The longissimus dorsi arises from the side, and all the spines of the sacrum; from the posterior spine of the ilium; from the spines, and from the transverse processes of the lumbar vertebræ. It is inserted into the transverse processes of the dorsal vertebræ, and into the lower edge of all the ribs except the two inferior, near their tubercles. Its use is to extend the trunk.

3. The spinalis dorsi arises from the spines of the two uppermost lumbar vertebræ, and the three inferior dorsal vertebræ. It is inserted into the spines of the nine uppermost dorsal vertebræ, except the first. Its use is to fix the vertebræ, and to assist in raising the spine.

4. The semispinalis dorsi arises from the transverse processes of the seventh, eighth, ninth, and tenth dorsal vertebræ, and is inserted into the spines of all the dorsal vertebræ above the eighth, and into the two lowermost cervical vertebræ. Its use is to extend the spine obliquely backwards.

On the neck:

1. The semispinalis colli arises from the transverse processes of the six uppermost vertebræ of the back. It is inserted into the spines of all the cervical vertebræ, except the first and last. Its use is to extend the neck obliquely backward.

2. The multifidus spinæ arises from the side and spine of the sacrum, and from the posterior part of the ilium; from all the oblique and transverse processes of the lumbar vertebræ; from all the transverse processes of the dorsal vertebræ; and from those of the cervical, except the three first. It is inserted into all the spines of the lumbar, dorsal, and cervical vertebræ, except the first. Its use is to extend the vertebræ backwards.

1. The interspinales colli arise from the spine of the inferior vertebræ of the neck, and ascend to be inserted into the spine of the superior vertebræ. They are five in number. Their use is to draw these processes nearer to each other.

2. The intertransversales colli arise from the inferior transverse process of each vertebra of the neck, and first of the back, and are inserted into the superior transverse processes. Their use is to draw these processes towards each other, and turn the neck to one side.

3, 4, and 5. The interspinales dorsi et lumborum, and the intertransversales dorsi, are rather small tendons than muscles, serving to connect the spinal and transverse processes.

6. The intertransversales lumborum are four distinct small bundles which fill up the spaces between the transverse processes of the lumbar vertebræ, and serve to draw them towards each other.

Muscles on the shoulder.

1. Deltoides arises from the clavicle, processus, acromion and spine of the scapula. It is inserted into the anterior and middle part of the os humeri. Its use is to raise the arm.

2. Supraspinatus arises from the basis, spine, and upper costa of the scapula. It is inserted into a large tuberosity at the head of the os humeri. Its use is to raise the arm.

3. Infraspinatus arises from the basis and spine of the scapula. It is inserted into the upper and middle part of the tuberosity. Its use is to roll the os humeri outwards.

4. Teres minor arises from the inferior costa of the scapula. It is inserted into the lower part of the tuberosity, and rolls the humerus outward.

5. Teres major arises from the inferior angle, and costa of the scapula. It is inserted into the ridge at the inner side of the groove formed for the long head of the biceps. Its use is to assist in the rotatory motion of the arm.

6. Subscapularis arises from the basis, superior and inferior costæ of the scapula. It is inserted into the upper part of a small tuberosity at the head of the os humeri. Its use is to roll the arm inwards.

7. Coraco-brachialis arises from the coracoid process of the scapula. It is inserted into the inner side of the os humeri. Its use is to raise the arm forwards and upwards.

Muscles on the arm.

1. Biceps flexor cubiti arises by two heads, one from the coracoid process, and the other, or long head, from the upper and outer edge of the glenoid cavity of the scapula. It is inserted into the tuberosity at the upper end of the radius. Its use is to bend the fore-arm.

2. Brachialis internus arises from the os humeri, below, and at each side of the tendon of the deltoides. It is inserted into a small tuberosity at the fore part of the coronoid process of the ulna, and into the upper and outer part of the olecranon. Its use is to assist in bending the fore-arm.

3. Triceps extensor cubiti arises by three heads: the first from the inferior costa of the scapula; the second from the upper and outer part of the os humeri; and the third from the back part of that bone.

Muscles on the fore arm.

1. Supinator longus arises from the ridge and anterior surface of the os humeri, a little above its outer condyle. It is inserted into the radius near its styloid process. Its use is to assist in turning the palm of the hand upwards.

2. Extensor carpi radialis longus arises immediately below the origin of the supinator longus. It is inserted into the upper part of the metacarpal bone of the middle finger. Its use is to assist the extensor longus.

3. Extensor carpi radialis brevis arises from the outer and lower part of the outer condyle and the upper part of the radius. It is inserted into the back part of all the bones of the four fingers. Its use is to extend the fingers.

4. Extensor digitorum communis arises from the outer condyle of the os humeri. It is inserted into the back part of all the bones of the four fingers.

5. Extensor minimi digiti arises from the outer condyle of the os humeri. It is inserted into the bones of the little finger. Its use is to extend the little finger.

6. Extensor carpi ulnaris arises from the condyle of the os humeri. It is inserted into the metacarpal bone of the little finger. Its use is to assist in extending the wrist.

7. Anconæus arises from the outer condyle of the os humeri. It is inserted into the outer edge of the ulna. Its use is to extend the fore-arm.

8. Flexor carpi ulnaris arises from the inner condyle of the os humeri, and anterior edge of the olecranon. It is inserted into the os pyriforme. Its use is to assist in bending the hand.

9. Palmaris longus arises from the inner condyle of the os humeri. It is inserted into the internal annular ligament. Its use is to bend the hand.

10. Flexor carpi radialis arises from the inner condyle of the os humeri. It is inserted into the metacarpal bone of the fore finger. Its use is to bend the hand.

11. Pronator radii brevis arises from the outer condyle of the os humeri, and coronoid process of the ulna. It is inserted into the anterior and convex edge of the radius, near its middle. Its use is to roll the hand inwards.

12. Flexor sublimis perforatus arises from the inner condyle of the os humeri, inner edge of the coronoid process of the ulna, and upper and anterior part of the radius. It is inserted into the second bone of each finger. Its use is to bend the second joint of the fingers.

13. Supinator radii brevis arises from the outer condyle of the os humeri, the posterior surface and outer edge of the ulna. It is inserted into the anterior, inner, and upper part of the radius. Its use is to roll the radius outwards.

14. Abductor pollicis longus arises from the middle and back part of the ulna, interosseous ligament, and radius. It is inserted by two tendons into the os trapezium, and first bone of the thumb. Its use is to stretch the first bone of the thumb outwards.

15. Extensor minor pollicis arises from the back part of the ulna, and interosseous ligament and radius. It is inserted into the convex part of the second bone of the thumb. Its use is to extend the second bone of the thumb obliquely outwards.

16. Extensor major pollicis arises from the back part of the ulna and interosseous ligament. It is inserted into the third and last bone of the thumb. Its use is to stretch the thumb obliquely backwards.

17. Indicator arises from the middle of the ulna. It is inserted into the metacarpal bone of the fore finger. Its use is to extend the fore finger.

18. Flexor profundus perforans arises from the upper and fore part of the ulna, and interosseous ligament. It is inserted into the fore part of the last bone of each of the fingers. Its use is to bend the last joint of the fingers.

19. Flexor longus pollicis arises from the upper and fore part of the radius. It is inserted into the last joint of the thumb. Its use is to bend the last joint of the thumb.

20. Pronator radii quadratus arises from the inner and lower part of the ulna. It is inserted into the radius, opposite to its origin. Its use is to roll the radius inwards, and, of course, to assist in the pronation of the hand.

Muscles on the hand.

1. Lumbricales arise from the tendons of the perforans. They are inserted into the tendons of the extensor digitorum communis. Their use is to bend the first, and to extend the two last joints of the fingers.

2. Abductor brevis pollicis arises from the fore part of the internal annular ligament, os scaphoides, and one of the tendons of the abductor longus pollicis. It is inserted into the outer side of the second bone of the thumb, near its root. Its use is to move the thumb from the fingers.

3. Opponens pollicis arises from the inner and anterior part of the internal annular ligament, and from the os scaphoides. It is inserted into the first bone of the thumb. Its use is to move the thumb inwards, and to turn it upon its axis.

4. Flexor brevis pollicis arises from the os trapezoides, internal annular ligament, os magnum, and os unciforme. It is inserted into the ossa sesamoidea and second bone of the thumb.

5. Abductor pollicis arises from the metacarpal bone of the middle finger. It is inserted into the basis of the second bone of the thumb. Its use is to bend the second joint of the thumb.

6. Abductor indicis arises from the inner side of the first bone of the thumb, and from the os trapezium. It is inserted into the first bone of the fore finger posteriorly. Its use is to move the fore finger towards the thumb.

7. Palmaris brevis arises from the internal annular ligament, and aponeurosis palmaris. It is inserted into the os pisiforme, and the skin covering the abductor minimi digiti. Its use is to contract the palm of the hand.

8. Abductor minimi digiti arises from the internal annular ligament and os pisiforme. It is inserted into the side of the first bone of the little finger. Its use is to draw the little finger from the rest.

9. Flexor parvus minimi digiti arises from the os unciforme, and internal annular ligament. It is inserted into the first bone of the little finger. Its use is to bend the little finger.

10. Abductor metacarpi minimi digiti arises from the os unciforme, and internal annular ligament. It is inserted into the metacarpal bone of the little finger. Its use is to move that bone towards the rest.

11. Interossei interni, situated between the metacarpal bones. They are inserted into the roots of the fingers. Their use is to extend the fingers and move them towards the thumb.

12. Interossei externi, situated between the metacarpal bones on the back of the hand. They are inserted into the roots of the fingers. Their use is to extend the fingers; but the first draws the middle finger inwards, the second draws it outwards, and the third draws the ring-finger inwards.

Muscles on the upper part of the thigh.

1. Glutæus maximus arises from the spine of the ilium, posterior sacro-ischiatic ligaments, os sacrum, and os coccygis. Inserted into the upper part of the linea aspera of the os femoris. Its use is to extend the thigh and draw it outwards.

2. Glutæus medius, arises from the spine and superior surface of the ilium. It is inserted into the outer and back part of the great trochanter. Its use is to draw the thigh outwards and a little backwards, and when it is bended, to roll it.

3. Glutæus minimus, from the outer surface of the ilium, and the border of its great niche. It is inserted into the upper and interior part of the great trochanter. Its use is to assist the former.

4. Pyriformis arises from the anterior part of the os sacrum. It is inserted into a cavity at the root of the trochanter major. Its use is to roll the thigh outwards.

5. Gemini, arises by two portions, one from the outer surface of the spine of the ischium, the other from the tuberosity of the ischium, and posterior sacro-ischiatic ligament. It is inserted into the same cavity as the pyriformis. Its use is to roll the thigh outwards, and likewise to confine the tendon of the obturator internus, when the latter is in action.

6. Obturator internus arises from the superior half of the inner border of the foramen thyroideum. It is inserted into the same cavity with the former. Its use is to roll the thigh outwards.

7. Quadratus femoris arises from the tuberosity of the ischium. It is inserted into a ridge between the trochanter major and trochanter minor. Its use is to move the thigh outwards.

Muscles on the thigh.

1. Biceps flexor cruris arises by two heads; one from the tuberosity of the ischium, the other from the linea aspera, near the insertion of the glutæus maximus. It is inserted into the upper and back part of the fibula. Its use is to bend the leg.

2. Semitendinosus arises from the tuberosity of the ischium. It is inserted into the upper and inner part of the tibia. Its use is to bend and draw the leg inwards.

3. Semi-membranosus arises from the tuberosity of the ischium. It is inserted into the upper and back part of the head of the tibia. Its use is to bend the leg.

4. Tensor vaginæ femoris arises from the superior and anterior spinous process of the ilium. It is inserted into the inner side of the fascia lata, which covers the outside of the thigh. Its use is to stretch the fascia.

5. Sartolius arises from the superior and anterior spinous process of the ilium. It is inserted into the upper and inner part of the tibia. Its use is to bend the leg inwards.

6. Rectus arises by two tendons; one from the anterior and inferior spinous process of the ilium, the other from the posterior edge of the cotyloid cavity. It is inserted into the upper and fore part of the rotula. Its use is to extend the leg.

7. Gracilis, arises from the fore part of the ischium and pubis. It is inserted into the upper and inner part of the tibia. Its use is to bend the leg.

8. Vastus externus arises from the anterior and lower part of the great trochanter, and the outer edge of the linea aspera. It is inserted into the upper and outer part of the rotula. Its use is to extend the leg.

9. Vastus internus arises from the inner edge of the linea aspera, beginning between the fore part of the os femoris and the root of the lesser trochanter. It is inserted into the outer and inner part of the rotula. Its use is to extend the leg.

10. Cruræus arises from the outer and anterior part of the lesser trochanter. It is inserted into the upper part of the rotula. Its use is to extend the leg.

11. Pectinalis arises from the anterior edge of the os pubis. It is inserted into the upper and fore part of the linea aspera. Its use is to draw the thigh inwards, upwards, and to roll it a little outwards.

12. Adductor longus femoris arises from the upper and fore part of the os pubis. It is inserted near the middle and back part of the linea aspera. Its use is to draw the thigh inwards, upwards, and to roll it a little outwards.

13. Adductor brevis femoris arises from the fore part of the ramus of the os pubis. It is inserted into the inner and upper part of the linea aspera.

14. Adductor magnus femoris arises from the lower and fore part of the ramus of the os pubis. It is inserted into the whole length of the linea aspera.

15. Obturator externus arises from part of the obturator ligament, and the inner half of the circumference of the foramen thyroideum. It is inserted into the os femoris, near the root of the great trochanter. Its use is to move the thigh outwards in an oblique direction, and likewise to bend and draw it inwards.

Muscles on the leg.

1. Gastrocnemius externus arises by two heads; one from the inner condyle, the other from the outer condyle of the os femoris. It is inserted by a great round tendon, common to this and the following muscle. Its use is to extend the foot.

2. Gastrocnemius internus arises by two heads; one from the back part of the head of the fibula, the other from the upper and back part of the tibia. It is inserted by a large tendon (the tendo Achillis), common to this and the former muscle, into the lower and back part of the os calcis. Its use is to extend the foot.

3. Plantaris arises from the upper and posterior part of the outer condyle of the os femoris. It is inserted into the inside of the back part of the os calcis. Its use is to assist in extending the foot.

4. Popliteus arises from the outer condyle of the thigh. It is inserted into the upper and inner part of the tibia. Its use is to assist in bending the leg and rolling it inwards.

5. Flexor longus digitorum pedis arises from the upper and inner part of the tibia. It is inserted by four tendons, which, after passing through the perforations in those of the flexor digitorum brevis, are inserted into the last bone of all the toes, except the great toe. Its use is to bend the last joint of the toe.

6. Flexor longus pollicis pedis arises from the back part, and a little below the head of the fibula. It is inserted into the last bone of the great toe. Its use is to bend the great toe.

7. Tibialis posticus arises from the back part and outer edge of the tibia, and likewise from the interosseous ligament and adjacent

Part of the fibula. It is inserted into the inner and upper part of the os naviculare, and side of the os cuneiforme medium. Its use is to move the foot inwards.

8. Peroneus longus arises from the outer side of the head of the tibia, and also from the upper anterior and outer part of the fibula, to which it adheres for a considerable way down. It is inserted into the metatarsal bone of the great toe. Its use is to extend and to move the foot outward.

9. Peroneus brevis arises from the outer and fore part of the fibula. It is inserted into the metatarsal bone of the little toe. Its use is to assist the last-described muscle.

10. Extensor longus digitorum pedis arises from the upper, outer, and fore part of the tibia, interosseous ligament, and inner edge of the fibula. It is inserted by four tendons into the first joint of the smaller toes. Its use is to extend the toes.

11. Peroneus tertius arises from the fore part of the lower half of the fibula, and from the interosseous ligament. It is inserted into the metatarsal bone of the little toe. Its use is to bend the foot.

12. Tibialis anticus arises from the upper and fore part of the tibia. It is inserted into the os cuneiforme internum. Its use is to bend the foot.

13. Extensor proprius pollicis pedis arises from the upper and fore part of the tibia. It is inserted into the convex surface of the bones of the great toe. Its use is to extend the great toe.

Muscles on the foot.

1. Extensor brevis digitorum pedis arises from the upper and anterior part of the os calcis. It is inserted by four tendons; one of which joins the tendon of the externus longus pollicis, and the other three the tendons of the extensor digitorum longus. Its use is to extend the toes.

2. Flexor brevis digitorum pedis arises from the lower part of the os calcis. It is inserted by four tendons, which, after affording a passage to those of the flexor longus, are inserted into the second phalanx of each of the small toes. Its use is to bend the second joint of the toes.

3. Abductor pollicis pedis arises from the inner and lower part of the os calcis. It is inserted into the first joint of the great toe. Its use is to move the great toe from the other toes.

4. Abductor minimi digiti arises from the outer tubercle of the os calcis, the root of the metatarsal bone of the little toe, and also from the aponeurosis plantaris. It is inserted into the outer side of the first joint of the little toe. Its use is to draw the little toe outwards.

5. Lumbricalis pedis arises from the tendons of the flexor longus digitorum pedis It is inserted into the tendinous expansion, at the part of the toes. Its use is to draw the toes inwards.

6. Flexor brevis pollicis pedis arises from the inferior and anterior part of the os calcis, and also from the inferior part of the cuneiforme externum. It is inserted by two tendons into the first joint of the great toe. Its use is to bend that joint.

7. Adductor pollicis pedis arises from near the roots of the metatarsal bones of the second, third, and fourth toes. It is inserted into the outer sesamoid bone, or first joint of the great toe. Its use is to draw the great toe nearer to the rest, and also to bend it.

8. Transversales pedis arises from the outer and under part of the anterior end of the metatarsal bone of the little toe. It is inserted into the inner os sesamoideum and anterior end of the metatarsal bone of the great toe. Its use is to contract the foot.

9. Flexor brevis minimi digiti pedis arises from the basis of the metatarsal bone of the little toe. It is inserted into the first joint of the little toe. Its use is to bend the little toe.

10. Interossei pedis interni et externi, situated between the metatarsal bones.

SPLANCHNOLOGY explains the doctrine of the viscera. These are, according to their situation, divided into thoracic, abdominal, and pelvic. The cavity of the thorax is divided into five lesser cavities, viz. the anterior cavity of the mediastinum, the posterior cavity of the mediastinum, the cavity of the pericardium, and the right and left cavities of the thorax. The contents of the thorax are the pleura, pericardium, heart, lungs and bronchiæ, thymus gland, œsophagus, thoracic duct, arch of the aorta, descending cava, vena azygos, par vagum, and great intercostal nerve. The pleura is, from its situation, lining the ribs,or covering the lungs, divided into pleura pulmonalis, and costalis. The pericardium, or capsule of the heart, exhales from its internal surface a vapour which in the dead subject forms the aqua pericardii. The heart consists of a base, sides, and an apex; its right side being also anterior, and its left posterior; the auricles are placed toward its base, the ventricles extend to its apex; the last-mentioned cavities contain the columnæ carniæ and chordæ tendineæ, give exit to the great arteries, and are separated from the auricles by the tricuspid valves, while the mouths of the arteries are protracted by the semilunar valves; the right auricle contains the musculi pectinati, tuberculum Loweri, fossa ovalis, Eustachian valve, and opening of the coronary vein, as well as the terminations of the venæ cavæ; the left auricle contains the openings of the pulmonary veins; the auricles are separated by the septum auriculorum, the ventricles by the septum ventriculorum. The lungs consist of a right and left; the right having three lobes, the left only two; the bronchiæ continued from the trachia, and consisting of smaller cartilaginous circles, divide into capillary tubes,which terminate in the vesiculæ bronchiales; the combination of these vesicles form the lobuli, which are connected by the interlobular substance. The thymus gland is peculiar to the fœtus, nor has its duct been discovered. The œsophagus is a membranous and muscular canal, requiring no particular description; and the thoracic duct, arch of the aorta, &c. as well as the minutiæ of the thoracic viscera in general, are described elsewhere. The mammæ on the external part of the thorax consist of a body containing the mammary gland and lactiferous ducts, an areola, and a papilla or nipple.

Before describing the abdominal viscera, we may enumerate the salival glands, as they also are referable to the article splanchnology. They are the parotid, maxillary, sublingual, thyroid, molar, buccal, labial, lingual, amygdaline, palatine, uvular, arytenoid, &c. the names of most of which explain their situation. The mouth, fauces, pharynx, and œsophagus, are the continuations of one cavity.

The abdomen is divided into the epigastric, hypochondriac, umbilical, epicholic, hypogastric, and inguinal regions. Its contents are the peritoneum and its productions, the stomach, the small and large intestines, the liver and gall-bladder, the spleen and the pancreas, the kidneys, ureters, &c. The chief productions of the peritoneum are the great and small omentum and the mesentery, supporting and conveying the vessels to the intestines. The stomach consists of a great and small curvature, a great and small extremity, one orifice named cardiac, and another termed pylorus. The small intestines consist of the duodenum, distinguished by its valvulæ conniventes and glandulæ Brunneri, the jejunum, remarkable for its ligamentary band, valvulæ conniventes, and plexus glandulosi Peyeri, and the ileum, distinguished also by its ligamentary band, but having less prominent valves and glands. The great intestines consist of the cæcum, which possesses an appendix, and has upon it the commencement of three ligamentary bands of the colon, consisting of an ascending, transverse, and descending portion, and having externally appendices epiploicæ, and strong ligamentary bands, and internally valvulæ conniventes forming between them the cells of the colon, and that valve which has been called the great valve of the colon, cæcum, or ileum, and of the rectum terminating in the anus. The liver consists of two great and one small lobe, termed lobulus Spigellii; it has a middle, right, left, and a round ligament; its internal structure is composed of the penecilli, or terminations of the venæ portæ, the pori biliarii, in which the bile is secreted, and the hepatic ducts, which terminate in one trunk, and convey the bile from the liver. The gall-bladder consists of a fundus, a body, and a neck, which terminates in the duct called cysticus, and this joining the hepatic, they form together the ductus communis choledochus. The spleen is not properly understood, either in its structure or uses. The pancreas resembles in structure the salivary glands, and possesses a duct which terminates together with the ductus communis choledochus, in the duodenum. The kidneys are placed behind the peritoneum, and consist internally of a papillary, and externally of a cortical substance, while their middle part is striated; their internal cavity is called pelvis, and opens into the ureter. The renal capsules are placed at the upper part of the kidney, and their uses are unknown.

The pelvic viscera consist of the urinary bladder, and the male and female organs of generation. The bladder consists of a fundus or bottom, a body, and a neck; its coats are a muscular, a cellular, and a villous. The male organs of generation consist of the testis, which has three coats, the tunica vaginalis, the cremaster, and the tunica albuginea, the internal structure of which consists of delicate tubes, membranous septa, cells, and semeniferous ducts, terminating in the epididymis. This convoluted vessel afterwards assumes the name of vas deferens, and opens within the prostate gland along with the vesiculæ seminales, which are apparently cellular, but in reality tubular bodies, placed between the rectum and inferior part of the bladder. The prostate gland is situated between the neck of the bladder and the bulb of the urethra; the small projection on its inner surface is named caruncula, or

verumontanum, and on each side of it several ducts open from the gland. The penis itself consists of the corpora cavernosa on each side, the urethra inferiorly, the corpus spongiosum surrounding the former, the glans penis terminating the corpus spongiosum, and the integuments and preputium, which invest the whole. The female organs of generation consist of the pubes, or mons Veneris, the labia, the clitoris consisting of two crura and a body, the nymphæ internal to the labia, the urethra much shorter than that of the male, and having similar lacunæ, and the vagina, which in virgins contains the hymen or circulus membraneus, and in married women its remains called caruncule myrtiformes. These are the external parts of generation in the female. The internal are the uterus and its appendages. The uterus consists of a neck, a body, and a fundus, and has a triangular cavity within it; its inferior aperture is called os tincæ. The ligamenta lata tie the uterus to the sides of the pelvis. The ovaria are fixed by the round ligaments to its corners, and the Fallopian tubes proceed from its fundus toward the sides of the pelvis, terminating in a fimbriated manner, and being enveloped, as well as the ovaria, in the broad ligaments.

ANGIOLOGY, or the doctrine of the vessels of the body, (from αγγειον, a vessel, and λογος, a discourse) is divided into three parts, one which treats of the absorbents, another the arteries, and a third of the veins.

Of the absorbent system.

For the discovery of the principal parts of this system, we are chiefly indebted to Aselius, Pacquet, Rudbeck, Jolyffe, and Bartholin. Some of the vessels of which it consists had indeed been seen and mentioned by their predecessors, but it was in too cursory a manner to give them any title to the discovery.

Thus the lacteals had been seen in kids by Erasistratus, who calls them arteries, as we are informed by Galen: and the thoracic duct had been seen by Eustachius, who speaks of it as a vein of a particular kind.

In 1622, Asellius discovered those vessels on the mesentery, which, from their carrying a milk-white fluid, he denominated lacteals. This discovery being made by opening a living dog, anatomists were thence encouraged to make experiments on living animals; and Pacquet, on opening a dog, in the year 1651, found a white fluid mixed with the blood in the right auricle of the heart: suspecting this fluid to be chyle, he endeavoured to determine how it got from the the lacteals into the heart. This he found was by means of the ductus thoracicus, which he traced from the lacteals to the subclavian vein; and thus he clearly proved the existence of that duct which we now consider as the trunk of the system. Just before this time, the lacteals had been supposed to terminate in the liver, conformably to the idea which the physiologists of that period had adopted about the use of this organ, which, from the authority of the older anatomists, they believed was the viscus hæmatopoeticum, or received the chyle from the intestines to convert it into blood.

In the years 1651 and 1652, Rudbeck, Jolyffe, and Bartholin, discovered the other parts of this system, which, from their carrying a transparent and colourless fluid, are called the lymphatic vessels. Thus there was proved to exist in the animal body a system of small vessels, containing fluids very different from the blood, and opening into the sanguiferous vessels at the left subclavian vein.

After this period, Nuck added to our knowledge of this system, by his injections of the lymphatic glands: Ruysch, by his description of the valves of the lymphatic vessels; and Dr. Meckel, by his accurate account of the whole system, and by tracing those vessels in many parts where they had not been before described.

Besides these, doctors Hunter and Monro have called the attention of the public to this part of anatomy in their controversy concerning the discovery of the office of the lymphatics.

When the lymphatic vessels were first seen and traced into the thoracic duct, it was natural for anatomists to suspect, that as the lacteals absorbed from the cavity of the intestines, the lymphatics, which are similar in figure and structure, might possibly do the same office with respect to the other parts of the body. And accordingly, Dr. Glisson, who wrote in 1654, supposed these vessels arose from cavities, and that their use was to absorb. And Frederick Hoffman has very explicitly laid down the doctrine of the lymphatic vessels being a system of absorbents. But anatomists in general have been of a contrary opinion; for from experiments, particularly such as were made by injections, they have been persuaded that the lymphatic vessels did not arise from cavities, and did not absorb, but were merely continuations from small arteries. The doctrine therefore that the lymphatics, like the lacteals, were absorbents, as had been suggested by Glisson and by Hoffman, has been revived by Dr. Hunter and by Dr. Monro, who have controverted the experiments of their predecessors in anatomy, and have endeavoured to prove that the lymphatic vessels are not continued from arteries, but are absorbents.

To this doctrine, however, several objections were started, particularly by Haller; and it was found, before the doctrine of the lymphatics being a system of absorbents, could be established, it was first to be determined whether this system existed in other animals besides man and quadrupeds. Mr. Hewson claims the merit of having proved the affirmative of this question, by discovering the lymphatic system in birds, fish, and amphibious animals. The celebrated Soemmerring has observed, that these vessels are more than proportionably larger in tall men, and more than proportionably less in men of inferior stature.

The absorbent system consists of the lacteals, the lymphatic vessels, their common trunk, the thoracic duct, and the glands called conglobate.

The lacteals begin from the intestinal tube, and can, for the most part, be seen in a dog, or other large quadruped, that is killed two or three hours after eating, when they appear filled with a white chyle; but they do not always convey a fluid of this colour; for even in a dog, if opened long after a meal, they are found distended with a liquor that is transparent and colourless, like the lymph; and in birds the chyle is never found white, but always transparent. These vessels therefore might, with as much propriety, be called the lymphatics of the intestines.

The lymphatic vessels are small pellucid tubes, that have now been discovered in most parts of the human body. The fluid they contain is generally as colourless as water; a circumstance which procured them at first the name of ductus aquosi, and afterwards that of vasa lymphatica. The course of the lymph, like that of the chyle, is from the extreme parts of the body towards the centre; and many of the lymphatic vessels lie close to the large blood-vessels. If, therefore, a ligature be thrown round the large blood-vessels of the extremities of a living animal, or of one just dead, that ligature, by embracing the lymphatics, will stop the course of the lymph, which, by distending the vessels, will make them visible below the ligature.

All the lacteals, and most of the lymphatic vessels, open into the thoracic duct, which lies upon the spine, and runs up towards the neck of the animal, where it commonly opens into the angle between the internal jugular and subclavian veins of the left side: and thus both the chyle and the lymph are mixed with the blood. If therefore a ligature be thrown round the thoracic duct immediately after killing an animal, not only the lacteal, but also the lymphatic vessels in the abdomen and lower extremities, become distended with their natural fluids.

The lacteals, the lymphatics, and the thoracic duct, all agree in having their coats thinner and more pellucid than those of the blood-vessels. But although their coats are so thin, they are very strong; as we daily see on injecting them with mercury, since they resist a column of that fluid whose weight would make it burst through blood-vessels, the coats of which are many times thicker than those of the lymphatic system.

The thinness of the coats prevents our dividing them from one another, and thereby ascertaining their number as we do those of the blood-vessels. But as the blood-vessels have a dense internal coat, to prevent transudation, we have reason to believe the lymphatics have the same. And as the blood-vessels have a muscular coat, which assists in the circulation, so may the lymphatics. This is rendered probable from what Dr. Haller says of his having found them irritable in his experiments, and also from what is observed on seeing them in living animals distended with their lymph, in which case they appear of a considerable size; but upon emptying them of their contents, they contract so much as not to be easily distinguished. This experiment, Mr. Hewson informs us, he frequently made in the trunk of the lacteals in a goose, and on the lymphatic vessels on its neck; both of which, when distended with their natural fluids, are as large as a crow-quill; but upon emptying them in the living animal, he has seen them contract so much, that it was with the greatest difficulty he could distinguish them from the fibres.

The coats of lymphatic vessels have, in common with all other parts of the body, arteries and veins for their nourishment. This is rendered probable by their being susceptible of inflammation; for they are frequently found in the form of a cord, painful to the touch, and extending from an ulcer to the next lymphatic gland. These painful swellings of lymphatic vessels likewise show that their coats have sensibility, and therefore that they have nerves as well as arteries and veins. Besides, we can clearly trace in different parts of the body, blood-vessels running along their surfaces.

The lymphatic system in most animals, but particularly in man and quadrupeds, is full of valves. These valves have been painted by the celebrated Nuck, Ruysch, and others, and are much more frequent than in the common veins; and thence these lymphatics have sometimes been distinguished by the name of valvular lymphatic vessels. Those valves are generally two in number, are of a semilunar shape, and one is sometimes much larger than the other. In some parts of the body, these valves are so numerous, that there are three or four pair in an inch of space; but sometimes there is no more than one pair, sometimes several inches of a lymphatic appear without a valve. They are less numerous in the thoracic duct than in the branches of the system. Thence it might be supposed, that in proportion as we go from the trunk to the branches, we should find them thicker set. But this not always true; for Mr. Hewson observed them more numerous in the lymphatic vessels of the thigh than on those of the leg. When the vessels are distended with lymph, they appear larger on that side of the valves next the heart, which sometimes gives a lymphatic vessel an appearance of being made of a chain of vesicles; as such they are represented by some authors; but it is an appearance that very seldom occurs in the human body. In quadrupeds, however, this appearance is very remarkable. Wherever a lymphatic vessel enters the thoracic duct, we find either one or two valves which prevent the return of the lymph.

Lastly, the lymphatic system in different parts of its course has the glands, called conglobate or lymphatic. These glands are so placed, that the vessels come in on one side, and pass out on the other, in their way to the thoracic duct. They are commonly of an oval, though sometimes of a round shape, and frequently somewhat flattened, and of various sizes; some being no larger than a millet seed, while others are almost an inch in diameter. They vary in colour in different parts of the body, and at different times of life. In young people they are generally of a reddish or brown colour, but become paler with age. They have a shining external surface, which is owing to a smooth dense coat that covers them. Like other glands, they have arteries, veins, and nerves, which enter into their composition; but with respect to the rest of their structure, anatomists are much divided in opinion. Soemmerring has endeavoured to prove that they are partly cellular and partly vascular. That these glands are wanting in some animals is now known.

The absorbent system, besides the glands, is divided into three parts, viz. the lacteal, the lymphatic vessels and the lacteal sac, and the lymphatic duct. The lacteals belong to the intestinal tube; the lymphatics to all the other parts of the body, and the lacteal sac and thoracic duct is the common trunk which receives both the lacteals and lymphatics. We shall give a particular description of the latter from the celebrated Monro, as being that part of the absorbent system which is most important, both to the general reader and to the medical student.

"The receptaculum chyli, or saccus lacteus, is a membranous, somewhat pyriform bag, two-thirds of an inch long, one-third of an inch over in its largest part when collapsed; situated on the first vertebra of the loins of the right of the aorta, a little higher than the right emulgent artery, behind the right inferior muscle of the diaphragm; it is formed by the union of three tubes, one from under the aorta, the second from the interstice of the aorta and cava, the third from under the emulgents of the right side.

"The lacteal sac becoming gradually smaller toward its upper part, is contracted into a slender membranous pipe, of about a line diameter, which is generally named the thoracic duct. This passes betwixt the muscular appendices, or inferior muscles of the diaphragm, on the right of, and somewhat behind the aorta; then being lodged in the cellular substance, behind the pleura, it mounts between the aorta and the vena azygos, as far as the fifth vertebra of the thorax, where it is hid by the azygos, as this vein rises forward to join the descending or superior cava; after which the duct passes obliquely over to the left side behind the œsophagus, aorta descendens, and the great curvature of the aorta, until it reaches the left carotid artery; behind which, on the left side of the œsophagus, it runs to the interstice of the first and second vertebræ of the thorax, where it begins to separate from the carotid, stretching further toward the left internal jugular vein by a circular turn, whose convex part is uppermost. At the top of this arch it splits into two for a line and a half; the superior branch receiving into it a large lymphatic vessel from the cervical glands. This lymphatic appears by blowing air and injecting liquors into it, to have few valves. When the two branches are again united, the duct continues its course toward the internal jugular vein, behind which it descends, and immediately at the left side of the insertion of this vein, enters the superior posterior part of the left subclavian vein, whose internal membrane duplicated forms a semilunar valve, that is convex externally, and covers two-thirds of the orifice of the duct; immediately below this orifice, a cervical vein from the musculi scaleni enters the subclavian.

"The coats of the sac and duct are thin transparent membranes, from the inside of which, in the duct, small semilunar valves are produced most commonly in pairs, which are so situated, as to allow the passage of liquor upward, but oppose its return in an opposite course. The number of these is generally ten or twelve.

"This is the most simple and common course, situation, and structure, of the receptaculum chyli, and thoracic duct."

Of the heart, lungs, and arterial system.

Previous to describing the arterial system of the human body, it will be necessary to give a general account of the thorax and its contents.

By the thorax we commonly understand all that part of the body which answers to the extent of the sternum, ribs, and vertebræ of the back, both outwardly and inwardly.

The thorax is divided into the anterior part, called commonly the breast; the posterior part called the back, and the lateral parts called the right and left sides.

The internal parts of the thorax are contained in the cavity of the portion of the trunk, which is named the cavity of the breast. This cavity is lined by a membrane called pleura, which forms the mediastinum, and contains the heart, and lungs, with the vessels, &c. which go into or out from them; through it likewise the œsophagus passes to the stomach, and part of the nerves are contained in it which go to the contents of the abdomen.

Cavity of the thorax. The hard parts which form the sides of this cavity, are the twelve vertebræ of the back, all the ribs, and the sternum. The soft parts, which complete the sides, are, the membrane called pleura, which lines the cavity, and the musculi intercostales, sterno-costales, and diaphragma, already described.

All these hard and soft parts taken together represent a kind of cage, in some measure of a conical figure, flatted on the foreside, depressed on the back side, and in a manner divided into two nooks, by the figure of the vertebræ of the back, and terminated below a broad arched basis, inclined backward. The intercostal muscles fill up the intestines betwixt the ribs, and so complete the sides of the cavity. The basis is the diaphragm; and the pleura not only covers the whole inner surface of the cavity, but by forming the mediastinum, divides it into two, one on the right, the other on the left.

Pleura and mediastinum.

The pleura is a membrane which adheres very closely to the inner surface of the ribs, sternum, and musculi intercostales, sub-costales, and sterno-costales, and to the convex side of the diaphragm. It is of a very firm texture, and is supplied with blood-vessels and nerves, in all which it resembles the peritonæum; and likewise in that it is made up of an inner true membranous lamina, and a cellular substance on the outside.

Each side of the thorax has its particular pleura entirely distinct from the other: and making, as it were, two great bladders, situated laterally with respect to each other in the great cavity of the breast; in such a manner as to form a double septum, or partition, running between the vertebræ and the sternum, their other sides adhering to the ribs and diaphragm.

This particular duplicature of the two pleuræ is termed mediastinum: the two laminæ of which it is made up are closely united together near the sternum and vertebræ; but in the middle, and toward the lower part of the fore side, they are separated by the pericardium and heart, as we shall see hereafter. A little more backward they are parted in a tubular form by the œsophagus, to which they serve as a covering; and in the most posterior part a triangular space is left between the vertebræ and the two pleuræ from above downward, which is filled chiefly by the aorta.

Before the heart, from the pericardium to the sternum, the two laminæ adhere very closely, and there the mediastinum is transparent, except for a small space near the upper part, where the thymus gland is situated, so that in this place there is naturally no interstice, or particular cavity. The apparent separation is owing entirely to the common method of raising the sternum, as was plainly demonstrated by Bartholinus in his treatise of the diaphragm, published at Paris in 1676.

The mediastinum does not commonly terminate along the middle of the inside of the sternum, as the common opinion has been. Muslow demonstrated, in the year 1715, to the Royal Academy of Sciences, that from

above downward, it inclines towards the left side; and that if before the thorax is opened, a sharp instrument be run through the middle of the sternum, there will be almost the breadth of a finger between the instrument and the mediastinum, provided that the sternum remain in its natural situation, and the cartilages of the ribs be cut at the distance of an inch from it on each side.

From all this, we see not only that the thorax is divided into two cavities, entirely separated from each other by a middle septum, without any communication, but also that by the obliquity of this partition, the right cavity is greater than the left; but there are exceptions to the above descriptions. Lieutaud says he has met with several subjects in which the mediastinum descended along the middle of the sternum; and others, where it was inclined to the left side. Sabatier observes this is rare; but he has likewise met with several examples, where an instrument thrust through the middle of the sternum, got into the left cavity of the thorax. And he has sometimes seen the right lamina of the mediastinum fixed to the middle of the sternum, while the left one was fixed opposite to the articulation, with the cartilages of the ribs; a space being left between the two, which was filled with cellular substance intermixed with fat.

The pleura is connected to the membranous portion of the sternum, ribs, and muscles; to the diaphragm, pericardium, thymus gland, and vessels: and, in a word, to whatever lies near its convex side.

The surface of the pleura turned to the cavity of the breast, is continually moistened by a lymphatic serosity, which transudes through the pores of the membranous portion. This fluid is said to be secreted by imperceptible glands; but the existence of these glands has not been hitherto demonstrated.

Use. The pleura serves in general for an inner integument to the cavity of the thorax. The mediastinum cuts off all communication between the two cavities, and hinders one lung from pressing on the other when we lie on one side. It likewise forms receptacles for the heart, pericardium, œsophagus, &c. and it is continued over the lungs in the manner which shall be explained hereafter.

Before we leave the pleura it must be observed, that it adheres firmly to the ribs. This adhesion keeps the pleura stretched, and hinders it from slipping, or giving way. It likewise renders this membrane extremely sensible of the least separation, caused by a coagulable lymph or accumulated blood; the nervous filaments being likewise in this case very much compressed in inspiration by the swelling of the intercostal muscles.

Pericardium.

The heart, with all the parts belonging to it, is contained in a membranous capsula, called pericardium, which is, in some measure, of a conical figure, and somewhat bigger than the heart; but the difference must be less during life, when the heart is full of blood. It is not fixed to the basis of the heart, but round the large veins above the auricles, before they send off the ramifications, and round the large arteries before their division.

The pericardium is made up of three laminæ; the middle and chief of which is composed of very fine tendinous filaments, which are best seen in old persons; they are closely interwoven, and cross each other in different directions. The internal lamina seems to be a continuation of the outer coat of the heart, auricles, and great vessels. The trunks of the aorta and pulmonary artery have one common coat, which contains them both, as in a sheath, and is lined on the inside by a cellular substance, chiefly in that space which lies between where the trunks are turned to each other and the sides of the sheath. There is but a very small portion of the vena cava contained in the pericardium.

It is the middle lamina which chiefly forms the pericardium; and the figure of this bag is not simply conical, its apex or point being very round, and the basis having a particular elongation, which surrounds the great vessels, as has been already said, as amply as the other portion surrounds the heart.

The pericardium is closely connected to the diaphragm, not at the apex, but exactly at that place which answers to the flat or lower side of the heart; and it is a very difficult matter to separate it from the diaphragm in dissection, the tendinous fibres of the one substance intermixing with those of the other. This adhering portion is in some measure of a triangular shape, answering to that of the lower side of the heart; and the rest of the bag lies upon the diaphragm, without any adhesion.

The external lamina, or common covering, as it may be called more properly, is formed by the duplicature of the mediastinum. It adheres to the proper bag of the pericardium by the intervention of the cellular substance in that duplicature, but leaves it where the pericardium adheres to the diaphragm; on the upper surface of which it is spread, as being a continuation of the pleura.

The internal lamina is perforated by an infinite number of very small holes through which a serous fluid continually transudes, in the same manner as in the peritonæum, there being no glands for this purpose as some have supposed. This fluid being generally collected after death, makes what is called aqua pericardii, which is found in considerable quantities in opening dead bodies while they remain fresh. Sometimes it is of a reddish colour, which may be owing to a transudation of blood through the fine membrane of the auricles.

Of the Heart.

Situation in general, and conformation. The heart is a muscular body situated in the cavity of the thorax on the anterior part of the diaphragm between the two laminæ of the mediastinum. It is in some measure of a conical figure flatted on the sides, round at the top, and oval at the basis. Accordingly we consider in the heart, the basis; the apex; two edges, the one right and the other left; and two sides, one of which is generally flat and inferior, the other more convex and superior.

Besides the muscular body, which forms what we chiefly call the heart, its basis is accompanied by two appendices called auriculæ, and by large blood-vessels; of which hereafter; and all these are included in the pericardium.

The heart is hollow within, and divided by a septum which runs besween the edges into two cavities called ventriculæ, one of which is thick and solid, the other thin and soft. This latter is generally termed the right ventricle, the other the left ventricle; though in their natural situation, the right ventricle is placed more anteriorly than the left, as we shall see hereafter.

Each ventricle opens to the basis by two orifices; one of which answers to the auricles, the other to the mouth of a large artery; and accordingly, one of them may be termed the auricular orifice, the other the arterial orifice. The right ventricle opens into the right auricle, and into the trunk of the pulmonary artery; the left into the left auricle, and into the great trunk of the aorta. At the edges of these orifices are found several moveable pelliculæ, called valves, of which some are turned inward toward the cavity of the ventricles called the tricuspid; others are turned toward the great vessels, called semilunar, or sigmoid. The tricuspid valves of the left ventricle are likewise termed mitral.

Ventricles. The inner surface of the ventricles is very uneven, many eminences and cavities being observable therein. The most considerable eminences are thick fleshy productions, called columnæ carniæ, fleshy columns. To the extremities of these pillars are fastened several chordæ tendinæ, tendinous cords, the other ends of which are joined to the valvulæ tricuspides. There are likewise other small short tendinous ropes along both edges of the septum, between the ventricles. These small cords lie in an obliquely transverse situation, and form a kind of net-work at different distances.

The cavities of the inner surface of the ventricles are small deep fossulæ or lacunæ placed very near each other, with small prominent interstices between them. The greatest part of these lacunæ are orifices of the venal duct, to be described hereafter.

Structure of the ventricles. The fleshy or muscular fibres of which the heart is made up, are disposed in a very singular manner, especially those of the right or anterior ventricle, being either bent into arches or folded into angles.

The fibres which are folded into angles are longer than those which are only bent into arches. The middle of these arches and the angles of the folds are turned toward the apex of the heart, and the extremities of the fibres towards the basis. These fibres differ not only in length; but in their directions, which are very oblique in all, but much more so in the long or folded fibres than in the short ones which are simply bent.

It is commonly said, that this obliquity represents the figure 8; but the comparison is very false, and can only agree to some bad drawings made by persons ignorant of the laws of perspective.

All these fibres, regard being had to their different obliquity and length, are disposed in such a manner as that the longest form partly the most external strata of the convex side of the heart, and partly the most internal on the concave side, the middle of the arches and the angles meeting obliquely and successively to form the apex.

The fibres situated within these long ones, grow gradually shorter and straighter all the way to the basis of the heart, where they are very short and very little incurvated. By this disposition, the sides of the ventricles are

very thin near the apex of the heart, and very thick towards the basis.

Each ventricle is composed of its proper distinct fibres; but the left ventricle has many more than the right, its substance being considerably thicker. Where the two ventricles are joined, they form an impervious septum which belongs equally to both. Opposite to this septum a groove is seen on the outside of the heart, one running longitudinally on the upper, the other on the under surface: in these grooves the great branches of the coronary arteries and veins are lodged.

There is this likewise peculiar to the left ventricle, that the fibres which form the innermost septum of its concave side, form the outermost stratum of the whole convex side of the heart, which consequently is common to both ventricles: so that by carefully unravelling all the fibres of the heart, we find it to be made up of two bags contained in a third.

The anterior or right ventricle is somewhat larger than the posterior or left, as well observed by the ancients, and clearly demonstrated by Mr. Helvetius.

The left is a little longer than the right, and in some subjects they end exteriorly in a kind of double apex. But it appears from experiments, that the inequality between the parts of the right and those of the left side of the heart, is not so great during life as after death; for in the hearts of animals killed by cutting across the vessels of the neck, and in those of persons who have died in battle from a wound in the vena cava, or pulmonary artery, the inequality is less than we commonly perceive. This was first observed by M. Vienssens, professor of anatomy at Altorf.

Sabatier has made several experiments on animals, the result of which is nearly the same with that mentioned above.

All the fibres are not directed the same way, though they are all more or less oblique: for some end toward the right hand, others toward the left, some forward, some backward, and others in the intermediate places; so that in unravelling them, we find that they cross each other gradually, sometimes according to the length of the heart, and sometimes according to its breadth.

The tubes which cross each other transversely, are much more numerous than those which cross longitudinally: which ought to be taken notice of, that we may rectify the false notions that have been entertained concerning the motion of the heart; namely, that it is performed by a contortion or twisting like that of a screw, or that the heart is shortened in the time of contraction, and lengthened in dilation.

The fibres which compose the inner or concave surface of the ventricles do not all reach to the basis; some of them running into the cavity and there forming the fleshy columns to which the loose floating portion of the tricuspidal valves is fastened by tendinous cords.

Besides these fleshy pillars the internal fibres form a great many eminences and depressions, which not only render the inner surface of the ventricles uneven, but give it a great extent within a small compass. Some of these depressions are the orifices of the venal ducts, found in the substance of the ventricles, which have been already mentioned. The circumference of the great openings of the basis of the heart are tendinous, and may be looked upon as the common tendon of all the fleshy fibres, of which the ventricles are composed.

Valves. The valves at the orifices of the ventricles are of two kinds; one kind allows the blood to enter the heart, and hinders it from going out the same way; the other kind allows the blood to go out of the heart, but hinders it from returning. The valves of the first kind terminate the auricles; and those of the second lie in the openings of the great arteries. The first are termed semilunar or sigmoid valves; the others tricuspidal or mitral.

The tricuspidal valve of the right ventricle is of a circular form, and is fixed to the opening of the auricle, while the other end is attached to the internal surface of the ventricle. The circular membrane of the valve soon divides into many parts, three of which are more considerable than the rest; and these have got the name of tricuspid valves, though they are now generally considered as forming one. That which is next the mouth of the pulmonary artery is the largest, and is said by some to prevent the blood from getting into the artery, while the ventricle is filling. It has three triangular productions, very smooth and polished, on that side which is turned towards the auricle; and on the side next the cavity of the ventricle, they have several membranous and tendinous expansions, and their edges are notched or indented. The valve of the auricular orifice of the left ventricle is of the same shape and structure, but it is only divided into two parts; and, from some small resemblance to a mitre, has been named mitralis. That which is next the mouth of the aorta is the largest.

The semilunar valves are six in number, three belonging to each ventricle, situated at the mouths of the great arteries, and they may be properly enough named valvulæ arteriales. Their concave sides are turned toward the cavity of the arteries, and their convex sides approach each other. In examining them with a microscope, we find fleshy fibres lying in the duplicature of the membranes of which they are composed.

They are truly semilunar, or in form of a crescent on that side by which they adhere; but their loose edges are of a different figure, each of them representing two small crescents; the two extremities of which meet at the middle of this edge, and there form a kind of small papilla, first described by Arantius, and afterwards by Morgani, and therefore named from them.

The great artery that goes out from the left ventricle is termed aorta. At the beginning of the aorta, and behind the semilunar valves, three elevations are observed on the outside: these correspond to an equal number of pits on the inside, which from the discoverer have been called sinuses of Valsolva. Their use is not well known.

The trunk of the artery which goes out from the right ventricle is called arteria pulmonaris. This trunk, as it is naturally situated in the thorax, runs first of all directly upward for a small space, then divides laterally into two principal branches, one for each lung; that which goes to the right lung being the longest, for a reason that shall be given hereafter.

Auricles. The auricles are muscular bags situated at the basis of the heart, and their capacities are in proportion to those of their respective ventricles; one toward the right ventricle, the other toward the left, and joined together by an inner septum, and external communicating fibres, much in the same manner with the ventricles; one of them being named the right auricle, the other the left. They are very uneven on the inside, but smoother on the outside, and terminate in a narrow, flat, indented edge, representing a cock's comb, or in some measure the ear of a dog; this properly gets the name of auricle, the larger and smooth part of the cavity being called sinus venosus; but as the two parts make one general cavity, the name of auricle is commonly applied to the whole. They open into the orifices of each ventricle, which I name auricular orifices; and they are tendinous at their openings, in the same manner as the ventricles.

The right auricle is larger than the left, and joins the right ventricle by a common tendinous opening, as has been already observed. It has two other openings united into one, and formed by two large veins which meet and terminate there almost in a direct line, called vena cava, superior and inferior. Highmore has described an eminence in form of a valve, placed between the mouths of the two venæ cavæ: this he supposed directs the blood from the veins into the auricle; afterwards Lower described and delineated it; and other anatomists have called it tuberculum Loweri, till Morgagni denied its existence in the human subject. At the mouth of the inferior cava, we find a membrane in form of a crescent, described by Eustachius, and named from him. Its convex edge is fixed to the union of the vein and right auricle, while its concave edge is turned upward over the mouth of the vein. It is most complete in the fœtus; but it is found likewise in a person of advanced age, though it sometimes from use has a reticular appearance. It is said to prevent the blood in the auricle from returning into the cava; but it has a different use in the fœtus. The notched edge of this auricle terminates obliquely in a kind of obtuse point, which is a small particular production of the great bag, and is turned toward the middle of the basis of the heart.

The whole inner surface of the right auricle is uneven, by reason of a great number of prominent lines which run across the sides of it, and communicate with each other by smaller lines which lie obliquely in the intestines between the former. The lines of the first kind represent trunks, and the other small branches run in an opposite direction to each other: these are called musculi pectinati. In the interstices between these lines the sides of the auricle are very thin and almost transparent, seeming to be formed merely by the external and internal coats of the auricle joined together, especially near the point.

The left auricle is in the human body a kind of muscular bag or reservoir of a pretty considerable thickness, and unequally square, into which the four veins open called venæ pulmonares, and which has a distinct appendix belonging to it like a third small auricle. This bag is very even on both surfaces, and is therefore called sinus venosus; but to distinguish it from the one on the

right side, it is called sinus venosus sinister. However, the bag and appendix have but one common cavity, and therefore may still be both comprehended under the common name of left auricle. In men the small portion may likewise be named the appendix of the left auricle; but in other animals the case is different.

This small portion or appendix of the left auricle is of a different structure from that of the bag or large portion. Exteriorly it resembles a small oblong bag bent different ways, and indented quite round the edges. Interiorly it is like the inside of the right auricle. The whole common cavity of the left auricle is smaller in an adult subject than that of the right; and the fleshy fibres of the left auricle cross each other obliquely in strata differently disposed.

Coronary arteries and veins.—Besides the great common vessels, the heart has vessels peculiar to itself called the coronary arteries and veins, because they in some measure crown the basis of the heart. The coronary arteries, which are two in number, go out from the beginning of the aorta, and afterward spread themselves round the basis of the heart, to the substance of which they send numerous ramifications.

Vieussens believed that some of the branches of the coronary artery opened into the cavities of the ventricles and auricles; for by throwing a fine injection into these arteries, he found it run out into all sides of the right ventricle and auricle. Thebesius of Allemand being nearly of the same opinion, endavoured to prove that there were veins which carried part of the blood from the coronary arteries immediately into the cavities of the heart; and these have therefore got the name of veins of Thebesius, though he is not the first discoverer. Winslow, Haller, and several others describe such veins; but Duverney, after injecting the heart of an elephant, doubts of their existence. Senac, who has paid much attention to this subject, denies it altogether; and Sabatier coincides with him in opinion.

There are seldom more than two arteries, of which one lies toward the right hand, the other toward the left of the anterior third part of the circumference of the aorta. The right coronary artery runs in between the basis and right auricle, all the way to the flat side of the heart, and so goes half-way round. The left artery has a like course between the basis and left auricle, and before it turns on the basis, it sends off a capital branch which runs in between the two ventricles. Another principal branch goes off from the union of the two arteries on the flat side of the heart, which running to the apex, there joins the other branch.

The coronary veins are distributed exteriorly much in the same manner. The largest opens into the posterior inferior part of the right auricle, by an orifice which is furnished with a valve first described by Eustachius. Besides the coronary veins, the heart has other anterior veins, which have been called by Vieussens venæ innominatæ. Some of them go into the right auricle, others end in the right ventricle; and there are other veins still smaller, which are found in the substance of the heart, and which terminate in the right sinuses and auricle.

Particular situation of the heart.—The heart lies almost transversely on the diaphragm, the greatest part of it being in the left cavity of the thorax, and the apex being turned toward the bony extremity of the sixth true rib. The basis is toward the right cavity; and both auricles, especially the right, rest on the diaphragm; but the situation of the heart during life changes a little, according to the state of respiration, and to the position of the body.

The origin or basis of the pulmonary artery is, in this natural situation, the highest part of the heart on the fore side; and the trunk of this artery lies in a perpendicular plane, which may be perceived to pass between the sternum and spina dorsi. Therefore some part of the basis of the heart is in the right cavity of the thorax; and the rest, all the way to the apex, is in the left cavity; and it is for this reason that the mediastinum is turned toward that side.

According to this true and natural situation of the heart, the parts are commonly said to be on the right side, or rather anterior, and those on the left side posterior; and that side of the heart which is thought to be the fore side, is naturally the upper side, and the back side consequently the lower side.

The lower side is very flat, lying wholly on the diaphragm; but the upper side is a little convex through its whole length, in the direction of the septum, between the ventricles.

Uses in general.—The heart, and parts belonging to it, are the principal instruments of the circulation of the blood. The two ventricles ought to be considered as two syringes, so closely joined together as to make but one body; and furnished with suckers, placed in contrary directions to each other, so that by drawing one of them a fluid is let in, and forced out again by the other.

Lungs.

Situation and general figure.—The lungs are two large spongy bodies, of a reddish colour in children, greyish in adult subjects, and bluish in old age; filling the whole cavity of the thorax, one being seated in the right side, the other in the left, parted by the mediastinum and heart; and of a figure answering to that of the cavity which contains them; that is, convex next the ribs, concave next the diaphragm, and irregularly flatted and depressed next the mediastinum and heart.

Division and figure in particular.—They are distinguished into the right and left lung; and each of these into two or three portions, called lobes, of which the right lung has commonly three, or two and a half, and the left lung two. The right lung is generally larger than the left, answerably to the cavity of the breast, and to the obliquity of the mediastinum.

In the lower edge of the left lung there is an indented notch or sinus, opposite to the apex of the heart, which is therefore never covered by that lung, even in the strongest respiration; and consequently the apex of the heart and pericardium may always strike against the ribs, the lungs not surrounding the heart in the manner commonly taught.

Structure.—The substance of the lungs is almost all spongy, being made of an infinite number of membranous cells, and of different sorts of vessels spread among the cells in innumerable ramifications.

Coats.—This whole mass is covered by a membrane continued from each pleura, which is commonly said to be double; but what is looked upon as the inner membrane, is only an expansion and continuation of a cellular substance, which shall be spoken of after we have described the vessels of the viscus.

Bronchia.—The vessels which compose part of the substance of the lungs are of three or four kinds; the principal of these are air-vessels and blood-vessels. The air-vessels make the chief part, and are termed bronchia.

These bronchia are conical tubes, composed of an infinite number of cartilaginous fragments, like so many irregular arches of circles, connected together by a ligamentary elastic membrane; and disposed in such a manner, that the lower easily insinuates themselves within those above them.

They are lined on the inside by a very fine membrane, which continually discharges a mucilaginous fluid; and in the substance of the membrane are a great number of small blood-vessels, and on its convex side many longitudinal lines, which appear to be partly fleshy, and partly made up of an elastic substance of another kind.

The bronchia are divided, in all directions, into an infinite number of ramifications, which diminish gradually in size; and as they become capillary, change their cartilaginous structure into that of a membrane. Besides these very small extremities of this numerous series of ramifications, we find that all the subordinate trunks, from the greatest to the smallest, send out from all sides a vast number of short capillary tubes of the same kind.

Vesiculæ bronchiales.—Each of these bronchial tubes is widened at the extremity, and thereby formed into a membranous cell, commonly called a vesicle. These cells or folliculi are closely connected together in bundles; each small branch producing a bundle proportionable to its extent, and the number of its ramifications.

Lobuli.—These small vesicular or cellulous bundles are termed lobules; and as the great branches are divided into small rami, so the great lobules are divided into several small ones. The cells or vesicles of each lobule have a free communication with each other, but the several lobules do not communicate so readily.

Interlobular substance.—The lobules appear to be distinctly parted by another cellular substance, which surrounds each of them in proportion to their extent, and fills up the interstices between them. This substance forms likewise a kind of irregular membranous cells, which are thinner, looser, and broader, than the bronchial vesicles.

This substance is dispersed through every part of the lungs, forms cellulous or spongy vaginæ, which surround the ramifications of the bronchia and blood-vessels, and is afterwards spread over the outer surface of each lung, where it forms a kind of fine cellular coat, joined to the general covering of that viscus.

When we blow into this interlobular substance, the air compresses and flattens the lobuli; and when we blow into the bronchial vesicles they presently swell; and if we continue to blow with force, the air passes insen-

sibly into the interlobular substance. We owe this observation to M. Helvetius.

Vascular texture.—All the bronchial cells are surrounded by a very fine reticular texture of the small extremities of arteries and veins, which communicate every way with each other. The greatest part of this admirable structure is the discovery of the illustrious Malphigi.

Blood-vessels.—The blood-vessels of the lungs are of two kinds; one common, called the pulmonary artery and veins; the other proper, called the bronchial arteries and veins.

The pulmonary artery goes out from the right ventricle of the heart; and its trunk, having run directly upward as high as the curvature of the aorta, is divided into two lateral branches, one going to the right hand, called the right pulmonary artery; the other to the left, termed the left pulmonary artery. The right artery passes under the curvature of the aorta, and is consequently longer than the left. They both run to the lungs, and are dispersed through their whole substance by ramifications nearly like those of the bronchia, and lying in the same direction.

The pulmonary veins having been distributed through the lungs, in the same manner go out on each side by two great branches, which open laterally into the reservoir or muscular bag of the right auricle.

The ramifications of these two kinds of vessels in the lungs, are surrounded every where by the cellular substance already mentioned, which likewise gives them a kind of vagina; and the rete mirabile of Malphigi, described above, is formed by the capillary extremities of these vessels. It must be observed, that the ramifications of the arteries are more numerous and larger than those of the veins, which in all other parts of the body exceed the arteries both in number and size.

Bronchial arteries and veins.—Besides these capital blood-vessels, there are others called the bronchial arteries and veins, which are very small, but they follow the bronchia through all their ramifications. They communicate with the pulmonary arteries and veins in many places, likewise with the arteries and veins of the œsophagus, and with branches of the coronary artery and vein. These are nutrient vessels of the lungs.

Ligaments.—Under the root of each lung, that is, under that part formed by the subordinate trunk of the pulmonary artery, by the trunks of the pulmonary veins, and by the trunk of the bronchia, there is a pretty broad ligament, which ties the posterior edge of each lung to the lateral parts of the vertebræ of the back from the root all the way to the diaphragm.

Trachea arteria.—The bronchia, already described, are branches or ramifications of a large canal, partly cartilaginous, and partly membranous, called trachea, or aspera arteria. It is situated anteriorly in the lower part of the neck, whence it runs down into the thorax between the two pleuræ through the upper space left between the duplicature of the mediastinum, behind the thymus.

Having reached as low as the curvature of the aorta, it divides into lateral parts, one toward the right hand, the other toward the left, which enter the lungs, and are distributed through them in the manner already said. These two branches are called bronchia; and that on the right side is shorter than that of the left, whereas the right pulmonary artery is the longest.

The trachea is made up of segments of circles of cartilaginous hoops, disposed in such a manner as to form a canal, open on the back part of the cartilages, not going quite round; but this opening is filled by a soft glandular membrane, which completes the circumference of the canal; but this cannot be to give way to the œsophagus: for, instead of descending immediately upon the middle of that canal, the trachea inclines a little to the right side; and the same structure is formed in the back part of the bronchial vessels, which are at some distance from the œsophagus.

Each circle is about the twelfth part of an inch in breadth, and about a quarter of that space in thickness. Their extremities are round; and they are situated horizontally above each other, small interstices being left between them, and the lower edge of the superior segments being turned toward the upper edge of those next below them.

They are all connected by a very strong elastic membranous ligament fixed to their edges.

The trachea is covered externally with a quantity of cellular substance, which unites it to the neighbouring parts, and it is lined on the inside by a particular membrane; which appears to be partly fleshy or muscular, and partly ligamentary, perforated by an infinite number of small holes, more or less imperceptible, through which a mucilaginous fluid continually passes, to defend the inner surface of the trachea against the acrimony of the air which we breathe.

This fluid comes from small glandular bodies dispersed through the substance of the membrane, but especially from glands something larger than the former, which lie on the outer or posterior surface of that strong membrane by which the circumference of the canal is completed. The same structure is observable in the ramifications of the trachea, from the greatest to the smallest.

All the vessels of which the lungs are chiefly composed, that is, the air-vessels or bronchia, and the blood-vessels or the pulmonary and bronchial arteries and veins, accompany each other through this viscus.

They are disposed commonly in such a manner, even to the last ramifications, as that a subordinate trunk or branch of the bronchia lies between the like trunks or branches of the pulmonary artery and vein; the bronchial vessels being immediately joined to the bronchia. In some places these three kinds of vessels touch each other in such a manner as to have a triangular space in the middle.

The bronchia are divided into a very great number of ramifications; and the last rami are the pedicles or footstalks of the small lobuli. All the lobuli are angular, oblong, broad, thin, &c. The footstalks send out other smaller membranous pedicles, which are very short, and terminate in the bronchial vesicles or cells, of which they are continuations. The subordinate trunks and rami detach a great number of these pedicles from their convex surface.

When we blow into the lungs, the bronchial cells nearest their outer surface appear like small portions of round vesicles; and from this appearance all the bronchial cells have got the name of vesicles, though they are all angular, except those which we have now mentioned.

When we examine a lung without blowing it up, we find that the cartilaginous segments of the bronchia lie so near as to be engaged in each other; and in drawing out any portion of the bronchia by two ends, these segments are parted, and the whole canal is increased in length; but it contracts again, by means of its elastic membrane, as soon as that force is taken off.

When we open lengthwise any portion of the pulmonary artery and vein in the same lung, we meet with a great number of transverse rugæ, which are destroyed when these vessels are elongated. This is an observation made by M. Helvetius.

By virtue of this structure all the ramifications, both of the bronchia and pulmonary arteries and veins, have constantly the same direction whether the lung be inflated or collapsed: and they contract in length without being contorted or folded. In expiration these vessels are elongated, and shortened in inspiration.

These three vessels lie in a sort of cellular vagina, which accompanies all their ramifications, and is a continuation of their interlobular cells. The pelliculæ which compose it are, however, there disposed in a more regular manner, and more longitudinally than in other places, and thereby appear to form a true vagina.

When we blow through a pipe, introduced so far as to touch immediately a trunk of the blood-vessels or bronchia, the air runs through all the cells that lie nearest that trunk or its branches; but if we continue to blow, it insinuates itself through the whole interlobular substance.

Bronchial glands. At the angle of the first ramification of the trachea arteria, we find on both the fore and the back sides certain soft, roundish, glandular bodies, of a bluish or blackish colour, but reddish in a child; in size they vary from that of a field bean to that of a millet-seed. Through these the lymphatic vessels of the lungs pass in their way to the thoracic duct.

The trachea has several coats, as has been already observed. The outermost or common covering surrounds that part of the trachea which lies in the thorax; but out of the thorax this first coat is derived from the aponeurotic expansions of the muscles of the neck; and it is between this and the following covering that the glands, already mentioned, are situated.

The second is a proper coat, being a continuation of the cellular covering of the lungs; the pelliculæ of which, near the cartilaginous segments, serve them for an external pericardium. The third membrane lies on the inside, adhering closely to the same cartilages, and supplying to these the place of an internal pericardium.

The fourth membrane is that which completes the circumference of the cartilaginous circles of the trachea. It consists chiefly of two laminæ or strata, partly muscular and partly tendinous: the external or posterior lamina being made up of longitudinal fibres; and the internal or anterior of transverse fibres. The membrane is perforated by the small

ducts of the above-mentioned glands, which discharges a fluid when pressed; and being examined through a microscope, they appear vascular or folliculous, much like that of the stomach.

The ligaments between the cartilaginous circles are very strong and elastic, and each of them is confined to two cartilages, without communicating with any of the rest; being fixed to the edges of these cartilages much in the same manner as the intercostal muscles are inserted in the ribs.

As the bronchia penetrate into the substance of the lungs, they gradually lose their cartilages, till at last they become purely membranous; but the muscular lines of M. Morgagni appear as much, and sometimes more than before. The two planes above-mentioned continue likewise to be visible; and we observe very distinctly sometimes, even without a microscope, a great many small holes in the pellicles of the lobuli, and bronchial vesicles or cells, which open from within outward.

Of the arteries in general.

The arteries are long elastic and pulsating tubes, the diameters of which decrease according to the number of branches which they give off.

The coats of the arteries are three in number: an external or cellular coat, a middle or muscular coat, and an internal or smooth membranous coat.

The use of the arteries is to convey blood from the heart through the lungs, throughout the system in general, or the heart itself.

The origin of the two great trunks from which they all arise has already been explained, and of these two all the rest are branches.

OF PARTICULAR ARTERIES.

The aorta.

The large arteries, termed aorta, open with a wide orifice from the superior and posterior side of the left ventricle of the heart. Its roots seem incorporated with the very substance of the heart; as it is not only intimately united with its internal surface, but some muscular striæ of the ventricle are also mixed with the white line, which is called tendo-arteriosus, and which indicates the commencement of the artery. Some transverse fibres of the heart are united to the external part of the aorta, and cover it for a line and a half. Having left the heart, the aorta is immediately expanded; nor does it again recover its diameter till it sends off the subclavian artery of the right side.

In its ascent, it is first inflected to the right, behind and beyond the pulmonary artery; it gradually inclines itself to the left, till, having formed a transverse arch, it is seen projecting behind the lungs at the left side of the vertebræ. Supported by these it descends in the same straight line with themselves: till having, at last, entered the abdomen, it again begins to turn toward the right, and rests upon the middle of the vertebræ.

By the arch of the aorta is meant its parabolic flexure, the right pillar of which first stretches to the right, and then to the left, while the left advances almost in a straight line.

In considering the whole extent of the arch, we observe that it springs from the ventricle at the inferior margin of the third rib, ascends by an oblique and winding course to the lower margin of the first; its exterior and right extremity corresponding to the middle of the cartilages of the ribs; and its left extremity, being concealed by tthe left lobe of the lungs, proceeding onward, and in like manner corresponding to the vertebral extremity of the ribs.

FIRST SUBDIVISION.

Branches from the arch of the aorta.

I. The two coronary arteries of the heart, viz. the right or inferior, and left or superior, which being sent off above the interior and posterior semilunar valves, form, in returning to the heart, an acute angle with the rising trunk. II. The innominata. III. The left common carotid. IV. The left subclavian.

The three last arise at distinct branches from the greatest convexity of the arch. The first of them passes obliquely upward, and to the right over the trachea; and having advanced about two inches, divides at its right extremity into the right common carotid, and the right subclavian. The other two branch out from the aorta near the former, and are also similar to them.

I. The right coronary is larger than the left. Covered with fat, it runs between the auricle and ventricle to the flat surface and apex of the heart, inosculating freely with the left coronary, both by its branches, and the extremity of its trunk.

II. The left coronary, after going out between the pulmonary artery and left auricle, divides into two branches.

III. The right subclavian. For the description of this and the left one, see below.

IV. The common carotid has on each side a similar distribution of its branches, though the right be a little larger than the left. It lies on the anterior surface of the vertebræ, and is united by a cellular membrane to the intercostal nerve, the par vagum beneath, and the internal jugular vein above. It thus ascends one continued trunk parallel to the trachea, as high as the superior margin of the thyroid cartilage. It there divides into branches of equal size; the anterior of which is called the external, and the posterior the internal or cerebral.

Distribution of the common carotid.

(I.) The external or superficial carotid.—This artery has scarcely arisen, when it advances forward, and divides into eight branches variously distributed.

1. The superior thyroid, issuing near the origin of the trunk, and descending windingly to the superior margin of the thyroid gland.

2. The lingual or sublingual artery, winding above the os hyoides, forward, upwards, and inwards, to the tongue. At its commencement, it either passes over, or is covered by, the hyo-glossus; then is concealed by the genioglossus.

3. The internal maxillary, labial, angular, or facial. Concealed at its origin by the stylohyoideus, and the tendon of the digastric. Ascends tortuously forward, through the depression of the sub-maxillary gland, and, winding over the maxilla, follows the anterior margin of the masseter; afterward branches out under the zygomatic muscles, in serpentine windings, upon the face and the sides of the mouth and of the nose.

4. The ascending pharyngeal of Haller arises from the back part of the trunk, near the lingual, or from the bifurcation of the carotid. The auricular excepted, it is the smallest of the branches. It ascends upon the long anterior rectus muscle to the foramen lacerum, through which it passes, to be lost in the dura mater.

5. Occipital artery passes transversely before the jugular vein, above the rectus lateralis, proceeding between the transverse process of the atlas and mastoid process to the back part of the neck, and ascends, in widely-spreading branches, to the occiput. In its course it is covered by the diagastric, the trachelomastoid, the splenius, and the complexus; and becomes subcutaneous as it approaches the occiput.

6. The posterior auricular or stylomastoid, rises from the trunk in the parotid gland, above the digastric muscle, and before the styloid process, then passes transversely to the ear. As it curves behind the ear, it also inclines to the posterior part of the squamous bone, inosculating with the temporal and occipital arteries.

7. The superficial temporal. This artery, concealed at first in the parotid gland, stretches above the zygomatic arch, between the jaw and meatus auditorius, and is at last extensively ramified over the side of the head.

8. Internal maxillary. This artery, larger than the temporal, rises about the middle of the ramus of the inferior maxillary bone, before the external pterygoid; and, bending inward, forward, and downward, is concealed by the maxilla. It then rises obliquely upward and forward to the spheno-maxillary fissure.

(II.) The internal carotid or cerebral artery.—This artery, in rising to its canal, is connected before to the par vagum and intercostal nerves; and behind to the rectus anticus muscle. Sometimes it forms above the vertebræ a larger or smaller projecting curvature. In this course no branches are, in general, given off. At last it enters the foramen carotideum; and passing along this canal, undergoes many remarkable inflections. On its first entering the foramen, it proceeds upward, inward, and a little forward. It then rises from the canal forward and upward at a very obtuse angle. Having at last reached the posterior part of the sella Turcica, it bends in the cavernous sinus, so as to run in an horizontal direction to the anterior clinoid process. It here rises perpendicularly, perforates the internal surface of the dura mater, and proceeds near the bottom of the brain backward to the cerebrum.

Its most remarkable branches are,

1. The ophthalmic artery, rising in the angle where the carotid artery leaves the sphenoid bones near its anterior clinoid processes, and running with the nerve which accompanies and rests upon it, through the optic hole, to the orbit. Lying by the external side of the optic nerve, it passes obliquely forward over it; and reaching the internal angle of

the eye above its adductor, divides it into two branches.

2. The communicating artery.—This, along with the deep branch of the vertebral artery of the cerebrum, forms the circle of Willis. It proceeds straight backward and inward, near the infundibulum, where it reaches the artery already mentioned, and there seems an obtuse-angled quadrangle.

3. The anterior carotid artery, or arterial callosa.—The internal carotid at that place where the anterior lobe of the brain is separated from the posterior, divides into two branches of nearly equal size; of which the anterior proceeds immediately inwards, and a little forwards; then bends above the corpus callosum, between the hemispheres, to the posterior lobes of the brain.

4. The posterior carotid, or the artery of the fossa sylviana, enters the fossa sylvii, and gives to each numerous superficial and deep-seated branches to both lobes of the brain.

Distribution of the subclavian artery and its branches.

The division of the right and left subclavian artery differs only in this respect, that the right subclavian is much larger, passes obliquely over the trachea, and sends off the common carotid. Having left this branch at the side of the trachea, it is now more properly the right subclavian; and, still continuing larger than the left, proceeds nearly in a transverse direction. The left subclavian, on the other hand, while it gradually ascends from the inclining part of the arch, passes on to its place of destination with a more rapid and extensive curvature.

These two arteries run in such a direction above the superior margin of the first rib, as to be concealed for some time by the clavicle. They then proceed with the brachial plexus, across that space lying between the first and second scalene muscles; and being covered by the flattened extremity of the clavicle and pectoral muscle, bend to the axillæ, where they take the name of axillary arteries. The branches of the subclavian arteries, and their ramuli, present so many varieties, that no description, either as to their number or their direction, can in every respect correspond with nature. In general, however, the four first branches arise before the artery sinks under the scalenus, while the rest are sent off beyond the margin of this muscle. These are,

1. The internal mammary—going off from the lower and anterior part of the trunk at the highest part of the pleura, where ascending gradually, and again bending downwards to the sternum, it reaches the margin of the first rib, under which it passes; and running between the pleura and middle part of the cartilages of the ribs, descends between the internal intercostal and their sterno-costal muscles, as far as the diaphragm. It then passes between the diaphragm and the ribs, and dividing into many twigs, it is lost under the rectus of the abdomen, from its origin to the third rib. It bends towards the sternum, then gradually inclines outward.

2. The inferior thyroid or anterior cervical artery, rising from the fore part of the trunk, near the mammary and vertebral arteries; and being covered by the sterno-mastoid, and bent a little upwards and outwards, immediately divides into four principal branches; the transverse scapular, the transverse cervical, the ascending thyroid, and the thyroid branch of the thyroid.

3. The superior intercostal artery rises more externally than the vertebral, from the upper and posterior surface of the trunk, then ascends with it to the hollow, then it is formed by the anterior scalenus, the surface of the first rib, and bodies of the vertebræ. It is there suddenly reflected, and proceeds to the roots of the first and second ribs within the thorax.

4. The vertebral artery, larger than the former, rises from the superior side of the subclavian; and ascending a little backwards, covered by the ganglions of the intercostal and cellular membranes, reaches the perforations of the transverse processes of the cervical vertebræ; thro' these it penetrates, and rising perpendicularly from the sixth or sometimes from the fifth or fourth opening, reaches the aperture of the atlas, where it bends a little outwards, and having passed through, undergoes another more extensive flexion backwards and inwards, by which it is carried transversely in a groove between the occipital bone and the atlas, to the foramen magnum. Through this opening having at last entered the cranium, it proceeds upwards and forwards, and at the basilar apophysis, under the medulla oblongata, meets at an acute angle with the vertebral artery of the opposite side, forming the basilar artery, to be distributed to the cerebrum and cerebellum.

The basilar artery, being formed as above, occupies the depression in the middle of the tuber annular, and at its anterior part divides into four parallel branches, proceeding from the trunk at right angles. Of these the posterior go to the cerebellum, and the two anterior, ramified on the cerebrum, unite with communicating arteries of the carotid, and form the great circle of Willis.

5. The deep or posterior cervical artery, irregular in its origin, size, and extent, and like the superficial cervical or transverse scapula of the thyroid, spreads sometimes more and sometimes less extensively with its branches. We have sometimes observed it the smallest of all, and proceeding from the superior intercostal, it generally issues from the subclavian, beyond the margin of the scalenus, though sometimes sooner under this muscle. It then winds upwards and backwards between the deep muscles of the back and the sixth vertebræ; and is at least so dispersed among the muscles as to bestow its ultimate branches on the complexus near the occiput.

6. The superficial cervical rises about half an inch or an inch from the first scalenus at the upper and anterior side of the subclavian, where it begins to bend downwards, and immediately hides itself among the brachial nerves; and spreading out afterwards toward the superior costa scapula, divides into many irregular branches.

Distribution of the axillary artery.

The subclavian artery, as it bends from its first situation between the breast and scapula, to the humerus, assumes the name of axillary. Passing out under the arch of the clavicle, it is surrounded by the nerves of the brachial plexus, the veins, glands, and a quantity of fat; lies in the hollow of the axilla, between the subscapular and serratus major; and protected externally by the pectoral muscles, it soon approaches forwards to the arm and interior margin of the biceps. At last, proceeding from the axilla to the inferior border of the tendon of the latissimus dorsi, it takes the name of the humeral artery. It sends off,

1. The thoracics.

2. The inferior scapular, or infrascapular, or subscapular, rising in the inferior margin of the subscapular muscle, divided into conspicuous branches, which run in various directions.

3. The posterior circumflex artery, issuing between the subscapular and teres major; it sinks between them, winds round the neck of the humerus, under the long extensor, and afterwards bends transversely under the deltoid, backwards and outwards from the inner side of the arm. It sometimes gives rise to the anterior circumflex, and the deep branch of the humerus or humeral profunda.

4. The anterior circumflex artery, of smaller size, sent out near the former, above the teres major, proceeds round the humerus, under the biceps and coraco-brachial to the outer part of the arm, where it either disappears under the deltoid, or enters this muscle.

Distribution of the brachial or humeral artery.

The axillary artery is first known by the name of the humeral or brachial, where it proceeds from the axilla to the internal side of the arm. Having left the cavity of the axilla, and passed to the internal surface of the tendon of the teres major, it continues its course above the internal brachial to the inner side of the biceps, and gradually runs along the middle of the arm to the anterior surface of its extremity; where at last, concealed under the aponeurosis of the biceps, it divides near the bend of the fore arm into the ulnar and radial arteries.

1. The deep branch of the humerus, the large collateral, or large humeral profunda, sometimes double, rising from the inner side of the trunk, at the inferior margin of the teres major; but sometimes sooner, from the inferior scapular, or posterior circumflex.

It proceeds backward with a gentle curve; and, accompanying the extensor, runs to the cavity between the anconei muscles, where, in the passage of the spiral nerve, it divides into two branches, at the upper junction of the external anconeus and internal brachial.

2. The large anastomotic, rising sometimes double from the internal side of the trunk, a few inches above the joint; but immediately dividing, it passes in a transverse course upon the surface of the internal brachial to the flexor condyles, where, perforating the intermuscular ligament, it runs upward to the cavity, between the condyle and olecranon, covered by the tendon of the biceps and the ulnar flexor of the carpus.

The ulnar artery.—The humeral artery

sometimes undergoes the division already mentioned at the middle of the humerus, or even higher. This, however, is the largest artery which arises from the trunk at the bend of the arm. Scarcely has it arisen, when it sinks deep into the cavity that is occupied by the tendon of the biceps, the nerve, blood-vessels, and fat. It then bends near the interstice of the bones, under the pronator teres, radial flexor, palmaris longus, and sublimis, to the lunar side of the fore arm, proceeding gradually with many deflections between the sublimis, the profundis, and ulnar flexor, to the wrist. Passing over the wrist, it forms the superficial arch of the hand, which gives beautiful arteries to the fingers, and finally inosculates at the palm with the radial. The chief branch is,

1. The common interosseal, rising at the higher extremity of the profundus, running on the interosseous ligament, between the flexor pollicis and profundus, toward the pronator quadratus.

The radial artery, the smallest of the two branches which proceed from the division of the humeral. It runs down in a straight line upon the surface of the pronator, and gradually inclines towards the radius, between the long supinator and radial flexus, resting on the flexor of the thumb. At the lower extremity of the radius, where it is easily felt between the styliform process and the trapezium, on the back of the hand, it bends under the abductor and extensor of the thumb, near the first radial extensor; then penetrating the abductor, or semi-interosseus of the fore-finger, between the metacarpal bone of the fore-finger and thumb, bends, while there concealed, to the palm between the fibres of the adductor pollicis, and forms, in the hollow of the hand, under the flexors, and above the interosseous muscles, the deep volar arch, in which it terminates.

SECOND SUBDIVISION.

Branches from the descending aorta.

It appears, from the general description of the aorta, that, after the formation of the arch, it bends gradually behind the lungs to the left side of the vertebral column; and lying close upon this column, penetrates, in a straight line, behind the pleura, through the cavity of the thorax, to the muscular crura of the diaphragm, directing its course in the abdomen to the inferior lumbar vertebræ.

Anatomists have therefore properly divided the descending aorta into the thoracic and ventral, whose limits are defined by the diaphragm, which allows, by the separation of its crura, a convenient passage for the descending trunk.

Distribution of the thoracic aorta.

Through its whole descent, the thoracic aorta inclines to the left; though near the lesser or inferior diaphragm it seems gradually to approach the middle of the vertebræ. The numerous branches which it sends out, though not large, are yet worthy of notice. These are, the pericardiac, bronchial, œsophageal, and aorta, or inferior intercostal arteries.

Distribution of the ventral aorta.

The ventral or abdominal aorta, is the lowest part of the common trunk. It passes from the thorax, through the inferior muscle of the diaphragm, to the right side of the œsophagus, in a straight direction, inclining rather to the left, and proceeds gradually through the abdomen upon the surface of the vertebral column to the fifth lumber vertebra, and to the thick ligament connecting the fourth and fifth. The inner or long crura of the diaphragm, variously interwoven behind the œsophagus, separate anteriorly on the aorta, allowing a passage through which it descends, resting posteriorly on the vertebral column. This passage is considerably larger than the trunk, loose cellular substances, connecting the pleura and peritoneum, being interposed. The aorta at this place is separated from the vena cava by the left lobe of the liver, a part of the diaphragm, and a large quantity of cellular substance; but in the space between the kidneys and the liver, these two vessels approach so near, that the margin of the artery is partly covered by the vein that afterwards sends some of its branches anteriorly across.

The ventral aorta is divided at the vertebra mentioned above, into two branches of equal size, forming an acute angle as they run forwards to the brim of the pelvis. These anatomists have called ilia communes, or common iliacs. The branches of the ventral aorta are best described in the order in which they occur.

1. The phrenic artery, right and left, very irregular in origin and division. Sometimes a single trunk arising above the cœliac, divides into the right and left phrenic: sometimes, again, and indeed most frequently, the right rises from the cœliac, and the left from the aorta; while, at other times, they have been observed rising together, both from the cœliac, or both from the aorta. Sometimes the single trunk or common phrenic, being larger than usual, constitutes the fourth branch of the cœliac; and then forms the superior coronary branch of the stomach. There are sometimes three or four phrenic arteries, which, as soon as they arise, tend obliquely outwards before the crura of the diaphragm to the inferior margin of its tendinous alæ; and, while they here wind tortuously under the fleshy fibres, distribute various twigs, upwards, outwards, inwards, and downwards. Bending at last to the external margin of the tendon, and passing between the muscular layers, they run forwards, and inosculate, upon the costal muscles, with the thoracic vessels and the artery of the opposite side. At the bend of the artery, however, they send a large branch to the posterior and inferior portion of the diaphragm, as it rises from the ribs.

II. The cœliac artery, short, but of large diameter, rising between the aorta of the diaphragm, above the eleventh dorsal vertebra, from the anterior part of the aorta, and at the superior margin of the pancreas, between the papillary lobule, or lobule of Spigelius, and the left side of the lesser arch of the stomach. It then descends in a tortuous manner forwards, and to the right, and running about the third of an inch, ultimately separates into three branches in such a manner, that the two on the right seem to arise from the common base; while the left is more distinct at its origin. These are,

1. The superior coronary, or great left gastric, or superior or left gastro-hepatic, smaller than the other branches, if reflected only to the stomach; but almost equal in size to the splenic, if, as sometimes happens, it sends a branch also to the liver. It appears sometimes to issue from the splenic, ascends to the left, and forwards to the cardia and lesser arch of the stomach; then bending downwards and to the right, reaches the margin of the stomach, where it distributes extensively its circuitous branches, forming a corona to both sides of the stomach.

2. The hepatic.—This artery, which in adults is smaller than the splenic, but in children larger, rises from the right side of the cœliac, or, as sometimes happens, from the superior mesenteric, when, turning upwards near the outer point of the lobule of Spigelius, it is concealed by the pancreas; then proceeding forwards, upwards, and to the right, behind the right extremity of the stomach and duodenum, it observes the same obliquity as the lesser arch; and after running an inch or an inch and a half, divides below the neck of the gall-bladder into the right transverse and left ascending hepatics; entering at last, with the other hepatic vessels, the transverse fissure or fossa of the liver. Inclosed in the capsule of Glisson, it occupies a middle space between the biliary ducts and the vena porta.

3. The splenic.—While this artery runs along the upper surface of the pancreas, and passes transversely to the depression of the spleen, it exhibits large and repeated flexions upwards and downwards, bending in a circular or spiral form. Approaching the substance of the spleen, it divides into many branches, which are equally tortuous; and of those that sink into the spleen, some smaller ones return through the substance of the diaphragm or stomach.

III. The superior mesenteric, the largest of the abdominal or ventral branches, rising between the crura of the diaphragm, three or four lines below the cœliac, from the anterior part of the aorta, and under the lower edge of the pancreas, proceeds between the gland and the inferior transverse flexion of the duodenum. Passing over this portion of the intestine, it bends to the right under the meso-colon, where, received near the vertebra into the folds of the mesentery, it first inclines to the left and then to the right, where the whole artery, advancing to the right ilium, assumes the form of the Roman S, with the concave side of its large curvature looking to the right. After giving off smaller branches, the trunk sends from its right side only two branches to the large intestines; but from the left it gives a greater number of branches to the smaller intestines.

These, from twelve to twenty, rise close to one another from the left convex side of the superior mesenteric, distributing ramuli to the ileum and jejunum. Of these the superior are short and slender, the middle long and thick, the inferior shortest, and the last branch of all, as observed above, inosculates with the ileo-colic. Running near and parallel to each other, they first proceed transversely; then, rising between the layers of the mesentery, divide into smaller branches, which so diverge, that in whatever direction they go, they are soon after divided into two. These branches, as they meet, form various arches, from whose

convex margin new parallel branches arise, which again soon dividing, inosculate with the adjacent branches, forming smaller and more numerous arches. From the convexity of these arches other branches arise, forming a third series of arches, and where the branches are longest, even the fourth or fifth series, till the last branches near the intestines, dividing into anterior and posterior, encircle these viscera, and gradually penetrating their coats, form most beautiful arborescent ramifications on the cellular membrane. These arches, by means of their twigs, not only form various inosculations among themselves, but also with the arborescent ramifications of the two surfaces. The inner intestinal coat is so covered by these branches and the veins, as to give it the appearance of being wholly vascular. The trunks of these arborescents lie on the roots of the valvulæ. The arches are polygons; and the first series larger than the rest. The lymphatic glands and coats of the vessels are surrounded with numerous and various twigs as variously described.

IV. The inferior mesenteric or left colic.—This artery rises between the venal and common iliacs, from the anterior and left side of the aorta, descends behind the peritoneum to the left side of the trunk; and having reached that place where the aorta divides into two remarkable crura forming the iliacs, sends off a large branch; and after passing the iliac artery, sinks behind the rectum into the pelvis. As it here rises forward and to the right, it enters the duplicature of the meso-rectum, and accompanies the intestine as far as its internal sphincter.

V. Capsular or atrabiliary, right and left.—These are distinct small arteries, which, though never wanting, as they distribute many branches to the capsular gland, yet, in almost every individual, they present irregularities in number, size, or direction. They do not, like the vein, issue from one common trunk, but from various branches, coming near together nigh the seat of the gland.

VI. The renal or emulgent artery, right and left.—It is unnecessary to enumerate the varieties which anatomists have observed as to the number, origin, and magnitude of this artery. It generally rises single from the side of the aorta between the superior and inferior mesenteric artery, from which it descends transversely at less than a right angle. The left, which is rather shorter than the right, and more posterior in its origin, turns, near the kidney, over its concomitant vein; while the right, which is longer, is covered by its concomitant vein. Approaching the renal depression, it divides into two or four branches, which, sinking separately before and behind the pelvis of the kidney, are again divided, and distribute their spreading branches to the papillary ones. These, as they encircle the convex margin of the papillæ, form arches with the adjoining branches, and seem to separate the cortical from the tubular substance. From the convex and concave margin of each arch rise innumerable small arteries, of which the former encircle the cortex, and with some of their branches, pass through its substance, and disappear on the fat; while the rest are chiefly dispersed and exhausted on the tubular part. Before entering the kidney, the renals give out,

VII. The spermatic artery, right and left.—This artery is very slender, but, considering the smallness of its diameter, is the longest that rises from the lateral part of the aorta. It generally has its origin between the renal and mesenteric arteries, though the right and left do not always issue from the same place; the left often rising higher, and proceeding frequently from the renal or the inferior capsular. I have observed at times, two on each side. It descends from the aorta somewhat tortuously, at a very acute angle, behind the peritoneum, and passes before the vena cava on the right side. It is more tortuous in women than in men, in whom it passes through the abdominal ring. It joins its concomitant vein upon the surface of the psoas muscle. Received by the spermatic cord, it is divided, at some inches before reaching the testes, into five branches: two of which go to the head and upper extremity of the epididymis; while the rest running down to the testicle itself, penetrate the tunica albuginea, and send off new branches in every new direction; which, proceeding in a winding course, and reduced to the inferior margin of the testes, are partly exhausted on its substance, and partly on the convolutions of the seminiferous ducts.

VIII. The lumbar arteries, right and left—five in number; issuing from the lateral and posterior part of the aorta, at nearly a right angle. The first runs transversely under the first vertebra of the loins; the fifth, between the last vertebra and os sacrum; and the rest between the vertebral intestines: while all of them, after being reflected round the spine, sink into the intervening spaces of the vertebræ. The right are longer than the left. The superior proceed in a straight line, while the inferior incline a little downwards. Two sometimes arise from a single trunk, and all except the first are covered by the psoas muscle.

THIRD SUBDIVISION.

Branches from the termination of the aorta. Distribution of the common iliacs.

The common iliacs exhaust the whole of the aorta. The right iliac crosses the lower part of the vena cava, near the origin of the iliac vein. The left leans on the outside of its concomitant vein, but does not cover it. A little below, each divides into two branches: the one, named the internal iliac or hypogastric, sinks into the cavity of the pelvis; the other, called the external iliac, passes to the thigh, where it receives the name of the femoral. The sacro-median, and, at times, some minute arteries, are in general, the only branches of the common iliacs.

The sacro-median—similar in size to the lumbar, is an azygous artery; and, rising from the bifurcation, or a little higher from the middle of the aorta, or from one of the lumbars, or sometimes from one of the common iliacs, runs down along the middle of the anterior surface of the sacrum, as far as the coccyx, where it forms with the sacro-laterals, an arch whose convexity is downward.

(I.) The internal iliac or hypogastric—five times larger in the fœtus than the external; but, after a year, only equal in size; for while the umbilical exhausts almost the whole blood of the trunk, it seems continued into this artery, forming an arch convex downward, from whose circumference the other small arteries of the pelvis are sent off. When passing the brim of the pelvis, behind the peritoneum, it lies, with a more obtuse angle, in the middle, between the ileum and sacrum; thence bending gradually downwards, between the pelvis and its viscera. When the umbilical artery decays, the trunk distributes its numerous branches in directions so various, that none of them seem to follow its course. As the common pudic and ischiadic, however, run most directly downward, they have generally been considered by anatomists as its continuation. Its branches, though constant in their destination, are irregular in their origin; some being distributed to the pelvic viscera, while others run to the external and adjoining parts.

1. The sacro-lateral arteries—irregular in origin and number. Sometimes only one, sometimes more, even to five, come off from the trunk, from the posterior iliac, or the ileo-lumbar. If only one be present, it goes down, near the foramina of the sacrum as far as the coccyx, and there forms the arch already mentioned. If more, the superior inosculate among themselves; while the inferior terminates in the sacro-median.

2. The obturator artery—rising sometimes from the epigastric branch of the external iliac, and running toward the pelvis; more frequently, issuing from the trunk of the hypogastric, the posterior iliac, the ischiadic or ileo-lumbar. It runs downward and forward, connected to the bones of the pelvis by cellular membrane, following the superior edge of the obturator internus: and passing through the sinuous depression of the thyroid hole, runs to the thigh with its concomitant nerve and vein.

3. The posterior iliac, or gluteal—the largest of all the arteries, issuing from the hypogastric. It rises from the back part of the trunk, soon after the sacro-lateralis and obturator; passes, deeply upward and backward, to the superior edge of the pyriform muscle, till concealed by the two origins of the ischiadic nerve, it leaves the pelvis; then winding externally around the pyriformis, it distributes its branches among the gluteal muscles. Within the pelvis, it sometimes gives rise to the ileo-lumbar, obturator, sacro-lateralis, ischiadic, and common pudic.

4. The ischiadic—smaller than the former artery, but observing the same course with the hypogastric. It passes from the pelvis, between the lower edge of the pyriformis and the levator ani, and descends under the great gluteus, parallel with the larger ischiadic ligament. We have observed the trunk divide into two, sending off the middle hæmorrhoidal and pudic.

5. The common pudic—the pudic—circumflex, internal, middle, or external pudic—rising often from a common trunk with the ischiadic, but easily distinguished by its smaller size, by its bending more forward and inward while in the pelvis, by its passing out between the pyriformis and the posterior part of the levator ani, and by its greater distance from that extremity of the pyriformis which is attached to the sacrum.

Having passed from the cavity of the pelvis, it is concealed by the great sacro-sciatic ligament, under which it runs to the spine of the ischium, and enters the space between the lesser and greater sacro-sciatic ligaments. Having passed the spine, it next

runs to the internal surface of the tuberosity of the ischium, where, being attached to the bone by the aponeurosis of the obturator internus, it follows the curved margin of the ischium, and bends forward to the ramus. The artery is here exhausted by two branches sent off near the transverse muscle of the perineum.

(II.) The external iliac—the other branch of the common iliac, after it has divided into two branches, near, or a little below, the junction of the sacrum and ileum. It observes the same oblique direction outwards as the common iliac. Having passed obliquely over the inner edge of the psoas, and running behind the peritoneum, upon this muscle and the tendinous portion of the iliacus, it passes to the thigh under the Fallopian ligament, along with the vein covering it before, and the crural nerve attached to its external side. Having passed Poupart's ligament, it becomes the common femoral. The branches of this artery are,

1. The epigastric—rising at an acute angle, from the inner side of the trunk, near the external lateral margin of the abdominal ring, and the inferior part of the Fallopian ligament. It first descends; then, being immediately reflected, proceeds inward, behind the internal and posterior surface of the spermatic cord and epigastric vein. Now rising a little higher, and resting upon the peritoneum as it lines the abdominal muscles, it passes the outer and upper commissure of the abdominal ring, and then proceeds inward under the inferior part of the transverse muscle, bending to the rectus, behind which it ascends to the umbilicus.

2. The circumflex iliac, abdominal, or small external iliac—generally smaller than the last, and sent off a little lower than the external side of the trunk; passes upward and outward, in a retrograde course, under the peritoneum; reaches the crest of the ileum; and bending, parallel to the arched circumference of this bone, proceeds between the extremity of the iliacus internus and transversalis, as also betwixt the transversalis and obliquus internus, where it is finally expended among the abdominal muscles.

Distribution of the common femoral.

The common femoral, a continuation of the external iliac, runs without the Fallopian ligament in the groin. The femoral vein under which it lies, conceals its internal margin, while the whole is covered by a large quantity of cellular substance, fat, inguinal glands, and the fascia of the thigh. Advancing about two inches, it divides on the inferior part of the iliacus internus, into two arteries of nearly equal size. Of these, the continuation of the trunk is called the superficial femoral; and that which rises from the back part of the trunk, the deep femoral or femoral profunda. From the common trunk generally arise,

(I.) The deep femoral—concealed at its origin by the superficial femoral, the glands, and a quantity of fat, lies in the deep triangular cavity, between the iliacus, pectineus, and adductors; and bending convexly outward, over the united iliacus and psoas, runs backward and downward, to the higher extremity of the vastus internus. Having reached the bottom of the cavity, it again bends greatly forward; and passing between the long and short adductors, and the vastus internus, runs, downward and backward, near to the middle of the femur. At last, entering the space between the long and short adductors, or perforating this last muscle, it reaches the adductor magnus, and passes through it with various branches, running among the posterior muscles of the thigh. The first direction and size of the trunk vary considerably, according as it issues, sooner or later, from the common femoral, and according to the number and size of the branches which it sends off. Of these some are of little consequence; but there are some which merit attention.

1. The external circumflex—a conspicuous branch, and often the first when it arises from this artery; though it sometimes issues from the superficial femoral. It bends outward, between the iliacus internus, the rectus and sartorius, and between the tensor faciæ and the anterior surface of the middle gluteus; then passing transversely under the tendinous head of the vastus externus, disappears at last near the root of the large trochanter.

2. The internal circumflex—rises near the origin of the external, from the internal and posterior part of the trunk; passes to the middle of the pectineus through the adipose substance, between this muscle and the tendon of the psoas, and runs deeply backward above the trochanter minor. Concealed here by muscles and fat, it divides into branches between the short and great adductor, or between the adductor and pectineus. Of these branches, the largest approaches the neck of the femur, acetabulum, and obturator externus, and proceeding outwards and backwards to the insterstice between the quadratus and adductor magnus, divides into two branches; and is partly expended on the muscles attached to the femur, and partly through the interstice to the flexus of the thigh.

3. The perforants.

(II.) The superior femoral artery, lying externally, and covered through its whole course by the broad facia, by the inguinal glands above, and on the middle part by the sartorius, as it runs obliquely across the femur. It then proceeds downward, inward, and backward, passing gradually from the anterior to the inner surface of the thigh, and from that to the ham or poples. At first it is separated from the deep femoral, by a quantity of fat, and by the glands; then lies upon the vastus internus, and, passing along in a declivity between the vastus internus and adductors, enters the oblique canal in the common tendon of the adductors. Having passed through this canal, it takes the name of popliteal artery, where it runs from the inner to the back part of the thigh. Before reaching the posterior part, it passes over two-thirds of the femur; and though the thigh be here more slender than at the superior part, it lies more deeply concealed among the muscles.

1. The large anastomatic branch, rising from the inner surface of the trunk, at the superior margin of the tendinous canal; and, bending downwards, spreads, with many serpentine ramifications, on the vastus internus, into which it sinks.

2. The several perforants.

The popliteal artery; that part of the superficial femoral which runs along the ham. Its superior part is bounded by the posterior margin of the tendon of the triceps, and its inferior by the higher extremity of the soleus muscle, under which it divides into the anterior and posterior tibial arteries. Being covered externally by the aponeurosis which surrounds the joint, it runs obliquely outward and downward, through the adipose substance, between the flexor tendons, passing into the cavity between the condyles and the heads of the gastrocnemii. As it proceeds over the joint of the knee, it lies upon the capsules and afterwards on the popliteal muscle. The numerous branches to which, in this course, it gives origin, are divided into articular and muscular.

1. The anterior tibial artery, smaller than the posterior, rises anteriorly from the popliteal, at the inferior margin of the popliteal muscle, and, perforating the interosseous ligament, runs to the anterior part of the leg. It descends on the ligament, at first between the tibialis anticus and common extensor, then between the anticus and extensor longus of the great toe. In this course it lies nearer the fibula than the tibia; but gradually separating from the ligament, it turns forwards and inwards the farther it descends; and passing over the lower extremity of the tibia and the tarsus, along with the extensor tendons, under the crucial ligament, divides between the first and second metatarsal bones into two branches; of which one, sinking between the bones to the planta of the foot, inosculates with the branches of the posterior tibial, while the other, passing along the dorsum of the foot, runs to the great toe.

(II.) The posterior tibial, the other branch of the popliteal, passes down under the soleus upon the posterior surface of the flexor longus and tibialis posticus, to the lower extremity of the tibia, and is afterwards inflected to the sole of the foot, behind the internal ancle. While there covered by the laciniated ligament and fat, it meets the broad extremity of the abductor pollicis, and divides into two branches: one of which passing to the great toe, is the internal plantar; the external planter runs to the sole, between the flexor brevis and longus, and under these, still deeper, to the fifth metatarsal bone. Here returning to the great toe, by an oblique and transverse flexion under the tendons of the flexor longus, it forms the plantar arch. Its chief branch is,

1. The common fibular or peroneal, very irregular in size and in the distribution of its branches. It often equals in dimension the anterior tibial; sometimes is entirely wanting, and at other times is rather smaller than the posterior tibial. Rising near the upper part of the tibialis posticus, it descends between the muscle and the flexor pollicis, by which a little lower it is covered; and at last it touches the interosseous ligament. Near the inferior part of the bones, it divides into the anterior and posterior fibular.

Veins.

Veins are membranous canals, which either terminate in the vena cava superior, vena cava inferior, or vena portæ. Like the arteries, they also consist of three tunics, but they have no pulsation, collapse when divided, possess a greater diameter than the arteries, have more numerous branches, a more reticular arrangement, and run more superficially. Except the veins of the viscera and brain, these vessels also possess valves.

The veins of the external part of the head

and neck are the frontal, angular, temporal, auricular, lingual, occipital, and muscular. All these terminate in the external jugular, which opens into the subclavian. The veins or sinuses of the brain, viz. the cavernous, circular, petrosal, occipital, longitudinal, superior, and inferior, the torcular, herophili, and the lateral, on the contrary, terminate in the internal jugular, which also opens into the subclavian. The vertebral veins returning from the brain, terminate similaritly.

The chief veins of the upper extremities are the axillary in the axilla, the brachial in the arm, and the cephalic on the outside, the median on the middle, and the basilic on the inside, of the fore-arm. The cephalic and basilic veins being joined by the mediana cephalica and mediana basilica, pass up the arm.

The veins of the thorax are the internal thoracic veins, the vena azygos, which returns the blood of the intercostal veins, and the two subclavian, of which the left is longer than the right, on account of the situation of the superior cava toward the right side.

The vena portæ, which is distributed through the liver, derives its blood from the mesenteric and splenic veins.

Those of the loins and pelvis exactly correspond to the lumbar and pelvic arteries.

The veins of the lower extremities are the vena saphena major, which passes up the inside of the leg and thigh, and terminates in the groin; the vena saphena minor, which passes up the outside of the leg, and terminates in the ham; the popliteal and the crural veins, which accompany their corresponding arteries.

It must be observed that both in the leg and in the thigh, each deep-seated artery is accompanied by two corresponding veins, denominated venæ sodales.

Of the eye.

The principal and most essential part in each organ, is the globe or ball of the eye; the others are partly external and partly internal. The external parts are the supercilia, or eye-brows, the palpebræ, or eye-lids, the caruncula lachrymalis, and the puncta lachrymalia; and the internal parts are the muscles, fat, lachrymal gland, nerves, and blood-vessels.

The globe or ball of the eye.

Composition.---The globe of the eye being the most essential of all the soft parts belonging to the organ of sight, and being likewise a part which we are obliged to mention as often as we speak of the other soft parts, must be first described. It is made up of several proper parts; some of which being more or less solid, represent a kind of shell formed by the union of several membranous strata, called the coats of the globe of the eye; and the other parts being more or less fluid, and contained in particular membranous capsulæ, or in the interstices between the coats, are termed the humours of the globe of the eye. The coats of the globe of the eye are of three kinds. Some form chiefly the shell of the globe; some are additional, being fixed only to a part of the globe; and some are capsular, which contain the humours. The coats, which form the globe of the eye, are, the sclerotic, to which the convexity of the globe is owing; the cornea, which forms the anterior part of the globe; the iris, or circle, surrounding the pupil, choroides, and retina, or expansion of the optic nerve. The additional is the conjunctiva, which covers the whole fore-part of the eye, and lines the eyelids. The capsular tunicæ are two, the vitreæ and crystallina.

The globe of the eye thus formed, receives from behind a pretty large pedicle, which is the continuation of the optic nerve. It is situated about the middle of the orbit, in the manner which we shall afterwards see; and it is tied to it by the optic nerve, by six muscles, by the tunica conjunctiva, and by the palpebræ. The back part of the globe, the optic nerve, and muscles, are surrounded by a soft, fatty substance, which fills the rest of the bottom of the orbit. The humours are three in number: the aqueous, vitreous, and crystalline. The first is contained in a space formed in the interstices of the anterior portion of the coats. The second or vitreous humour, is contained in a particular membranous capsula, and fills above three-fourths of the shell or cavity of the globe of the eye. It has been named vitreous, from its supposed resemblance to melted glass; but is really more like the white of a new-laid egg. The crystalline humour is so called from its resemblance to crystal, and is often named simply the crystalline. It is rather a gummy mass than an humour, of a lenticular form, more convex on the back than on the fore-side, and contained in a fine membrane called membrana or capsula crystallina.

The external parts of the eye.

The supercilia, or eye-brows, are the two ridges covered with hair, situated at the lower part of the forehead, between the top of the nose and temples.

The palpebræ are a kind of veils or curtains placed transversly above and below the anterior portion of the globe of the eye. The superior is the largest and most moveable in man.

The tarsi are thin cartilages forming the principal part of the edge of each palpebra; and they are broader at the middle than at the extremities. The broad ligaments of the tarsi are membranous elongations formed by the union of the periosteum of the orbits, and pericranium along both edges of each orbit. The lacrymal gland, the use of which till of late years was not known, is yellowish, and of the number of those called conglomerate glands. From this gland several small ducts go out, which run down almost parallel to each other, through the substance of the tunica interna or conjunctiva of the superior palpebræ, and afterwards pierce it inwardly near the superior edge of the tarsus.

The flat edge of each palpebra is adorned with a row of hairs, called cilia, or the eyelashes. Those belonging to the superior palpebræ are bent upward, and longer than those of the lower palpebræ, which are bent downward.

Along the same border of the palpebræ, near the internal membrane, or toward the eye, we see a row of small holes, which may be named foramina, or puncta ciliaria. They are the orifices of the same number of small oblong glands which lie in the sulci, channels, or grooves, on the inner surface of the tarsus. Near the great and internal angle of the palpebræ lacrymales, and ductus, two small holes are very visible, commonly named puncta lacrymalia, being the orifices of two small ducts called lacrymal, which unite beyond the angle of the eye, and open a little below the upper end of a particular reservoir, termed sacculus lacrymalis. The caruncula lacrymalis is a small reddish, granulated, oblong body, situated precisely between the internal angle of the palpebræ and globe of the eye. The fold which has the name membrana semilunaris, appears most when the eye is turned toward the nose; it is shaped like a crescent, the two points of which answer to the puncta lacrymalia, and conduct the tears into the puncta.

The vessels, nerves, and muscles of the eye, are each described in their place.

Of the nose.

The parts of which the nose is composed may be derived in two different ways, viz. from their situation, into external and internal parts; and from their structure, into hard and soft parts.

The external parts are from the root of the nose, the arch, the back or spine of the nose, the sides of the nose or of the arch, the tip of the nose, the alæ, the external nares, and the part under the septum.

The internal parts are the internal nares, the septum narium, the circumvolutions, the conchæ superiores, or ossa spongiosa superiora, conchæ inferiores, the posterior openings of the internal nares, the sinus frontales, sinus maxillares, sinus sphenoidales, the ductus palatini. The firm or hard parts are mostly bony, and the rest cartilaginous, viz. the os frontis, os ethmoides, os sphenoides, ossa maxillaria, ossa nasi, ossa unguis, ossa palati, vomer, conchæ inferiores, and the cartilages. To these we may add the periosteum and perichondrium, as parts belonging to the bones and cartilages.

The soft parts are the integuments, muscles, sacculus lacrymalis receiving the tears, membrana pituitaria lining all the cavity of the nose, vessels, nerves, and hairs of the nares. The bony parts have been all explained in the description of the skeleton; and therefore we need only in this place to set down the distribution and disposition thereof, for the formation of some of the principal parts. The septum is formed by the descending lamina of the os ethmoides, and by the vomer, and it is placed in the groove formed by the cristæ of the ossa maxillaria, and rising edges of the ossa palati. The fore part of the nose is formed by the ossa nasi; and the sides by the superior apophyses of the ossa maxillaria.

The internal nares, or the two cavities of the nose, comprehend the whole space between the external nares and posterior openings, immediately above the arch of the palate, whence these cavities reach upward as far as the lamina cribrosa of the os ethmoides, where they communicate forward with the sinus frontales, and backward with the sinus sphenoidales. Laterally, these cavities are bounded on the inside by the septum narium; and on the outside, or that next the cheek, by the conchæ, or ossa spongiosa, between which they communicate with the sinus maxillares.

Of the ear.

The external ear.---Two portions are distinguished in the external ear; one large and solid, called pinna, which is the superior, more cartilaginous, and by much the greater

part; the other small and soft, called the lobe, which makes the lower part. We may likewise consider two sides in the outward ear, one turned obliquely forward, and irregularly concave; the other turned obliquely backward, and unequally convex.

The foreside is divided into eminences and cavities. The eminences are four in number, called helix, antihelix, tragus, and antitragus. The helix is the large folded border, or circumference of the great portion of the ear. The antihelix is the large oblong eminence, or rising, surrounded by the helix. The tragus is the small anterior protuberance below the anterior extremity of the helix, which, in an advanced age, is covered with hairs. The antitragus is the posterior tubercle, below the inferior extremity of the antihelix.

The cavities on the fore side are four in number; the hollow of the helix, the depression at the superior extremity of the antihelix, called fossa auricularis; the conchæ, or great double cavity, that lies under the rising termed antihelix, the upper bottom of which is distinguished from the lower by a continuation of the helix, in form of a transverse crista; and lastly, the meatus of the external ear, situated at the lower part of the bottom of the concha.

The other parts of the external ear are ligaments, muscles, integuments, sebaceous and ceruminous glands, vessels, and nerves.

The bony part of the organ of hearing may be divided into four general parts. 1. The meatus auditorius externus. 2. The tympanum. 3. The labyrinth. 4. The meatus auditorius internus. It may likewise be divided into immoveable or containing parts, which take in all the four already mentioned; and moveable or contained parts, which are four little bones lodged in the tympanum, called incus, malleus, stapes, and os orbiculare or lenticulare.

The meatus externus is somewhat more than half an inch in length, running obliquely from behind forward in a curved direction. It terminates inwardly by an even circular edge, which is grooved quite round, for the attachment of the membrana tympani.

The tympanum, or drum of the ear, is a cavity somewhat spherical, or rather hemispherical, the bottom of which is turned inward, and the mouth joined to the circular groove already mentioned. The remarkable eminences are three in number; a large tuberosity, lying in the very bottom of the tympanum, a little toward the back part, and a small irregular pyramid, situated above the tuberosity, and a little more backward, the apex of which is perforated by a small hole. In the third eminence is a cavity situated at the upper end, a little toward the anterior part of the bottom of the tympanum. This cavity is part of a half-canal, which, in a natural state, has one of the muscles of the malleus lodged in it.

The principal cavities in the tympanum are, the opening of the mastoid cells, the opening of the Eustachian tube, the bony half-canal, the fenestra ovalis and rotunda; and to these may be added the small hole in the pyramid.

The labyrinth is divided into three parts; the anterior, middle, and posterior; the middle portion is termed vestibulum, the anterior cochlea, and the posterior labyrinth in particular, which comprehends the three semicircular canals.

The cochlea lies forward and inward, toward the extremity of the pars petrosa; the semicircular canals backward and outward, toward the basis of the process, and the vestibulum between the other two.

The meatus auditorius internus, is on the back side of the pars petrosa, in some measure behind the vestibule and basis of the cochlea fossulæ; one large and the other small.

The ductus auris palatinus, or Eustachian tube, is a canal or duct, which goes from the tympanum to the posterior openings of the nares, and toward the arch of the palate.

The membrana tympani is a thin, transparent, flattish pellicle, the edge of which is round, and strongly fixed in the orbicular groove which divides the bony meatus of the external ear from the tympanum, or barrel. The whole internal cavity of the labyrinth is filled with a watery fluid, secreted from the vessels, which are dispersed upon the periosteum. This fluid transmits to the nerves the vibrations it receives from the membrane situated between the tympanum and labyrinth.

The superfluous part of this fluid is supposed to pass off through two small canals, called aqueducts of Cotunnius.

The portio mollis of the auditory nerve ends, by its trunk, at the great fossula of the internal auditory hole, whence the filaments pass through the cochlea, the vestibule, and the semicircular canals, upon membranous canals, and bags disposed within them.

Of the mouth, and organ of taste.

The mouth may be distinguished into external and internal; and the parts of which it consists may likewise come under the same two general heads. The bony parts are the ossa maxillaria, ossa palati, maxilla inferior, and the teeth; to these we may add os hyoides, and the upper vertebræ of the neck.

The external parts of the mouth are, the two lips, one upper the other under; the borders, or red part of the lips, the corners, or commissures of the lips; the fossula of the upper lip, the basis of the under lip; the chin, the basis of the chin; the skin; the beard; and even the cheeks, as being the lateral parts of the mouth in general, and of the lips in particular.

The internal parts of the mouth are, the gums, palate, septum palati, uvula, amygdalæ, the tongue, the membrane which lines the whole cavity, the salival duct and glands, and the bottom of the mouth.

The palate is that arch or cavity of the mouth, surrounded anteriorly by the alveolar edge and teeth of the upper jaw, and reaching thence to the great opening of the pharynx. The arch is partly solid and immoveable, and partly soft and moveable. The solid portion is that which is bounded by the teeth, being formed by the two ossa maxillaria, and two ossa palati. The soft portion lies behind the other, and runs backward, like a veil fixed to the edge of the ossa palati, being formed partly by the common membrane of the whole arch, and partly by several muscular fasciculi, &c.

The velum palati, terminates below by a loose floating edge, representing an arch, situated transversely above the basis, or root, of the tongue. The highest portion, or top, of this arch, sustains a small, soft, and irregularly conical glandular body, fixed by its basis to the arch, and its apex hanging down, without adhering to any thing, which is called uvula. On each side of the uvula there are two muscular half-arches, called columnæ septi palati, which contain between them the glands called amygdalæ.

The tongue is divided into the basis and point, the upper and under sides, and the lateral portions, or edges. The basis is the posterior and thickest part; the point the anterior and thinnest part. The upper side is not quite flat, but a little convex, and divided into two lateral halves, by a shallow depressed line, called linea linguæ mediana. The edges are thinner than the other parts, and a little rounded, as well as the point. The lower side reaches only from the middle of the length of the tongue to the point. Three sorts of papillæ may be distinguished in the upper side of the tongue, capitalæ, semi-lenticulares, and villosæ.

Of the skin and organ of touch.

The common integuments are divided into cuticula, rete mucosum, cutis vera, and corpus adiposum.

The outside of the skin is covered by a thin transparent insensible pellicle, closely joined to it, which is called epidermis, cuticula, or scarf-skin.

Under the cuticle, we meet with a substance of a greyish colour, which has got the name of corpus cuticulare, or rete mucosum; it is of a soft, mucilaginous, and viscid nature, and fills up the interstices of the fibres running between the cutis vera and cuticula. After raising the cuticle in a negro, where it is thickest and most distinct, this substance appears of a black colour, and is composed of two layers. It is this that chiefly gives the colour to the skin, for it is black in the African, and white, brown, or yellowish, in the European.

The cutis vera, or skin, properly so called, is a substance of very large extent, made up of several kinds of fibres, closely connected together, and running in various directions, being composed of the extremities of numerous vessels and nerves.

It is not easily torn, may be elongated in all directions, and afterwards recovers itself, as we see in the persons, in women with child, and in swellings; and it is thicker and more compact in some places than in others.

In different parts of the body, we meet with small glands, or follicles, of an oval form, and seated chiefly under the skin in the corpus adiposum. These are called sebaceous and miliary.

The last universal integument of the human body is the membrana adiposa, or corpus adiposum.

The nails are productions of the epidermis.

The hairs belong as much to the integuments as the nails. Their roots, or bulbs, lie toward that side of the skin which is next the membrana adiposa.

Of the brain.

This mass is divided into three particular portions; the cerebrum, or brain, properly so called, the cerebellum, and medulla oblongata. To these three parts, contained within the cranium, a fourth is added, which fills the great canal of the spina dorsi, by the name of medulla spinalis, being a continuation of the medulla oblongata.

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The meninges, or membranes of the brain, are two in number; one of which is very strong, and lies contiguous to the cranium; the other is very thin, and immediately touches the brain. The first is named dura mater, the second pia mater. The last is again divided into two, the external lamina being termed arachnoides, the internal retaining the common name of pia mater. From the former are the falx pentorium, &c. which are septa of the brain, while the latter more immediately invest the cerebral mass.

Cerebrum.

Situation and figure.—The cerebrum, properly so called, is a kind of medullary mass, of a moderate consistence, and of a greyish colour on the outer surface, filling all the superior portion of the cavity of the cranium; or that portion which lies above the transverse septum. The upper part of the cerebrum is of an oval figure. It is flatter on the lower part, each lateral half of which is divided into three eminences, which correspond with the cavities at the base of the cranium.

Division and lobes.—The cerebrum is divided into two lateral portions, separated by the falx, or great longitudinal septum of the dura mater. They are generally termed hemispheres, but they are more like quarters of an oblong spheroid. Each of these portions is divided into two extremities, one anterior, and one posterior, which are termed the lobes of the cerebrum, between which there is a large inferior protuberance, which goes by the same name; so that in each hemisphere there are three lobes, one anterior, one middle, and one posterior. The anterior and middle lobes of the cerebrum on each side are parted by a deep narrow sulcus, termed fissura magna sylvii.

Sides and inequalities.—Each lateral portion of the cerebrum has three sides; one superior, which is convex, one inferior, which is uneven, and one lateral, which is flat, and turned to the falx. Through the whole surface of these three sides, we see inequalities, or windings, like the circumvolutions of intestines, formed like weaving streaks or furrows, very deep and narrow, into which the septa, or duplicatures of the pia mater, insinuate themselves, and thereby separate these circumvolutions from each other.

Near the surface of the cerebrum, these circumvolutions are at some distance from each other, representing serpentine ridges; and in the interstices between them, the superficial veins of the cerebrum are lodged.

Substance.—The substance of the cerebrum is of two kinds, distinguished by two different colours, one part of it being of a greyish or ash colour, the other, which is somewhat firmer than the former, is remarkably white, but redder in the fœtus. The ash-coloured substance lies chiefly on the outer part of the cerebrum, like a kind of cortex, whence it has been named substantia corticalis, or cinerea. The white substance occupies the inner part, and is termed substantia medullaris, or substantia alia. This abounds in greater quantity than the other, and in many places is perforated with red arteries.

Corpus callosum.—Having cut off the falx from the crista galli, and turned it backward; if we separate gently the two lateral parts or hemispheres of the cerebrum, we see a longitudinal portion of a white convex body, which is named corpus callosum. Both extremities of this medullary body terminate by a small edge, bent transversely downward.

Medullary arch and centrum ovale.—The corpus callosum becomes afterward continuous on each side, with the medullary substance, which, through all the remaining parts of its extent, is entirely united with the cortical substances and together with the corpus callosum forms a medullary arch or vault, of an oblong or oval figure. To perceive this, the whole cortical substance, together with the medullary laminæ mixed with it, must be cautiously and dextrously cut in the same direction with the convexity of the cerebrum.

Ventriculi laterales.—Under this arch are two lateral cavities, much longer than they are broad, and very shallow, separated by a transparent medullary septum; of which hereafter. These cavities are generally named the lateral ventricles of the brain.

The lateral ventricles are broad, and rounded at those extremities which lie next the transparent septum. They go from before backward, contracting in breadth, and separating from each other gradually in their progress. Afterward they bend downward, and return obliquely from behind forward, in a course like the turning of a ram's horn, and terminate almost under their superior extremities, only a little more backward and outward.

At the posterior part, where they begin to bend downward, there is on each side a particular elongation, which runs backward, and terminates in a triangular pointed cavity, turned a little inward, the two points resembling horns. These ventricles are every where lined with a continuation of the pia mater.

Septum lucidum.—The transparent partition, or septum lucidum, as it is commonly called, lies directly under the raphe, or suture of the corpus callosum, of which it is a continuation, and a kind of duplicature. It is made up of two medullary laminæ, more or less separated from each other by a narrow medullary cavity, sometimes filled with a serous substance.

Fornix.—The septum lucidum is united by its lower part, to the anterior portion of the particular medullary body, called improperly the fornix with three pillars. It is in reality nothing but the corpus callosum; the lower side of which is like a hollow ceiling, with three angles, one anterior, and two posterior, and three edges, two lateral and one posterior. The lateral edges are terminated each by a large semicylindrical border, like two arches, which, uniting at the anterior angle, form by their union what is called the anterior pillar of the fornix; and as they run backward separately toward the two posterior angles, they have then the name of the posterior pillars.

The anterior pillar being double, is larger than either of the posterior; and the marks of this duplicity always remain. Immediately below the basis of this pillar we observe a large, white, short medullary rope, stretched transversely between the two hemispheres, and commonly called the anterior commissure of the cerebrum. It is to this pillar that the septum lucidum adheres. The posterior pillars are bent downward, and continue through the lower portions of the ventricles all the way to their cavities, resembling a ram's horn, which is a name that has been given to them. They diminish gradually in thickness during this course, and at their outsides have each a small, thin, flat, collateral border, to which the name of campora fimbriata is applied.

The posterior pillars of the crura of the fornix unite with two medullary protuberances, called pedes hippocampi. The inferior surface of the triangular ceiling, which lies between these arches, is full of transverse, prominent, medullary lines; for which reason the ancients called it psalloides and lyra, comparing it to a stringed instrument, something like what is now called a dulcimer.

Under the fornix, and immediately behind its anterior crura, there is a hole, the foramen Monroi, of a considerable size, by which the two lateral ventricles communicate, and another passage leads down from this under the different appellations of foramen commune anterius, valva, iter ad infundibulum, but more properly iter ad tertium ventriculum.

Eminences.—The fornix being cut off, and inverted, or quite removed, we see first of all a vascular web, called plexus choroides, and several eminences more or less covered by the expansion of that plexus. There are four pairs of eminences, which follow each other very regularly, two large, and two small. The first two great eminences are named corpora striata, and the second thalami nervorum opticorum. The four small eminences are closely united together; the anterior being called nates, and the posterior testes; but it would be better to call them simply anterior and posterior tubercles. Immediately before these tubercles, there is a single eminence, called glandula pinealis.

Corpora striata.—The corpora striata got that name, because, by cutting them with the knife, we meet with a great number of white and ash-coloured lines, alternately disposed, which are only the transverse section of the medullary and cortical laminæ, mixed together, in a vertical position, in the basis of the cerebrum, as appears evidently by incisions made from above downward. These two eminences are of a greyish colour on the surface, oblong, roundish, pyriform, and larger on the fore than on the back part, where they are narrow and bent.

They lie in the bottom of the superior cavity of the lateral ventricles, which they resemble in some measure in shape, their anterior parts being near the septum lucidum, from which they separate gradually, as they run backward, and diminish in size. They are in reality the convex bottoms of the ventricles; and it is at the lower part of the interstice, between the largest portions of them, that we observe the greatest transverse cord, termed the anterior commissure of the cerebrum, which we mentioned already in describing the anterior pillar of the fornix. This cord communicates more particularly with the bottom of the corpora striata, by a turn toward each side.

Thalami nervorum opticorum.—The thalami nervorum opticorum are so named, because these nerves rise chiefly from them. They are two large eminences by the side of each other, between the posterior portions or the extremities of the corpora striata. Their figure is semispheroidal, and a little oval, and they are of a whitish colour on the surface, and their inner substance is partly greyish and partly white; so that in cutting them we

streaks of different colours, like those of the corpora striata.

These two eminences are closely joined together; and at their convex part they are so far united, as really to become one body; the whitish outer substance being continued uniformly over them both.

Third ventricle. Immediately under the union, or beginning of the thalami nervorum opticorum, lies a particular cavity, called the third ventricle of the cerebrum. This cavity communicates, at its upper and fore part, with the passage between the two lateral ventricles, and sends down from its under and fore part a passage through the infundibulum. It opens backward into the passage called the *iter* ad quartum ventriculum.

Infundibulum. Between the basis of the anterior pillar of the fornix, and the anterior part of the union of the optic thalami, lies a small medullary canal, named infundibulum. It runs down toward the basis of the cerebrum, contracting gradually, and terminates in a straight course by a small membranous canal, in a softish body, situated in the sella Turcica, named glandula pituitaria.

Plexus choroides. The plexus choroides is a very fine vascular texture, consisting of a great number of arterial and venal ramifications, partly collected in two loose vasculi, which lie on each lateral ventricle, and partly expanded over the neighbouring parts, and covering in a particular manner the thalami nervorum opticorum, glandula pinealis, tubercula quadrigemina, and the other adjacent parts, both of the cerebrum and cerebellum, to all which it adheres.

Glandula pituitaria. The pituitary gland is a small spongy body, lodged in the sella Turcica, between the sphenoidal folds of the dura mater. On the outside it is partly greyish, and partly reddish, and white within. It is transversely oval or oblong; and on the lower part, in some subjects, is divided by a small notch in two lobes, like a kidney-bean. It is covered by the pia mater, as by a bag, the opening of which is the extremity of the infundibulum: and is surrounded by the small circular sinuses, which communicate with the sinus of the cavernosi.

Tubercula. The tubercles are four in number, two anterior and two posterior; adhering together, as if they made but one body, situated behind the union of the thalami nervorum opticorum. They are transversely oblong, the anterior being a little more rounded, and broader, or larger, from before backward than the posterior. Their surface is white, and their inner substance greyish.

Directly under the place where the tubercles of one side are united to those of the other side, lies iter ad quartum ventriculum, which communicates by its anterior opening with the third ventricle, under the thalami nervorum opticorum, and by its posterior opening with the fourth ventricle, which belongs to the cerebellum.

Foramen commune posterius, where the convex parts of the two anterior tubercles join these posterior convex parts of the thalami nervorum opticorum, an interstice, or opening, is left between these four convexities; but it does not communicate with the third ventricle, for the bottom of it is shut up by the pia mater. It has got the name of anus applied to it.

Glandula pinealis. The glandula pinealis is a small, soft, greyish body, about the size of an ordinary pea, irregularly round, and sometimes of the figure of a pine-apple, situated behind the thalami nervorum opticorum, above the tubercula quadrigemina. It is fixed like a small button to the lower part of the thalami, by two very white medullary pedunculi, which at the gland are very near each other, but separate transversely toward the thalami. This gland is almost always found to contain a peculiar gritty substance: below the glandula pinealis there is a medullary tranverse cord, called the posterior commissure of the hemispheres of the cerebrum.

Cerebellum.

Situation and figure. The cerebellum is contained under the transverse septum of the dura mater, in the under and back part of the cranium. It is broader laterally than on the fore or back sides, flatted on the upper side, and gently inclined both ways, answerable to the septum, which serves it as a kind of tent or ceiling. On the lower side it is rounder; and on the back side it is divided into two lobes, separated by the occipital septum of the dura mater.

Structure. It is made up like the cerebrum, of two substances. It has two middle eminences, called appendices vermiformes: one anterior and superior, and turned forward; the other posterior and inferior, which goes backward. There are likewise two lateral appendices, both turned outward. They are termed vermiformes, from their resemblance to a large portion of an earthworm.

Fourth ventricle. When we separate the two lateral portions or lobes, having first made a pretty deep incision, we discover first of all the posterior portion of the medulla oblongata, of which hereafter: and in the posterior surface of this portion, from the tubercula quadrigemina, all the way to the posterior notch, in the body of the cerebellum; and a little below that notch, we observe an oblong cavity, which is called the fourth ventricle; this terminates backward, like the point of a writing pen. Hence the under end of it is called calamus scriptorius. If we cut one lobe of the cerebellum vertically, from above downward, the medullary substance will appear to be dispersed in ramifications, through the cortical substance. These ramifications have been named arbor vitæ, and the two trunks, whence these different laminæ arise, are called pedunculi cerebelli.

Medulla oblongata.

The medulla oblongata is a medullary substance, situated from before backward in the middle part of the basis of the cerebrum and cerebellum, without any discontinuation between the lateral parts of both these bases.

The chief medullary productions are these; the large, or anterior branches of the medulla oblongata, which have likewise been named crura anteriora medullæ oblongatæ, and pedunculi cerebri; the transverse protuberance, called likewise processus annularis, or pons Varolii; the smaller posterior branches, called pedunculi cerebelli, or crura posteriora medullæ oblongatæ; the extremity, or cauda, of the medulla oblongata, with two pairs of tubercles; one of which is named corpora olivaria, the other corpora pyramidalia; and to all these productions we must add a production of the infundibulum, and two medullary papillæ.

Medulla spinalis.

The medulla spinalis is only an elongation of the extremity of the medulla oblongata, and it has its name from its being contained in the bony canal of the spina dorsi. It is consequently a continuation or common appendix of the cerebrum and cerebellum, as well because of the two substances of which it is composed, as because of the membranes by which it is invested.

NEUROLOGY.

Of the Nerves in general.

The continuity of the cortex with the medulla of the encephalon and spinal marrow is observable with the naked eye, and is more distinctly seen with the assistance of a microscope. In dissecting the brain and cerebellum, we see the small beginnings of the medulla proceeding from the cortex, and can trace its gradual increase by the addition of more such white substance coming from the cortex. Both these substances are very succulent; for being exposed to the air to dry, they lose more of their weight than most parts of the body do.

In several places we can observe the medulla to be composed of fibres laid at each other's sides; and it is employed in forming the white fibrous cords, which have now the name of nerves appropriated to them. Within the skull we see the nerves to be the medullary substance continued, and the spinal marrow is employed in forming all nerves.

The common opinion concerning the use of the nerves, founded on a superficial inspection of those parts, is, that the nerves are propagated from that side of the encephalon at which they go out of the skull. But it having been remarked, after a more strict enquiry, and preparing the parts by maceration in water, that the medullary fibres decussate or cross each other in some parts of the medulla, as, for example, at the corpus annulare, and beginning of the spinal marrow; and practical observations having related several examples of people whose brain was hurt on one side, while the morbid symptoms, palsy, appeared on the other side of the body, of which we have seen some instances; and experiments on brutes having confirmed these observations, it has been thought that the nerves had their rise from that side of the encephalon which is opposite to their egress from the skull. It may, however, still be said, that this last opinion is not fully demonstrated, because a decussation in some parts is not a proof that it obtains universally; and if there are examples of palsy of the side opposite to where the lesion of the brain was, there are also others, where the injury done to the brain and the palsy were both on the same side.

The nerves are composed of a great many threads lying parallel to each other, or nearly so, at their exit from the medulla. This fibrous texture is evident at the origin of most of the nerves within the skull; and in the cauda equina of the spinal marrow, we can divide them into such small threads, that a very good eye can scarce perceive them: but these threads, when looked at with a microscope, appear each to be composed of a great number of smaller threads. How small one of these fibres of the nerve is, we know not; but when we consider that every, even the most minute, part of the body is sen-

sible, and that this must depend upon the nerves (which, all conjoined, would not make a cord of an inch diameter) being divided into branches or filaments, to be dispersed through all these minute parts, we must be convinced that the nervous fibrils are very small. From the examination of the minimum visible, it is demonstrated, that each fibre in the retina of the eye, or expanded optic nerve, cannot exceed the size of the 32400th part of a hair.

The medullary substance of which the nervous fibrils are composed, is very tender, and would not be able to resist such forces as the nerves are exposed to within the bones, nor even the common force of the circulating fluids, were not the pia mater and tunica arachnoides continued upon them; the former giving them firmness and strength, and the latter furnishing a cellular coat to connect the threads of the nerves, to let them lie soft and moist, and to support the vessels which go with them. It is this cellular substance that is distended, when air is forced through a blow-pipe thrust into a nerve; and that makes a nerve appear all spongy, after being distended with air till it dries: the proper nervous fibrils shrivelling so in drying, that they scarce can be observed. These coats would not make the nerves strong enough to bear the stretching and pressure they are exposed to in their course to the different parts of the body; and therefore, where the nerves go out at the holes in the cranium and spine, the dura mater is generally wrapped closely round them to collect their disgregated fibres into tight firm cords; and that the tension which they may happen to be exposed to may not injure them before they have got this additional coat, it is firmly fixed to the sides of the holes in the bones through which they pass.

The nervous cords, thus composed of nervous fibrils, cellular coat, pia and dura mater, have such numerous blood-vessels, that after their arteries only are injected, the whole cord is tinged of the colour of the injected liquor; and if the injection is pushed violently, the cellular substance of the nerves is at last distended with it.

A nervous cord, such as has been just now described, has very little elasticity, compared with several other parts of the body. When cut out of the body, it does not become observably shorter, while the blood-vessels contract three-eighths of their length.

Nerves are generally lodged in a cellular or fatty substance, and have their course in the interstices of muscles and other active organs, where they are guarded from pressure; but in several parts they are so placed, as if it was intended that they should there suffer the vibrating force of arteries, or the pressure of the contracting fibres of muscles.

The larger cords of the nerves divide into branches as they go off to the different parts; the branches being smaller than the trunk from which they come, though not proportionally so; for, as Soemmerring observes, they rather form cones with apices toward the brain, and bases toward the superficies of the body. Where the nerves separate, they generally make an acute angle.

In several places different nerves unite into one cord, which is commonly larger than any of the nerves which form it. Several nerves, particularly those which are distributed to the bowels, after such union, suddenly form a hard knot, considerably larger than all the nerves of which it is made. These knots were called corpora olivaria, and are now generally named ganglions. The ganglions have thicker coats, more numerous and larger blood-vessels, than the nerves; so that they appear more red and muscular. On dissecting the ganglions, fibres are seen running longitudinally in their axes, and other fibres are derived from their sides in an oblique direction to the longitudinal ones. Commonly numerous small nerves, which conjunctly are not equal to the size of the ganglion, are sent out from it, but with a structure no way different from that of other nerves.

The nerves sent to the organs of the semen lose there their firm coats, and terminate in a pulpy substance. The optic nerves are expanded into the soft tender webs, the retinæ. The auditory nerve has scarce the consistence of mucus in the vestibulum, cochlea, and semi-circular canals of each ear. The papillæ of the nose, tongue, and skin, are very soft. The nerves of muscles can likewise be traced till they seem to lose their coats by becoming very soft; from which, and what we observed of the sensatory nerves, there is reason to conclude, that the muscular nerves are also pulpy at their terminations, which we cannot indeed prosecute by dissection. It would seem necessary that the extremities of the nerves should continue in this soft flexible state in order to perform their functions right; for, in proportion as parts become rigid and firm by age, or any other cause, they lose their sensibility, and their motions are more difficultly performed.

Though the fibres in a nervous coat are firmly connected, and frequently different nerves join into one trunk, or into the same ganglion, yet the sensation of each part of the body is so very distinct, and we have so much the power of moving the muscles separately, that, if the nerves are principal agents in these two functions, we have reason to believe that there is no union, confusion, or immediate communication of the proper nervous fibrils, but that each fibre remains distinct from the origin to its termination.

Many experiments and observations concur in proving, that when nerves are compressed, cut, or any other way destroyed, the parts served by such nerves, farther from the head or spine than where the injuring cause has been applied, have their sensations, motions, and nourishment, weakened or lost, while no such effects are seen in the parts nearer to the origin of those nerves; and in such experiments, where the cause impeding the nerves from exerting themselves could be removed, and the structure of the nerves not injured, (as, for example, when a ligature made upon a nerve, and stopping its influence, has been taken away,) the motion and sensation of the parts soon were restored; from which it would appear, that the nerves are principal instruments in our sensations and motions; and that this influence of the nerves is not inherent in them, unless the communication between these cords and their origin is preserved.

Experiments and observations show, too, that when parts of the encephalon or spinal marrow have been irritated, compressed, or destroyed, the parts of the body, whose nerves had their origin from such affected parts of the encephalon or spinal marrow, became convulsed, paralytic, insensible, or wasted; and in such cases, where the injuring cause could be removed from the origin of the nerves, the morbid symptoms observed in the parts to which these nerves were distributed, went off upon the removal of that cause; from which it is thought reasonable to conclude, that the nerves must not only have a communication with their origin, but that the influence they have upon the parts they are distributed to, depends upon the influence which they derive from the medulla encephali and spinalis.

If such causes produce constantly such effects in us and other creatures living in nearly the same circumstances as we do, the conclusions already made must be good, notwithstanding the examples of children and other creatures being born without brains or spinal marrow, or notwithstanding that the brains of adult creatures can be much changed in their texture by diseases, and that tortoises and some other animals continue to move a considerable time after their heads are cut off. We may be ignorant of the particular circumstances requisite or necessary to the being or well being of this or that particular creature, and we may be unable to account for a great many phenomena; but we must believe our eyes in the examination of facts; and if we see constantly such consequences from such actions, we cannot but conclude the one to be the cause and the other the effect. It would be as unjust to deny the conclusions just now made, because of the seemingly preternatural phenomena mentioned at the beginning of this head, as it would be to deny the necessity of the circulation of the blood in us and most quadrupeds, because a frog can jump, or a tortoise can walk about after all the bowels of its thorax and abdomen are taken out, or because the different parts of a worm crawl after it has been cut into a great many pieces. It is therefore almost universally allowed, that the nerves are principal instruments in our sensations, motions, and nourishment; and that the influence which they have, is communicated from their origin, the encephalon and medulla spinalis. But authors are far from agreeing about the manner in which this influence is communicated, or in what way nerves act to produce their effects: some alleging that the nervous fibres are all solid cords, acting by elasticity, or vibration; others maintaining that these fibres are small pipes conveying liquors, by means of which their effects are produced; and certainly very considerable objections may be made to both doctrines.

Of particular nerves.

It is generally said, that there are forty pair of nerves in all; of which ten come out from the encephalon, and the other thirty have their origin from the spinal marrow.

Of the ten pair of nerves which come from the encephalon, the first is the olfactory, which long had the name of the mamillary processes of the brain, because in the brutes, cows and sheep, which were more commonly dissected by the antients, the anterior ventricles of the brain are extended forward upon these nerves, and adhere so firmly to them, that they seem to make the upper side of the nerves. Each of them is large where it begins to stretch out, and gradually becomes smaller as it approaches the cribriform bone.

The tender structure and sudden expansion of these nerves on such a large surface,

render it impossible to trace them far, which has made some authors deny them to be nerves; but when we break the circumference of the cribriform lamella, and then gently raise it, we may see the distribution of the nerves some way on the membrane of the nose, where they form a beautiful net-work, which has been exquisitely delineated by Scarpa, in his treatise De Olfactu et Auditu.

The contrivance of defending these long soft nerves from being too much pressed by the anterior lobes of the brain, under which they lie, is singular; because they have not only the prominent orbitar processes of the frontal bone to support the brain on each side, with the veins going into the longitudinal sinus, and other attachments bearing it up, but there is a groove formed in each lobe of the brain itself for them to lodge in. Their splitting into so many small branches before they enter the bones of the skull is likewise peculiar to them; for generally the nerves come from the brain in disgregated filaments, and unite into cords, as they are going out at the holes of the bones. This contrivance is the best for answering the purpose they are designed for, of being the organs of smelling; for had they been expanded upon the membrane of the nose into a medullary web, such as the optic forms, it would have been too sensible to bear the impressions of such objects as are applied to the nose; and a distribution in the more common way of a cord sending off branches, would not have been equal enough for such an organ of sensation.

The second pair of nerves, the optic, rising from the thalami nervorum opticorum, make a large curve outward, and then run obliquely inward and forward, till they unite at the forepart of the sella Turcica; these soon divide, and each runs obliquely forward and outward, to go out at its proper hole in the sphenoid bone, accompanied with the ocular artery to be extended to the globe of the eye, within which each is expanded into a very fine cup-like web, that lines all the inside of the eye, to within a little distance of the edge of the crystalline lens, and is universally known by the name of retina.

Though the substance of this pair of nerves seems to be blended at the place where they are joined, yet observations of people whose optic nerves were not joined, and others who were blind of one eye from a fault in the optic nerve, or in those who had one of their eyes taken out, make it doubtful whether there is any such intimate union of substance; the optic nerve of the affected side only being wasted, while the other was large and plump. In many fishes indeed, the doctrine of decussation is favoured; for their optic nerves plainly cross each other, without any union at the part where they are joined in men and most quadrupeds.

Those people whose optic nerves were not joined, having neither seen objects double, nor turned their eyes different ways, is also a plain proof, that the conjunction of the optic nerves will not serve to account for either the uniform motions of our eyes, or our seeing objects single with two eyes, though it may be one cause of the remarkable sympathy of one eye with the other in many diseases.

The retina of a recent eye without any preparation, appears a very fine web, with some blood-vessels coming from its centre to be distributed on it; but after a good injection of the arteries that run in the substance of this nerve as is common to other nerves, it is with difficulty that we can observe its nervous medullary substance. The situation of these vessels in the central part of the optic nerve, the want of medullary fibres here, and the firmness of this nerve before it is expanded at its entry into the ball of the eye, may be the reason why we do not see such bodies, or parts of bodies, whose picture falls on this central part of the retina. An inflammation in those arteries of the retina which several fevers and an ophthalmia are generally attended with, may well account for the tenderness of the eyes, and inability to bear the light, which people have in these diseases. The over-distension of these vessels may likewise serve to account for the black spots observed on bright-coloured bodies especially, and for that smoky fog through which all objects are seen by people in some fevers. If these vessels lose their tone, and remain preternaturally distended, no object affects our retina, though the eye externally appears sound; or this may be one cause of amaurosis or gutta serena. From a partial distension of these vessels, or paralysis of part of the retina, the central part, or the circumference, or any other part of objects, may be lost to one or both eyes.

The third rise from the anterior part of the processus annularis; and piercing the dura mater a little before and to a side of the ends of the posterior clinoid process of the sphenoid bone, run along the receptacula or cavernous sinuses, at the side of the ephippium, to get out at the foramina lacera; after which each of them divides into branches, of which one, after forming a little ganglion, is distributed to the globe of the eye; the others are sent to the muscular rectus of the palpebra, and to the attollens, adductor, deprimens, and obliquus minor, muscles of the eye-ball. These muscles being principal instruments in the motions of the eye-lid and eye-ball, this nerve has therefore got the name of the motor oculi. We have frequently observed in convulsions that the eye-lids widely opened, the cornea turned upward and outward, and the eye-balls sunk in the orbit, which well described the conjunct action of the muscles which this pair of nerves serves. The distension of a considerable branch of the carotid which passes over this nerve near its origin on each side, may possibly be the reason of the heaviness in the eye-lids and eyes after drinking hard or eating much.

The fourth pair, which are the smallest nerves of any, derive their origin from the back part of the base of the testes; and then making a long course on the side of the annular protuberance, enter the dura mater a little further back, and more externally, than the third pair, to run also along the receptacula, to pass out at the foramina lacera, and to be entirely spent on the musculi trochleares, or superior oblique muscles of the eyes. These muscles being employed in performing the rotatory motions, and the advancement of the eye-balls forward, by which several of our passions are expressed; the nerves that serve them have got the name of pathetici. Why these small nerves should be brought so far to this muscle, when it could have been supplied easily by the motor oculi, we know not.

The fifth pair are large nerves, rising from the annular processes, where the medullary processes of the cerebellum join in the formation of that tube to enter the dura mater, near the point of the petrous process of the temporal bones; and then sinking close by the receptacula at the sides of the sella Turcica, each becomes in appearance thicker, forms a distinct ganglion, and goes out of the skull in three great branches.

The first branch of the fifth is the ophthalmic, which runs through the foramen lacerum to the orbit, having in its passage thither a connection with the sixth pair. It is afterward distributed to the ball of the eye with the third: to the nose, along with the olfactory, which the branch of the fifth that passes through the foramen orbitarium internum joins, as was already mentioned in the description of the first pair. This ophthalmic branch likewise supplies the parts at the internal canthus of the orbit, the glandula lachrymalis, fat, membranes, muscles, and teguments, of the eye-lids; its longest farthest extended branch passing through the foramen superciliare of the os frontis, to be distributed to the forehead.

The small fibres which this first branch of the fifth and third pair of nerves send to the eye-ball, being situated on the optic nerves, and after piercing the sclerotic coat, running along the clinoid coat, on the outside of the retina, in their course to the uvea or iris, may be a cause of the sympathy between the optic nerve and the uvea, by which we more readily acquire the habit of contracting the iris, and thereby lessen the pupil, when too strong light is excluded; and, on the contrary, enlarge the pupil when the light is too faint. This, with the sympathy which must arise from some of the nerves of the membrane of the nostrils being derived from the first branch of the fifth pair of nerves, may also be the cause why an irritation of the retina, by too strong light, may produce sneezing, as if a stimulus had been applied to the membrane of the nose itself; why pressing the internal canthus of the orbit sometimes stops sneezing; why irritation of the nose, on the other hand, causes the eye-lids to shut convulsively, and makes the tears to flow plentifully; and why medicines put into the nose affect diseases of the eyes.

The second branch of the fifth pair of nerves may be called maxillaris superior, from its serving principally the parts of the upper jaw. It goes out at the round hole of the sphenoid bone, and sends immediately one branch into the channel on the top of the antrum maxillare; the membrane of which, and the upper teeth, are supplied by it in its passage. As this branch is about to go out at the foramen orbitarium externum, it sends a nerve through the substance of the os maxillare to come out at Sterno's duct, to be distributed to the fore part of the palate; and what remains of it escaping at the external orbitar hole, divides into a great many branches that supply the cheek, upper lip, and nostril. The next considerable branch of the superior maxillary nerve, after giving branches which are reflected through the sixth hole of the sphenoid bone, to join the intercostal where it is passing through the skull with the carotid artery, and the portio-

dura of the seventh pair as it passes through the os petrosum, is sent into the nose by the hole common to the palate and sphenoidal bone; and the remaining part of this nerve runs in the palato-maxillary canal, giving off branches to the temples and pterygoid muscles, and comes at-last into the palate to be lost. Hence the ache in the teeth in the upper jaw occasions a growing pain deep-seated in the bones of the face, with swelling in the eye-lids, cheek, nose, and under lip: and, on the other hand, an inflammation in these parts is often attended with sharp pain in the teeth.

The third or maxillaris inferior branch of the fifth pair, going out of the oval hole of the sphenoid bone, serves the muscles of the lower jaw, and the muscles situated between the os hyoides and jaw. All the salivary glands, the amygdales, and the external ear, have branches from it: it has a large branch lost in the tongue, and sends another through the canal, in the substance of the lower jaw, to serve all the teeth there, and to come out at the hole in the fore part of the jaw, to be lost in the chin and under lip. Hence a convulsive contraction of the muscles of the lower jaw, or the mouth's being involuntarily shut, a great flow of spittle or salivation, a pain in the ear, especially in deglutition, and a swelling all about the throat, are natural consequences of a violent irritation of the nerves of the lower teeth in the tooth-ache; and pain in the teeth and ear is as natural a consequence of angina. Perhaps the sympathy of the organs of tasting and smelling may, in some measure, depend on their both receiving nerves from the fifth pair.

The sixth pair, which is the smallest except the fourth, rises from the fore part of the corpora pyramidalia: and each entering the dura mater some way behind the posterior clinoid process of the sphenoid bone, has a long course below that membrane, and within the receptaculum at the side of the sella Turcica, where it is immersed in the blood of the receptacle. It afterwards goes out at the foramen lacerum into the orbit, to serve the abductor muscle of the eye. In the passage of this nerve below the dura mater, it lies very contiguous to the internal carotid artery, and to the ophthalmic branch of the fifth pair of nerves. At the place where the sixth pair is contiguous to the carotid, a nerve either goes from each of them in an uncommon way, to wit, with the angle beyond where it rises obtuse to descend with the artery, and to form the beginning of the intercostal nerve, according to the common description; or, according to other authors, this nerve comes up from the great ganglion of the intercostal to be joined to the sixth here.

The arguments for this latter opinion are, that, according to the common doctrine, this beginning of the intercostal nerve, as it is called, would rise in a manner not ordinary in nerves. In the next place, it is observed, that the sixth pair is larger nearer to the other than it is before it comes to the place where this nerve is said to go off; and therefore it is said to be more probable that it receives an addition there, rather than gives off a branch. Lastly, it is found that, upon cutting the intercostal nerves of living animals, the eyes were plainly affected; they lost their bright water; the gum or gore, as we call it, was separated in greater quantity; the pupil was more contracted; the cartilaginous membrane, at the internal canthus, came more over the eye; and the eye-ball itself was diminished.

To this it is answered, in defence of the more common doctrine, 1st. That other branches of nerves go off in a reflected way, as well as this does, supposing it to be the beginning of the intercostal; and that the reflection would rather be greater, if it is thought to come up from the intercostal to the sixth. 2d. It is denied that this nerve is in ordinary thicker at its fore than at its back part; and if it was to be the thickest nearest to the orbit, the conclusion made above could not be drawn from this appearance, because other nerves enlarge sometimes where there is no addition made to them, as in the instance already mentioned of the trunk of the fifth pair, while below the dura mater. 3dly. The experiments on living animals show, indeed, that the eyes are affected upon cutting the intercostal nerve; but not in the way which might have been expected, if the intercostal had furnished such a share of the nerve that goes to the abductor muscle of the eye: for it might have been thought that this muscle would have been so much weakened immediately upon cutting the intercostal, that its antagonist, the adductor, would have greatly prevailed over it, and have turned the eye strongly in toward the nose; which is not said to be a consequence of this experiment: so that the arguments are still equivocal; and more observations and experiments must be made before it can be determined with certainty whether the sixth pair gives or receives a branch here. In the mean time, we shall continue to speak about the origin of the intercostal with the generality of anatomists.

At this place, where the intercostal begins, the fifth pair is contiguous, and adheres to the sixth; and it is generally said, that the ophthalmic branch of the fifth gives a branch or two to the beginning of the intercostal, or receives such from it. Others deny any such communication between them; and those who affirm the communication confess that, in some subjects, they could not see it.

The seventh or auditory pair comes out from the lateral part of the annular process, behind where the medullary process of the cerebellum is joined to that tube; and each being accompanied with a larger artery than most other nerves, enters the internal meatus auditorius, where the two large bundles of fibres, of which it appeared to consist within the skull, soon separate from each other: one of them entering by several small holes into the vestibule, cochlea, and semicircular canal, is stretched on the inner camera of the ear in a very soft pulpy substance; and being never seen in the form of a firm cord, such as the other parcel of this and most other nerves become, is called the portio mollis of the auditory nerve.

The other part of the seventh pair passes through Galen's foramen cœcum, or Fallopius's aqueduct, in its crooked passage by the side of the tympanum; in which passage a nerve sent to the lingual branch of the inferior maxillary nerve along the outside of the tuba Eustachiana, and across the cavity of the tympanum, where it has the name of chorda tympani, is commonly said to be joined to it. The very acute angle which this nerve makes with the fifth, or the sudden violent reflection it would suffer on the supposition of its coming from the fifth to the seventh, appears unusual; whereas if we suppose that it comes from the seventh to the fifth, its course would be more in the ordinary way, and the chorda tympani would be esteemed a branch of the seventh pair going to join the fifth, the size of which is increased by this acquisition. This smaller bundle of the seventh gives branches to the muscles of the malleus, and to the dura mater, while it passes through the bony crooked canal; and at last comes out in a firm chord, named portio dura, at the end of this canal, between the styloid and mastoid processes of the temporal bone, giving immediately filaments to the little oblique muscles of the head, and to those that rise from the styloid process. It then pierces through the parotid gland, and divides into a great many branches, which are dispersed in the muscles and teguments that cover all the side of the upper part of the neck, the whole face and cranium, as far back as the temples, including a considerable part of the external ear. Its branches having thus a considerable connection with all the three branches of the fifth pair, and with the second cervical, occasions a considerable sympathy of those nerves with it. Hence in the tooth-ache the pain is occasioned very little in the affected tooth, compared to what it is all along the side of the head and in the ear. By this communication or connection possibly too it is that a vibrating string held between one's teeth, gives a strong idea of a sound to the person who holds it, which nobody else can perceive. Perhaps too the distribution of this nerve occasions the head to be so quickly turned upon the impression of sound on our ears.

The eighth pair of nerves or par vagum rise from the lateral bases of the corpora olivaria in disgregated fibres, and as they are entering the anterior internal part of the holes common to the os occipitis and temporum, each is joined by a nerve which ascends within the dura mater from the tenth of the head, the first, second, and inferior cervical nerves: this every body knows has the name of the nervus accessorius. When the two get off the skull, the accessorius separates from the eighth, and descending obliquely outward passes through the sterno-mastoideus muscle, to which it gives branches, and afterwards terminates in the trapezius muscle of the scapula. In this course it is generally, more or less, joined by the second cervical nerve. Why this nerve, and several others which are distributed to muscles, are made to pierce through muscles, which they might have only passed near to, we do not know.

The large eighth pair, soon after its exit, gives nerves to the tongue, larynx, pharynx, and ganglion, of the intercostal nerve; and being disjoined from the ninth and intercostal, to which it adheres closely some way, runs straight down the neck behind the internal jugular vein, and at the external side of the carotid artery. As it is about to enter the thorax, a large nerve goes off from the eighth of each side; this branch of the right side turns round from the fore to the back part of the subclavian artery, while the branch of the left side turns round the great curve of the aorta; and both of them mounting up

again at the side of the oesophagus, to which they give branches, are lost at last in the larynx. These are called the recurrent nerves. The muscles of the larynx being in a good measure supplied with nerves from the recurrent, it is to be expected that the cutting of them will greatly weaken the voice, though it will not entirely be lost so long as the superior branches of the eighth pair are entire. Why the recurrent nerves rise so low from the eighth pair, to go round a large artery, and to have such a long course upward, we know not.

The eighth pair above, and at or near the place where the recurrent nerves go off from it, or frequently the recurrents themselves, send off small nerves to the pericardium, and to join with the branches of the intercostal that are distributed to the heart; but their size and situation are uncertain.

After these branches are sent off, the par vagum on each side descends behind the great branch of the trachea, and gives numerous filaments to the lungs, and some to the heart, in going to the oesophagus. The one of the left side running on the fore part of the oesophagus, communicates by several branches with the right one in its descent to be distributed to the stomach; the right one goes behind the oesophagus, where it splits and rejoins several times before it arrives at the stomach, to which it sends nerves; and then being joined by one or more branches from the left trunk, they run toward the cœliac artery, there to join into the great semilunar ganglion formed by the two intercostals.

From the distribution of the par vagum we may learn how tickling the fauces with a feather, or any such substance, excites a nausea and inclination to vomit; why coughing occasions vomiting, or vomiting raises a cough; why an attempt to vomit is sometimes in danger of suffocating asthmatic people; why the superior orifice of the stomach is so sensible as to be looked on as the seat of the soul by some; why people subject to distensions of the stomach have so often the sensation of balls in their breast and throat; why the globus hystericus is so often attended with a violent strangulation of the glottis.

The ninth pair of nerves comes from the inferior part of the corpora pyramidalia, to go out of the skull at their proper holes of the occipital bone. After their egress they adhere for some way to the eighth and intercostal; and then sending a branch that, in many subjects, is joined with branches of the first and second cervical nerves, to be distributed to the thyroid gland and muscles on the fore part of the trachea arteria, the ninth is lost in the muscles and substance of the tongue. Some have thought this nerve, and others have esteemed the third branch of the fifth pair of nerves, to be the proper gustatory nerve. We know no observation or experiments to prove either opinion, or to assure us that both nerves do not serve for tasting and for the motion of the tongue. May not the distribution of this nerve to the muscles below as well as above the os hyoides, contribute to their acting more uniformly in depressing the lower jaw or head?

The tenth pair rises in separate threads from the sides of the spinal marrow, to go out between the os occipitis and first vertebra of the neck. After each of them has given branches to the great ganglion of the intercostal, eighth, ninth, and first cervical nerves, it is distributed to the straight, oblique, and some of the extensor muscle of the head. Whether the name of the tenth of the head, or of the first vertebral, ought to be given to this pair of nerves, is of no such consequence as to deserve a debate, though it has some of the mark of spinal nerves; to wit, its being formed of filaments, proceeding from both the fore and back part of the medulla; and a little ganglion being formed where these filaments meet.

In the description of the sixth pair we followed the usual way of speaking among anatomists, and called that the beginning of the intercostal nerve which comes out of the skull; and shall therefore here subjoin a cursory description of this nerve, notwithstanding its much larger part is composed of nerves coming out from the spinal marrow. There is no greater incongruity in point of method to say, that the nerve we are describing receives additions from others that have not been described, than it is to repeat in the description of a great many nerves, that each of them gives branches to form a nerve which we are ignorant of; which is all the difference between describing the intercostal before or after the spinal nerves.

The branch reflected from the sixth pair, joined possibly by some filaments of the ophthalmic branch of the fifth, runs along with the internal carotid artery, through the crooked canal formed for it in the temporal bone, where the little nerve is very soft and pappy, and in several subjects divides and unites again, and is joined by one or more branches from the fifth, particularly of its superior maxillary branch, before it comes out of the skull. May not the compression of this nerve by the carotid artery, when stretched during the systole, contribute to the diastole of the heart? As soon as the nerve escapes out of the bony canal, it is connected a little way with the eighth and ninth; then separating from these, after seeming to receive additional nerves from them, it forms a large ganglion, into which branches from the tenth of the head, and from the first and second cervical, enter. From the ganglion the nerves come out again small, to run down the neck along with the carotid artery, communicating by branches with the cervical nerves, and giving nerves to the muscles that bend the head and neck. As the intercostal is about to enter the thorax it forms another ganglion, from which nerves are sent to the trachea and to the heart; those designed for the heart, joining with the branches of the eighth, and most of them passing between the two great arteries and the auricles, as the substance of that muscle. The intercostal after this consisting of two branches, one going behind, and the other running over, the fore part of the subclavian artery, forms a new ganglion where the two branches unite below the artery; and then descending along the sides of the vertebræ of the thorax, receives branches from each of the dorsal nerves; which branches appearing to come out between the ribs, have given the name of intercostal to the whole nerve. Where the addition is made to it from the fifth dorsal nerve, a branch goes off obliquely forward; which being joined by such branches from the sixth, seventh, eighth, and ninth dorsal, the anterior trunk is formed, and passes between the fibres of the appendix musculosa of the diaphragm to them, along with the other intercostal and the branches of the eighth pair, a large semilunar ganglion, situated between the cellular and superior mesenteric arteries; the roots of which are as it were involved in a sort of nervous net-work of this ganglion, from which a great number of very small nervous threads run out to be extended on the surface of all the branches of those two arteries, so as to be easily seen when any of the arteries are stretched, but not to be raised from them by dissection; and thus the liver, gall-bladder, duodenum, pancreas, spleen, jejunum, ilium, and a large share of the colon, have their nerves sent from this great solar ganglion or plexus. May not the peristaltic motion of the intestines depend, in some measure, on the passage of the intercostal nerves through the diaphragm?

Several fibres of this ganglion, running down upon the aorta, meet with other nerves, sent from the posterior trunk of the intercostal, which continues its course along the sides of the vertebræ: they supply the glandular renales, kidneys, and testes in men, or ovaria in women; and then they form a net-work on the inferior mesenteric artery, where the nerves of the two sides meet, and accompany the branches of this artery to the part of the colon that lies in the left side of the belly, and to the rectum, as far down as the lower part of the pelvis.

The intercostal continuing down by the sides of the vertebræ of the loins, is joined by nerves coming from between these vertebræ, and sends nerves to the organs of generation, and others to the pelvis, being even joined with those that are sent to the inferior extremities.

The spinal nerves rise generally by a number of disgregated fibres from both the fore and back part of the medulla spinalis; and soon after form a little knot or ganglion, where they acquire strong coats, and are extended into firm cords; but the ganglion is entirely formed by the posterior bundle. They are distinguished by numbers, according to the vertebræ from between which they come out; the superior of the two bones forming the hole through which they pass, being the one from which the number is applied to each nerve. There are generally said to be thirty pair of them; seven of which come out between the vertebræ of the neck, twelve between those of the back, five between those of the loins, and six from the false vertebræ.

The first cervical pair of nerves comes out between the first and second vertebræ of the neck; and having given branches to join with the tenth pair of the head, the second cervical, and intercostal, and to serve the muscles that bend the neck, it sends its largest branches backwards to the extensor muscles of the head and neck; some of which piercing through these muscles, run up on the occiput to be lost in the teguments here; and many fibres of it advance so far forward as to be connected with the fibrils of the first branch of the fifth pair of the head, and of the portio dura of the auditory nerve. Hence possibly it is, that a clavus hystericus changes suddenly sometimes, from the forehead to a violent pain and spasm in the back part of the head, and neck.

The second cervical is soon joined by some branches to the ninth of the head and inter-

costal, and to the first and third of the neck; then has a large branch that comes out at the exterior edge of the sterno-mastoideus muscle, where it joins with the accessorius of the eighth pair; and is afterwards distributed to the platysma myoides, teguments of the side of the neck and head, parotid gland, and external ear, being connected to the portio dura of the auditory nerve, and to the first cervical. The remainder of this second cervical is spent on the levator scapulæ and the extensors of the neck and head. Generally a large branch is here sent off to join the accessorius of the eighth pair, near the superior angle of the scapula. From the irritation of the branches of this nerve it probably is, that in an inflammation of the parotid gland, the neck is pained so far down as the clavicle, the head is drawn towards the shoulder of the affected side, and the chin is turned to the other side.

The third pair of the neck passes out between the third and fourth cervical vertebræ; having immediately a communication with the second, and sending down a branch, which, being joined by a branch from the fourth cervical, forms the phrenic nerve. This descending enters the thorax between the subclavian vein and artery; and then being received into a groove formed by it in the pericardium, it has its course along the capsula of the heart, till it is lost in the middle part of the diaphragm. The right phrenic has a straight course; but the left one is obliged to make a considerable turn outwards, to go over the prominent part of the pericardium, where the point of the heart is lodged. Hence in violent palpitations of the heart, a pungent acute pain is felt near the left orifice of the stomach. The middle of the diaphragm scarce could have been supplied by any other nerve which could have had such a straight course as the phrenic has.

The other branches of the third cervical nerve are distributed to the muscles and teguments at the lower part of the neck and top of the shoulder. No wonder then that an inflammation of the liver or spleen, an abscess in the lungs adhering to the diaphragm, or any other cause capable of irritating the diaphragm, should be attended with a sharp pain on the top of the shoulder, as well as wounds, ulcers, &c. of the muscle itself. If the irritation of the muscle is very violent, it may occasion that convulsive contraction of the diaphragm which is called an hiccough.

The fourth cervical nerve, after sending off that branch which joins with the third to form the phrenic, and bestowing twigs in the muscles and glands of the neck, runs to the armpit, where it meets with the fifth, sixth, and seventh cervicals, and first dorsal, that escape in the interstices of the musculi scaleni to come at the armpit, where they join, separate, and rejoin, in a way scarcely to be rightly expressed in words; and, after giving several considerable nerves to the muscles and teguments which cover the thorax, they divide into several branches, to be distributed to all the parts of the superior extremity. Several of these branches we shall describe under particular names.

1. Scapularis runs straight to the cavitas semilunata of the upper coats of the scapula, which is a hole in the recent subject, by a ligament being extended from one angle of the bone to the other; giving nerves, in its way, to the muscles of the scapula. When it has passed this hole it supplies the supraspinatus muscle, and then descending at the anterior of the spine of the scapula, it is lost in the other musclesthat lie on the dorsum of that bone.

2. Articularis sinks downwards at the axilla, to get below the neck of the head of the os humeri, and to mount again at the back part of it; so that it almost surrounds the articulation, and is described in the muscles that draw the arm back, and to those that raise it up.

3. Cutaneus runs down the fore part of the arm, near the skin, to which it gives off branches; and then divides on the inside of the fore-arm into several nerves which supply the teguments there, and on the palm of the hand. In opening the basilic vein of the arm, at the usual place, the same symptoms are sometimes produced as in opening the external jugular vein, and from a like cause; to wit, from hurting a branch of this cutaneous nerve with the lancet.

4. Musculo-cutaneus, or perforans casseri, passes through the coraco-brachialis muscle; and after supplying the biceps, flexor cubiti, and brachialis internus, passes behind the tendon of the biceps, and over the cephalic vein, to be bestowed on the teguments on the outside of the fore arm and back of the hand. This nerve is sometimes hurt in opening the cephalic vein, and causes pain and numbness for a short time.

5. Muscularis has a spinal course from the axilla, under the os humeri, and backward to the external part of that bone; supplying by the way the extensor muscles of the forearm, to which it runs between the two brachial muscles, and within the supinator radii longus. At the upper part of the fore arm, it sends off a branch which accompanies the supinator longus, till it comes near the wrist; where it passes obliquely over the radius, to be lost in the back of the hand and fingers. The principal part of this nerve pierces through the supinator radii brevis, to serve the muscles that extend the hand and fingers, whose actions are not injured when the supinator acts. Part of this nerve seems to be lost upon the ligament of the wrist.

6. Ulnaris is extended along the inside of the arm, to give nerves to the muscles that extend the fore arm, and to the teguments of the elbow: toward the lower part of the arms it slants a little backward to come at the groove behind the internal condyle of the os humeri, through which it runs to the ulna. In its course along this bone it serves the neighbouring muscles and teguments; and as it comes near the wrist, it detaches a branch obliquely over the ulna to the back of the hand, to be lost in the convex part of the several fingers. The larger part of the nerve goes forward to the internal side of the os pisiforme of the wrist; where it sends off a branch, which sinks under the large tendons in the palm to go across to the other side the wrist, serving the musculi lumbricales and interossei, and at last terminating in the short muscles of the thumb and fore-finger. What remains of the ulnar nerve after supplying the short muscles of the little finger, divides into three branches: whereof two are extended along the sides of the sheath of the tendons of the flexors of the little finger, to furnish the concave side of that finger; the third branch is disposed in the same way upon the side of the ring-finger, next to the little finger.

When we lean or press upon the internal condyle of the os humeri, the numbness and pricking we frequently feel, point out the course of this nerve. We have seen a weakness and strophy in the parts which we mentioned this nerve to be sent to, after a wound in the internal lower part of the arm.

7. Radius accompanies the humeral artery to the bending of the elbow, serving the flexor of the cubit in its way; then passing through the pronator radii teres muscle, it gives nerves to the muscles on the fore part of the fore arm, and continues its course near to the radius, bestowing branches on the circumjacent muscles. Near the wrist it sometimes gives off a nerve which is distributed to the back of the hand, and the convex part of the thumb, and several of the fingers, instead of the branch of the muscular. The large part of the nerve passing behind the annular ligament of the wrist, gives nerves to the short muscles of the thumb; and afterwards sends a branch along each side of the sheath of the tendons of the flexors of the thumb, fore-finger, middle-finger, and one branch of the side of the ring-finger, next to the middle one, to be lost on the concave side of those fingers.

Though the radial nerve passes through the pronator muscle, and the muscular nerve seems to be still more unfavourably placed within the supinator brevis; yet the action of these muscles does not seem to have any effect in hindering the influence of these nerves; for the fingers or hand can be bent while pronation is performing vigorously, and they can be extended while supination is exercised.

The manner of the going off of these nerves of the fingers, both from the ulnar and the radial, is, that a single branch is sent from the trunk to the side of the thumb and little finger farthest from the other fingers; and all the rest are supplied by a trunk of a nerve, which splits into two in some way before it comes as far as the end of the metacarpus, to run along the sides of the different fingers that are nearest to each other.

It might have been observed, that in describing the posterior branches of the ulnar and muscular nerve, we did not mention the particular fingers, to the convex part of which they are distributed. The reason for this omission is, the uncertainty of their distribution; for though sometimes these posterior branches go to the same fingers, to the concave part of which the anterior branches of the ulnar and radial are sent, yet frequently they are distributed otherwise.

The twelve dorsal nerves of each side, as soon as they escape from between the vertebræ, send a branch forward to join the intercostal, by which a communication is made among them all; and they soon likewise give branches backward to the muscles that raise the trunk of the body, their principal trunk being extended outwards to come at the furrow in the lower edge of each rib; in which they run toward the anterior part of the thorax, between the internal and external intercostal muscles, giving off branches in their course to the muscles and teguments of the thorax.

The first dorsal, as was already observed

is particular in this, that it contributes to form the brachial nerves; and that the two branches of the intercostal which come down to the thorax form a considerable ganglion with it.

The sixth lower dorsal nerves give branches to the diaphragm and abdominal muscles.

The twelfth joins with the first lumbar, and bestows nerves on the musculus quadratus lumborum and illiacus internus.

May not the communications of all these nerves be one reason why the parts they serve act so uniformly and conjunctly in respiration, and conspire together in the convulsive motions of coughing, sneezing, &c.?

The communications of these lower ones with the intercostals, may serve to explain the violent efforts of the abdominal muscles in a tenesmus, and in childbearing.

As the intercostal is larger in the thorax than any where else, and seems to diminish gradually as it ascends and descends, there is cause to suspect that this is the trunk from which the superior and inferior parts are sent as branches.

The five lumbar nerves on each side, communicate with the intercostal and with each other, and give branches backward to the loins.

The first communicates with the last dorsal, sends branches to the abdominal muscles, to the psoas iliacus, and to the teguments and muscles of the fore-parts of the thigh; while its principal branch joins with the other nerves, to form the crural nerve.

The second lumbar nerve passes through the psoas muscle, and is distributed nearly in the same way as the former; as is also the third.

Branches of the second, third, and fourth, make up one trunk which runs along the fore part of the pelvis, and passing in the notch at the fore part of the great hole, common to the os pubis and ischium, is spent on the adductor muscles, and on the teguments on the inside of the thigh. This nerve is called the obturator or posterior crural nerve.

By uniting branches from the second third and fourth lumbar nerves, a nerve is formed that passes along the psoas muscle, to escape with the external iliac vessels out of the abdomen, below the tendinous arcade of the external oblique muscle. This nerve which is named the anterior crural, is distributed principally to the muscles and teguments of the fore part of the thigh. A branch however of this nerve runs down the leg to the upper part of the foot, keeping near the vena saphena; in opening of which with a lancet at the ankle, the nerve is somewhat hurt, and occasions sharp pain at the time of operation, and afterwards numbness.

The remainder of the fourth lumbar and the fifth, join in composing the largest nerve of the body, which is soon to be described.

Whoever attends to the course of these lumbar nerves, and of the spermatic vessels and nerves upon the psoas muscle, with the oblique passage of the ureter over that muscle, will not be surprised that when a stone is passing in this canal, or even when it is inflamed, the trunk of the body cannot be raised erect without great pain, or that the skin of the thigh becomes less sensible, and the thigh is drawn forward, and that the testicle often swells, and is drawn convulsively towards the ring of the abdominal muscles.

The sixth pair of the false vertebræ consist each of small posterior branches sent to the hips and large anterior branches.

The first, second, and third, after coming through the three upper holes of the os sacrum, join together with the fourth and fifth of the loins, to form the largest nerve of the body, which is well known by the name of schiatic or ischiatic nerve: this, after sending large nerves to the different parts of the pelvis, and to the external parts of generation and the povex, as also to the muscles of the hips, passes behind the great tuber of the os ischium, and then over the quadrigemini muscles to run down near to the bone of the thigh at its back part, giving off nerves to the neighbouring muscles and teguments some way above the ham, where it has the name of popliteus nerve, it sends off a large branch that passes over the fibula, and sinking, among the muscles on the anterior external part of the leg, runs down to the foot to be lost in the upper part of the larger toes, supplying the neighbouring muscles and teguments every where in its passage. The larger branch of the schiatic, after giving branches to the muscles and teguments above the ham and knee, and sending a large cutaneous nerve down the calf of the leg to be lost at last on the outside of the foot, and the upper part of the lesser toes, sinks below the gemellus muscle, and distributes nerves to the muscle on the back of the leg, among which it continues its course till passing behind the malleolus internal, and in the internal hollow of the os calcis, it divides into the two external and internal plantar nerves. The internal is distributed to the toes in the same manner that the radial nerve of the hand serves the concave side of the thumb and fingers; and the external plantar is divided and distributed to the sole of the foot and toes, nearly as the ulnar nerve is in the palm of the hand, and in the concave part of the fingers.

Several branches of these nerves that serve the inferior extremities, pierce through muscles.

The fourth, which with the two following, is much smaller than the three superior, soon is lost in the vesica urinaria and intestinum rectum.

The fifth comes forward to the extremity of the os sacrum and coccygis to be distributed principally to the levatores ani.

The sixth may be considered as the termination of a substance called ligamentum denticulatum. For the uses of the various parts of the human body, see the article PHYSIOLOGY. See also COMPARATIVE ANATOMY.

EXPLANATION OF THE ANATOMICAL PLATES.

EXPLANATIONS OF THE BONES.

FIG. 1.

1. The Cranium.
2. The Cervical Vertebræ.
3. The Clavicles.
4. The Acroniums.
6. The Humerus.
7. The Radius.
8. The Ulna.
9. The Carpus.
10. The Metacarpus.
11, 12. The Sternum.
13. The Ribs.
a. The true Ribs.
c. The false Ribs.
c. The transverse processes of the Lumbar Vertebræ.
14. The Lumbar Vertebræ.
15. The os Sacrum.
16. The os Innominata.
17. The ossa Ilii.
18. The ossa Pubis.
19. The ossa Ischii.
r. The brim of the Pelvis.
s. The foramen Thyroideum.
t. The trochanter Major.
u. The trochanter Minor.
20. The Femur.
21. The Patella.
22. The Tibia.
23. The inner Ancle.
24. The Fibula.
25. The Astragabes.
26, 27, 28, 29. The Tarsus.
30. The Metatarsus.

FIG. II.

1. The Cranium.
2. The os occipitis.
4. The os Temporis.
5. The os Sphenoides.
6. The Scapula.
7. Its Spine.
8. The Humerus.
9. The Radius.
10. The Ulna.
11. The Olecranon.
12. The Carpus.
13. The Metacarpus.
14. The cervical Vertebræ.
15. The Clavicles.
a. a. The Spines of the cervical Vertebræ.
p. The Ribs.
16. The lumbar Vertebræ.
17. The ossa Innominata.
18. Their Spines.
19. The ossa Pubis.
20. The os Sacrum.
22. The Femur.
24. The trochanter Minor.
25. The Patella.
26. The Tibia.
27. Fibula.
28. The os Calcis.
a, b, c, d, e. The bones of the Foot.

EXPLANATIONS OF THE MUSCLES.

FIG. 1. Superficial Muscles.

a. Platystica Myoides.
b. Deltoides.
c. Biceps.
d. Provator Teres.
e. Supinator Longus.
f. Flexor Radialis.
g. Palmaris Longus.
h. Flexor Ulnaris.
i. Pectoralis Major.
k. Obliquus Externus.
l. Linea Semilunaris.
m. Linea Alba.
n. Abdominal Ring.
o. Sartorius.
p. Tensor Femoris Vaginæ.
q. Long head of the Triceps.

r. Pectinalis.
s. Short head of Triceps.
t. Great head of Triceps.
u. Obturator Externus.
v. Fascia of the Thigh.
w. Rectus Cruris.
x. Its termination in the Patella.

FIG. 2.

a. Sterno-Cleido-Mastoideus.
b. Sterno-Hyoideus.
c. Biceps.
d. Flexor Digitorum.
e. Pectoralis Minor.
f. Serratus Magnus.
g. Transversalis.
h. Pyramidalis.
i. Obliquus Internus.
k Pectinalis.
l. Obturator Externus.
m. Triceps Brevis.
n. Triceps Magnus.
o. Triceps Longus.
p. Vastus Externus.
q. Cruralis.
r. Vastus Internus.
s. Ligament of the Patella.

FIG. 3.

a. Trapezius.
b. Latissimus Dorsi.
c. Deltoides.
d. Triceps Cubiti.
e. Gluteus Magnus.
f. Biceps Cruris.
g. Semitendinosus.
h. Semimembranosus.

FIG. 4.

a. Levator Scapulæ
b. Supra-Spinatus.
c. Infra-Spinatus.
d. Rhomboideus Minor.
e. Rhomboideus Major.
f. Triceps Cubiti.
g. Serratus Inferior Posticus.
h. Gluteus Minimus.
i. Obliquus Internus.
k. Biceps.
l. Gracilis.
m. Semitendinosus.
n. Plantaris.
o. Soleus.
p. Serratus Superior Posticus.

EXPLANATIONS OF THE VISCERA.

FIG. 1.

1. The Liver.
2. The round Ligament.
3. The Gall Bladder.
4. The Pancreas.
5. The Spleen.
6. The Kidneys.
7. The Aorta.
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FIG. 2.

1. The Vertebræ of the Neck.
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5. The Spermatic.
6. The branches of the Superior Mesenteric.

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a. The anterior lobes of the Brain.
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c. The Cerebellum.
d. The Medulla Oblongata.
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a, a. The convolutions of the Cerebrum.
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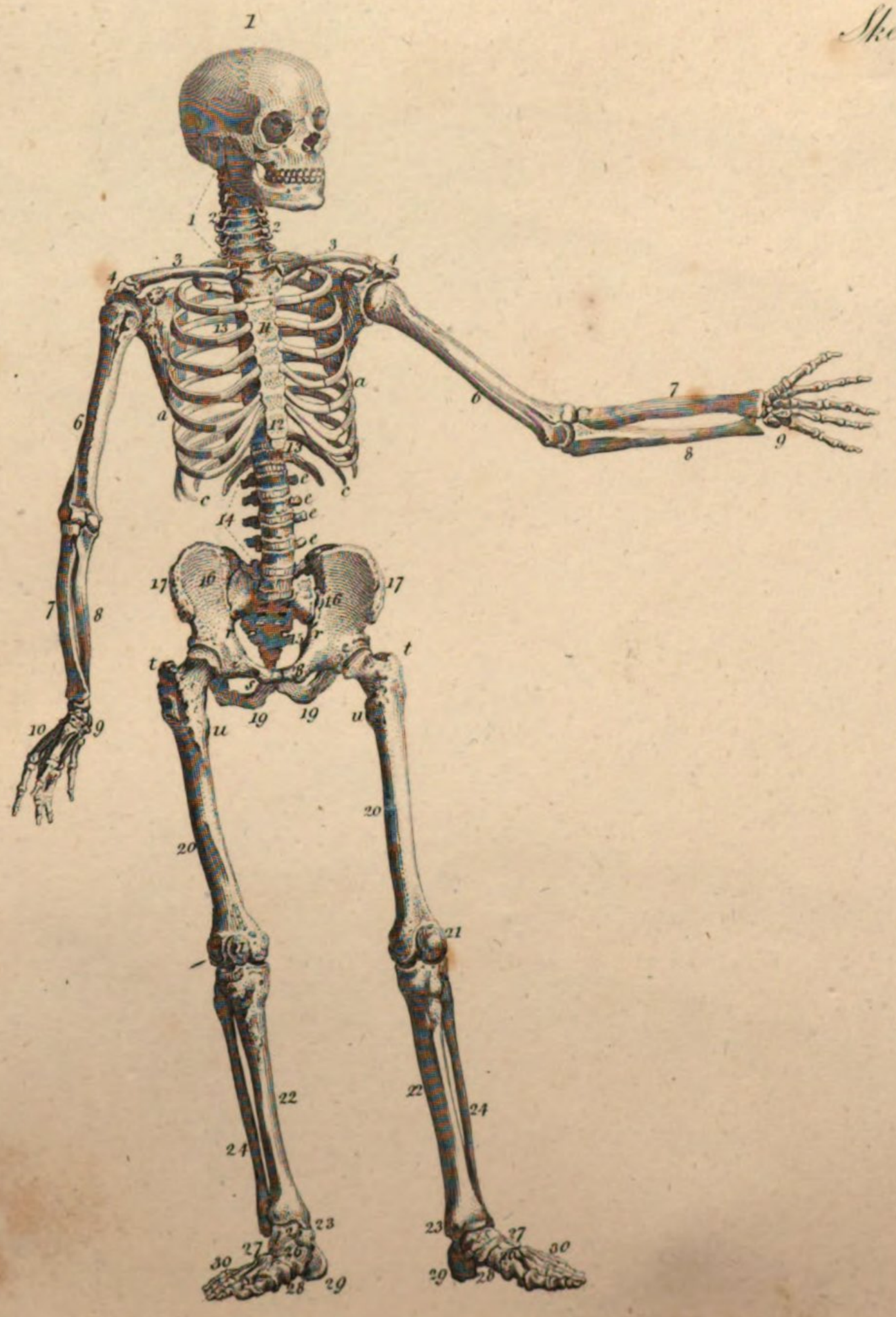
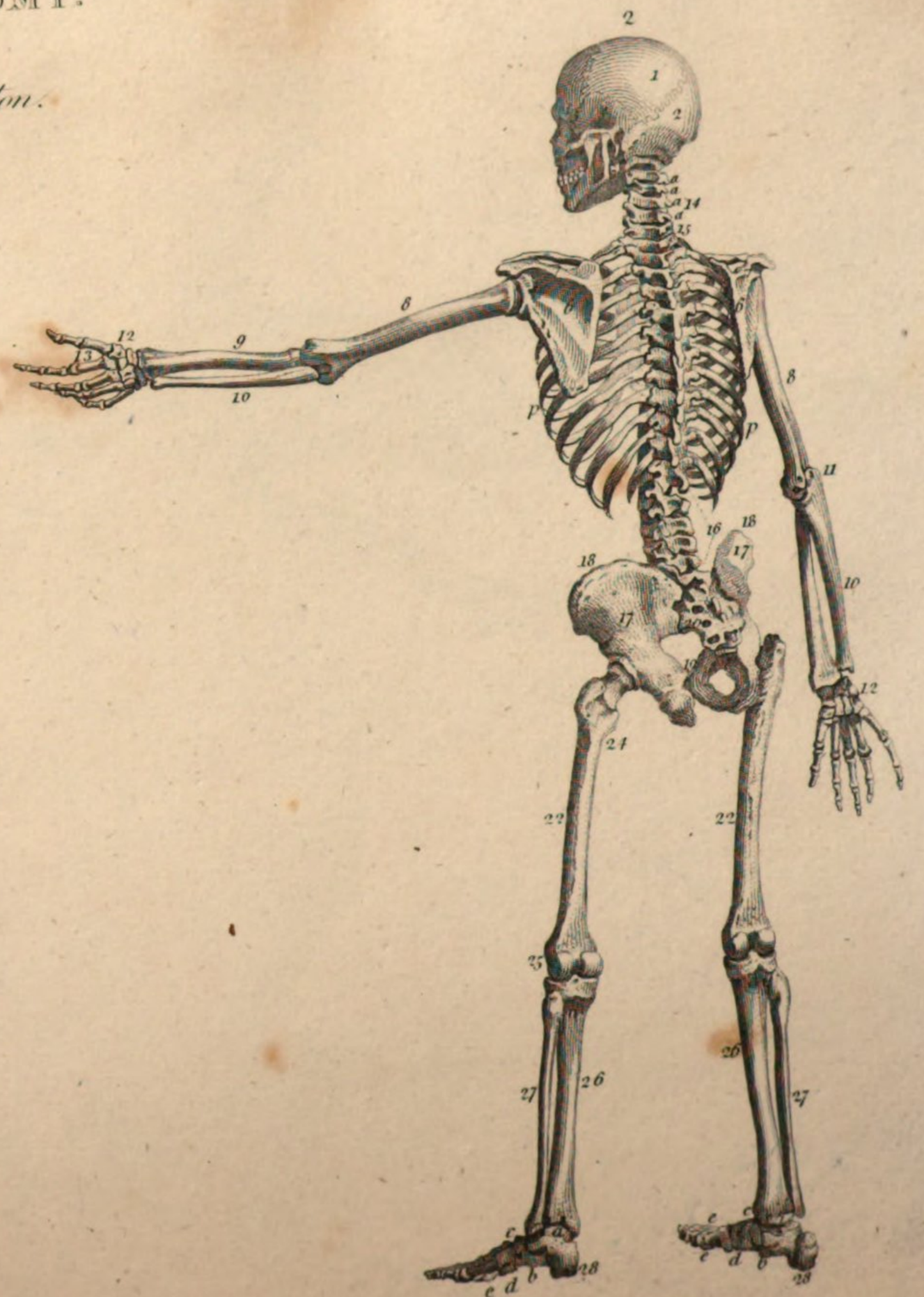
ANATOMY.

Skeleton.





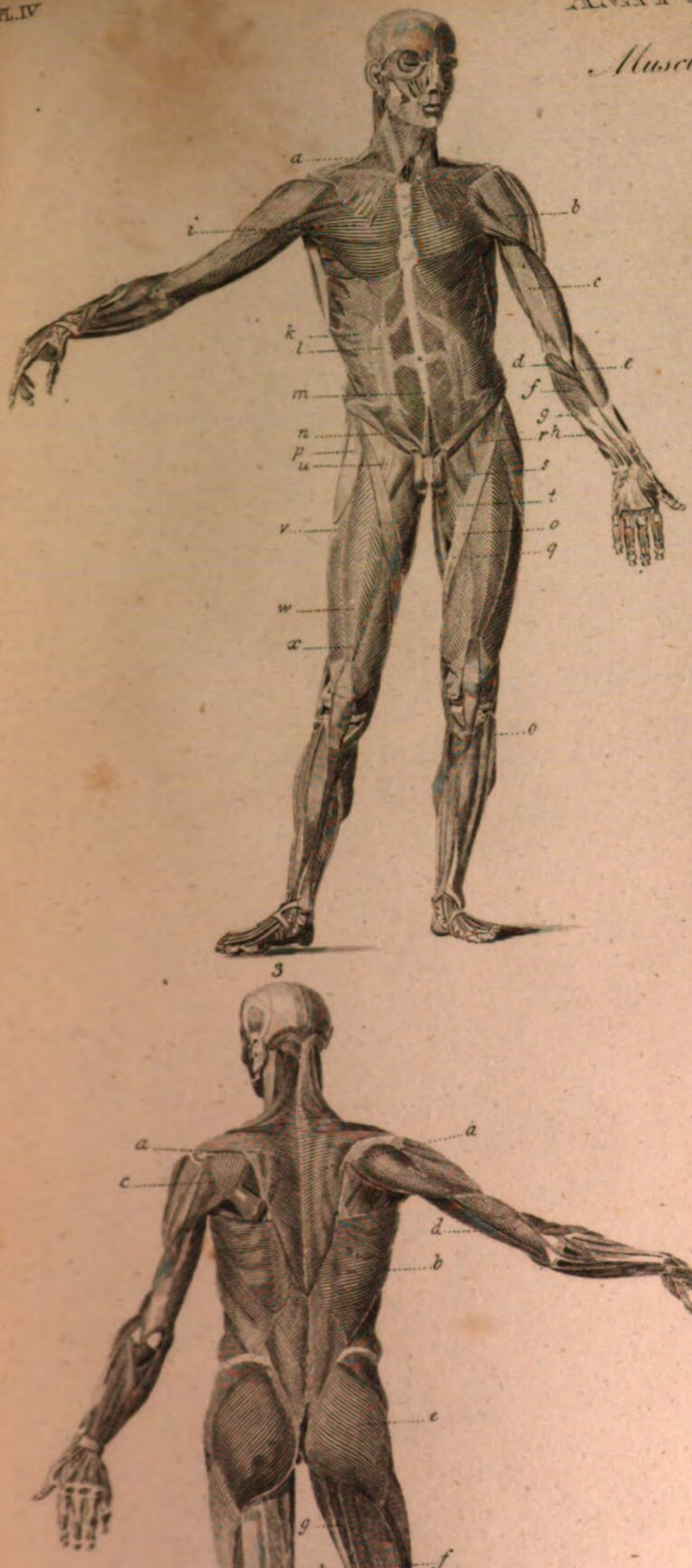
Printed March 1. 1808 for Richard Phillips, New Bridge Street, Blackfriars.

PL. IV

ANATOMY.

Muscles.

1



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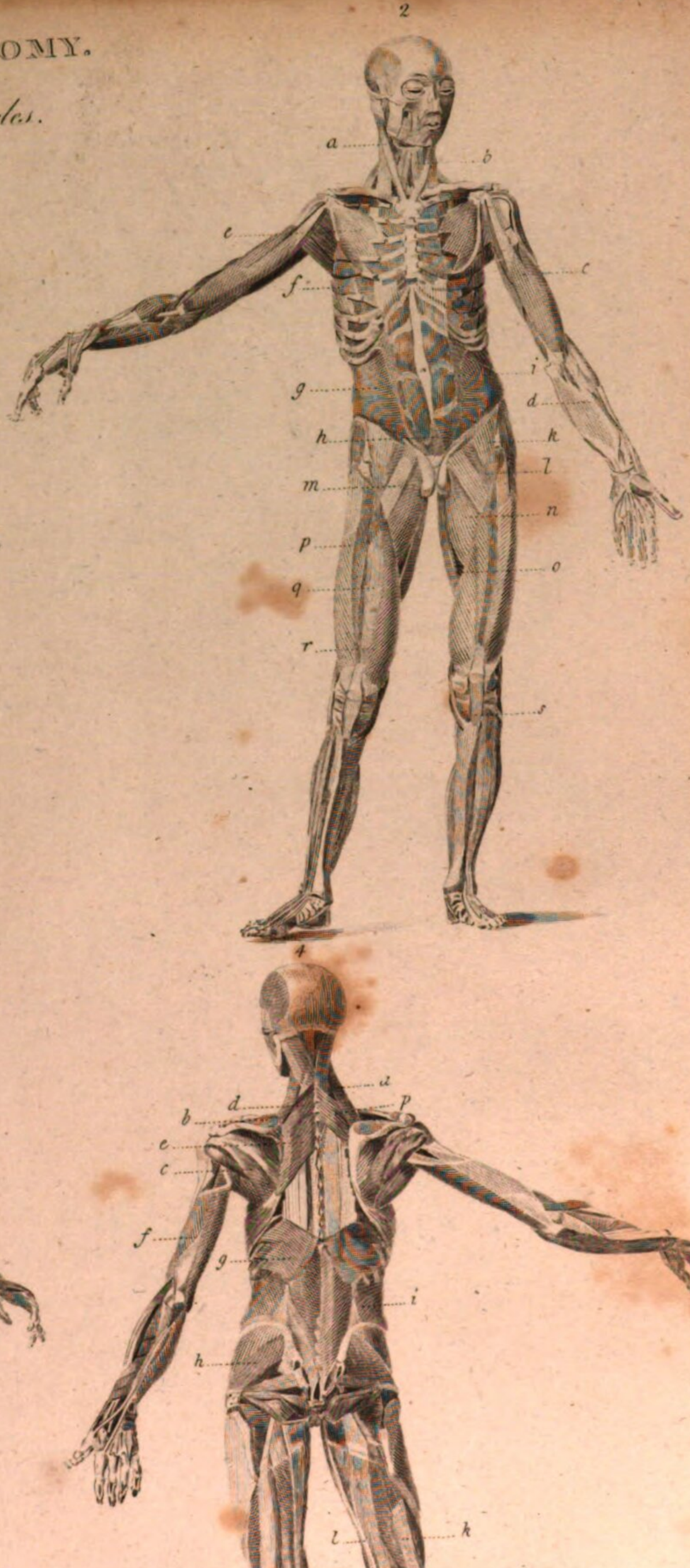

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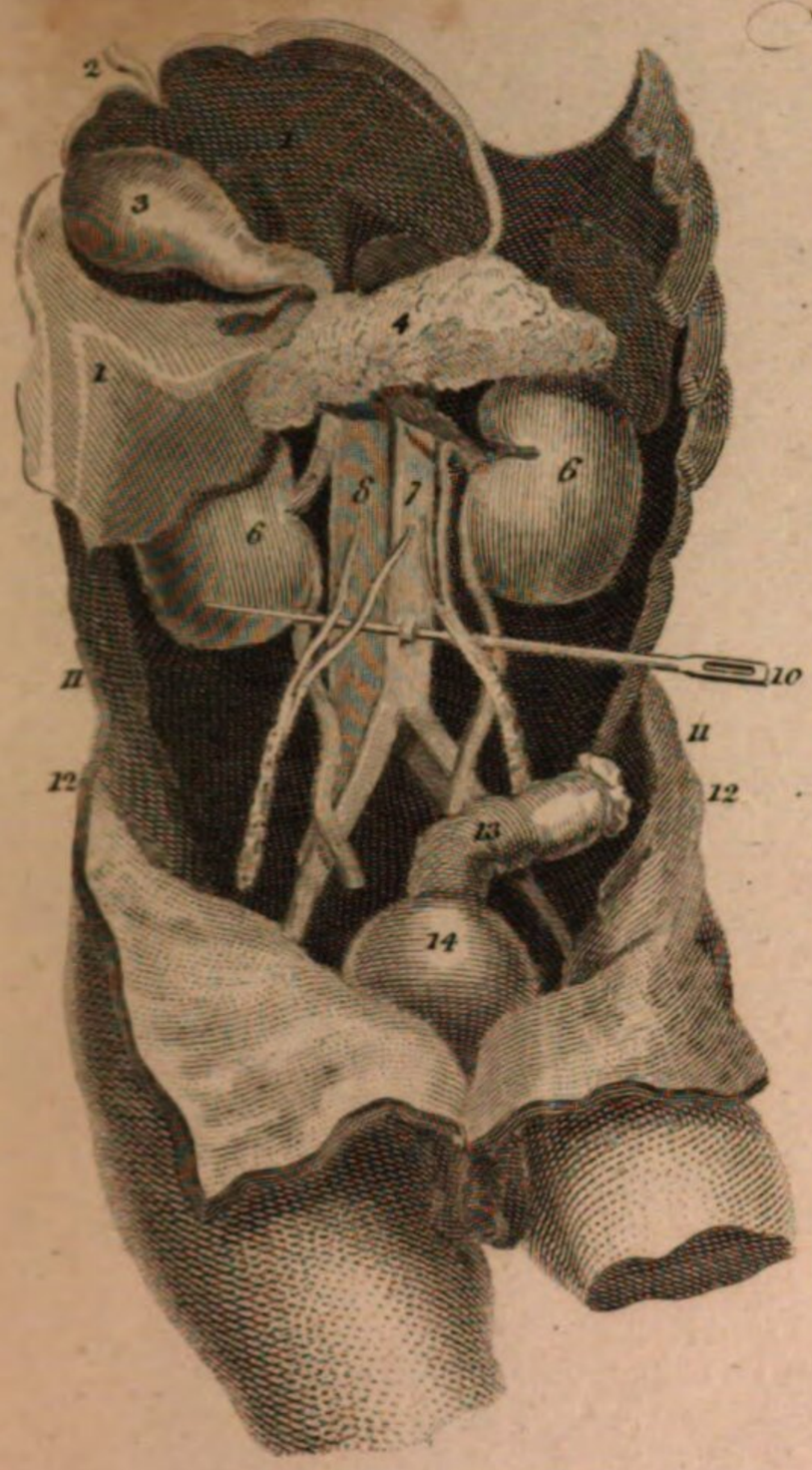
Printed March 1-1805, for Richard Phillips, New Bridge Street, Blackfriars.

ANATOMY.

Viscera, Brain, &c.

1.



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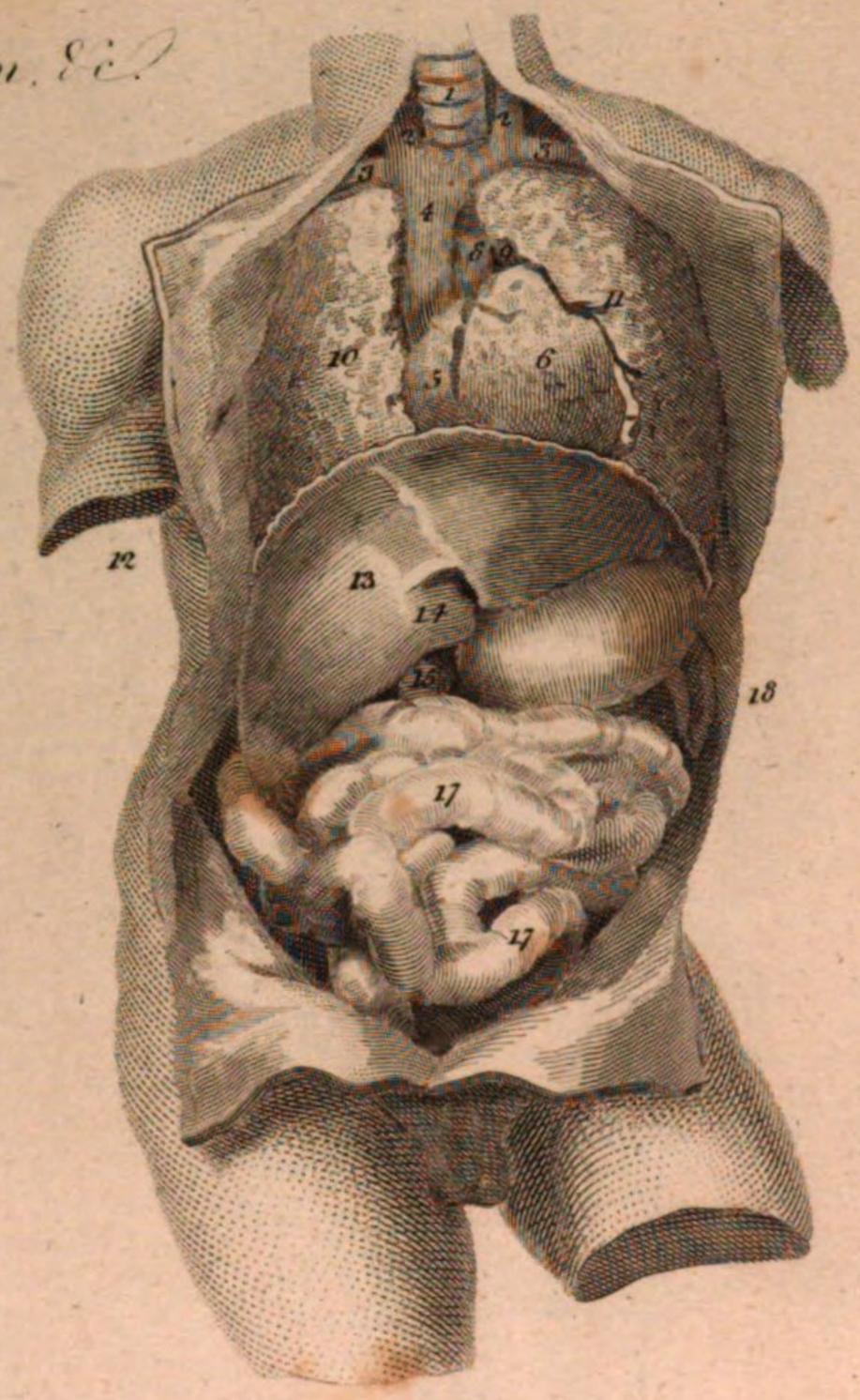

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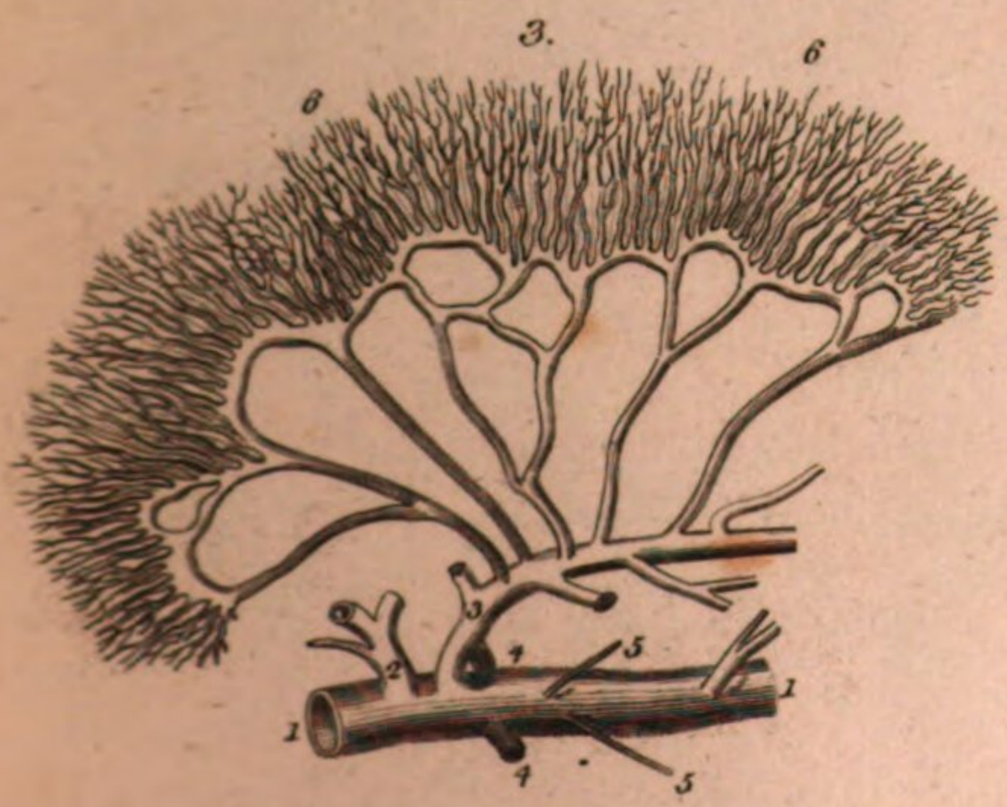

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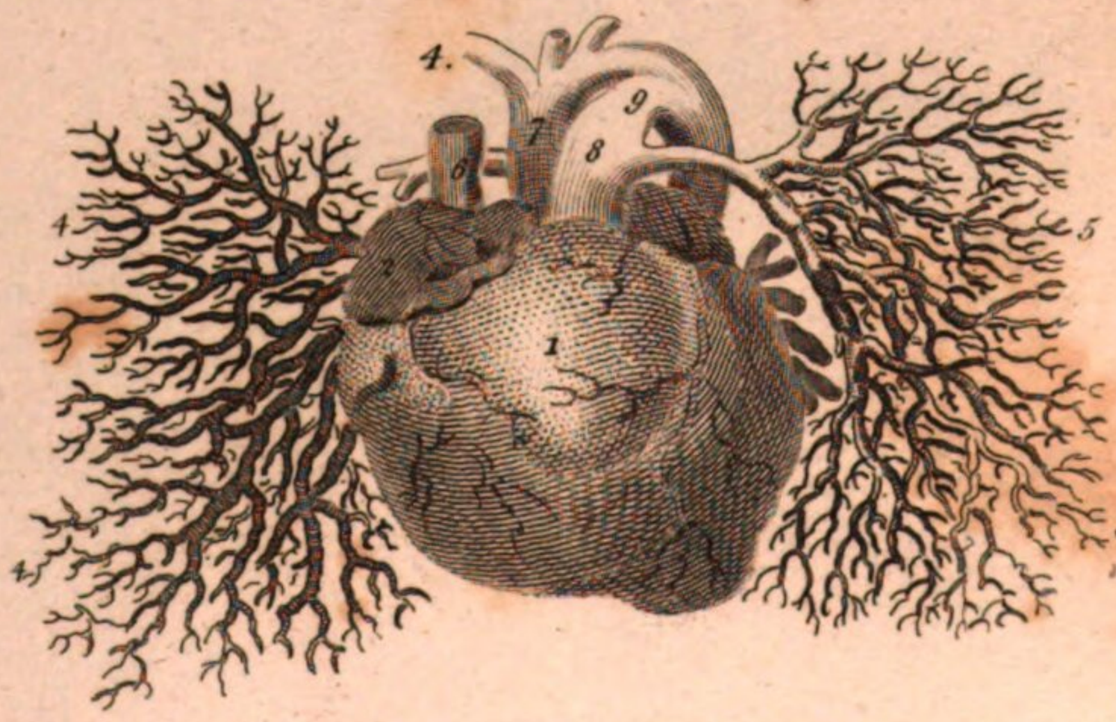

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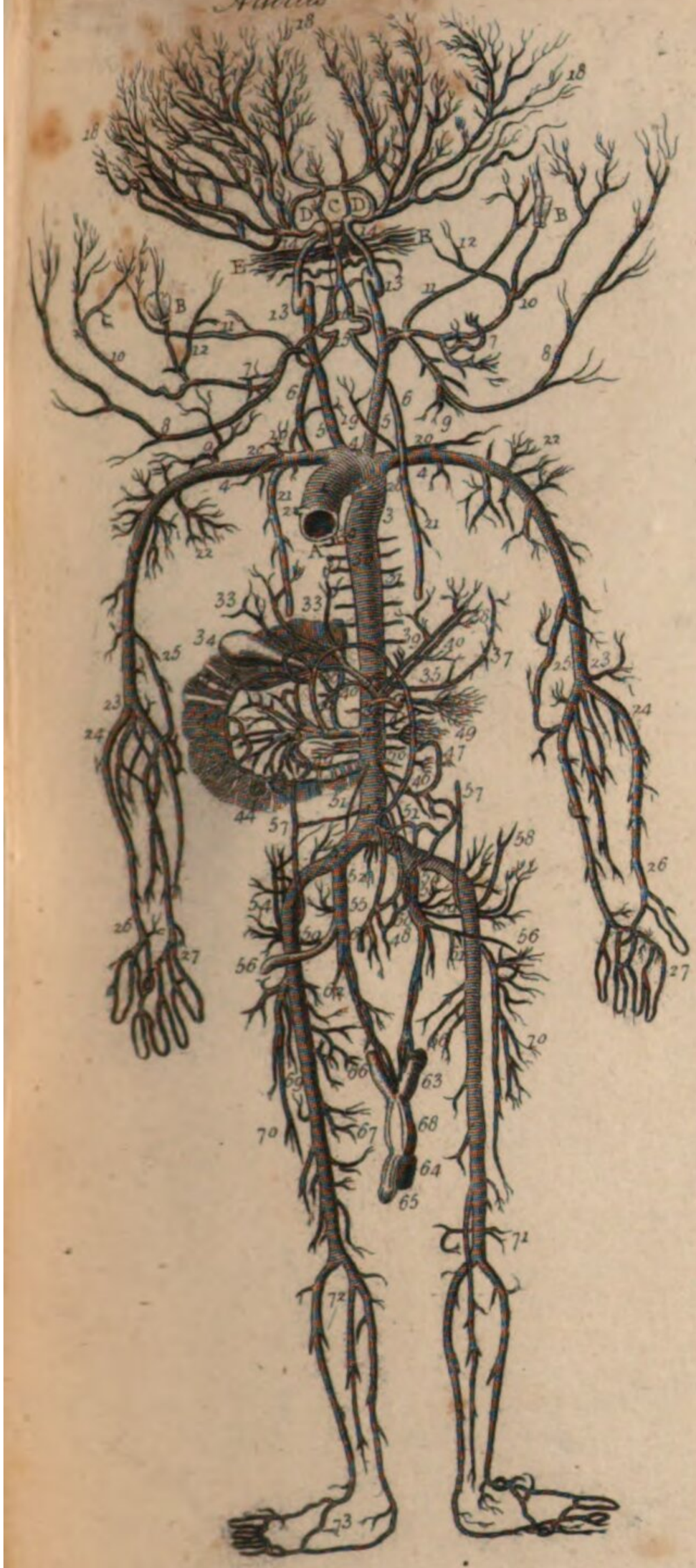
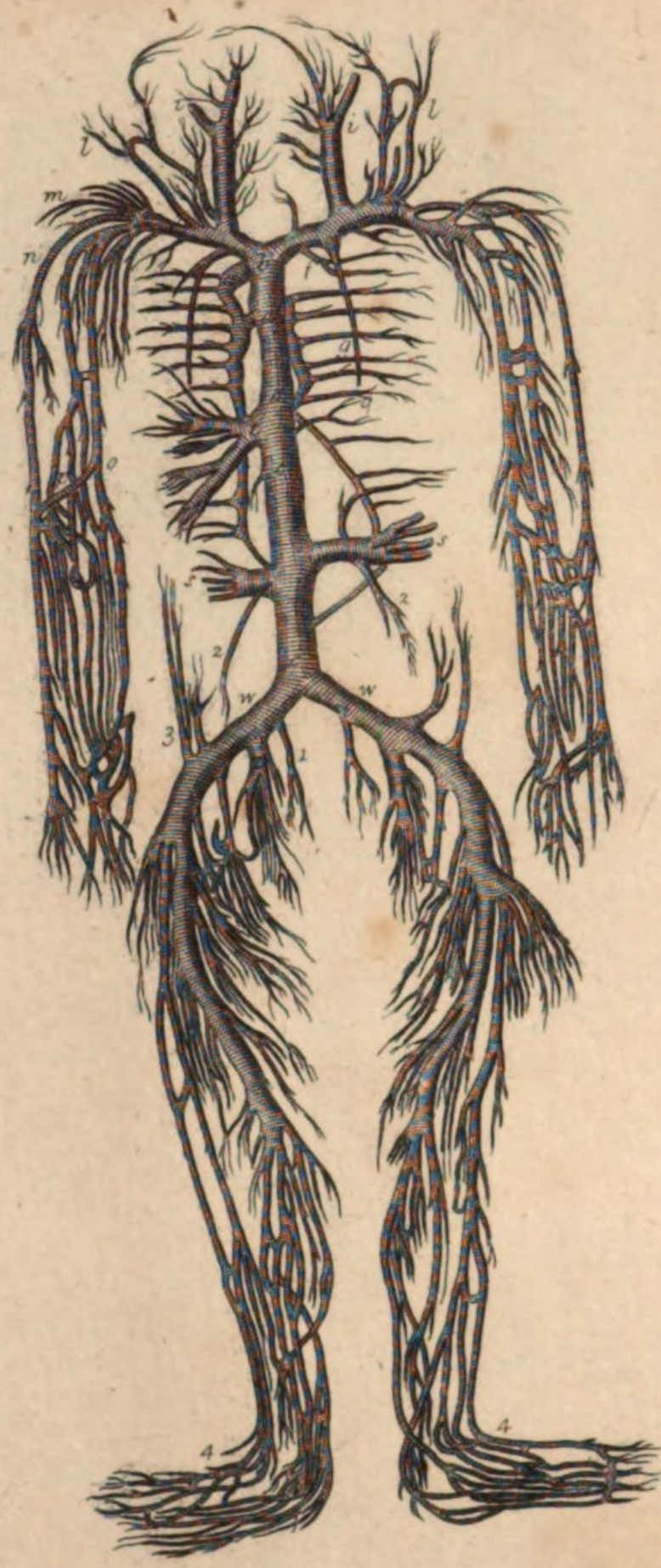
ANATOMY.

Vessels.

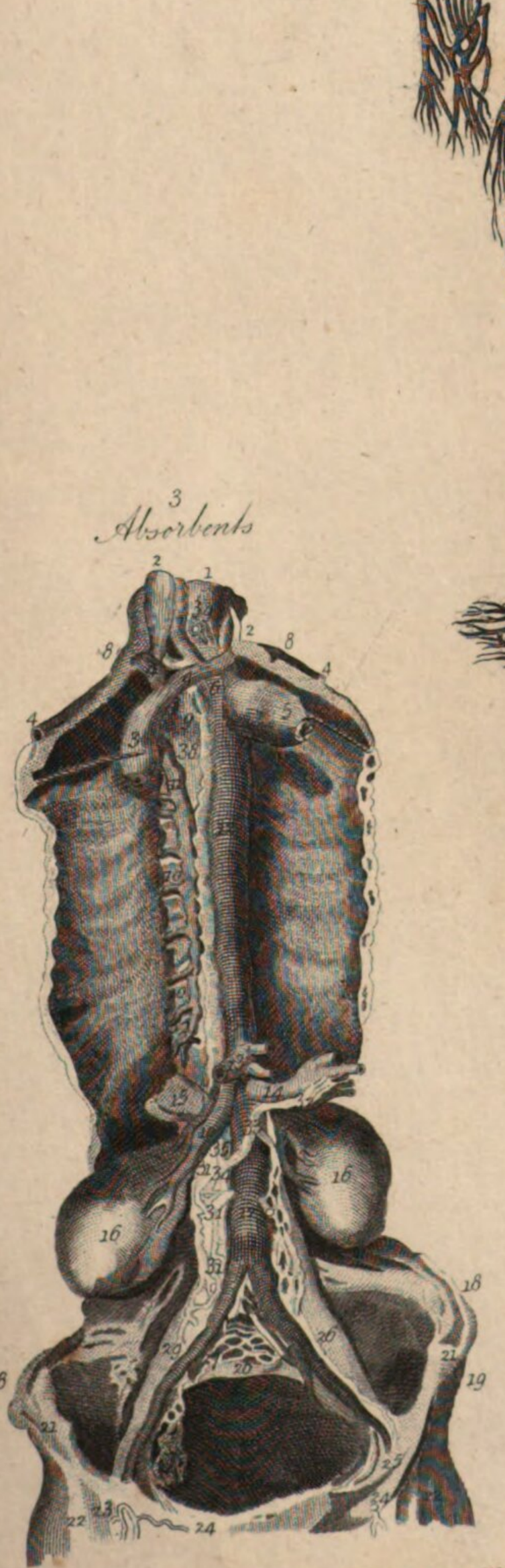
1 Arteries



2 Veins



3 Absorbents



Printed March 1, 1806, for Richard Phillips, New Bridge Street, Blackfriars.

the stamina consist of five short filaments; the antheræ oblong and covered: the pistillum has four germina, a filiform stylus, and obtuse stigma: there is no pericarpium, the calyx containing the seeds in its bosom: the seeds are four, oblong, gibbous, and engraven at the base. There are eight species, all of which may be propagated by seeds.

ANCHYLOSIS, in surgery, an immobility of the joints. This term is used when any joint of the body becomes, whether from external or internal causes, stiff and inflexible.

ANCISTRUM, a genus of the *diandria monogynia* class and order, and of the natural order of *rosaceæ*. The essential character is, cal. four-leaved; cor. none: stigma, many parted: drupe, dry, hispid, one-celled.

There are three species, but scarcely deserving notice.

ANCLE. See TALUS in ANATOMY.

ANCON, in anatomy, the gibbous eminence, or flexure of the arm, the middle of the eminence on which we rest when we lean. See ANATOMY.

ANCONES, in architecture, the corners or coins of walls, cross-beams, or rafters. Vitruvius calls the consoles, which are a sort of shouldering pieces, by the name ancones.

ANCONY, in mineralogy, denotes a piece of iron fashioned into a flat bar, about three feet long, with a square rough knot at each end.

ANCRE'E, in heraldry, the same with anchored.

ANCYLE, in antiquity, a kind of shield which fell, as was pretended, from heaven, in the reign of Numa Pompilius; at which time, likewise, a voice was heard, declaring that Rome should be mistress of the world as long as she should preserve this holy buckler.

ANCYLE, in surgery, a distortion of the joints, caused by a settlement of the humours, or a distension of the nerves; in which case remedies of a mollifying and relaxing nature are required.

ANCYLOGLOSSUM, a contraction of the ligaments of the tongue, hindering speech. This happens, either when the membrane which supports the tongue is naturally imperfect, or of too hard substance, or is occasioned by a preceding ulcer, and a hard cicatrix left under the tongue. It is to be cured only by manual operation by the surgeon.

ANCYLOTOMUS, a knife for loosening the tongue. It is applied also to all crooked bladed knives.

ANDABATÆ, in antiquity, a sort of gladiators, who mounted on horseback, or in chariots, fought hoodwinked, having a helmet that covered their eyes.

ANDAMENTO, in *music*, the movement in giving out the subject of a fugue; a theme, longer, and more important than a point.

ANDANTI, in music, signifies, especially in thorough basses, that the notes are to be played distinctly.

ANDIRA, a tree in the Brazils, the wood of which is well adapted for building. It is a genus of the diadelphia decandria class and order. It is scarcely known in Europe.

ANDRACHNE, in botany, the name given by Linnæus to a genus of plants, of the gynandria order, belonging to the monoecia class of plants. The characters are: the male calyx consists of five leaves; the corolla has five petals; and the stamina, which are also five in number, are inserted into the stylus: the female calyx is divided into five leaves; there is no corolla; the styli are three: and the capsule is trilocular, containing three seeds. Three species of no account.

ANDREW, or Knights of St. Andrew, an order of knights more usually called the order of the thistle.

ANDREW, knights of St., is also an order instituted by Peter the Great of Muscovy, in 1698; the badge of which is a golden medal, on one side whereof is represented St. Andrew's cross, and on the other are these words: *Czar Pierre monarque de toute la Russie*.

ANDRIA, in Grecian antiquity, public entertainments first instituted by Minos of Crete, and, after his example, appointed by Lycurgus at Sparta, at which a whole city, or a tribe, assisted. They were managed with the utmost frugality, and persons of all ages were admitted, the younger sort being obliged by the lawgiver, to repair thither as to schools of temperance and sobriety.

ANDRAPODOCAPELI, were dealers in slaves in ancient times. At Athens, several places in the forum were appointed for the sale of slaves. Upon the first day of each month, the merchants brought them into the market, and exposed them to sale, while the crier, standing upon a stone erected for that purpose, called the people together.

ANDROGYNA, in botany, plants bearing male and female flowers, with stamens only, and some with pistils only on the same root: such are the cucumber and melon.

ANDROLEPSY, in Grecian antiquity, an action allowed by the Athenians, against such as protected persons guilty of murder. The relations of the deceased were empowered to seize three men in the city or house, whither the malefactor had fled, till he were either surrendered, or satisfaction made some other way for the murder.

ANDROMEDA, in astronomy, a small northern constellation, consisting of twenty-seven stars, visible to the naked eye; behind Pegasus, Cassiopeia, and Perseus.

ANDROMEDA, in botany, the marsh cystus: a genus of the monogynia order, belonging to the decandria class of plants; and in the natural method ranking under the eighteenth order, bicornes. The characters are: the calyx is a quinquepartite perianthium, small, coloured, and persistent: the corolla is monopetalous, campanulated, and quinquefid, with reflected divisions: the stamina consist of ten subulated filaments, shorter than the corolla: the antheræ two-horned and nodding: the pistillum has a roundish germen, a cylindric stylus larger than the stamina, and persistent, and an obtuse stigma: the pericarpium is a roundish five-cornered capsule, with five cells and five valves; the seeds are very numerous, roundish, and glossy. There are twenty-five species chiefly American plants and hardy. They are planted in black earth with other bog plants, and are on the whole ornamental.

ANDRONA, among the ancients, denotes a street, or public place, where people met and conversed together. It is also used for that part of churches destined for the men.

ANDROPOGON, a genus of the *polygamia monoecia* class and order, and of the natural order of grasses. The essential character is the same in the male as in the her. only in the former the styles are three; in the hermaph. the cal. is a glume; one flowered cor. glume, awned at both ends, except the A. nardus; which produces three, styles two, seed one.

There are thirty-five species, one deserving notice.

ANDROPOGON NARDUS, which produces the Indian nard, or spikenard of the shops. The spikenard, as brought from the East Indies, is a congeries of small fibres issuing from one head, and matted close together, so as to form a bunch about the size of the finger, with some small strings at the opposite end of the head. The matted fibres (which are the parts chosen for medicinal purposes) are supposed by some to be the head or spike of the plant, by others the root: they seem rather to be the remains of the withered stalks, or ribs of the leaves: sometimes entire leaves and pieces of stalks are found among them: we likewise now and then meet with a number of these bunches issuing from one root. Spikenard has a warm, pungent, and bitterish taste; and a strong, not very agreeable smell. It is stomachic and carminative; and said to be alexipharmic, diuretic, and emmenagogue; but at present it is perhaps improperly very little employed.

ANDROSACE, in botany, a genus of plants, the flower of which consists of one saucer-like petal, very wide at the mouth, and divided into five segments; and its fruit is a globose, unilocular capsule, containing a number of small oval or roundish seeds, affixed to a placenta. This genus belongs to the pentandria monogynia class of Linnæus, takes its name from the relief it was supposed to give mankind; being aperitive, and good in the gout, dropsy, and retention of urine. There are seven species, but now of little account.

ANDRYALA, in botany, a genus of plants, the flower of which is monopetalous, and the seed, which is single, oval, and crowned with down, has no other cover but the cup.

It belongs to the *syngenesia polygamia* class of Linnæus. Six species.

ANEE, in commerce, a measure for grain, used in some provinces of France.

At Lyons, it signifies a certain quantity of wine, which is the load an ass can carry at once. That load is fixed at eighty English quarts, wine measure.

ANEMOMETER, among mechanical philosophers, an instrument contrived for measuring the strength of the wind. See PNEUMATICS.

ANEMONE, WIND-FLOWER: a genus of the polygamia order, belonging to the polyandria class of plants; and in the natural method ranking under the twenty-sixth order, Multifiliquæ. It has its name from the Greek ανεμος, signifying the wind; because the flower is supposed not to open unless the wind blows. The characters are: there is no calyx; the corolla consists of petals of two or three orders three in each series, oblongish: the stamina consist of numerous capillary filaments; the antheræ didymous and erect. The pistillum has numerous germina collected into a head; the styli are

r. Pectinalis.
s. Short head of Triceps.
t. Great head of Triceps.
u. Obturator Externus.
v. Fascia of the Thigh.
w. Rectus Cruris.
x. Its termination in the Patella.

FIG. 2.

a. Sterno-Cleido-Mastoideus.
b. Sterno-Hyoideus.
c. Biceps.
d. Flexor Digitorum.
e. Pectoralis Minor.
f. Serratus Magnus.
g. Transversalis.
h. Pyramidalis.
i. Obliquus Internus.
k Pectinalis.
l. Obturator Externus.
m. Triceps Brevis.
n. Triceps Magnus.
o. Triceps Longus.
p. Vastus Externus.
q. Cruralis.
r. Vastus Internus.
s. Ligament of the Patella.

FIG. 3.

a. Trapezius.
b. Latissimus Dorsi.
c. Deltoides.
d. Triceps Cubiti.
e. Gluteus Magnus.
f. Biceps Cruris.
g. Semitendinosus.
h. Semimembranosus.

FIG. 4.

a. Levator Scapulæ
b. Supra-Spinatus.
c. Infra-Spinatus.
d. Rhomboideus Minor.
e. Rhomboideus Major.
f. Triceps Cubiti.
g. Serratus Inferior Posticus.
h. Gluteus Minimus.
i. Obliquus Internus.
k. Biceps.
l. Gracilis.
m. Semitendinosus.
n. Plantaris.
o. Soleus.
p. Serratus Superior Posticus.

EXPLANATIONS OF THE VISCERA.

FIG. 1.

1. The Liver.
2. The round Ligament.
3. The Gall Bladder.
4. The Pancreas.
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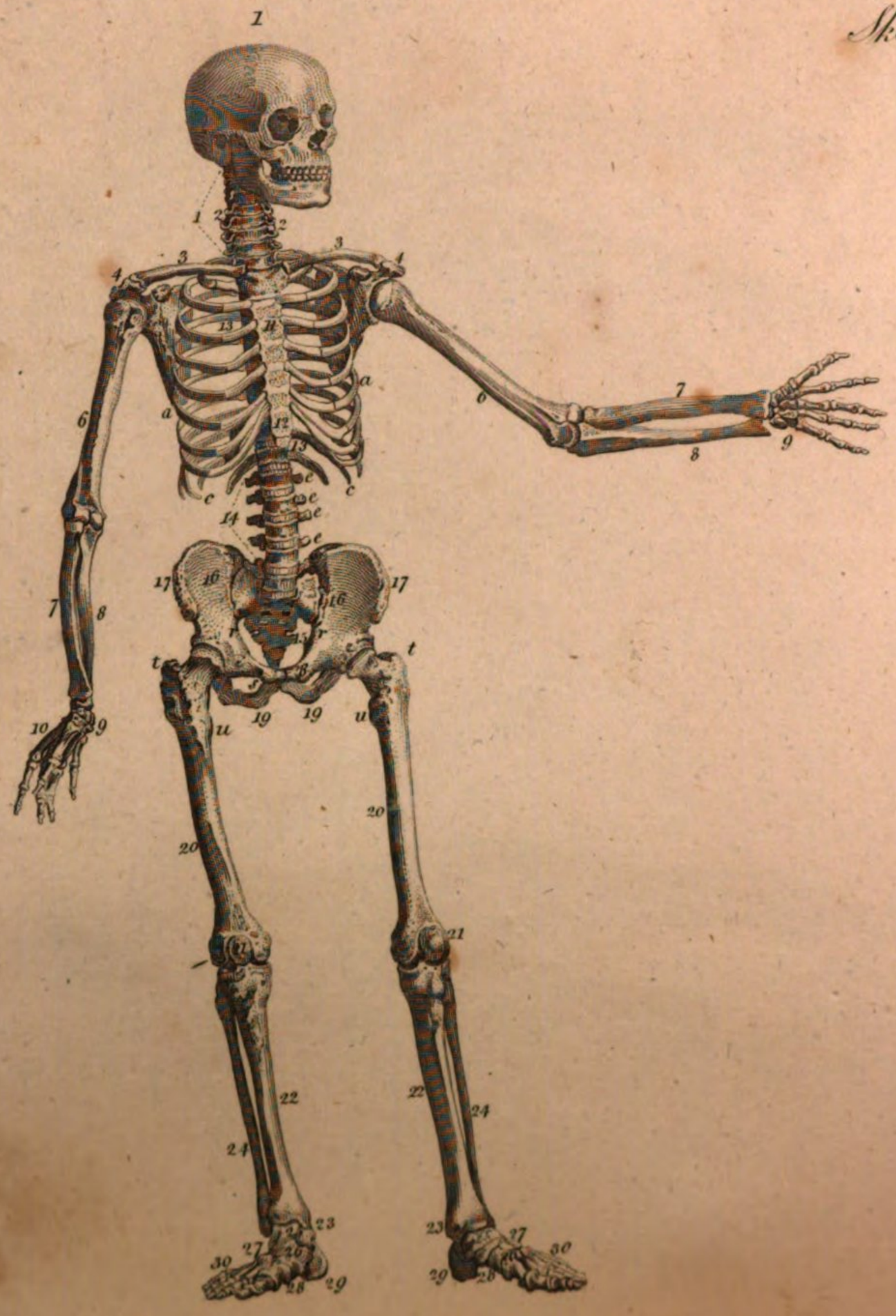
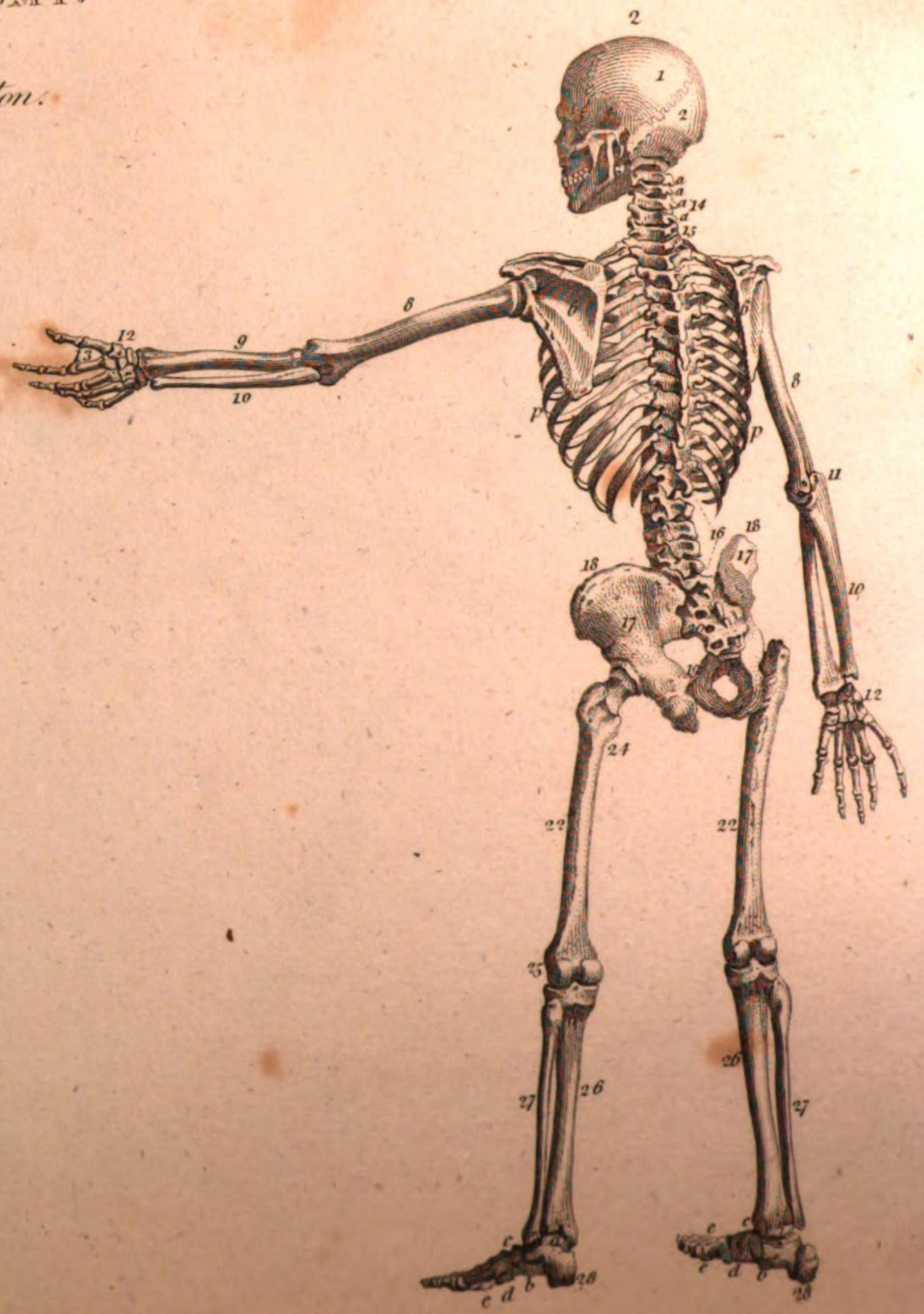


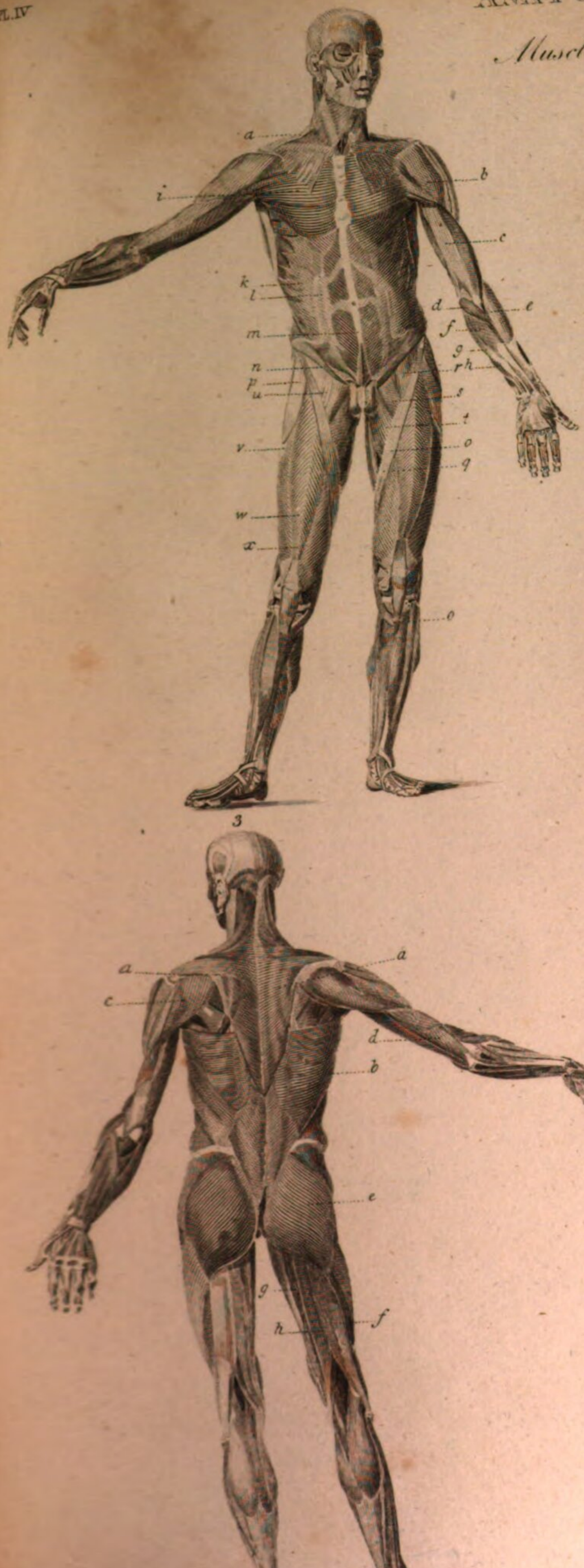


PL. IV

ANATOMY.

Muscles.

1



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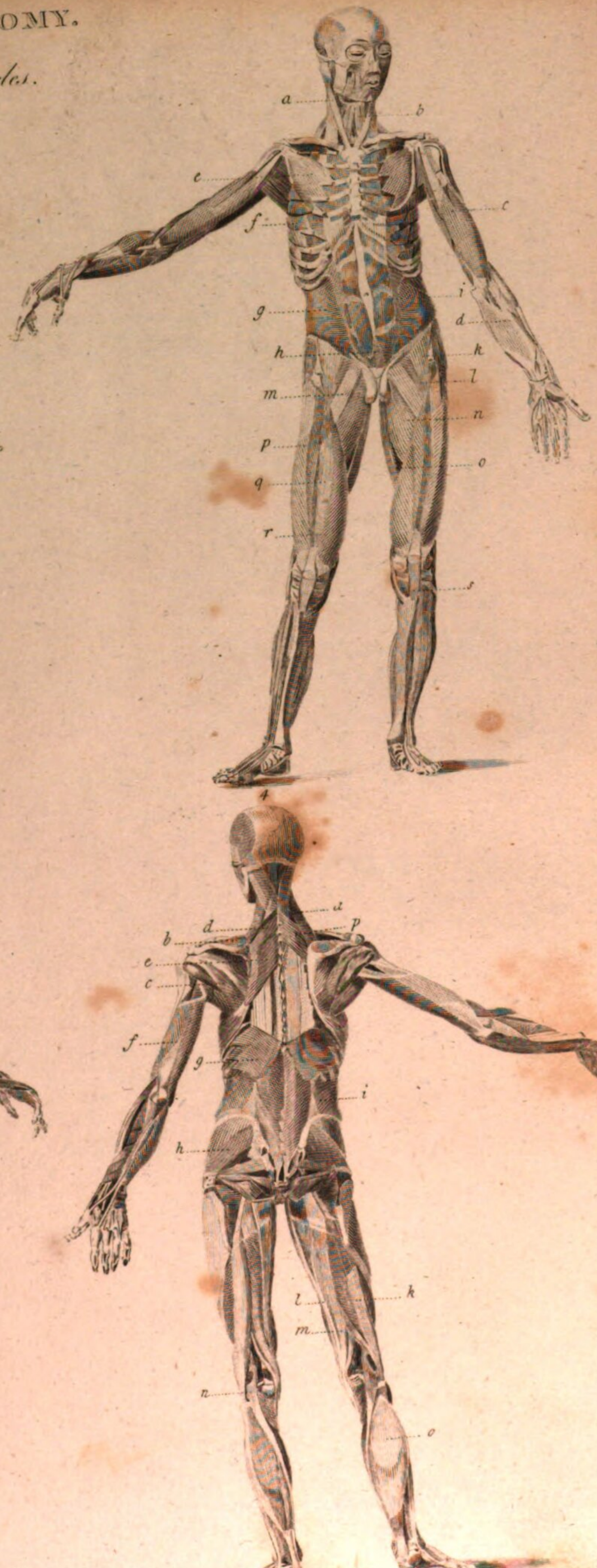

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ANATOMY.

Viscera, Brain, &c.

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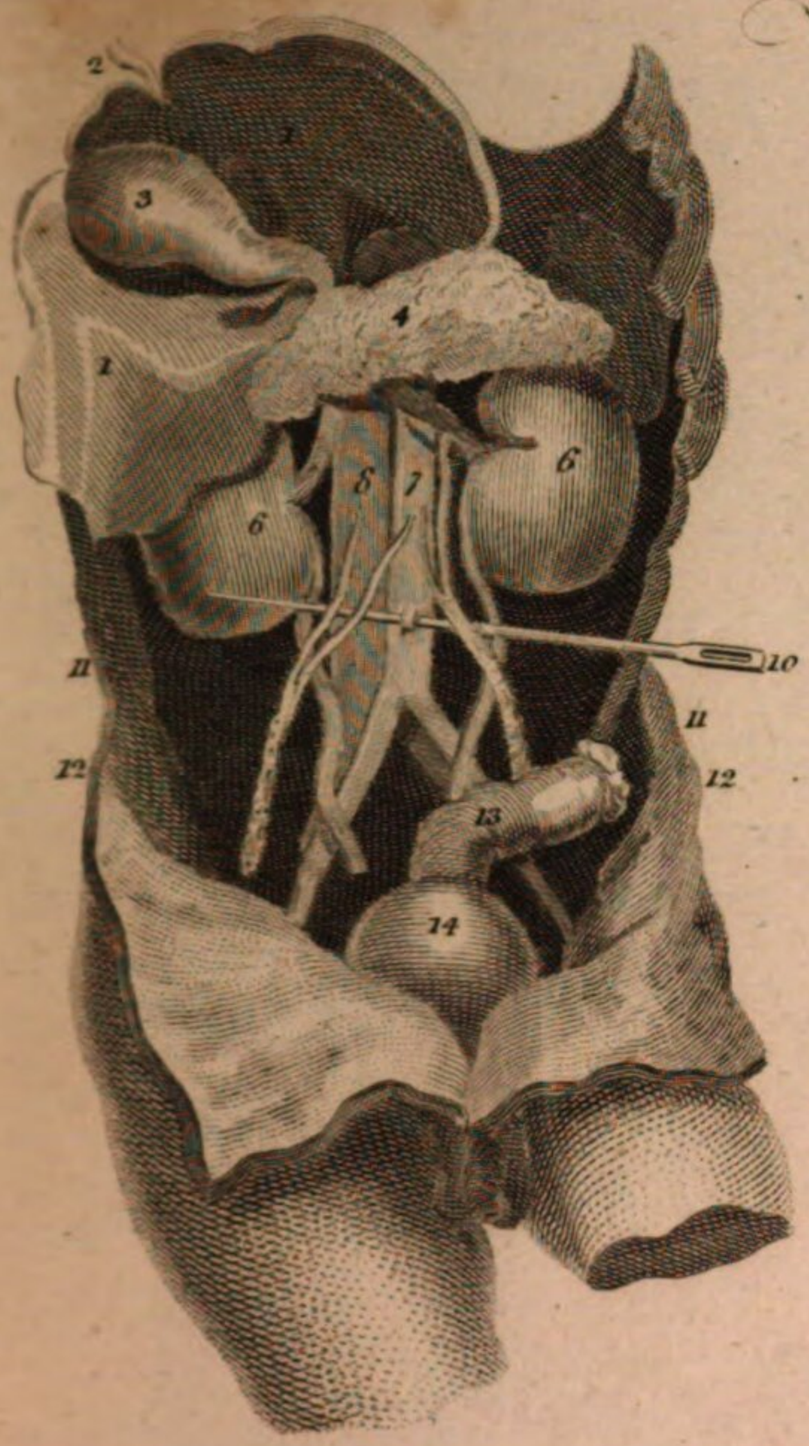

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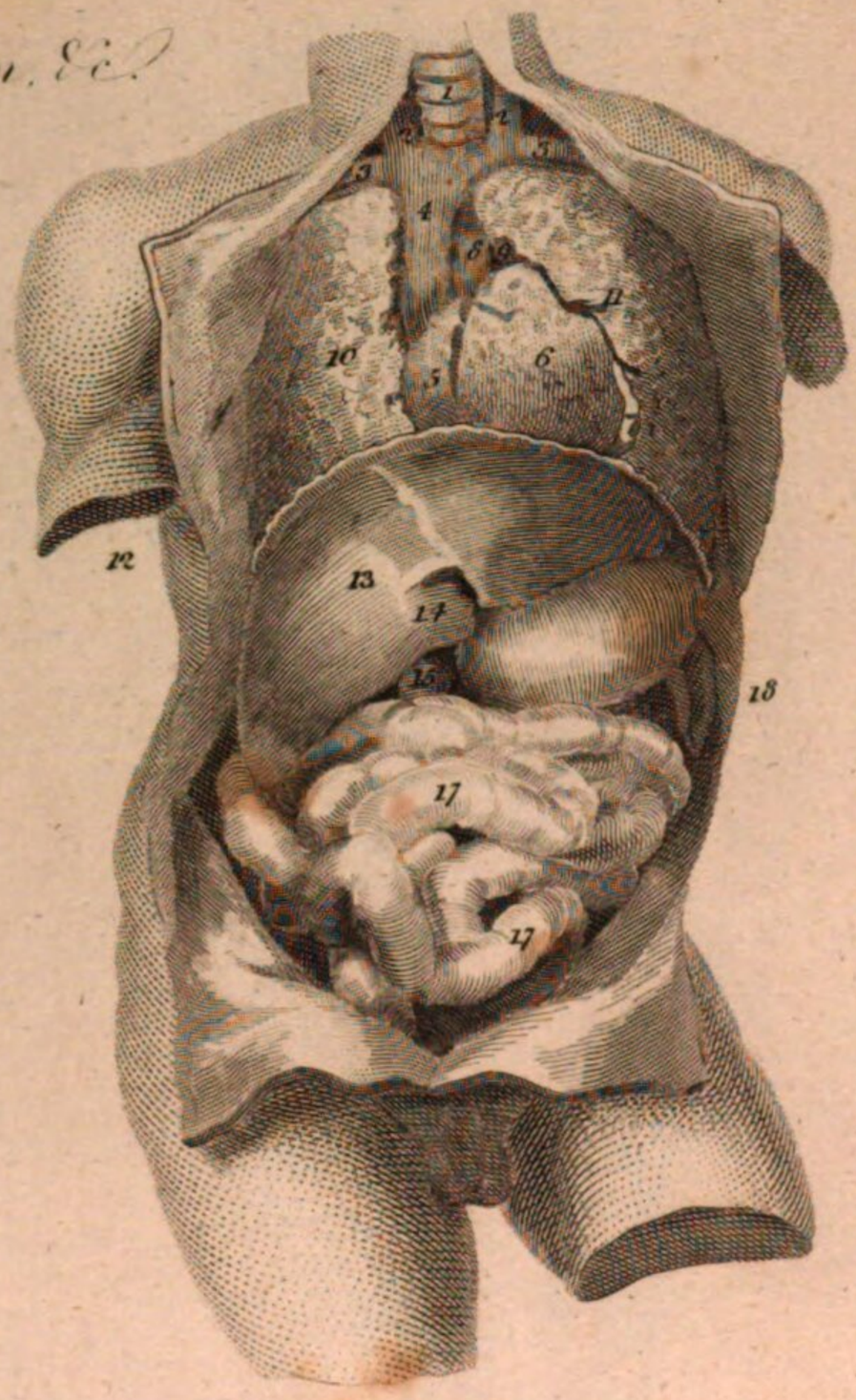

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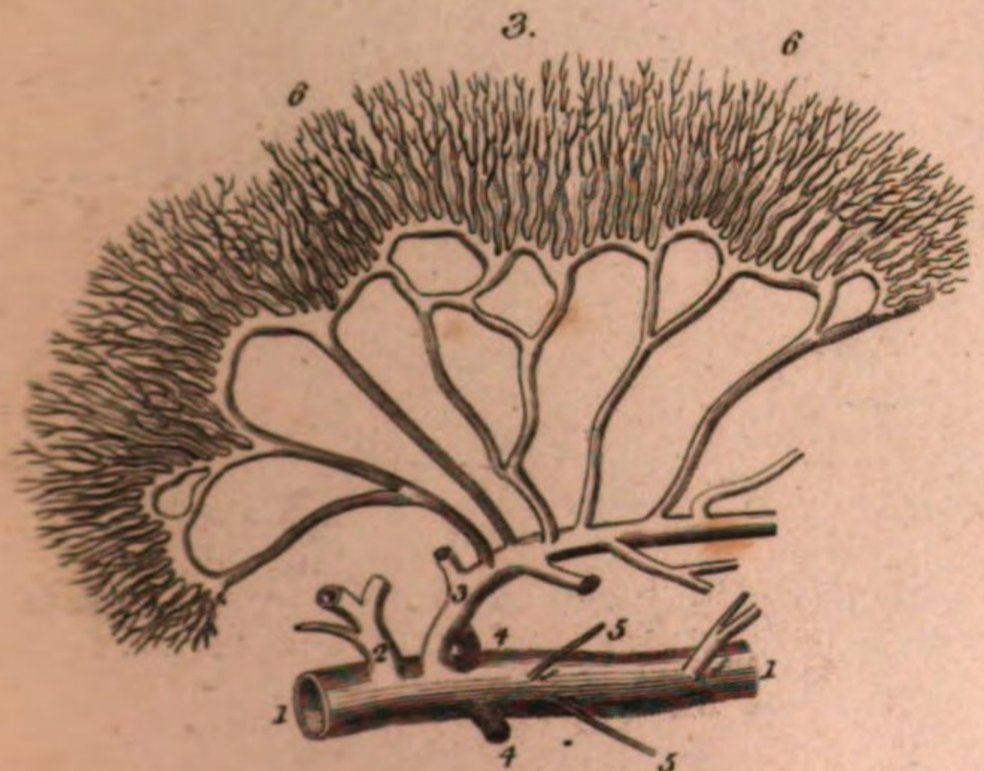

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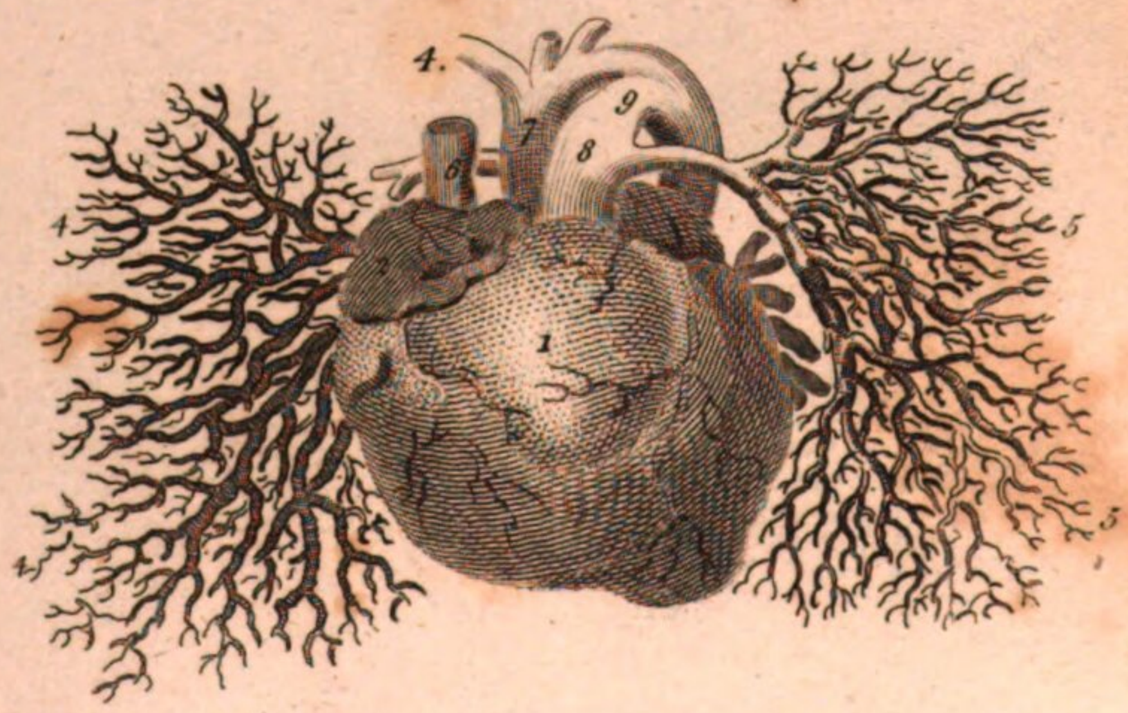

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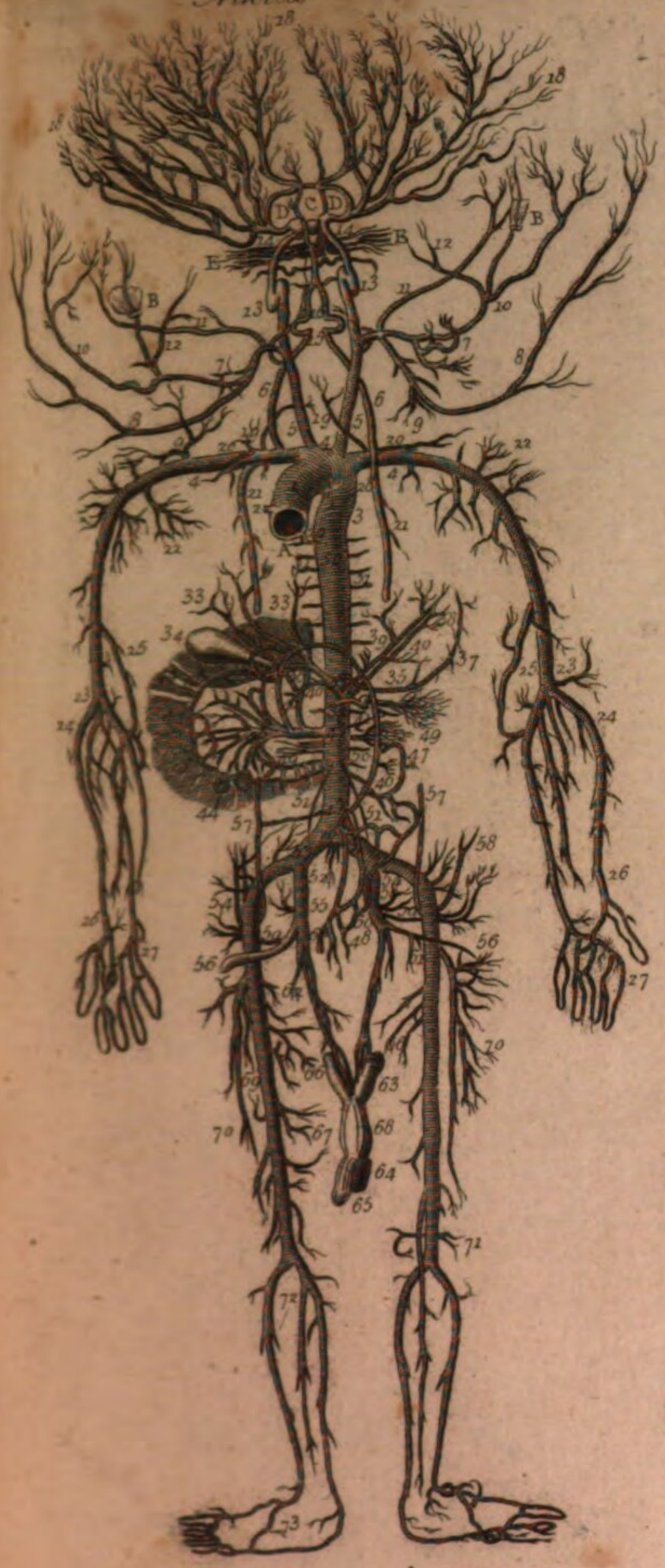
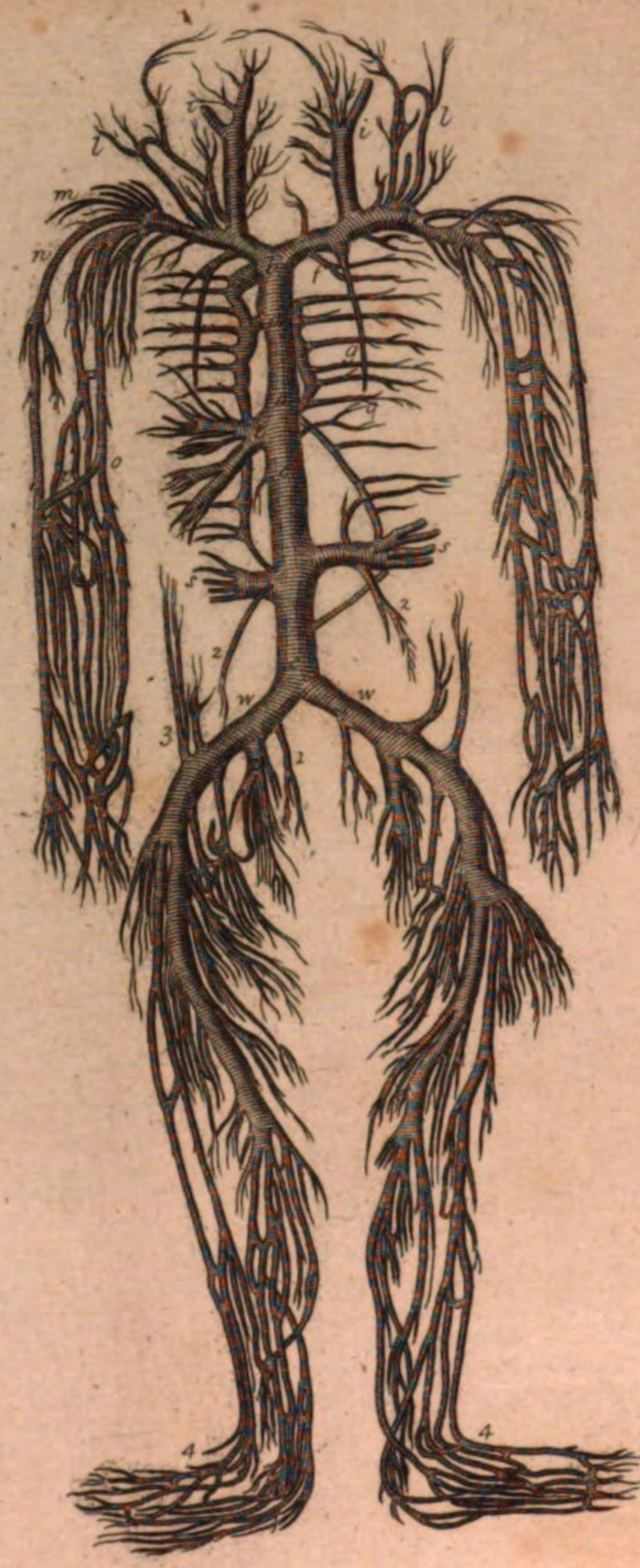
1 Arteries

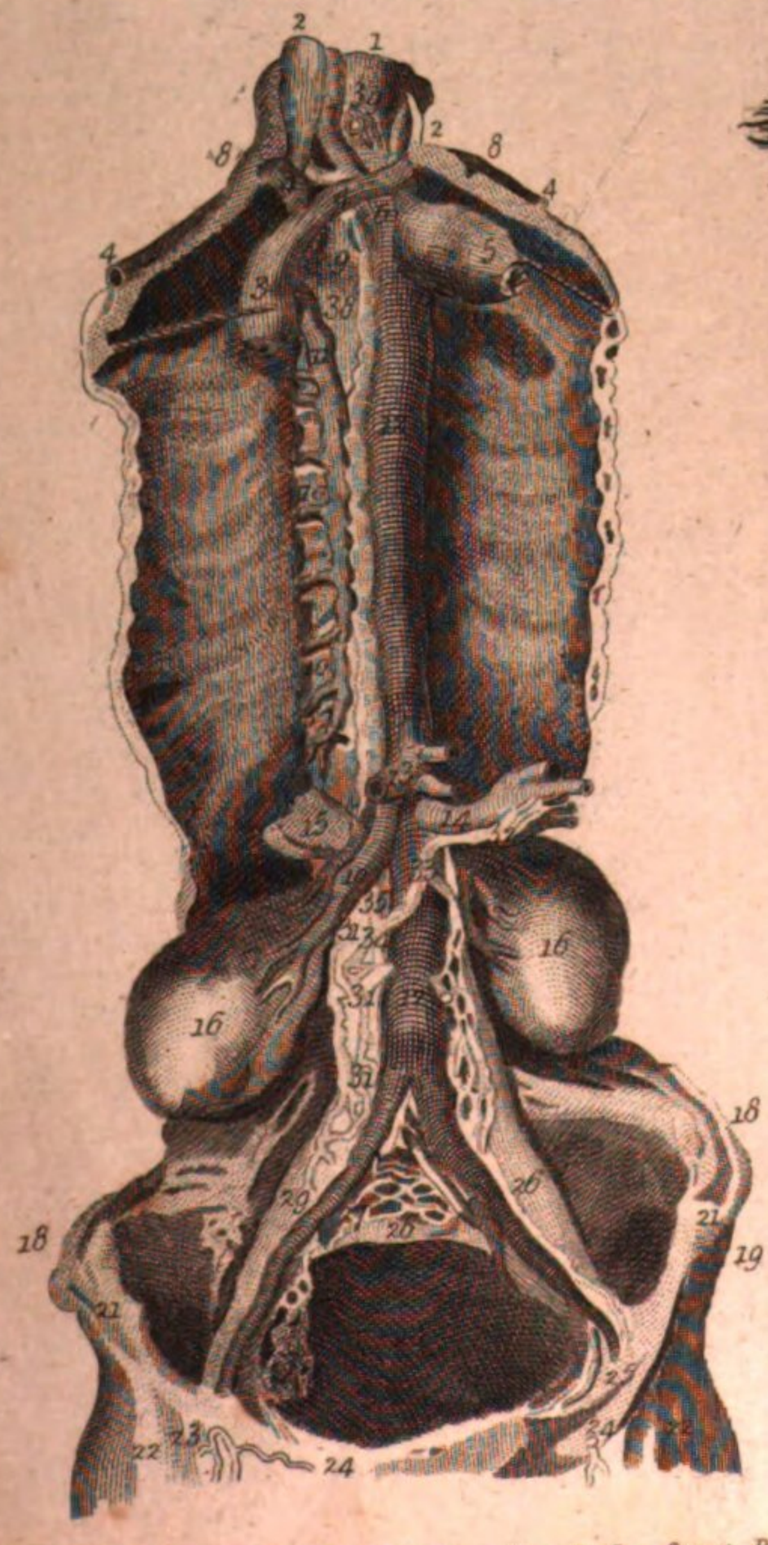


Vessels

2 Veins



3 Absorbents



Printed March 1, 1806, for Richard Phillips, New Bridge Street, Blackfriars.

the stamina consist of five short filaments; the antheræ oblong and covered: the pistillum has four germina, a filiform stylus, and obtuse stigma: there is no pericarpium, the calyx containing the seeds in its bosom: the seeds are four, oblong, gibbous, and engraven at the base. There are eight species, all of which may be propagated by seeds.

ANCHYLOSIS, in surgery, an immobility of the joints. This term is used when any joint of the body becomes, whether from external or internal causes, stiff and inflexible.

ANCISTRUM, a genus of the *diandria monogynia* class and order, and of the natural order of *rosaceæ*. The essential character is, cal. four-leaved; cor. none: stigma, many parted: drupe, dry, hispid, one-celled.

There are three species, but scarcely deserving notice.

ANCLE. See TALUS in ANATOMY.

ANCON, in anatomy, the gibbous eminence, or flexure of the arm, the middle of the eminence on which we rest when we lean. See ANATOMY.

ANCONES, in architecture, the corners or coins of walls, cross-beams, or rafters. Vitruvius calls the consoles, which are a sort of shouldering pieces, by the name ancones.

ANCONY, in mineralogy, denotes a piece of iron fashioned into a flat bar, about three feet long, with a square rough knot at each end.

ANCRE'E, in heraldry, the same with anchored.

ANCYLE, in antiquity, a kind of shield which fell, as was pretended, from heaven, in the reign of Numa Pompilius; at which time, likewise, a voice was heard, declaring that Rome should be mistress of the world as long as she should preserve this holy buckler.

ANCYLE, in surgery, a distortion of the joints, caused by a settlement of the humours, or a distension of the nerves; in which case remedies of a mollifying and relaxing nature are required.

ANCYLOGLOSSUM, a contraction of the ligaments of the tongue, hindering speech. This happens, either when the membrane which supports the tongue is naturally imperfect, or of too hard substance, or is occasioned by a preceding ulcer, and a hard cicatrix left under the tongue. It is to be cured only by manual operation by the surgeon.

ANCYLOTOMUS, a knife for loosening the tongue. It is applied also to all crooked bladed knives.

ANDABATÆ, in antiquity, a sort of gladiators, who mounted on horseback, or in chariots, fought hoodwinked, having a helmet that covered their eyes.

ANDAMENTO, in *music*, the movement in giving out the subject of a fugue; a theme, longer, and more important than a point.

ANDANTI, in music, signifies, especially in thorough basses, that the notes are to be played distinctly.

ANDIRA, a tree in the Brazils, the wood of which is well adapted for building. It is a genus of the diadelphia decandria class and order. It is scarcely known in Europe.

ANDRACHNE, in botany, the name given by Linnæus to a genus of plants, of the gynandria order, belonging to the monœcia class of plants. The characters are: the male calyx consists of five leaves; the corolla has five petals; and the stamina, which are also five in number, are inserted into the stylus: the female calyx is divided into five leaves; there is no corolla; the styli are three: and the capsule is trilocular, containing three seeds. Three species of no account.

ANDREW, or Knights of St. Andrew, an order of knights more usually called the order of the thistle.

ANDREW, knights of St., is also an order instituted by Peter the Great of Muscovy, in 1698; the badge of which is a golden medal, on one side whereof is represented St. Andrew's cross, and on the other are these words: *Czar Pierre monarque de toute la Russie.*

ANDRIA, in Grecian antiquity, public entertainments first instituted by Minos of Crete, and, after his example, appointed by Lycurgus at Sparta, at which a whole city, or a tribe, assisted. They were managed with the utmost frugality, and persons of all ages were admitted, the younger sort being obliged by the lawgiver, to repair thither as to schools of temperance and sobriety.

ANDRAPODOCAPELI, were dealers in slaves in ancient times. At Athens, several places in the forum were appointed for the sale of slaves. Upon the first day of each month, the merchants brought them into the market, and exposed them to sale, while the crier, standing upon a stone erected for that purpose, called the people together.

ANDROGYNA, in botany, plants bearing male and female flowers, with stamens only, and some with pistils only on the same root: such are the cucumber and melon.

ANDROLEPSY, in Grecian antiquity, an action allowed by the Athenians, against such as protected persons guilty of murder. The relations of the deceased were empowered to seize three men in the city or house, whither the malefactor had fled, till he were either surrendered, or satisfaction made some other way for the murder.

ANDROMEDA, in astronomy, a small northern constellation, consisting of twenty-seven stars, visible to the naked eye; behind Pegasus, Cassiopeia, and Perseus.

ANDROMEDA, in botany, the marsh cystus: a genus of the monogynia order, belonging to the decandria class of plants; and in the natural method ranking under the eighteenth order, bicornes. The characters are: the calyx is a quinquepartite perianthium, small, coloured, and persistent: the corolla is monopetalous, campanulated, and quinquefid, with reflected divisions: the stamina consist of ten subulated filaments, shorter than the corolla: the antheræ two-horned and nodding: the pistillum has a roundish germen, a cylindric stylus larger than the stamina, and persistent, and an obtuse stigma: the pericarpium is a roundish five-cornered capsule, with five cells and five valves; the seeds are very numerous, roundish, and glossy. There are twenty-five species chiefly American plants and hardy. They are planted in black earth with other bog plants, and are on the whole ornamental.

ANDRONA, among the ancients, denotes a street, or public place, where people met and conversed together. It is also used for that part of churches destined for the men.

ANDROPOGON, a genus of the *polygamia monœcia* class and order, and of the natural order of grasses. The essential character is the same in the male as in the her. only in the former the styles are three; in the hermaph. the cal. is a glume; one flowered cor. glume, awned at both ends, except the A. nardus; which produces three, styles two, seed one.

There are thirty-five species, one deserving notice.

ANDROPOGON NARDUS, which produces the Indian nard, or spikenard of the shops. The spikenard, as brought from the East Indies, is a congeries of small fibres issuing from one head, and matted close together, so as to form a bunch about the size of the finger, with some small strings at the opposite end of the head. The matted fibres (which are the parts chosen for medicinal purposes) are supposed by some to be the head or spike of the plant, by others the root: they seem rather to be the remains of the withered stalks, or ribs of the leaves: sometimes entire leaves and pieces of stalks are found among them: we likewise now and then meet with a number of these bunches issuing from one root. Spikenard has a warm, pungent, and bitterish taste; and a strong, not very agreeable smell. It is stomachic and carminative; and said to be alexipharmic, diuretic, and emmenagogue; but at present it is perhaps improperly very little employed.

ANDROSACE, in botany, a genus of plants, the flower of which consists of one saucer-like petal, very wide at the mouth, and divided into five segments; and its fruit is a globose, unilocular capsule, containing a number of small oval or roundish seeds, affixed to a placenta. This genus belongs to the pentandria monogynia class of Linnæus, takes its name from the relief it was supposed to give mankind; being aperitive, and good in the gout, dropsy, and retention of urine. There are seven species, but now of little account.

ANDRYALA, in botany, a genus of plants, the flower of which is monopetalous, and the seed, which is single, oval, and crowned with down, has no other cover but the cup.

It belongs to the *syngenesia polygamia* class of Linnæus. Six species.

ANEE, in commerce, a measure for grain, used in some provinces of France.

At Lyons, it signifies a certain quantity of wine, which is the load an ass can carry at once. That load is fixed at eighty English quarts, wine measure.

ANEMOMETER, among mechanical philosophers, an instrument contrived for measuring the strength of the wind. See PNEUMATICS.

ANEMONE, WIND-FLOWER: a genus of the polygamia order, belonging to the polyandria class of plants; and in the natural method ranking under the twenty-sixth order, Multifiliquæ. It has its name from the Greek ανεμος, signifying the wind; because the flower is supposed not to open unless the wind blows. The characters are: there is no calyx; the corolla consists of petals of two or three orders three in each series, oblongish: the stamina consist of numerous capillary filaments; the antheræ didymous and erect. The pistillum has numerous germina collected into a head; the styli are

pointed; the stigmata obtuse: there is no pericarpium; the receptaculum is globular: the seeds are very numerous. Of this genus there are twenty-eight species; but those valuable on account of the beauty of their flowers are the following:

1. Anemone Appenina is a native of Britain, and grows in woods. The flowers of this species are sometimes single, and sometimes double; their colours are white, blue, or violet. They appear in April.

2. Anemone Coronaria. 3. Anemone Hortensis. These two are natives of the Levant, particularly of the Archipelago islands, where the borders of the fields are covered with them of the most beautiful colours. When they grow wild, the flowers are commonly single; but by culture they are greatly improved: they become large and double, making some of the greatest ornaments of gardens. Their principal colours are red, white, purple, and blue; some of them are finely variegated with red, white, purple, and many intermediate shades of these colours.

4. Anemone Nemorosa grows wild in the woods in many parts of Britain, where it flowers in April and May. The flowers are white, purple, or reddish purple, sometimes single, and sometimes double, so that they make a pretty appearance.

The hepaticas and pulsatillas are now classed among the anemonies. All the single kinds are easily cultivated by seed, which must be sown in the spring in a wide pot or pan, and scarcely covered. The pot must stand out of the way of the sun, till the plants are strong, and they may be planted out in the autumn. The double anemonies are propagated by offsets. All the sorts are considered as among the finest ornaments of our gardens.

ANEMOSCOPE, according to Vitruvius's description, a machine shewing from what point of the compass the wind blows.

This is done by means of an index moving about an upright circular plate, the index being turned by an horizontal axis, and the axis by an upright staff, at the top of which is the fane moved about by the wind.

ANETHUM, Dill, in botany, a genus of umbelliferous plants, of the digynia order, belonging to the pentandria class of plants. The essential characters are: the fruit is oval, compressed, striated; and the petals, five, are involute, entire, and very short. There are three species.

1. Anethum feniculum, or fennel; of which there are two varieties, the common and the sweet. Both sorts are cultivated in our gardens: the common is a perennial plant: the sweet fennel perishes, after it has given seed; nor do its seeds come to perfection in this climate.

2. Anethum graveolens, or dill, is an annual plant.

3. Finochio, a sallad herb. Of the first species, the fennel, both the seeds and roots are used in medicine. The seeds of both the fennels have an aromatic smell, and a moderately warm pungent taste: those of the sweet fennel are in flavour most agreeable, and have also a considerable degree of sweetness; hence our colleges have directed the use of these only. They are ranked among the hot seeds, and are undeservedly looked upon as stomachics. The whole of the genus are indeed only filthy weeds, unpleasant in the taste, and causing the breath to smell of those who are so indelicate as to eat them.

ANEURISM, or Aneurysm, in surgery, a throbbing tumour, distended with blood, and formed by a dilatation or rupture of an artery. See Surgery.

ANGARIA, in Roman antiquity, a kind of public service, imposed on the provincials, which consisted in providing horses and carriages for the conveyance of military stores, and other public burdens.

ANGEIOGRAPHY, or Angeiology, among anatomists, the description and history of the several vessels of the human body, as the arteries, veins, lymphatics, &c.

ANGEIOLOGY, the description of the vessels of the body, which are concerned in the circulation of the blood, and in absorption. See Anatomy.

ANGEL is a title given to bishops of several churches. In this sense is St. Paul understood by some authors, where he says women ought to be covered in the church, because of the angels; and thus in the Revelations, the seven stars are the angels, that is, bishops of the seven churches.

Angel, in commerce, the name of an antient gold coin in England, of which some are still to be seen in the cabinets of the curious. It had its name from the figure of an angel, represented upon it. It was $23\frac{3}{4}$ carats fine, and weighed four pennyweights. Its value differed in different reigns. In the reign of Henry VI. it was 6s. 8d.; in the 1st Henry VIII. 7s. 6d.; in the 34th Henry VIII. 8s.; in the 6th Edward VI., and in the succeeding reigns of Mary and Elizabeth, it was 10s.

ANGELIC *garment*, one which, among our ancestors, was put on a little before their death, that they might have the prayers of the monks.

ANGELICA, a genus of the digynia order, belonging to the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The essential characters are: the fruit is roundish, angled, solid, with reflecting styli; the corollæ are equal, and the petals incurvated. There are six species. The angelica arch-angelica, sativa, or common angelica, which is cultivated in gardens for medicinal use, and likewise for a sweetmeat, grows naturally in the northern countries.

All the parts of angelica, especially the root, have a fragrant aromatic smell, and a pleasant bitterish warm taste, glowing upon the lips and palate for a long time after they have been chewed. The flavour of the seeds and leaves is very perishable, particularly that of the latter, which, on being barely dried, lose the greatest part of their taste and smell: the roots are more tenacious of their flavour, though even these lose part of it upon keeping. Angelica is one of the most elegant aromatics of European growth, though little regarded in the present practice. The root, which is the most efficacious part, is used in the aromatic tincture; and the stalks make an agreeable sweetmeat.

ANGELICS, in church history, an antient sect of heretics, supposed by some to have gained this appellation from their excessive veneration of angels, and by others from their maintaining that the world was created by angels.

Angelics is also the name of an order of knights, instituted in 1191, by Angelus Flavius Comnenus, emperor of Constantinople.

ANGELITES, in church history, an antient sect of heretics, whose distinguishing tenet was, that the persons of the Trinity have no distinct subsistence, but partake in common of the same divine essence.

ANGELOT, in the history of coins, a gold coin struck at Paris, while subject to the English, so called from the representation of an angel supporting the arms of England and France.

ANGERONALIA, in antiquity, feasts celebrated at Rome in honour of Angerona, the goddess of silence and patience.

ANGINA, in medicine, a violent inflammation of the throat, otherwise called quinsey.

Angina *pectoris*, a disease so called from the seat of the disorder, and the sense of anxiety and strangling with which it is attended. See Medicine.

ANGIOSPERMIA, in the Linnæan system of botany, denotes those plants of the didynamia class, which have their seeds inclosed in a capsule, or seed-vessel.

ANGLE, in geometry, the inclination of two lines meeting one another in a point, and called the legs of the angle. See Geometry.

ANGLING, among sportsmen, the art of fishing with a rod, to which are fitted a line, hook, and bait.

In angling the following rules are to be observed. 1. To place yourself so that your shadow does not at any time lie upon the water, if shallow. 2. To angle in a pond near the ford where the cattle go to drink, and in rivers, in such places as the fish you intend to angle for, usually frequent; as for breams, in the deepest water; for eels, under banks; for chub, in deep shaded holes; for perch, in scowrs; for roach, in the same places; for trouts, in quick streams.

The best times for angling are from April to October; for in cold stormy weather, or bleak easterly winds, the fish will not bite. The time of the day, in the warm months, is in the morning, about nine o'clock, and in the afternoon, between three and five. In order to attract the fish to the place intended for angling, it will be proper once in four or five days to cast in some corn boiled soft, garbage, worms chopt to pieces, or grains steeped in blood, and dried; and if you fish in a stream, it will be best to cast in the grains above the hook.

The best way of angling with the fly, is down the river; and in order to make them rise freely, be sure to use such flies as you know they are naturally inclined to, and in such manner as they are accustomed to receive them.

ANGON, in the antient military art, a kind of javelin used by the French. They darted it a considerable distance. The iron head of this weapon resembled a flower-de-luce. It is the opinion of some writers, that the arms of France are not flowers, but the iron point of the angon, or javelin of the antient French.

ANGUINUM, ovum, among antient naturalists, a fabulous kind of egg, said to be produced by the saliva of a cluster of serpents, and possessed of certain magical virtues.

This name is also given by Mercatus to the lapis scolopendrites.

ANGUIS, in zoology, the name of a genus

of serpents, distinguished from the rest by having the belly and under part of the tail covered with scales, like those on the other parts of the body. The body is shorter, and more uniformly cylindric, than in the genus of the coluber, and the eyes are in general small, and the tail rather obtuse. No poisonous species of anguis has yet been discovered. There are 15 species; the most remarkable are:

Anguis bipes, or two-footed snake; it is a native of the Indies, and has two short feet, with two toes, near the anus. In every scale of this species there is a brown point. 2. Anguis cerastes, a native of Egypt. 3. Anguis colubrina, an inhabitant of Egypt. 4. Anguis eryx, a native of Britain, and likewise of America, is about a span in length, and about the thickness of a man's finger. One from Aberdeenshire, described by Mr. Pennant, was fifteen inches long: the belly is of a bluish lead colour, marked with small white spots, irregularly disposed; the rest of the body of a greyish brown, with three longitudinal dusky lines; one extending from the head, along the back, to the point of the tail; the others broader, and extending the whole length of the sides. 5. Anguis fragilis, (see plate, Nat. Hist. fig. 20) or glass snake of Catesby. The skin is smooth, with small scales, closely connected. A small blow with a stick will cause the body to separate, not only at the place struck, but at two or three other places, the muscles being articulated in a singular manner quite through to the vertebra. They appear earlier in the spring than any other serpent, and are numerous in the sandy woods of Virginia and Carolina. 6. Anguis jaculus, or dart snake. Anguis laticauda, a native of Surinam. 7. Anguis lumbricalis, a native of America. 8. Anguis maculata, a native of America. 9. Anguis meleagris, is a native of the Indies. 10. Anguis platura: the head is oblong and without teeth; the body is about a foot and a half long, black above and white below. 11. Anguis quadrupes, or four-footed snake. The body of this species is cylindrical, with 14 or 15 longitudinal ash-coloured streaks; the teeth are extremely small; it has no ears: the feet are at a great distance from each other, very short, with five toes and small nails; but the toes are so minute, that they can hardly be numbered. It is a native of Java. 12. Anguis reticulata, a native of America. 13. Anguis scytale, a native of the Indies, is white, interspersed with brownish rings. 14. Anguis ventralis, blind worm, or slow worm, grows to about a foot in length, and to the thickness of a man's little finger; the head is small; the neck still more slender; from that part the body grows suddenly, and continues of an equal bulk to the tail, which ends quite blunt. The colour of the back is cinerous, marked with very small lines, composed of minute black specks. It resembles the viper, in the manner of producing its young, which are put forth alive. It is frequent with us in gardens and pastures, where it lives principally under ground, feeding on worms.

ANGUIUM *lapis*, the name of a supposed stone in Germany, which is cylindric, with a cavity capable of admitting the finger; of a yellow colour, with variegations. The vulgar think it derives its origin from a serpent ant, but it is certainly made of glass, tinged with two or three colours. They were probably used for the same purposes with the anguinum ovum.

ANGURIA, the water-melon, a genus of the diandria order, belonging to the monœcia class of plants, and in the natural method ranking under the 34th order, cucurbitaceæ. The essential characters are these: the male calyx is quinquefid, and the corolla quinquepetalous: the female calyx and corolla the same: the pericarpium is a pome beneath, with two cells: the seeds are numerous. Of this genus, Linnæus reckons three species, viz.

1. Anguria pedata; 2. Anguria trifoliata; and, 3. Anguria trilobata. Of these only one species is known in this country, by the name of Citrul. The fruit is cultivated in Spain, Portugal, Italy, and other warm countries of Europe; as also in Africa, Asia, and America, where it is esteemed on account of its cooling quality; but in Britain it is deservedly held in little estimation.

ANGUSTICLAVIA, in Roman antiquity, a tunic embroidered with little purple studs. It was worn by the Roman knights, as the laticlavia was by the senators.

ANIMAL, in natural history, an organized and living body, which is also endowed with sensation: thus, minerals are said to grow or increase, plants to grow and live, but animals alone to have sensation.

The description, history, and classing of animals, makes not only a considerable, but the most excellent part of natural history, known by the name of zoology. Different authors have established different divisions or families of animals; but the most natural one seems to be into quadrupeds, birds, fishes, amphibious animals, insects, and animalcules, visible only by the help of a microscope.

ANIMALS, in heraldry, are much used, both as bearings and supporters.

ANIMAL *manures*, in agriculture, are all such as are formed from the decomposition of animal substances of any kind, as flesh, blood, hair, wool, bones, fat, &c. these are generally considered as more powerful in their effects, in promoting vegetation, than such as are derived from vegetable bodies.

ANIMAL *matter*, in chemistry. See CHEMISTRY.

ANIMAL *secretion*, the separation of the several fluids of the body from the blood.

ANIMAL *system* denotes the whole class of beings endowed with animal life, otherwise called the animal kingdom,

ANIMAL *fossile substances*, those found buried in the earth at various depths, and embedded among various strata: these are principally, (1) sea-shells: (2) the teeth, bony palate, and bones of fishes; (3) the bones of land animals; (4) complete fish.

ANIMAL *economy*, the structure and uses of the different parts of the body.

ANIMALCULE, an animal so minute in its size, as not to be the immediate object of our senses.

Animalcules are seen only by the assistance of microscopes, and are perhaps more numerous than any other part of the animal creation; but the species, on a close examination, are found to be but few, in proportion to the number of individuals. The most obvious distinction among them is, that some have, and others have not tails; and that some have, and others have not visible limbs. According, therefore, to these characters, they are arranged under three classes, distinguished by the names of gymnia, cercaria, arthronia; the first containing those which have no visible limbs, nor any tail; the second, those which have tails; the third, those which have visible limbs.

Animalcules are discovered by the microscope in most liquors, as water, wine, vinegar, &c. in several chalybeat waters, in oats, barley, &c. and in the pustules of the itch. See MICROSCOPE.

ANIMATED POWER, in mechanics, denotes a man, or other animal, in opposition to weights, &c.

ANIMATION, suspended. See DROWNING.

ANIME, or GUM ANIMÆ, in natural history and pharmacy, a kind of gum, or rather resin, being a friable substance, inflammable, and soluble in highly rectified spirit. There are two kinds, the oriental and occidental: the oriental is a dry resin, brought in large casks, and of a very uncertain colour, some being greenish, some reddish, and some of the colour of myrrh. See HYMENÆA.

The occidental is a yellowish white, resembling frankincense in colour. Both kinds are used in perfumes, and in medicine externally.

ANIME', in heraldry, a term used when the eyes of any rapacious creature are borne of a different tincture from the creature itself.

ANIMELLÆ, the glands under the ears, called also lactiinea.

ANINGA, in commerce, a root which grows in the Antilles islands, and is pretty much like the china plant. It is used by sugar-bakers for refining the sugar, and is more effectual and less dangerous than the sublimate of mercury and arsenic.

ANISE, *anisum*, in the materia medica, a small seed, of an oblong shape, ending each way in an obtuse point, with a surface very deeply striated, and of a lax and brittle substance. For the plant which produces it, see PIMPINELLA.

ANKER, a liquid measure at Amsterdam. It contains about thirty-two gallons English measure.

ANNALE, in the church of Rome, a term applied to the masses celebrated for the dead, during a whole year.

ANNALS, a species of history, which relates events in the chronological order wherein they happened.

ANNATES, or first fruits, a year's income of a spiritual living.

These were, in antient times, given to the pope throughout all christendom, upon the decease of any bishop, abbot, or parish-clerk, and were paid by his successor. In England, the pope claimed them first of such foreigners as he conferred benefices upon, by way of provision; but afterwards they were demanded of all other clerks on their admission to benefices. At the reformation they were taken from the pope, and vested in the king; and finally, queen Anne restored them to the church, by appropriating them to the augmentation of poor livings.

ANNEALING, or NEALING, as it is called by the workmen, is a process particularly employed in the glass-houses, and consists in putting the glass vessels as soon as they are formed, and while they are yet hot, into a furnace or oven, not so hot as to remelt

them, and in which they are suffered to cool gradually. This is found to prevent their breaking so easily as they otherwise would, and particularly on exposure to heat. There is also this difference between annealed and unannealed glass, that when the latter is broken it often flies into small powder, as is remarkably exemplified in the little glass bubbles sold in the streets, and called Prince Rupert's drops, which are drops of common bottle glass which fall from the rods on which bottles are made, into water, which suddenly cools them. See RUPERT'S DROPS. Various theories have been started to account for these phenomena, but none of them quite satisfactory, and all that can be said is, that by gradually cooling, the glass becomes perfectly chrystallized.

A similar process is used for rendering cast-iron vessels less brittle, and the effect depends probably on the same principles.

ANNEXATION, in law, a term used to imply the uniting of lands or rents to the crown.

ANNONA, in Roman antiquity, denotes provision for a year of all sorts, as of flesh, wine, &c. but especially of corn.

Annona is likewise the allowance of oil, salt, bread, flesh, corn, wine, hay, and straw, which was annually provided by contractors for the maintenance of an army.

ANNONA, or Custard Apple, a genus of the polyandria polygynia class and order. The characters are: the calyx is a triphylous perianthium: the corolla consists of six heart-shaped petals: the stamina have scarcely any filaments; the antheræ are numerous, sitting on the receptaculum: the pistillum has a roundish germen; no styli: the stigmata obtuse and numerous: the pericarpium is a large roundish unilocular berry, covered with a scaly bark: the seeds are numerous. There are 10 species; the most remarkable are:

1. The annona muricata, or sour-sop, which rarely rises above 20 feet high: the fruit or apple is large, of an oval shape, irregular, and pointed at the top, of a greenish yellow colour, and full of small knobs on the outside: the pulp is soft, white, and of a sour and sweet taste intermixed, having many oblong, dark coloured seeds. It much resembles the black currant, and is a native of the West Indies. 2. The annona palustris, or water-apple, grows to the height of 30 or 40 feet; the fruit is seldom eaten but by negroes, and the tree grows in moist places in all the West India islands. 3. The annona reticulata, or custard apple, is also a native of the West Indies, where it grows to the height of 25 feet; the fruit is of a conical form, as large as a tennis-ball, of an orange colour when ripe, having a soft, sweet, yellowish pulp, of the consistence of a custard, whence it has its name. 4. The annona triloba, or North American annona, called by the inhabitants papaw, is a native of the Bahama islands, and likewise of Virginia and Carolina. The trunks of the trees are seldom bigger than the small part of a man's leg, and are about 10 or 13 feet high. The fruit grows in clusters of 3 or 4 together: when ripe, they are yellow, covered with a thin smooth skin, which contains a yellow pulp of a sweet luscious taste. All parts of the tree have a rank, if not a fetid, smell; nor is the fruit relished by many except negroes. This last sort will thrive in the open air in England, if it is placed in a warm and sheltered situation; but the plants should be trained up in pots, and sheltered in winter for 2 or 3 years till they have acquired strength. The seeds frequently remain a whole year in the ground; and therefore the earth in the pots ought not to be disturbed, though the plants do not come up the first year. All the other sorts require to be kept in a warm stove.

ANNONÆ PRÆFECTUS, in antiquity, an extraordinary magistrate, whose business it was to prevent a scarcity of provision, and to regulate the weight and fineness of bread.

ANNOTATION, in matters of literature, a brief commentary or remark upon a book or writing, in order to clear up some passage, or draw some conclusion from it.

ANNOTTO, in commerce, a kind of red dye, brought from the West Indies. It is procured from the pulp of the seed-capsules of a tree called bixa in South America. See BIXA.

The annotto is prepared only by the Spaniards; the mode is as follows: the contents of the fruit or capsule are thrown into a wooden bowl, where as much hot water is poured on them as is necessary to suspend the red matter or pulp. When the seeds are left quite naked, they are taken out, and the wash is left to settle. The water is then poured off, and the sediment dried by degrees in the shade, after which it is made into balls or cakes for exportation.

ANNUAL, an appellation given to whatever returns every year: thus we say, the annual motion of the earth, annual plants, &c.

ANNUAL, or ANNUEL, in the Scotch law, any yearly revenue, or rent, payable at the two great terms, Whitsuntide and Martinmas.

ANNUAL *plants*, called also simply *annuals*, are such as only live their year, *i. e.* come up in the spring, and die again in the autumn.

ANNUAL *leaves*, are such as come in the spring, and perish in autumn.

ANNUENTES MUSCULI, in anatomy, the same with *recti interni minores*.

ANNUITIES, periodical payments of money, amounting to a fixed sum in each year, and continuing for a certain period, as for 10, 50, or 100 years, or for an uncertain period, to be determined by a particular event, as on the failure of a life, or for an indefinite term; which latter are called perpetual annuities. The times of payment are either yearly, half-yearly, quarterly, weekly, or at any other intervals that may be determined on previous to the commencement of the annuity, or regulated during its continuance.

All calculations relating to annuities are made on the principle of improving money at Compound Interest, and are generally for an annuity of 1*l.*, from which the value of any other annuity is easily derived. Let r represent the amount of 1*l.* in one year; that is, one pound increased by a year's interest, then r^n, or r, raised to the power whose exponent is any given number of years, will be the amount of 1*l.* in those years; its increase in the same time is $r^n - 1$; now the interest for a single year, or the annuity answering to the increase, is $r - 1$; therefore, as $r - 1$ is to $r^n - 1$, so is u (any given annuity) to a its amount. Hence we have

$$\frac{u \times \overline{r^n - 1}}{r - 1} = a,$$

by which the amount of an annuity for any number of years at any given rate of interest is found. In the same manner the present value of annuities is obtained; for, as 1*l.* is the present value of r^n, its amount in n years, and as the present value of any other amount, and consequently of $\frac{u \times \overline{r^n - 1}}{r - 1}$ must bear the same proportion to that amount, we have

$$\frac{u \times \overline{1 - \frac{1}{r^n}}}{r - 1}, \text{ or } \frac{u - \frac{u}{r^n}}{r - 1} = p.$$

From these theorems, the other cases relating to annuities may be easily deduced; but as the involution of high powers is a tedious operation by common arithmetic, most questions relative to annuities may be more conveniently answered by the help of logarithms. It is, however, seldom necessary to have recourse to either of these methods, as very accurate tables of the amount and present worth of annuities have been calculated by Mr. J. Smart and others, and are inserted in most books that treat of Compound Interest or Annuities.

TABLE I.

Shewing the Amount of an Annuity of £.1, in any Number of Years, not exceeding 100, when improved at 5 per Cent. per Annum, Compound Interest.

Yrs.	Amount.	Yrs.	Amount.	Yrs.	Amount.
1	1,0000	35	90,3203	69	559,5510
2	2,0500	36	95,8363	70	588,5285
3	3,1525	37	101,6281	71	618,9549
4	4,3101	38	107,7095	72	650,9027
5	5,5256	39	114,0950	73	684,4478
6	6,8019	40	120,7998	74	719,6702
7	8,1420	41	127,8398	75	756,6537
8	9,5491	42	135,2317	76	795,4864
9	11,0266	43	142,9933	77	836,2607
10	12,5779	44	151,1430	78	879,0738
11	14,2068	45	159,7002	79	924,0274
12	15,9171	46	168,6852	80	971,2288
13	17,7130	47	178,1194	81	1020,7903
14	19,5986	48	188,0254	82	1072,8298
15	21,5786	49	198,4267	83	1127,4713
16	23,6575	50	209,3480	84	1184,8448
17	25,8404	51	220,8154	85	1245,0871
18	28,1328	52	232,8562	86	1308,3414
19	30,5390	53	245,4990	97	1374,7585
20	33,0659	54	258,7739	88	1444,4964
21	35,7192	55	272,7126	89	1517,7212
22	38,5052	56	287,3482	90	1594,6073
23	41,4305	57	302,7157	91	1675,3377
24	44,5020	58	318,8514	92	1760,1045
25	47,7271	59	335,7940	93	1849,1098
26	51,1135	60	353,5837	94	1942,5653
27	54,6691	61	372,2629	95	2040,6935
28	58,4026	62	391,8760	96	2143,7282
29	62,3227	63	412,4698	97	2251,9146
30	66,4388	64	434,0933	98	2365,5103
31	70,7608	65	456,7980	99	2484,7859
32	75,2988	66	480,6379	100	2610,0252
33	80,0638	67	505,6698		
34	85,0670	68	531,9533		

EXAMPLE.

To what sum will an annuity of £.42 amount in 30 years, at 5 per cent. compound interest? The amount in the Table against 30 years is 66,4388, which multiplied by 42, gives the answer 2790*l.* 8*s.* 7*d.*

TABLE II.

Shewing the present Value of an Annuity of £.1 for any Number of Years, not exceeding 100, at 5 per Cent. per Annum, Compound Interest. By the help of these tables many practical problems, which are daily occuring, may be worked by any persons versed in common arithmetic.

Yrs.	Value.	Yrs.	Value.	Yrs.	Value.
1	,952381	35	16,374194	69	19,309810
2	1,859410	36	16,546852	70	19,342677
3	2,723248	37	16,711287	71	19,373978
4	3,545950	38	16,867893	72	19,403788
5	4,329477	39	17,017041	73	19,432179
6	5,075692	40	17,159086	74	19,459218
7	5,786373	41	17,294368	75	19,484970
8	6,463213	42	17,423208	76	19,509495
9	7,107822	43	17,545912	77	19,532853
10	7,721735	44	17,662773	78	19,555098
11	8,306414	45	17,774070	79	19,576284
12	8,863252	46	17,880066	80	19,596460
13	9,393573	47	17,981016	81	19,615677
14	9,898641	48	18,077158	82	19,633978
15	10,379658	49	18,168722	83	19,651407
16	10,837770	50	18,255925	84	19,668007
17	11,274066	51	18,338977	85	19,683816
18	11,689587	52	18,418073	86	19,698873
19	12,085321	53	18,493403	87	19,713212
20	12,462210	54	18,565146	88	19,726869
21	12,821153	55	18,633472	89	19,739875
22	13,163003	56	18,698545	90	19,752262
23	13,488574	57	18,760519	91	19,764059
24	13,798642	58	18,819542	92	19,775294
25	14,093945	59	18,875754	93	19,785994
26	14,375185	60	18,929290	94	19,796185
27	14,643034	61	18,980276	95	19,805891
28	14,898127	62	19,028834	96	19,815134
29	15,141074	63	19,075080	97	19,823937
30	15,372451	64	19,119124	98	19,832321
31	15,592810	65	19,161070	99	19,840306
32	15,802677	66	19,201019	100	19,847910
33	16,002549	67	19,239066		
34	16,192904	68	19,275301		

EXAMPLE.

What is the present worth of an annuity of £30, to continue for 16 years, at 5 per cent. compound interest? The value in the Table against 16 years is 10,83777, which multiplied by 30, gives the answer 325*l.* 2*s.* 7*d.*

Reversionary Annuities are those which do not commence till after a certain number of years, or till the decease of a person, or some other future event, has happened. The present value of an annuity which is not to commence till the expiration of a certain period, may be found by Table II., by deducting from the value of an annuity for the whole period, the value of an annuity to the time at which the reversionary annuity is to commence.

Example. What is the present value, at 5 per cent. compound interest, of £.50 per annum for 20 years, commencing at the end of 7 years from the present time? The value of an annuity for 27 years is 14,643034, and the value of an annuity for 7 years is 5,786373, the latter deducted from the former leaves 8,856661, which multiplied by 50, gives 442*l.* 16*s.* 7*d.* the value of the reversionary annuity.

For the value of Annuities on Lives, and of Reversionary Annuities on Lives or Survivorship, see LIFE-ANNUITIES.

ANNUITIES, *Public.* See NATIONAL DEBT and FUNDS.

ANNUITY, in law, a contract very distinct from a rent-charge, with which it is frequently confounded; a rent-charge being a burthen imposed upon and issuing out of lands, whereas an annuity is a yearly sum, chargeable only upon the person of the granter. Therefore, if a man by deed grant to another the sum of 20*l.* per annum, without expressing out of what lands it shall issue, no land at all shall be charged with it; but it is a mere personal annuity, which is of so little account in the law, that if granted to an eleemosynary corporation, it is not within the statutes of mortmain; and yet a man may have a real estate in it, though his security is merely personal. *Blacks. Com.* b. ii. ch. 3.

For the provisions respecting grants of annuities for lives, see LIFE ANNUITIES.

ANNULAR, in anatomy, something in the form of or resembling a ring. Hence, the annular cartilage is the second cartilage of the larynx; annular ligament that which encompasses the wrist, and binds the bones of the arm together; annular process, or protuberance, a part of the medulla oblongata. The sphincter muscle of the anus is, from its figure, called the annular muscle.

ANNULAR *eclipse.* See ASTRONOMY.

ANNULET, in architecture, a small square member in the Doric capital, under the quarter round. Annulet is also a narrow flat moulding, which is common to divers places of the columns, as in the bases, capitals, &c. It is the same member which Vitruvius calls a fillet; Palladio a listel or cincture; Scamozzi and Mr. Brown, a supercilium, list, tinea, eyebrow, square, and rabbit.

ANNULET, in heraldry, a mark of distinction which the fifth brother of a family ought to bear in his coat of arms.

ANNULLING, a term sometimes used for cancelling or making void a deed, sentence, or the like.

ANNULUS, a ring, in geometry, the area of which is equal to the difference of the areas of the outer and inner circles: or it may be found by multiplying the sum of their diameters by the difference, and the product by .7854.

ANNUNCIADA, ANNUNTIADA, or ANNUNTIATA, an order of knighthood in Savoy, first instituted by Amadeus I. in the year 1409.

ANNUNCIADA is also the title of several religious orders, instituted at different times, and at different places, in honour of the Annunciation.

ANNUNCIATION, the tidings brought by the angel Gabriel to the Virgin Mary; a festival on the 25th of March, vulgarly called lady-day.

In the Romish church, on this feast the pope performs the ceremony of marrying or cloistering a certain number of maidens, who are presented to him in the church della Minerva, clothed in white serge, and muffled up from head to foot: an officer stands by, with purses containing notes of fifty crowns for those who make choice of marriage, and notes of an hundred for those who choose the veil.

ANNUNTIATOR, the name of an officer in the church of Constantinople. It was his business to inform the people of the festivals that were to be celebrated.

ANODYNE, in pharmacy, a term applied to medicines which mitigate pain.

ANOLYMPIADS, *αναλυμπιαδις*, in Grecian antiquity, an appellation given by the Elæans to such Olympic games as had been celebrated under the direction of other states besides themselves.

ANOMALISTICAL *year*, in astronomy, the time that the earth takes to pass through her orbit: it is also called the periodical year. The space of time belonging to this year is greater than the tropical year, on account of the precession of the equinoxes.

ANOMALOUS *verbs*, in grammar, such as are not conjugated conformably to the paradigm of their conjugation.

ANOMALY, in astronomy, an irregularity in the motion of the planets, whereby they deviate from the aphelion or apogee; which inequality is either mean, excentric, or coequate and true. See ASTRONOMY.

ANOMIA, in conchology, the name of an extensive genus of bivalves, defined as inequivalve, one valve gibbous towards the beak, the other flat, and perforated near the hinge. The animal, which is but imperfectly known, is described—body thin and slender, emarginated, and fringed; the hairs affixed to the upper valve; and it has two arms, which are linear and longer than the body. Some conchologists separate the fossil kinds from those which are found in a recent state. There are 25 species, among which is the anomia terebratula. See Plate, Nat. Hist. fig. 21.

ANOMOEANS, a sect of Christians, who asserted that the Son was of a nature different from and in nothing like to that of the Father. This was the name by which the pure Arians were distinguished, in contradistinction to the semi-arians, who acknowledged a likeness of nature in the Son, at the same time that they denied, with the pure Arians, the consubstantiality of the Word. The semi-arians condemned the anomœans in the council of Seleucia; and the Anomœans in their turn condemned the semi-arians in the council of Constantinople.

ANOMORHOMBOIDIA, in natural history, a genus of crystalline spars, of no determinate form, easily fissile, but cleaving more readily in an horizontal than in a perpendicular direction, their plates being composed of irregular arrangements of short and thick rhomboidal concretions. See MINERALOGY.

ANONIS, *rest-harrow*, in botany, a genus of plants, the flower of which is papilionaceous, and its fruit a turgid villose pod, containing a few kidney-like seeds.

This genus belongs to the diadelphia-decandria class of Linnæus, who calls it *ononis*. The essential character is, calyx quinquepartite; segments linear; vexillum striated; legumen turgid and sessile; filaments coatited, without a fissure.

ANSÆ, in astronomy, the parts of Saturn's ring, which are to be seen on each side of the planet, when viewed through a telescope, and the ring appears somewhat open. They are so called because they are like handles to the body of the planet.

ANSEL-*weight*, the same with auncel-weight.

ANSER, the trivial name of the common goose. See ANAS.

ANSER, in astronomy, a star of the fifth or sixth magnitude, in the milky-way, between the swan and eagle.

ANSPESSADES, in the French armies, a kind of inferior officer in the foot, below the corporals, but above the common sentinels. There are usually four or five of them in a company.

ANT, in entomology, a well-known insect, much celebrated for its industry and œconomy. See FORMICA and TERMES.

ANTA, in the antient architecture, a square pilaster, placed at the corners of buildings. Anta is used by M. Le Clerc for a kind of shaft of a pillar, without base or capital, and even without any moulding.

ANTACIDS, in pharmacy, an appellation given to all medicines proper to correct and

resist acid, or sour humours. See MATERIA MEDICA.

ANTAGONIST *muscles*, in anatomy, those which have opposite functions, as flexors and extensors, abductors and adductors, &c. See ANATOMY.

ANTALKALINES, in the materia medica, signify medicines fitted to correct alkaline salts, or alkaline matters in the whole body.

ANATANACLASIS, in rhetoric, a figure which repeats the same word, but in a different sense, as, *dum vivimus, vivamus*. And the English, *Let the dead bury the dead*.

ANTANAGOGE, in rhetoric, a figure by which, when the accusation of the adversary is unanswerable, we load him with the same or other crimes. This is usually called *recrimination*.

ANTANISOPHYLLUM, in botany, see BOERHAAVIA.

ANTARCTIC, in a general sense, denotes something opposite to the arctic, or northern pole. Hence,

ANTARCTIC *circle*, in geography and astronomy, is one of the lesser circles of the sphere, and distant only 23° 30′ from the south pole, which is likewise called antarctic, for the same reason.

ANTARES, a star of the first magnitude, otherwise called the Scorpion's heart. See SCORPION.

ANTE', in heraldry, denotes that the pieces are let into one another in such form as is there expressed; as, for instance, by dove-tails, rounds, swallows' tails, or the like.

ANTEAMBULONES, in Roman antiquity, servants who went before persons of distinction to clear the way before them. They used this formula, *Date locum domino meo;* i. e. make way for my master.

ANTECEDENT, in grammar, the word to which a relative refers: thus, *God whom we adore*, the word God is the antecedent.

ANTECEDENT, in logic, is the first of the two propositions in an enthymema.

ANTECEDENT, in mathematics, is the first of two terms of a ratio, or that which is compared with the other, as in the ratio of 2 to 3, or *a* to *b*, 2 and *a* are each antecedents.

ANTECEDENT *signs*, in medicine, such as are observed before a distemper is so formed as to be reducible to any particular class, as a bad disposition of the blood.

ANTECEDENT *term*, in mathematics, the first one of any ratio: thus, if the ratio be *a* : *b*, *a* is the antecedent term.

ANTECEDENTIA, in astronomy, an apparent motion of a planet towards the west, or contrary to the order of the signs, viz. from Taurus towards Aries, &c.

ANTEDATE, among lawyers, a spurious or false date, prior to the true date of a bond, bill, &c.

ANTEDILUVIAN, whatever existed before Noah's flood: thus, the generations from Adam to Noah are called the antediluvians. There have been great disputes among philosophers about the form, constitution, figure, and situation of the antediluvian earth. Dr. Burnet contended that it was only a hollow crust, with an uniform equable surface, without mountains and without seas, and in all respects different from what we now find it to be. Dr. Woodward undertook to prove that its appearance was the same as at present; that it had the same position in respect of the sun, and consequently the same vicissitudes of seasons: and Mr. Whiston imagined that the chaos of which our earth was formed, had been the atmosphere of a comet; that the annual motion of the earth began as soon as it assumed a new form; but that the diurnal motion did not take place till the fall of Adam; that before the deluge the year began at the autumnal equinox; that the orbit of the earth was a perfect circle; and that the solar and lunar years were the same, each consisting of just three hundred and sixty days. The state of the antediluvian philosophy has been the subject of much debate among authors, and so also has the state of the population.

ANTEJURAMENTUM, by our ancestors called *juramentum calumniæ*, an oath which anciently both accuser and accused were to take before any trial or purgation. The accuser was to swear that he would prosecute the criminal; and the accused to make oath, on the day he was to undergo the ordeal, that he was innocent of the crime charged against him.

ANTELOPE, in zoology, a genus of quadrupeds. The generic character is, horns hollow, with a bony core, pointing upwards, annulated or wreathed, permanent; front teeth, in the lower jaw, eight; no canine teeth. Antelopes have but lately been included in a separate genus; they were formerly placed under that of the goat. They form a link indeed between the goat and deer kind, but possess sufficient distinctive marks to entitle them to stand apart from them both. They are in general natives of the hottest part of the globe, and peculiarly of Asia and Africa, Europe having but two species, and America none.

Antelopes have a slender elegant make, and are singularly agile and swift in their motions: they are restless, timid, vigilant, and full of animation. Their chace is a favourite amusement in the east; and such is their speed, that the fleetest dogs cannot overtake them; on which account falcons are trained to assail them, and by pecking at their eyes, to check their course, and throw them into confusion. A species of leopard is employed also to steal upon them unawares, and seize them by a few bounds.

Antelopes have the singular property of sometimes stopping short, and gazing at their pursuers. The beauty of their eyes affords a favourite object of comparison to eastern poets. They usually prefer hilly countries, and associate in numerous herds. They graze on herbage, or crop the shoots of trees, and their flesh is generally of a very delicate flavour. There are 28 species of the antelope.

1. Oryx, or Egyptian antelope. The Egyptian antelope, or pasan, is more easily distinguished than many others in this extensive race; the horns affording a character perfectly clear and constant: they are almost entirely straight, nearly three feet in length, very slender in proportion to their length, annulated at the lower part or towards the base, the remainder smooth, and gradually tapering to the point. The size of the animal is somewhat superior to that of a deer. The pasan is nearly four feet high, measured from the top of the shoulders to the ground: it is found about the Cape of Good Hope, as well as in other parts of Africa.

2. Leucoryx, or white antelope. The leucoryx is entirely milk-white, except the markings on the face and limbs: these are described as of a red colour, and not black, as in the pasan; the nose is thick and broad, like that of a cow; the ears somewhat slouching; the body heavy; the limbs somewhat less so; the horns very long, very slightly incurvated, slender, and annulated about half way upwards; their colour is black, and they are sharp-pointed; the hoofs are black, and the tail somewhat flocky, or terminated by loose hairs. The size of this species is compared by Mr. Pennant to that of a Welch runt. It is an inhabitant of an island called Gow Bahrein, in the gulph of Bassora.

3. Antilope gazella, or algazel. This species is a native of India and Persia, and is also found in many parts of Africa. It is about the size of a fallow deer, and is of a reddish or bright bay colour, with a white breast: the horns are very long, thin, and black, nearly upright, bending inwards at their extremities; they are nearly smooth; the rings with which they are marked being very slight, except near the base, where they are somewhat more distinct: they are almost three feet in length.

In celerity and general manners this species agrees with many others of its tribe, and is said to be easily tamed.

4. Oreas, or Indian antelope. This is one of the largest of the whole genus, and is found both in India and Africa, living in numerous herds. It is not much inferior in size to a cow, and is of a bluish grey or slate-colour, with the head of a bright bay. Along the upper part of the neck, and a part of the back, runs a coarse black mane: on the breast is a very large pendent tuft of hair, as in the Nilgau: the tail is also tipped with long black hairs; the horns are extremely stout, strait, sharp-pointed, and marked with two very thick prominent wreaths or spires: they are sometimes above two feet in length, and are of a blackish colour. The oreas is said to be an animal of great strength, and it has been thought not impracticable to train it to agricultural purposes, in the same manner as the horse or ox. It is said sometimes to grow extremely fat, so as to be easily run down. The flesh is reckoned extremely good; and the skin is very strong and serviceable for the purpose of leather. The female is said to be horned like the male.

5. Antilope ourebi, or ourebi. This is described by Mr. Pennant as the antelope with small strait horns, small head, long neck, long pointed ears: colour above a deep tawny, brightening towards the sides, neck, head, and legs; lower part of breast, belly, buttocks, and inside of thighs, white: tail only three inches long, and black: hair on the body short, under the chest long and whitish, on each knee a tuft of hair. The females are hornless: length three feet nine inches to the tail: inhabits the country very remote from the Cape of Good Hope. Seldom more than two are seen together. They generally haunt the neighbourhood of fountains surrounded with reeds; are excellent venison.

6. Antilope oreotragus, or klipspringer. This species is to be numbered among the late acquisitions in natural history, having been first described by Dr. Forster

7. Scripta, or harnessed antelope. This, which is numbered among the smaller antelopes, is of an elegant tawny chesnut-colour both above and below, each side of the body being marked by two longitudinal bands of white, crossed, at nearly equal distances, by two transverse ones: the rump is also marked on each side by two white descending stripes; and the thighs are variegated with seven or eight roundish white spots: the cheeks have a white spot or patch beneath the eye, and the under part of the throat is of the same colour: the tail measures ten inches, and is covered with long and rough hair: the horns point backward, and are nine inches long, of a black colour, and marked by two spiral ribs or wreaths. This elegant species is a native of Senegal, living in woods in large herds.

8. Grimmia, or Guinea antelope. The Guinea antelope, or grimm, is considerably smaller than a roebuck, and is of an elegant and lively aspect. Its colour on all parts except the throat, abdomen, and insides of the thighs, where it is pale cinereous, is a beautiful light yellowish or tawny brown. Like most other quadrupeds, however, it differs as to the intensity of its colour. The horns are very short, thick at the base, very slightly annulated to a small distance beyond, and are sharp-pointed, smooth, and black: the limbs are slender; the tail rather short, blackish above, white below, and is somewhat flocky or loose-haired: but what principally distinguishes this species is an upright pointed tuft of strong black hairs rising from the top of the forehead, between the horns, to the height of about two inches and a half: the sinus lachrymalis, as in many other antelopes, is extremely conspicuous. The grimm is found in several parts of Africa, extending, according to Dr. Pallas and Mr. Pennant, from Guinea to the Cape of Good Hope; residing principally in places overgrown with brushwood, into which it may retire on the approach of danger.

9. Pygmæa, or pygmy antelope. This beautiful and diminutive species appears to have been frequently confounded with the *moschus pygmæus*, or pygmy musk, which it resembles in size as well as in colour and manners. It is a native of the hottest parts of Africa, and is easily tamed, but is of so tender a nature as not to admit of being brought in a living state into Europe. So remarkable are its powers of activity in its native regions, that it is said to be able to leap over a wall of twelve feet high. Its colour is a bright bay, paler beneath, and on the insides of the limbs; and its height not more than nine inches. The horns are strait, short, strong, sharp-pointed, smooth, and perfectly black. The legs are scarcely thicker than a quill, and have been used for similar purposes with those of the moschus pygmæus. The female is said to be hornless.

10. Antilope picta, or nilghau. The nilghau, or white-footed antelope, is a large and beautiful species, known only within the space of a few years past. It has of late years been often imported into Europe, and has bred in England. In confinement it is generally pretty gentle, but is sometimes seized with fits of sudden caprice, when it will attack with great violence the objects of its displeasure. When the males fight, they drop on their knees at some distance from each other, and gradually advance in that attitude, and at length make a spring at each other with their heads bent low. This action, however, is not peculiar to the nilghau, but is observed in many others of the antelope tribe. See Plate Nat. Hist. fig. 22.

11. Tragocamelus, or Indostan antelope. The Indostan antelope is of a far less elegant appearance than the rest of the antelopes, and seems to partake, in some degree, of the form of a camel, having a strong bending neck, and a large elevation or protuberance over the shoulders. Along the neck runs a short mane; and the protuberance before mentioned is covered or tufted with long hair: the breast is furnished with a kind of dewlap, or loose pendent skin, resembling that of a cow: the hind part of the animal is small in proportion to the fore; the limbs are slender, and the tail is nearly two feet in length, and terminated by a hairy tuft. This highly singular animal is a native of India, and in its habits and manner of lying down is said to resemble a camel.

12. Bubalis, or cervine antelope. This species is said to be common in Barbary, and in all the northern parts of Africa. It is also found, though less frequently, in many other parts of that continent, and even extends as far as the Cape of Good Hope. It is supposed to have been the bubalus of the antients, instead of the common buffalo, as sometimes erroneously imagined. In its general form it seems to partake of the stag and heifer, having a large head, like that of an ox; and a thick broad nose. The height of the animal, when measured to the top of the shoulders, is about 4 feet; the general colour a reddish brown, white about the rump, insides of the limbs, and lower part of the belly; the upper part of the fore legs is marked in front by a dusky patch, as is also the hind part of the thighs; and on the upper part of the back is a stripe of the same colour. The horns bend outwards and backwards, and are very strong and black, thickly or coarsely annulated towards the base, and seated pretty close to each other on the head; they are about 20 inches in length, and 11 inches round at the base; the teeth are large, the lower lip black, with a sort of tuft of bristles on each side; along the snout and forehead runs a black band, terminated at the forehead by a tuft of hair between the horns.

13. Strepsiceros, or striped antelope. The striped antelope is a native of the country about the Cape of Good Hope, where it is said to be called coedoes. It is one of the larger kinds of antelopes, measuring near 9 feet in length, and being 4 feet high. Its colour is a rufous-grey, with the face brown, marked by two white lines, each proceeding from the corner of the eye, and uniting in a pointed form on the top of the nose, which is smooth and black; down the forehead runs a broad dusky stripe, and a streak of the same colour is continued down the upper part of the neck; the lower part of the back is marked by a white stripe, from which proceed several others, each about an inch broad, down the sides of the animal, three or four of them falling over the upper part of the thighs: the female of this species is said by Mr. Pennant to be destitute of horns, but Dr. Pallas affirms that it is horned like the male. The number of white stripes in this animal seems to vary.

14. Rupcapra, or common antelope. Of this numerous tribe there is perhaps no species more truly elegant in its appearance than the present, which is a native of many parts of Africa, as well as of India. It is particularly frequent in Barbary. Its general size is somewhat smaller than that of a fallow deer, and its colour is a reddish tawny brown above, and white below; the insides of the limbs are white, and on the head, back, and outsides of the limbs, the hair is darker than on other parts: the orbits of the eyes are white, and this colour is generally continued into a white spot or patch on each side the forehead; the muzzle is black; the horns are of a peculiarly beautiful form, having a double flexure, first inwards, and again outwards: their colour is black, and they are very elegantly and distinctly marked throughout almost their whole length by numerous prominent rings. Their general length is about fourteen inches, and they are about sixteen inches distant from each other at the tips. See Plate Nat. Hist. fig. 23.

15. Lerwia, or Gambian antelope. This seems a species not very distinctly understood.

16. Antilope saiga, or saiga. The saiga, or Scythian antelope, is an inhabitant of all the deserts from the Danube and the Dnieper to the river Irtish, but not beyond; nor is it ever seen to the north of 54 or 55 degrees of latitude. It is therefore found in Poland, Moldavia, about Mount Caucasus, and the Caspian Sea, as well as in the dreary open deserts of Siberia, where salt-springs abound, feeding on the salt, acrid, and aromatic plants of those countries.

The females of this species go with young the whole winter, and bring forth in the northern deserts in May, producing only one young at a birth, which is covered with a soft curling fleece, like that of a new-fallen lamb. It is said that a flock of saigas seldom lies down all at once, some always acting as a kind of sentinels, and being relieved in their turn by others; and thus they preserve themselves from the attacks both of wolves and hunters. They are so extremely swift as easily to outstrip the fleetest horse, but cannot run for any great length of time in this manner without stopping, as if to take breath. If bit by a dog, they instantly fall down, without attempting to rise, being entirely disabled through extreme terror. In their flight they appear to incline to one side, and their course is so rapid, that they scarcely seem to touch the ground with their feet. When taken young they may be easily tamed; but when caught at full age, are so wild and obstinate as to refuse all kind of food.

These animals are hunted for the sake of their flesh, horns, and skins, which latter are said to be excellent for gloves, belts, &c. The hunters are careful to approach them against the wind, lest the animals should perceive them by their smell: they also avoid putting on red or white clothes, or any colours which might attract their notice. They are both shot and taken with dogs, and sometimes by a species of eagle trained to this kind of falconry.

17. Gutturosa, or Chinese antelope. This is a species which is said to abound in the southern parts of the deserts between Tibet and China, and in the country of the Mongol Tartars, frequenting principally the dry and rocky plains and hills of those regions,

and feeding on the finer and more aromatic plants. It is said to be so averse to water, that it will not go into it even to save its life, when driven by dogs to the brink of a river. If taken young it may be easily tamed. Its flesh is much esteemed as a food, and the horns are in great request among the Chinese for various purposes. The female has no horns.

18. Subgutturosa, or Guldensted's antelope. This species was first described by Mr. Guldensted, in the Petersburgh Transactions. It is found in Persia, between the Caspian and the Black Seas; its size and general appearance is that of a roebuck, of a gregarious nature, and it feeds principally on the artemisia pontica.

19. Antilope euchore, or springer.

"This elegant species weighs about fifty pounds, and is rather less than a roebuck; inhabits the Cape of Good Hope; called there the *spring-bock*, from the prodigious leaps it takes on the sight of any body. When alarmed it has the power of expanding the white space about the tail into the form of a circle, which returns to its linear form when the animal is tranquil. They migrate annually from the interior parts in small herds, and continue in the neighbourhood of the Cape for two or three months, then join companies, and go off in troops, consisting of many thousands, covering the great plains for several hours in their passage; are attended in their migrations by numbers of lions, hyænas, and other wild beasts, which make great destruction among them; are excellent eating, and, with other antelopes, are the venison of the Cape. They make periodical migrations in seven or eight years, in herds of many hundred thousands, from the north, from the interior parts of Terra de Natal. They are compelled to it by the excessive drought which happens in that region, where sometimes there does not fall a drop of rain for two or three years. These animals, in their course, desolate Caffraria, spreading over the whole country, and not leaving a blade of grass. Lions attend them: where one of those beasts of prey are, the place is known by the vast void visible in the midst of the timorous herd. On its approach to the Cape, it is observed that the avant guard is very fat, the centre less so, and the rear guard almost starved, being reduced to live on the roots of the plants devoured by those which went before; but on their return they become the avant guard, and thrive in their turn on the renewed vegetation; while the former, now changed into the rear guard, are famished, by being compelled to take up with the leavings of the others. These animals are quite fearless, when assembled in such mighty armies; nor can a man pass through, unless he compels them to give way with a whip or a stick. When taken young, they are easily domesticated: the males are very wanton, and are apt to butt at strangers with their horns."

20. Antilope arundinacea, or ritbock. The ritbock, or ritrebock, is so named from its chiefly frequenting reedy places. Its size is that of a roebuck, and its colour a very elegant pale grey, with the throat, belly, hips, and insides of the limbs, white, but without any dusky line of separation along the sides of the body, as in many other antelopes.

21. Antilope sylvatica, or bosbock. In its general form this seems most allied to the harnessed antelope, but is said to be rather smaller. Like that species, it inhabits woods, and is found at a great distance above the Cape of Good Hope. Its colour is a dark brown above, and white beneath; the head and neck having somewhat of a rufous cast, and the thighs are marked with several small round white spots.

22. Eleotragus, or cinereous antelope. This appears to be an elegant species, and is supposed to be a native of Africa. The head, hind part, and sides of neck, back, sides, shoulders, and thighs, of a most elegant greyish ash-colour; front of the neck, breast, belly, and legs, pure white; horns marked with spiral wreaths. Mr. Pennant places it among those whose horns incline forwards.

23. Dorcas, or Barbary antelope. This species is about half the size of a fallow deer; its colour is reddish-brown above, and white beneath; the two colours being separated by a dark or blackish lateral line or stripe; on each knee is a tuft of blackish hair; the horns are 12 inches long, of a round or cylindric form, and incline first backwards, then bend in the middle, and lastly, revert forwards at their tips; they are of a black colour, and are annulated with about 13 rings on the lower part.

24. Kevella, or flat-horned antelope. This animal, in its general appearance, so exceedingly resembles the Barbary antelope, that it might readily pass for a variety of the same species, was it not that the horns, instead of being round, are flattened on their sides, and marked by somewhat more numerous rings. Its size is that of a small roebuck, and it is chiefly found in Senegal, but is said to occur also in Barbary and in Persia. It lives in large flocks, and has an odour resembling that of musk.

25. Pygarga, or white-faced antelope. So great is the similitude between this species and the flat-horned antelope, that the chief difference appears to consist in size; this being larger than a fallow deer. The horns resemble those of the animal before-mentioned, and are 16 inches long, and about 5 between tip and tip; they are very strongly annulated in the male, but said to be nearly smooth in the female; the face is white; the cheeks and neck, in the living animal, of a bright bay; the back and upper parts of ferruginous brown, with a dark stripe down the back; the belly and rump white, as is also, in the Leverian specimen, the lower half of the legs; the sides of the body are marked, as in many others of this genus, with a dark or blackish stripe; the tail is about seven inches long, covered with black hairs, which extend some inches beyond the end.

26. Antilope corinna, or corine. The corine is somewhat smaller than a roebuck, and is a native of Senegal and other parts of Africa.

27. Sumatrensis, or Sumatran antelope. The Sumatran antelope was first mentioned by Mr. Marsden, in his account of that island, under the name of cambing ootan, or goat of the woods.

28. Leucophæa, or blue antelope. This is a species of very considerable size, being larger than a fallow deer, and from the form of its horns, and the length of its hair, may be said to connect, in some degree, the antelope with the goats.

ANTENNÆ, in the history of insects, slender filaments with which nature has furnished the heads of these creatures, being the same with what in English are called horns, or feelers.

The structure of the antennæ in different insects are thus characterized. SETACEÆ, those which resemble a bristle: FILIFORMES, uniform, like a thread: MONILIFORMS, like the filiform, but consisting of a series of round knots: CLAVATÆ, club-shaped, increasing from the base to the extremity: CAPITATÆ, like the former, but the last articulation larger than the rest, and forming a capital or head: FISSILES are *capitatæ*, but have the head divided horizontally into laminæ: PERFOLIATÆ are likewise capitatæ, but the head divided horizontally, and connected by a kind of thread that passes through the centre: PECTINATÆ, resembling a comb or feather, having lateral appendages on both sides: ARISTATÆ, have a lateral hair, which is either naked or furnished with lesser hair.

ANTEPAGMENTA, in the antient architecture, the jams of a door. They are also ornaments in carved work, of men, animals, &c. made either of wood or stone, and set on the architrave.

ANTEPENULTIMA, in grammar, the last syllable but two from the end of a word.

ANTEPREDICAMENTS, among logicians, certain preliminary questions, which illustrate the doctrine of predicaments and categories. They are so called because Aristotle has placed them before the predicaments, in order to treat that subject afterwards without interruption.

ANTESIGNANI, in the Roman armies, soldiers placed before the standards, in order to defend them, according to Lipsius; but Cæsar and Livy mention the antesignani as the first line, or first body, of heavy-armed troops. The velites, who used to skirmish before the army, were likewise called antesignani.

ANTESINISTRA, a name given by the augurs of Rome to thunderbolts, or birds, which proceeded from the south and passed to the east, and were supposed to afford unfavourable presages.

ANTESTARI, denoted to bear witness against any one who refused to make his appearance in the Roman courts of judicature on the day appointed, according to the tenor of his bail. He might then be brought by force into court, some persons being called to bear witness of the fact.

ANTHELION, a mock sun, or meteor, seen through the clouds, larger than the disk of the sun. In its most refulgent state it is yellow as the sun, but the lucid tract surrounding it is of a paler yellow, interspersed with reddish spots.

ANTHELIX, in anatomy, the inward protuberance of the external ear, being a semicircle within, and almost parallel to the helix.

ANTHELMINTICS, medicines to destroy worms. See MATERIA MEDICA.

ANTHEMIS, CAMOMILE, a genus of the polygamia superflua order, belonging to the syngensia class of plants; and in the natural method ranking under the 49th order, compositæ discoides. The essential characters are these; the receptaculum is chaffy; there is no pappus; the calyx is hemispheric and subequal; and the florets of the ray are more than five. Of this genus there are 19 spe-

16

Ampelis pompadora
Pompadour Chatterer

15

Anarrhichas minor
Lesser Wolf Fish

14

Anarcardium occidentale
Cashew nut

18

Anas nigra
Black duck

19

Anas galericulata
Chinese duck

20

Anguis Fragilis
Blind Worm

22

Antelope Picta

23

Rupicapra Antelope

21

Arcuria Terebratula

24

Arbor Vitæ myriophylla

25

Apis hirsuta

26

27

Apis nidulans with a section of its hive.

cies, of which the most remarkable are the following.

1. Anthemis Arabica has a branching empalement. It grows near two feet high, with an upright stem, having a single flower at the top, from whose empalement there are two or three footstalks, each having a single flower smaller than the first, like the childing marigold, or hen-and-chicken daisy.

2. Anthemis nobilis, or common camomile, grows in plenty upon commons, and other waste land. There is a variety with double petals. Formerly this plant was used for planting of walks, which, when mowed and rolled, looked well for some time; but it was subject to decay in large patches, and the walks became unsightly.

3. Anthemis pyrethrum, or pellitory of Spain, is a perennial plant, which grows naturally in Spain and Portugal. The branches trail upon the ground. At the extremity of each branch is produced one large single flower, like camomile, but much larger; the rays of which are of a pure white within, but purple on the outside. The seeds will not come to perfection in this country.

4. Anthemis tinctoria is a perennial plant, which flowers from June to November, and makes a very pretty appearance, some of the flowers being of a white, others of a sulphur, and some of a bright yellow colour. Of these the nobilis and the pyrethrum are chiefly used in medicine. They are accounted carminative, aperient, emollient, and in some measure anodyne. These flowers are frequently also used externally in discutient and antiseptic fomentations, and in emollient glysters. An essential oil was formerly directed to be prepared from them, but it is now omitted. A simple watery infusion of them taken in a tepid state, is at present frequently employed to promote the operation of emetics.

ANTHERA, among botanists, that part of the stamen which is fixed on the top of the filamentum, within the corolla; it contains the pollen or fine dust, which, when mature, it emits for the impregnation of the plant.

ANTHERICUM, spider-wort, a genus of the monogynia order, belonging to the hexandria class of plants; and, in the natural method, ranking under the 10th order, coronariæ. The essential character is, corolla of six oblong petals, expanding. The pericarpium is an ovate trisulcated capsule, with three cells and three valves. There are 39 species. The anthericum frutescens was formerly known among the gardeners near London by the name of onion-leaved aloe. It produces many ligneous branches from the root, each supporting a plant with long taper leaves, in shape like those of an onion, and full of a yellow pulp very juicy. The flowers are yellow, produced on long loose spikes. It is a native of the Cape of Good Hope, and requires shelter in winter.

The anthericum liliastrum is a perennial plant; it flowers in June and July, and is known by the name of St. Bruno's lily.

ANTHESTERIA, in Grecian antiquity, festivals celebrated in the spring by the antient Athenians, in honour of Bacchus, during which the masters feasted their slaves, as the Romans did in the time of the Saturnalia. It was usual, during these feasts, to ride in chariots, and pass jests upon all that passed by.

ANTHISTIRIA, in botany, a genus of the trigynia order, belonging to the triandria class of plants, and, in the natural method, ranking under the 4th order, gramina. The essential character is: the corolla, a two-valved glume, cleft at the base into four divisions. There is only one species of this grass, the ciliata or fringed anthistiria, a native of India.

ANTHOCEROS, or horn-flower, a genus of the order of algæ, belonging to the cryptogamia class of plants, and, in the natural method, ranking under the 57th order, algæ. The essential characters are: the calyx of the male is sessile, cylindric, and entire; the anthera (one) is subulated, very long, and two-valved; the calyx of the female is monophyllous, divided into six parts, and expanding; the seeds are about three, naked and roundish. There are only three species of the anthoceros, viz.

1. Anthocerbs levis, a native of Europe and America.

2. Anthoceros multifidus, a native of Germany, found in moist shady places, and on heaths.

3. Anthoceros punctatus, or spotted anthoceros, a native of Britain.

ANTHOLOGION, the title of the service book used in the Greek church. It is divided into twelve months, containing the offices sung throughout the year, on the festivals of our Saviour, the Virgin, and other remarkable saints.

ANTHOLOGY, ανθολογια, a discourse of flowers, or of beautitul passages from any authors. It is also the name given to a collection of epigrams taken from several Greek poets.

ANTHOLYZA, mad-flower, a genus of the monogynia order, belonging to the triandria class of plants; and in the natural method ranking under the 6th order, ensatæ. The essent al characters are; the calyx is tubular, irregular, and bent back; and the capsule is beneath the flower. There are 7 species: the most remarkable are; 1. Antholyza ringens. This has red, round, bulbous roots, from which arise several red flowers. These appear in June, and the seeds ripen in September.

2. Antholyza spicata, with narrow furrowed leaves, is in shape and size like the vernal crocus. Between these arise the flower-stem, which is a foot and a half high: the flowers come out on one side, and are of a white colour, appear in May, and the seeds ripen in August. Both these species are natives of Africa. In summer they may be placed in the open air, but in winter they must be placed under a hot-bed frame, or in the green-house, where they are a great ornament when in flower.

ANTHOMANIA, an extravagant fondness for curious flowers. A remarkable instance of this occurred in Holland last century, which ruined many individuals, and was obliged to be put a stop to by the magistrates.

ANTHONY, or knights of St. Anthony, a military order, instituted by Albert duke of Bavaria, Holland, and Zealand, when he designed to make war against the Turks in 1382. The knights wore a collar of gold made in form of a hermit's girdle, from which hung a stick cut like a crutch, with a little bell, as they are represented in St. Anthony's pictures.

ANTHONY'S (St.) FIRE, a name sometimes given to the erysipelas.

ANTHOSPERMUM, the amber tree, a genus of the diœcia order, belonging to the polygamia class of plants, and in the natural method ranking under the 17th order, stellatæ. The essential characters are; the calyx of the hermaphrodite flower is divided into four parts; there is no corolla; the stamina are four, and the pistilla two; the germen is beneath the flower. Male and female on the same or separate plants. Of this genus Linnæus mentions three species, viz.

1. Anthospermum Æthiopica. 2. Anthospermum ciliare; and 3. Anthospermum herbacea. The first is most generally known in the gardens of the curious. Its beauty consists in its small evergreen leaves, which grow as close as heath. These being bruised between the fingers, emit a very fragrant odour; whence the name amber-tree. This plant is easily propagated, by cuttings during any of the summer months, in a border of light earth, where they will take root in six weeks time, provided they are watered or shaded as the season may require; or if they are planted in pots plunged in a moderate hot-bed, they will take root the sooner, and there will be a greater certainty of their growing. They must be frequently renewed by cuttings, as the old plants are very subject to decay.

ANTHOXANTHUM, or vernal grass, a genus of the digynia order, belonging to the diandria class of plants; and in the natural method ranking under the 13th order, gramina The essential characters are; the calyx is a bivalved gluma, with one flower; the corolla is bivalved, obtuse, and without any awn. There are three species, viz.

1. Anthoxanthum Indicum, a native of India.

2. Anthoxanthum odoratum, or spring-grass, a native of Britain: it is one of the earliest spring grasses, and is extremely common in our fertile pastures. The delightful smell of new-mown hay is chiefly from this plant.

ANTHRAX, a Greek term, literally signifying a burning coal, used by the antients to denote a gem, as well as a disease, more generally known by the name of carbuncle. It is sometimes also used for lithanthrax, or pit-coal.

ANTHROPOGLOTTUS, among zoologists, an appellation given to such animals as have tongues resembling that of mankind, particularly to the parrot kind.

ANTHROPOLATRÆ, in church-history, an appellation given to the Nestorians, on account of their worshipping Christ, notwithstanding that they believed him to be a mere man.

ANTHROPOLITES, a term denoting the petrifactions of the human body.

ANTHROPOMANCY, a species of divination, performed by inspecting the entrails of a human creature.

ANTHROPOMORPHITES, in church-history, a sect of antient heretics, who taking every thing spoken of God in the scripture in a literal sense, particularly that passage of Genesis in which it is said 'God made man after his own image,' maintained that God had a human shape.

ANTHROPHAGY, the act of eating human flesh. The origin of this custom, barbarous as it is, some authors trace as high as the deluge. In the southern part of Africa,

and in some parts of America, this horrid practice is said still to prevail. Mr. Marsden, in his History of Sumatra, informs us that the battas of that island are anthropophagi. They do not eat human flesh to satisfy hunger, but as a mode of shewing an abhorrence of their enemies. The objects of this savage repast are prisoners taken in war. When sentence is pronounced, the unhappy victim is tied to a stake, and when mortally wounded by lances thrown at him by the assembled multitude, they rush upon him, cut pieces from his body with their knives, dip them in a dish, previously prepared, of salt and lemon-juice, slightly broil them over a fire, and then devour them with savage enthusiasm.

ANTHROPOSOPHIA, the science of the nature of man, his structure amd composition, both internal and external.

ANTHYLLIS, kidney-vetch, or lady's finger, a genus of the decandria order, belonging to the diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ. The essential characters are; the calyx is ventricose, and the legumen is roundish and covered. There are 17 species, of which the following seem to be most worthy of attention.

1. Anthyllis barba Jovis, or silver-bush, has its name from the whiteness of its leaves. This is a shrub which often grows to the height of 10 or 12 feet, dividing into many lateral branches, with winged leaves. The flowers are produced at the extremities of the branches, collected into small heads, of a bright yellow colour.

2. Anthyllis cytisoides, or shrubby woundwort, has long been known in the English gardens. It is a low shrub, seldom rising above two feet high, but sends out many slender branches, with hoary leaves, which are sometimes single, but generally have three oval lobes: the flowers are yellow. This species and the barba Jovis may be propagated by cuttings planted during any of the summer months; they must always be housed in winter.

3. Anthyllis montana, or herbaceous woundwort, with winged leaves, grows naturally in the mountains in the south of France, and in Italy. The flowers are of a purple colour and globular form. They appear in June and July.

4. Anthyllis vulneraria, with unequal winged leaves, is a native of Spain and Portugal, as likewise of Wales. It is a biennial plant, and the flowers are of a bright scarlet colour.

ANTI, a Greek preposition, which enters into the composition of several words, both Latin, French, and English, in different senses. Sometimes it signifies before, as in antichamber, and sometimes opposite or contrary, as in the names of these medicines antiscorbutic, antivenereal, &c.

ANTIBACCHIUS, in antient poetry, a foot consisting of three syllables; the two first long, and the last one short.

ANTIBIBLOS, in the *civil law*, an instrument by which the defendant owns he has received the libel, or a copy of it, and notes the day whereon he received it.

ANTICAUSOTICS, denote medicines against burning fevers.

ANTICHORUS, in botany, a genus of the monogynia order, belonging to the octandria class; of which the essential characters are; the calyx is a four-leaved perianthium; the corolla consists of four expanding petals; the pericarpium is a capsule, above, subulated, with four cells, and four valves; the seeds are very numerous. There is but one species, viz.

Antichorus depressus, a native of Arabia.

ANTICARDIUM, in anatomy, the hollow part under the breast, commonly called the pit of the stomach, the same with scrobiculum cordis.

ANTICHRESIS, in civil law, a covenant, by which a person borrowing money of another engages to make over his property to the creditor, for the interest of money lent.

ANTICK, in sculpture and painting, denotes a fantastical composure of figures of different natures, sexes, &c. It amounts to the same thing as the French call *grotesque*.

ANTICLIMAX, in rhetoric, is a figure by which the progress of a discourse descends from great to little.

ANTICUM, in architecture, a porch before a door; also that part of a temple that lies between the body of the temple and the portico.

ANTICUS, a term used by anatomists, importing that the part with which it is joined stands before some others; serratus anticus, peronæus anticus, tibialis anticus, &c. See ANATOMY.

ANTIDACTYLUS, a name to a foot of poetry, the reverse of dactyl, consisting of three syllables, the first two short, and the last long.

ANTIDESMA, in botany, a genus of the diœcia order, belonging to the pentandria class of plass. The calyx of the male is five-leaved; there is no corolla; the antheræ are bifid; the female calyx is five-leaved; the corolla is wanting; the stigmata are five; the berry is cylindric and one-seeded. There are three species, natives of India.

ANTIDICOMARIANTES, in church-history, heretics who maintained that the Virgin Mary did not preserve a perpetual virginity.

ANTIDORON, a name given by the Greek church to the consecrated bread, part of which was given to the poor.

ANTIENT, in a military sense, denotes either the ensign who carries them, or the colours; in ships of war, the streamer or flag, borne in the stern.

ANTIHECTICS, medicines good in hectical disorders. See PHARMACY.

ANTILOGARITHM, the complement of a logarithm.

ANTIMONY, in natural history, one of the semi-metals, separated by fusion from a very hard and heavy lead-coloured substance, called ore of antimony: this ore is composed of a number of extremely small sparkling granules, which give it the appearance of a lump of the purest steel, when fresh broken.

I. Antimony is of a greyish white colour, and has a good deal of brilliancy. Its texture is laminated, and exhibits plates crossing each other in every direction, and sometimes assuming the appearance of imperfect crystals. Hauy has with great labour ascertained that the primitive form of these crystals is an octahedron, and that the integrant particles of antimony have the figure of tetrahedrons. When rubbed upon the fingers, it communicates to them a peculiar taste and smell. Its specific gravity is, according to Brisson, 6.702; according to Bergman, 6.86. It is very brittle, and may be easily reduced in a mortar to a fine powder. Its tenacity has not been tried. When heated to 809 degrees Fahrenheit, or just to redness, it melts. If after this the heat is increased, the metal evaporates. On cooling, it assumes the form of oblong crystals, perpendicular to the internal surface of the vessels in which it cools. It is to this crystallization that the laminated structure which antimony always assumes is owing.

II. When exposed to the air, it undergoes no change except the loss of its lustre. Neither is it altered by being kept under water. But when steam is made to pass over red-hot antimony, it is decomposed so rapidly that a violent detonation is the consequence.

When heated in an open vessel, it gradually combines with oxygen, and evaporates in a white vapour. This vapour, when collected, constitutes a white-coloured oxide, formerly called *argentine flowers of antimony*. When raised to a white heat, and suddenly agitated, antimony burns, and is converted into the same white-coloured oxide.

III. Antimony has never been combined with carbon nor hydrogen. When its oxides are heated along with charcoal or oils, they are reduced, but imperfectly, unless some body (as potass) be present to favour the fusion of the metal. The greater part remains in a state of black spongy mass, which often takes fire when exposed to the air. Antimony combines readily with sulphur and with phosphorus.

Sulphuret of antimony may be formed by mixing its two component parts together, and fusing them in a crucible. It has a dark blueish grey colour, with a lustre approaching the metallic; it is much more fusible than antimony, and may be crystallized by slow cooling. It is composed, according to Bergman, of 74 parts of antimony and 26 of sulphur. With this estimate the late experiments of Proust coincide almost exactly. According to that very accurate chemist, sulphuret of antimony is composed of

75.1 antimony
24.9 sulphur

100.0

This substance is found native in great abundance, and indeed is almost the only ore of antimony. It was to this sulphuret that the term *antimony* was applied by the earlier chemists; the pure metal was called *regulus of antimony*.

When equal parts of antimony and phosphoric glass are mixed together with a little charcoal powder, and melted in a crucible, phosphuret of antimony is produced. It is of a white colour, brittle, appears laminated when broken, and at the fracture a number of small cubic facettes are observable. When melted it emits a green flame, and the white oxide of antimony sublimes. Phosphuret of antimony may likewise be prepared by fusing equal parts of antimony and phosphoric glass, or by dropping phosphorus into melted antimony.

IV. Antimony does not combine with azote, nor with muriatic acid.

V. Antimony combines readily with most of the metals; but the greater number of its

alloys have not been applied to any use. Antimony and gold may be combined by fusion, and form a brittle compound of a yellow colour. Great attention was paid to this alloy by the alchymists, who affirmed that the quantity of gold might be increased by alloying it with antimony, and then purifying it. Platina easily combines with antimony. The alloy is brittle, and much lighter than platina. The antimony cannot afterwards be completely separated by heat. Silver may be alloyed with antimony by fusion. The alloy is brittle, and its specific gravity, as Gellert has observed, is greater than intermediate between the specific gravities of the two metals which enter into it. Antimony does not amalgamate with mercury while cold. When three parts of mercury are mixed with one part of melted antimony, a soft amalgam is obtained, which very soon decomposes of itself. Gellert also succeeded in forming this amalgam. Copper combines readily with antimony by fusion. The alloy, when it consists of equal parts of the two metals, is of a beautiful violet colour, and its specific gravity is greater than intermediate. This alloy was called *regulus of Venus* by the alchymists. Iron combines with antimony by fusion, and forms a brittle hard alloy, the specific gravity of which is less than intermediate. The magnetic quality of iron is much more diminished by being alloyed with antimony than with most other metals. This alloy may be obtained also by fusing in a crucible two parts of sulphuret and one of iron. It was formerly called *martial regulus*. The alloy of tin and antimony is white and brittle; its specific gravity is less than intermediate. This alloy is employed for different purposes; particularly for making the plates on which music is engraved. When equal quantities of lead and antimony are fused, the alloy is porous and brittle: three parts of lead and one of antimony form a compact alloy, malleable, and much harder than lead: 12 parts of lead and one of antimony form an alloy very malleable, and a good deal harder than lead: 16 parts of lead and one of antimony form an alloy which does not differ from lead except in hardness. This alloy forms printers' types. Its tenacity is very considerable, and its specific gravity is greater than the mean. Zinc may be readily combined with antimony by fusion. The alloy is hard and brittle, and has the colour of steel. Its specific gravity is less than intermediate. Antimony forms a brittle alloy with bismuth; to manganese it unites but imperfectly: the compounds which it forms with nickel and cobalt have not been examined.

VI. The affinities of antimony, and of its oxides, are according to Bergman, as follows:

Antimony.	*Oxide of Antimony.*
Iron,	Muriatic,
Copper,	Oxalic,
Tin,	Sulphuric,
Lead,	Nitric,
Nickel,	Tartaric,
Silver,	Saclactic,
Bismuth,	Phosphoric,
Zinc,	Citric,
Gold,	Succinic,
Platina,	Fluoric,
Mercury,	Arsenic,
Arsenic,	Lactic,
Cobalt,	Acetic,
Sulphur.	Boracic,
	Prussic,
	Carbonic.

ANTINOMIANS, in church history, certain heretics who first appeared about the year 1535; and so called, because they rejected the law, as of no use under the gospel dispensation.

The name is now applied to a sect of high Calvinists, who sprung up in England about the time of Oliver Cromwell, and who are accused of maintaining that the elect are incapable of incurring guilt for whatever actual sins they may commit.

ANTIPATHES, the name of a genus in the zoophyta order of vermes: the character is, animal growing in the form of a plant; stem within horny, with small spines; base expanded, the outside covered with gelatinous flesh, and numerous polypiferous warts. There are several species, as spiralis, myriophylla, &c. See Plate, Nat. Hist. fig. 24.

ANTIPHONY, in music, the name which the Greeks gave to that kind of symphony which was executed in octave or double octave. It is likewise the answer made by one choir to another, when an anthem is sung between them.

ANTIPHRASIS, in rhetoric, a figure by which in saying one thing we mean the contrary.

This figure regards sentences, and not single words.

ANTIPODES, in geography, a name given to those inhabitants of the globe that live diametrically opposite to one another. They lie under opposite parallels, and opposite meridians. They have the same elevation of their different poles. It is midnight with one when it is noon with the other; the longest day with the one is the shortest with the other; and the length of the day with the one is equal to that of the night of the other.

ANTIPTOSIS, in rhetoric, a figure which puts one case for another.

ANTIQUARE, among Roman lawyers, denotes the rejecting a new law, or refusing to pass it.

ANTIQUARY, a person who studies and searches after monuments and remains of antiquity.

The Society of Antiquaries in London was instituted in the year 1751. Every member pays five guineas as an admission fee, and two guineas a year, or an additional sum of twenty-one guineas. They have weekly meetings every Thursday evening at their rooms in Somerset-house. A similar society was founded in Edinburgh in 1780.

ANTIQUARY, is also used by antient writers for the keeper of a cabinet of antiquities. John Leland was antiquary to Henry VIII.

ANTIQUE, in a general sense, something that is antient; but the term is chiefly used by sculptors, painters, and architects, to denote such pieces of their different arts as were made by the antient Greeks and Romans. Thus we say, an antique bust, an antique statue, &c. See SCULPTURE.

ANTIQUITIES. There is scarcely a term, perhaps, in any language so thoroughly comprehensive as that now before us: since it implies all testimonies or authentic accounts that have come down to us, which illustrate either the particular or universal history of antient nations: a science equally complicated as extensive.

To enter elaborately into the subject would be to rewrite a hundred treatises: we must, here, content ourselves with an elementary survey; and without extending our views to those who have written on more trifling objects of enquiry, divide antiquities into two grand classes, *political* and *monumental:* the first forming a general, the other a particular study: the first embracing all that can increase our knowledge of *civil institutions*, the latter entirely confining itself to works of *art;* and, together, affording the most effectual means of learning the genius and manners of the various nations of the world. For the latter of these classes we shall refer to the respective arts whose investigation is concerned. But for the illustration of the former, we shall present a general view of antient history, confining ourselves to those which may be deemed either leading, or the parent, countries of science, in the different periods: beginning our researches with the *Jews*, at a time when the history of every other country is involved in darkness and uncertainty; proceeding with the *Egyptians* and the *Indians*, the remnants of whose greatness preserve the earliest relics of profane history; following them up with the *Greek* and *Roman* antiquities; and concluding with the antiquities of *Britain*. On the Egyptian and Indian antiquities we shall be more circumstantial than on those of other countries; since their history and remains present a field of enquiry still open to investigation.

The history of a people persecuted and scattered through the world, yet whom no change of fortune has been able to eradicate, is a subject of consideration too deep and too important to leave a slight impression on the mind. But the history of the JEWS has even more to boast: in the records of *their* nation they pass the general flood, the boundary to the annals of every other people; and fairly trace their ancestry back to the common father of the human race.

In the Bible we find the only authentic history of the origin, ordinances, and vicissitudes of the nation: from that we learn, that their religious rites were divinely communicated. Unlike to every other people, they have remained distinct; and are continued so for greater ends than the meanness of their present state may seem to promise.

Could we ascertain the antiquities of Egypt with precision, those of the Jews might be expected thence to receive collateral illustration; since Moses, their great lawgiver, was confessedly educated in the schools of Egyptian learning and legislation: and many even of the metaphors he uses in the Pentateuch are supposed to bear some connection with objects or symbols communicated to him by the Egyptian priests.

To the more enlightened nations of antiquity, however, their history and their religious customs were equally unintelligible. The Greeks, by a fabulous tradition, deduced them from Jupiter and Saturn; and the Romans, till Tacitus's time, knew little of them. Tacitus indeed charges the whole nation with a sullen hatred of all mankind. In one or two cases he gives something that appears to border on the truth. But, in the general account, he relates the various opinions that

were floating in the world, and leaves the truth to rest on better authority: apparently thinking that with regard to such a race minute enquiry was unnecessary. Though, at this period, the page of Jewish history was fully disclosed, and accessible to the curiosity of every Roman; Josephus lived at Rome, under Vespasian, Titus, and Domitian; and under the last of those emperors his Jewish Antiquities were given to the world.

A sufficient knowledge of the *general antiquities* of the Hebrews may be obtained from the Bible, Philo and Josephus, and the Talmud; and, among the writers of more modern date, Arias Montanus, Carpsovius, Maimonides, Buxtorf, Reland, Leusden, Calmet, Witsius, Bucher, Benzelius, Basnage, Hottinger, and Michaelis, may be deemed the best. Among the English, Selden, Godwyn, and Lewis. Calmet's Dictionary of the Bible also contains many references for the curious reader; and those who would know how far their antient and modern practices agree, may consult Levi's Jewish Ceremonies.

On the *civil history* of the Jews, Josephus may be consulted: with Struckford, and Prideaux's Connections. On the life and death of Moses, however; on the Exodus of the Israelites, and their leaders; on the Jewish kings; the Babylonish captivity; and on the history and condition of the Jews in different countries subsequent to their dispersion; the writers are extremely numerous: and a complete catalogue of them may be found in Mensel's Bibliotheca Historica. On the destruction of Jerusalem, Josephus and Tacitus are the principal writers in repute. And for the history of the Jews in England, Tovey's work may be referred to.

But the most copious work on Jewish antiquities is Ugolinus's Thesaurus, in thirty-four volumes folio; the first bearing the date of 1744, the last 1769; containing all the best works which, previously to that time, had appeared, on the manners, laws, rites, and institutions of the Hebrews: amounting in number to no less than four hundred and eighty-eight distinct treatises.

The most curious collection of Hebrew manuscripts in this country which illustrate the *literary antiquities* of the Jews, may be found in the Bodleian Library at Oxford. Few of them, in point of age, run beyond eight hundred years; and the most antient, we believe, were brought by Dr. Pococke from Constantinople.

We cannot close this part of our article without recommending to attentive perusal the late bishop Lowth's Lectures on the Poetry of the Hebrews, which afford a better view than any other work of the taste and learning of that extraordinary people.

We now come to the ANTIQUITIES of EGYPT: a country once as remarkable for the scheme of its laws, and the dark oracles of its priests, as for the commerce of its cities, the grandeur of its buildings, and the fertility of its territory. The earliest nations of the world are emphatically described by Dr. White to have been fed with the produce of her soil, and enriched with the treasures of her wisdom; and not only the more civilized countries at the present day, but the Arabs and the Indians, still view the relics of her greatness with a reverential regard. In 1801, when General Baird led his army from the Red Sea, a party of Seapoys, who saw the hooded serpent upon one of the antient monuments of Egypt, fell down and worshipped it.

The quarries of marble and porphyry of Upper Egypt furnished the principal materials with which the first inhabitants raised their most stupendous works of art. But whence their oracular intelligence was drawn it is impossible to say. To Hermes Trismegistus, a sage as highly reverenced among them as Zoroaster was among the Persians, the Egyptians ascribed the inventions of chief use to human life; and like every people who are unable to settle the antiquity of their origin, they represented his works to have outstood the shock even of the universal deluge. They otherwise called him Thoth; and their priests as constantly maintained that from the hieroglyphic characters upon the pillars he erected, and the sacred books, all the philosophy and learning of the world has been derived.

Both the earliest and the latest writing of the country, to the time of Cleopatra, appears to have been symbolic; and the use of hieroglyphic characters was not only applied to sacred, but to other uses: through them alone the avenues to knowledge could be opened; and their secret appears principally to have lain in certain analogies and correspondences between the forms, actions, and qualities of animals, and certain facts in nature, morals, or history. The animals which in the grosser periods of Egyptian history received the worship of the people, in the first ages it is probable were only used to express the attributes of the Egyptian gods; and their regard for them perhaps was much increased by their adherence to the doctrine of transmigration. A black ox, the symbol of the sun, was sacred to Osiris; and Isis typified the moon. Isis and Osiris indeed were every where adored, though differently represented; and the Mnevis, Apis, and Mendesian goat, are looked upon by the best writers but as different symbols of the same deity, or as animals in which the same deity was manifest. Thebes was in early times the grand deposit of Egyptian mystery: it is mentioned by Homer; and exists in ruins to the present hour. Dendera and Heliopolis present other ruins. To enter deeply here either into the particular ceremonies, or the mythological doctrines of Egypt, to seek for the phenomena of nature which were allegorized in the history of Isis and Osiris, or to detail the history of the priestly orders, would be impossible. Of the latter, the first after the inferior degrees was the chief of the music band, who usually carried some musical instrument as the ensign of his office; the next was the diviner, who in public processions bore the symbols of astrology; the third was the master of the sacred wardrobe; and the fourth, or chief priest, was the prophet, who interpreted the laws of Hermes, and presided over the ceremonies of religion. To these exclusively the Hermaic doctrines were accessible: and upon them the constitution of their country seems entirely to have depended.

In regard to Egyptian history, its early chronology is so perplexed, its facts and fable so heterogeneously blended, and its vanity of a remote antiquity so great, that little certain can be collected. Egypt was antiently divided into three parts. Thebais was a distinct district; the dynasty of Memphis was the *upper* Egypt; and that of Heliopolis, comprehending the rest of the Delta, the *lower* region. From Menes the Egyptian priests were accustomed to reckon no less than three hundred and thirty kings. Like other states, however, it had its revolutions; and the three districts did not in every period of its history form separate states. Under the shepherd kings, two of them were united. At a period considerably lower, Egypt became a kingdom still more flourishing than ever; and increased gradually till Sesostris, one of the greatest of its sovereigns, erected an universal empire. At a period still more subsequent, it was subjected by Cambyses to the *Persian* empire; and to his ravages it appears that Egyptian grandeur was principally indebted for its fall.

In the wreck of greatness which it still presents, the following are the principal remains: the colossal sphinx, and the pyramids among the level plains by Memphis; the statues which bear the name of Memnon; the catacombs of Saccara; the temples of Thebes, Tentyris, and Apollinopolis; and the Needle of Cleopatra. Pompey's Pillar is undoubtedly a monument of subsequent erection. One or two of the antient obelisks were transported to Italy at a very early period. But the finest remnants of Egyptian grandeur, which have been brought away of late years, are now in the metropolis of England. The sarcophagus of brecciated marble, reputed to be Alexander's tomb; and the triple inscription from Rosetta, in the hieroglyphic, the vernacular Egyptian, and the Greek characters; are undoubtedly the most curious. The latter, when in possession of the French, was termed the gem of antiquity.

To recite even the titles of the different works in which the antiquities of Egypt have been treated, would be endless. Among the antient writers, Herodotus, Pausanias, Strabo, Diodorus Siculus, and Plutarch, are the principal. Herodotus, Thales, and Pythagoras, it will be remembered, were initiated among the Egyptian priests. The best work on the mythology of Egypt is Jablonski's Pantheon Egyptiacum. On its present remains, Pococke, Norden, Niebuhr, Sonnini, and Denon, may be consulted: Greaves and Norden have expressly written on the pyramids: Kircher on the mummies: and all that is material on the subject of the obelisks, may be found in Zoega De Obeliscorum Usu. In the simple and authentic narrative of Dr. Wittman, modern readers will find some facts worthy of their attention, relative to the monumental remains still existing in Egypt.

For the illustration of the ANTIQUITIES of INDIA our accessible materials are less numerous and less distinct. The light which so strongly radiates from the page of classical antiquity upon most other abstruse points of literary research, casts but a glimmering ray on this subject. Whatever genuine information may be obtained on other points, its early history and literature can only be acquired by the generality of readers through the medium of faithful versions from the Sanscreet, the antient original language of the country, and the grand repository of all its history and sciences.

So long ago as 1776, Mr. Halhed, in the Code of Gentoo Laws, compiled under the

direction of Mr. Hastings, gave the first specimen which appeared of the early wisdom of the Indians, and their extensive skill in jurisprudence. But the attention of the world was principally roused by the publication of the Bhagvat Geeta, edited in 1785 by Mr. Wilkins. It was the episode only of a larger poem; but its theological and metaphysical doctrines were of the profoundest kind: it was represented to contain all the grand mysteries of the Hindoo religion; and laid claim to the venerable antiquity of four thousand years. The Heetopades, the Sacontala, and Ayeen Akbery, were the principal succeeding publications; the lights from which, added to those of the Asiatic Researches, occasioned Mr. Maurice to give the antiquities of India a more deep and elaborate investigation than they ever had received before. Till this book appeared, the antiquities of the Hindoos were considered by the generality of readers as unfathomable; and by the sceptical philosopher as affording arguments in respect to the age of the world, which struck at once at the root of the Mosaic system. With these authorities in hand, Mr. Maurice proceeded to elucidate the obscure history of the Avatars, or the ten descents of Veeshnu. The persons who are stated by the Indian writers to have flourished so many thousand years in the earliest ages, he supposes to have been not of terrestrial but celestial origin; and that their empire was rather the empire of imagination in the skies than that of real power on the earth. He considers that the *year of* ordinary reckoning, and the year of Brahma, are of a nature very widely different; and that the whole jargon of yugs, or grand periods, has no foundation but in the great solar and lunar cycles, or planetary revolutions. In the Indian Antiquities the greater part of the preliminary ground, which the student must of necessity go over, is cleared. The antient geographical divisions of India, according to the classical writers of Greece and Rome, and of Hindostan, according to the Hindoos themselves, are reconciled: the analogies of the Brahmanic with other systems of theology considered; and the grand code of civil laws, the original form of government, and the various and profound literature of Hindostan, are compared throughout with the laws, government, and literature, of Persia, Egypt, and Greece.

But after all, perhaps, the clearest notions of what the student may expect to discover in his Indian inquiries, may be gathered from the few papers published in the Asiatic Researches, by sir William Jones; written in consequence of the institution of a society for inquiring into the history, civil and natural, the antiquities, arts, sciences, and literature, of Asia.

His first dissertation was on the orthography of Asiatic words in Roman letters, a want of attention to which had occasioned great confusion in history and geography; and he proposed a system, which was not only at once useful to the learned, and essential to the student, but the convenience of which had been proved by careful observation and long experience. The gods of Greece, Italy, and India, were the next objects of attention; and in this dissertation the general union or affinity between the most distinguished inhabitants of the primitive world in regard to theological concerns, at the time when they first deviated from the rational adoration of the true God, is inferred. The general character and affinities of the antient pantheon of India are considered with the best attention. Ganésa, the Hindoo divinity of Wisdom, is compared with the Janus of the Romans; Menu, or Satyvrata (whose general history bears a strong resemblance to Noah's), with Saturn; the Lachsmi of the Hindoos, or goddess of Abundance, with Ceres; and Zeus, or Jupiter, in his various capacities, compared with the triple divinity Veeshnu, Siva, Brahma. Others of minor consideration are also fully noticed, the explanation of whose various attributes must be sought for in the dissertation itself: in which it seems to be fairly proved, that a connection subsisted between the old idolatrous nations of Egypt, India, Greece, and Italy, long before they migrated to their several settlements, and consequently before the birth of Moses: a proposition, says sir William Jones, which will in no degree affect the truth and sanctity of the Mosaic history.

From Goverdhan Caul, the society already mentioned received a valuable communication on the *literature* of the Hindoos, from a work in the Sanscrit. It was translated, and a commentary added. In the text, the Vedas are considered by the Hindoos as the fountain of all knowledge human and divine; and the commentary concludes with this remarkable expression, that if Europeans wish to form a correct idea of Indian religion and literature, let them begin with forgetting all that has been written on the subject by antients or moderns, before the publication of the *Gità*.

From sir William Jones's fourth anniversary Discourse, delivered to the Asiatic Society in 1786, we may form some notion of the various discoveries to which future exertions may give rise, not only in the literature, but the history, sciences, and art, of Asia.

India on its most enlarged scale, in which the antients appear to have understood it, comprizes an area of near forty degrees on each side: it is divided on the west from Persia by the Arachosian mountains; limited on the east by the Chinese part of the farther peninsula; confined on the north by the wilds of Tartary; and extending to the south as far as the isles of Java. By India, in short, is meant that whole extent of country in which the primitive religion and language of the Hindoos prevail at this day with more or less of their antient purity; and in which the Nágarì letters are still used with more or less deviation from their original form. Its inhabitants have no resemblance either in their figure or manners to any of the nations contiguous to them; their sources of wealth are still abundant: in their manufactures of cotton they surpass all the world; and though now degenerate and abased, there remains enough to show that in some early age they were splendid in arts and arms, happy in government, wise in legislation, and eminent in various knowledge. The Sanscrit *language*, whatever may be its antiquity, is of a wonderful structure; more perfect than the Greek, more copious than the Latin, and more exquisitely refined than either, yet bearing to both of them a stronger affinity, both in the roots of verbs and in the forms of grammar, than could possibly have been produced by accident. The *characters*, as we have already mentioned, are Nagari. Of the Indian *religion* enough has been already said. Of their *philosophy*, sir William Jones observes, that in the more retired scenes, in groves and in seminaries of learning, we may perceive the Brahmans and the Sarmanas of Clemens disputing in the forms of logic, or discoursing on the vanity of human enjoyments, on the immortality of the soul, her emanation from the eternal Mind, her debasement, wanderings, and final union with her source. The *six* philosophical schools, whose principles are explained in the *Dersana Sástra*, comprise all the metaphysics of the old Academy, the Stoa, the Lyceum: nor is it possible to read the Védantá, or the many fine compositions in the illustration of it, without believing that Pythagoras and Plato derived their sublime theories from the same fountain with the sages of India. The remains of *architecture* and *sculpture* seem to prove an early connection between India and Africa. Of their antient *arts* and *manufactures*, little but the labours of the Indian *loom* and *needle* are at this day known; but from a curious passage in one of their sacred law tracts relating to the extraordinary interest of money, in regard to *maritime* concerns, it should seem that they were in the early ages a *commercial* people. The Hindoos are said to have boasted of three inventions, all of which are indeed admirable; the method of instructing by *apologues*, *the decimal scale*, and the game of chess: and could their numerous works on grammar, rhetoric, and music, which are now extant, be explained in some language generally known, it would be found that they had still higher pretensions to the praise of a fertile and inventive genius. Their lighter *poems* are lively and elegant; their epic magnificent and sublime. Their most antient *medical* book, entitled Chereca, is believed to be the work of Siva: for each of the divinities in their triad has at least one *sacred* composition ascribed to him. On *history* and *geography* their works are few; and their *astronomical* and *mathematical* writings are still secret.

Cursory as the observations are which have been here brought together, their expansion and illustration would require volumes.

Of the Avatars, or descents of the Deity in his capacity of preserver, we have little to say. The three first, says sir William Jones, apparently relate to some stupendous convulsion of our globe from the fountains of the deep; and the fourth exhibits the miraculous punishment of pride and impiety. The three first, he thought, related to the same event, shadowed by a moral, a metaphysical, and a metaphysical and an astronomical allegory; and all three, connected with the hieroglyphical sculptures of the old Egyptians. The fourth avatar was *a lion* issuing from a bursting column of marble to devour a blaspheming monarch, who would otherwise have slain his religious son; and of the remaining six he says, not one has the least relation to the deluge. The tenth avatar, we are told, is yet to come; and is expected to appear mounted (like the crowned conqueror in the Apocalypse) on a white horse,

with a cimeter blazing like a comet to mow down all incorrigible and impenitent offenders who shall then be on earth.

Among the most curious of the existing monuments of antient India, we must reckon the sculptures and ruins of Mavalipuram, a few miles north of Sadras, and known to seamen by the name of the Seven Pagodas; the vast excavations of Canarah; the various temples and images of Buddha; and the idols which are continually dug up at Gayá, or in its vicinity.

The principal of the Hindoo excavations have been engraved and published by Mr. Daniel; and deserve the closest attention from all who are studious of the antiquities of India.

"The first accounts of *Greece*," says Mr. Mitford, "are derived from ages long before the common use of letters in the country." But so mysterious are the ages of antiquity, and so precarious are traditions, that we scarcely know by what method to distinguish where fable concludes, or truth begins. Certain however it is, that from the Phœnician and Egyptian colonies the Greeks first received the culture of humanity. By the Phœnicians they were undoubtedly instructed in trade, navigation, and the use of letters; and by the Egyptians in civil wisdom, the politer sciences, and religious mysteries. The antiquities of such a country then, which was afterwards so singularly illustrious in the annals of mankind, the introduction of its institutions, and the invention or introduction of its arts, must surely carry with them an interest still more striking than those either of Egypt or India. Its antiquities, of course, in every accessible period have been more carefully and more minutely inspected; and have received such deep and extensive investigation, that to attempt a summary here would be impossible. We shall only observe, that the Athenians were the first civilized people of Greece; and that in all the greatness of the Grecian states they still retained the highest polish.

Gronovius has given a collection of the chief writers on the antiquities of Greece, to which we shall refer the reader once for all; and Rou-e, Pfeiffer, Bos, and bishop Potter, have given shorter systems; the last of which is certainly esteemed the best, and which no scholar's library should be without. In what relates to the religion, the gods, vows, and temples of Greece, it has been deemed too summary; but in the military affairs and miscellaneous customs it remained till lately without a rival. A work which supersedes it, and perhaps all others in the English language, for accuracy and completeness, has just made its appearance from the pen of Mr. Robinson of Ravenstondale.

On the gods, temples, oracles, and priests of Greece, the writers are extremely numerous: on the public weal and magistracy of Greece, Stephanus, Laurentius, and Van Dale, of modern writers, have perhaps the greatest share of credit; on the court of Areopagus, Meursius, and Freher; on the laws and punishments of Greece, Prateius, Meursius, and Petit; on military concerns, Arrian, Polyænus, and Ælian; on the gymnastic art, and exercises of the Greeks, Hieronymus Mercurialis, Joubert, Faber, and Burette; on the theatres and scenic exhibitions, Donatus, Scaliger, Brindin, and the abbe Barthelemy; on their entertainments, luxury, and baths, Cornarius, Meusonius, Gedoyn, Du Choul, Ferrarius, and Kuhn; on their marriages and institution of their children, besides the general writers, Hauptmann, Junius, Stisser, and Zeibich, are the more particular; and on their funerals, Nicolai, Langius, and Eckhard.

The best relics which still mark the former splendor of the Grecian states have been preserved by Stuart in his Athens; in the Ionian Antiquities, published under the direction of the Dilettanti society; in the Voyage Pittoresque de la Grece; and in the Museum Horsleyanum. The best relics of its sculpture in this country are to be found among the Townley marbles; and of its beautiful coinage, in the cabinet of Dr. Hunter.

Poetry, sculpture, architecture, and painting, perhaps attained the summit of perfection under the respective cultivation of Homer, Phidias, Praxiteles, and Zeuxis.

Nothing, says Dr. Adams, has more engaged the attention of literary men, since the revival of learning, than to trace from antient monuments the rites and customs of the Romans, comprehended under the general name of ROMAN ANTIQUITIES. This branch of knowledge, he observes, is not only curious in itself, but absolutely necessary for understanding the classics, and for reading with advantage the history of that celebrated people. And it is particularly requisite for such as prosecute the study of the civil law.

Scarcely on any subject have more books been written, and many of them by persons of the most distinguished credit. Among the oldest of the good writers may be reckoned Dionysius Halicarnasseus, who traced the origin of the Romans, with the utmost fidelity, back to the remotest ages. His accounts are generally preferred to Livy's. They are more ample, and his facts described with more particulars; and on their ceremonies, worship, sacrifices, manners, customs, discipline, policy, courts, laws, &c. he is perhaps the most authentic writer.

A body of the authors on the Roman antiquities was published by Grævius in the Thesaurus; and Danet and Pitiscus published lexicons of them. For the most part however they are too voluminous, not only to be generally useful, but even to refer the studious reader to, except on single points. On this account a number of abridgements have been published; of which, till of very late years, those of Kennet and Nieuport were esteemed the best. The latter was written in Latin, but it abounded in difficult phrases, and was deficient in one or two material parts, which were supplied by Kennet. Both, however, have been since superseded by the work of Dr. Adams which of all the abridgements is the best adapted to illustrate the classics. It is sufficient to say that he has borrowed with freedom from all hands whatever he judged fit for his purpose; and the enumeration of his sources will prove the best aid to an enquiring reader. He was chiefly indebted to Manutius, Brissonius, and Middleton, on the senate: to Pignorius on slaves; to Sigonius and Grucchius, Manutius, Huber, Gravina, Merula, and Heineccius, on the assemblies of the people, the rights of citizens, the laws and judicial proceedings; to Lipsius on the magistrates, the art of war, shows of the circus, and gladiators; to Sheffer on naval affairs and carriages; to Ferrarius on the Roman dress; to Kirkmannus on funerals; to Arbuthnot on coins; to Dickson on agriculture; to Donatus on the city; to Turnebius, Abrahamus, Rossinus, Salmesius, Hottomanus, Grævius and Gronovius, Montfaucon, Pitiscus Ernesti, and particularly Gesner, in different parts of the work.

On the antiquities of antient Rome, the works of Publius Victor, Fulvius, Fabricius, Onuphrius Panvinius, Boissard, and Adler, are perhaps the best: on its antient edifices, the work of Desgodetz, in which the views are given from actual measurement; Venuti's Descrizione Topografica delle Antichita di Roma; and D'Overbeke's Restes de l'Ancienne Rome: on its public ways, its walls, aqueducts, and bridges, Bergier, Gautier, and D'Anville, may be referred to: while the statues and other works of art with which Rome and her provinces abounded have frequently furnished subjects for separate disquisitions.

The arts it should seem in the best periods of the Roman history flourished in the greatest perfection at Rome; where the specimens which remain are still viewed with singular veneration. Among the best of them are the columns of Antoninus and Trajan; the statue of Marcus Aurelius; the arches of Septimius Severus and Constantine; the amphitheatre; the theatre of Marcellus; and the different baths. The columns of the temple of Concord are the only eminent specimens in Rome of the Ionic order, where the volutes of the capital stand in a diagonal direction; and the first and purest specimen of the Corinthian order is exhibited in the three columns of the campo vaccino, supposed to have belonged to the temple of Jupiter Stator.

A correct view of the ANTIQUITIES of BRITAIN from the earliest period to the end of Henry the Eighth's reign, may perhaps be best collected from Dr. Henry's History. The writers he refers to will present the reader with all the most authentic sources of enquiry.

Of what relates to the early *Britons*, however, much that has been written is too nearly connected with the fabulous; and instead of seeking for information on Druidical history, where it was most likely to be obtained correctly, the generality of our writers have been too apt to busy themselves with theory and etymology. "Druidism," says one, "was palpably *Phœnician*. The Druidical system was taught the Gauls by *Pythagoras!*" The opinion, however, which in Cæsar's time was generally entertained in Gaul, has been overlooked. Cæsar evidently took considerable pains to learn every particular relating to the Druids; and he states it to have been the received opinion that Druidism originated in Britain. And in corroboration of this idea, it has been both strongly and correctly urged, that there is not a single authority for the existence of Druidism any where but in Celtic Gaul and part of England. Cæsar, however, did not himself witness its existence in Britain: Tacitus is the first, and, we believe, the only author who notices it; for the Romans did not meet with it till they had advanced far into Wales. Cæsar, Dio Cassius, and Tacitus, are the principal authorities in regard to British *history*. On the religious system, and the mysteries of

Druidism, the writers are more numerous; but Cæsar, Diodorus Siculus, Ælian, Strabo, Tacitus and Pliny, are perhaps the most valuable of the antients. Cluverius's Germania Antiqua, and the works of Pezron and Pelloutier upon the Celts, are however more recent authorities.

Of the structures which the Britons erected the remains are few: Abury and Stonehenge may be deemed the principal. On the vast tracts of solitary down with which our island abounds, relics of a smaller kind are continually discovered. Rowbright in Oxfordshire affords the best, perhaps; and they are very numerous in Anglesey. On these Stukeley and Rowland are perhaps the best authorities: for the history of the Britons under the *Roman* government, we refer to Horsley's Britannia Romana. Antonine's Itinerary preserves the names of the towns and stations on the Roman military ways, with the number of miles between each town.

On the *antiquities* of our *Saxon* ancestors there is more to say; and we can trace their history with tolerable certainty. The devastations of the Danes, however, proved a great destruction to their monuments; and though the Normans were the descendants of the same ancestors, they were not less injurious to the institutions of the people who had gone before them. The best of their remains of art were evidently fabricated upon Roman models. Their architecture exhibited, as its leading feature, a bad imitation of the Roman arch; and their coins had *Latin* inscriptions. The little science they possessed during the middle and latter *periods* of their existence, though originally perhaps obtained from abroad, was cultivated with uncommon zeal: and Alcuin, Bede, and Alfred, are names in the history of their literature that will never be forgotten. The illuminations of the Saxon manuscripts are the best records of their manners in the different centuries; and the most curious information relating to them will be found in the elaborate works of Mr. Strutt and Mr. Turner. In this branch of our antiquities the *field of* investigation is still open. They have never yet been viewed upon that enlarged scale on which they deserve to be considered. The best collection of Saxon coins is that which is now deposited in the British Museum. Their remains of art are numerous, but for the most part undecided: the Normans having imitated their exertions with little other difference than an occasional enlargement of the scale. Of Saxon *manuscripts*, the best collection will be found in the library of the British Museum, and in the Bodleian Library at Oxford. Mr. King has treated their military antiquities in his History of Castles, and Dr. Hickes's Thesaurus may be viewed as the grand repository of their general literature.

Of the English nation at nearer periods, our documents, as may be naturally expected, occur in still greater variety. There is scarcely a county-history but sets our antient manners in new points of view. They have been often and systematically treated; and the names of Camden, Henry, Strutt, and Gough, are sufficient to be noticed.

Thus much may suffice as an outline of the national antiquities of the more considerable people of the world, though there is scarcely a nation under heaven but lays claim to a greater degree of antiquity than the rest of its neighbours. The Scythians, the Phrygians, the Chaldeans, Egyptians, Greeks, and Chinese, pretend each to have the honour of being the first inhabitants of the earth; and even so far have folly and etymology in these researches borne each other company, that Goropius Becanus asserted *high Dutch* to have been the primitive language of the world.

To go further in this extensive science here, or to treat every class of antiquities which writers have separately considered, would be endless. Reland has expressly treated on *sacred* antiquities; Fabricius on *Hebrew* and *ecclesiastical* antiquities; Bingham on *Christian* antiquities; bishop Stillingfleet on the antiquities of the British churches; Cave on *apostolical* antiquities; Consingicus on *academical*; Heineccius on such of the *Roman* as illustrated the civil law; Mallet on *northern*, and bishop Kennet on *parochial* antiquities. Under the title of antiquities however, it may be proper we should notice that industry has sometimes been exerted upon the pettiest trifles; and not unfrequently on objects the most frivolous and absurd.

ANTIRRHINUM, SNAPDRAGON, or CALVES-SNOUT: a genus of the angiospermia order, belonging to the didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The essential characters are these: the calyx consists of five leaves: the basis of the corolla is bent backwards, and furnished with pectoria; the capsule is bilocular. There are 52 species of the antirrhinum; the most remarkable are:

1. Antirrhinum arvense, the corn blue toad-flax.
2. Antirrhinum cymbalaria, the ivy-leaved toad-grass.
3. Antirrhinum elatine, the sharp-pointed fluellin.
4. Antirrhinum linaria, the common yellow toad-flax. It is said to be cathartic and diuretic, but is not used in the shops.
5. Antirrhinum majus, the greater snapdragon.
6. Antirrhinum minus, the least toad-flax.
7. Antirrhinum monospermum, the sweet-smelling toad-flax.
8. Antirrhinum orontium, the least snapdragon.
9. Antirrhinum repens, the creeping toad-flax.
10. Antirrhinum spurium, the round-leaved fluellin.

The snapdragon is an old inhabitant of our gardens, and we have hardly yet a more beautiful flower. The scarlet and crimson kinds are particularly ornamental, especially upon walls, where they will thrive best.

ANTI-SABBATARIANS, a modern religious sect, who oppose the observance of the Christian sabbath.

ANTISCII, in geography, people who live on different sides of the equator, whose shadows at noon are projected opposite ways: the people of the north are antiscii to those of the south.

ANTISEPTICS, among physicians, a denomination given to all substances that resist putrefaction.

Concerning these, which are extremely numerous, we have several curious observations in sir John Pringle's Diseases of the Army. The following table exhibits a comparative view of the antiseptic virtue of salts, the common sea-salt being reckoned equal to unity.

Sea-salt	1	Saline mixture	3
Sal gemmæ	1	Nitre	4
Tartar vitriolat.	2	Salt of hartshorn	4
Spirit. minder.	2	Salt of wormwood	4
Tartar solub.	2	Borax	12
Sal diuret.	2	Salt of amber	20
Sal ammoniac.	3	Alum	30

Some resinous, and other substances, were found to be twelve times more antiseptic than sea-salt; such are myrrh, asa-fœtida, snake-root, pepper, ginger, saffron, contrayerva-root, &c.

ANTISPASMODICS, medicines proper for the cure of spasms and convulsions. See MATERIA MEDICA.

ANTISTASIS, in oratory, a defence of an action, from the consideration that if it had been omitted worse would have ensued.

ANTISTROPHE, among lyric poets, that part of a song and dance in use among the antients, which was performed before the altar, in returning from west to east, in opposition to strophe.

ANTITACTÆ, in church-history, a branch of gnostics, who held that God was good and just, but that a creature had created evil; and, consequently, that it is our duty to oppose this author of evil, in order to avenge God of his adversary.

ANTITHESIS, in rhetoric, a contrast drawn between two things, which serve as shades to set off the opposite qualities of each other.

ANTITRAGUS, or ANTITRAGICUS musculus, in anatomy, a muscle of the ear.

ANTLER, among sportsmen, a start or branch of a deer's attire.

ANTOECI, in geography, an appellation given to those inhabitants of the earth who live under the same meridian, but on different sides of the equator, and at equal distances from it. The antoeci having the same longitude, and equal degrees of latitude, one north and the other south: their hours of day and night are the same, but they have opposite seasons, of course the longest day to the one is the shortest to the other.

ANTONOMASIA, in rhetoric, a figure by which the proper name of one thing is applied to several others; or, on the contrary, the name of several things to one. Thus we call a cruel person a Nero; and we say the philosopher, to denote Aristotle.

ANTRUM, among anatomists, a term used to denote several cavities of the body; as the antrum genæ, or that in the cheek-bone. See ANATOMY.

AORIST, among grammarians, a tense peculiar to the Greek language, comprehending all the tenses; or rather, expressing an action in an indeterminate manner, without any regard to past, present, or future.

AORTA, in anatomy, called also arteria magna, a large artery arising with a single trunk from the left ventricle of the heart above its valves, called semilunares, which serves to convey the mass of blood to all parts of the body. See ANATOMY.

AOUTA, the name of the paper mulberry-tree at Otaheite, from which cloth is manufactured and worn by the principal inhabitants. The bark of the trees is stripped off, macerated and reduced to a fine pulp: it is then drained, and the fibres will adhere together in a piece. It is afterwards to be

beaten till it becomes as thin as muslin, when it is dyed red or yellow.

APACTIS, in botany, a genus of the dodecandria monogynia class and order. The essential character is, cor. four-petalled: cal. none. There is only one species, a tall tree, a native of Japan.

APANAGE, or APENNAGE, in the French customs, lands assigned by a sovereign for the subsistence of his younger sons.

APARGIA, a genus of the class and order syngenesia polygamia æqualis. The essential character is, cal. subimbricate, with linear, parallel, unequal scales; down plumose, subsessile; recept. naked, subvillose. There are seven species, much resembling the dandelion, with which they were formerly confounded.

APATIT, a mineral divided by the German mineralogists, into two varieties, the crystallized and earthy. It is the phospholite of Kirwan.

APATURIA, in Grecian antiquity, an Athenian festival kept in honour of Bacchus.

It was during this solemnity, that the young people were registered in the respective wards of their fathers.

APAUME, in heraldry, expresses a hand open and extended, so that the full palm appears, as is seen by the hand of Ulster, borne by the baronets of England.

APELLITES, Christian heretics in the second century, who affirmed that Christ received a body from the four elements, which at his death he rendered back to the world, and so ascended into heaven without a body.

APEPSY, in medicine, denotes crudity or a bad digestion, arising from a rawness of the stomach, and a want of concoction of the aliments. See MEDICINE.

APERIENTS, in the materia medica, an appellation given to such medicines as facilitate the circulation by removing all obstructions. See MATERIA MEDICA.

APERTURE, in geometry, the space between two right lines which meet in a point and form an angle.

APERTURE, in optics, a round hole in a turned bit of wood or plate of tin, placed withinside of a telescope or microscope, near to the object-glass, by means of which more rays are admitted, and a more distinct appearance of the object is obtained. According to Huygens, the best aperture for an object-glass of thirty feet, is as thirty to three; that is, as ten to one, so is the square root of the focal distance of any lens, multiplied by thirty, to its proper aperture. Mr. Auzout says, he found by experience, that the proper apertures of telescopes ought to be nearly in the subduplicate ratio of their length. It is certain that object-glasses will admit of greater apertures, if the tubes are blackened withinside, and their passage furnished with wooden rings.

APERTURES, or APERTIONS, in architecture, are used to signify doors, windows, chimneys, outlets and inlets for light, smoke, &c. They ought to be as few in number, and as moderate in dimensions, as possible, and never made too near the angles of the walls.

APERTURA TABULARUM, in law books, the breaking open a last will and testament. See the article WILL, &c.

APERTURA FEUDI, in the civil law, signifies the loss of a feudal tenure, by default of issue to him to whom the feud was first granted.

APPETALOUS, among botanists, an appellation given to such plants as have no flower-leaves, or corolla.

APEX, in antiquity, the crest of a helmet, but more especially a kind of cap worn by the flamens.

APHÆRESIS, in grammar, a figure by which a letter or syllable is cut off from the beginning of a word.

APHANES, a genus of the monogynia order, and tetandria class of plants; and in the natural method ranking under the 35th order, senticosæ. The essential characters are: the calyx is divided into eight parts; there is no corolla; the seeds are two and naked. There is only one species, viz.

Aphanes arvensis, or pensley-piert, a native of England. It is common in corn-fields. The stalks rise 5 or 6 together; the flowers are of a greenish white.

APHELIUM, or APHELION, in astronomy, is that point in any planet's orbit, in which it is farthest distant from the sun; being that end of the greater axis of the elliptical orbit of the planet, most remote from the focus wherein the sun is.

The times of the aphelia of the primary planets, may be known by their apparent diameters appearing least; as also, by their moving slowest in a given time. They may likewise be found by calculation, the method of doing which is delivered in most astronomical writers.

APELLAN, the name of a bright star in Gemini.

APHIS, in entomology, the puceron, vine-fretter, or plant louse, an extensive genus of the hemiptera order. The character is: beak inflected; sheath of five articulations, with a single bristle: antennæ setaceous and longer than the thorax; either four erect wings or none; feet formed for walking; posterior part of the abdomen usually furnished with two little horns. There are many species which infest an endless variety of plants, and it is probable that each species is particularly attached to one or a few kinds of vegetable only: on this account each kind has been usually named after the plants on which it feeds. The aphides are known by the indiscriminate name of plant lice; they abound with a grateful moisture, and are eagerly sought for by ants, and many other creatures, or they would become very probably more destructive to the whole vegetable creation than any other race of insects whatever. Linnæus enumerates 33 species.

The extraordinary nature of these insects has for some time past justly excited the wonder and attention of naturalists. They were ranked among the animals which had been classed with the true androgynes spoken of by Mr. Breynius, till Mr. Bonnet seemed to have cleared it up in the affirmative, by taking and shutting up a young aphis at the instant of its birth, in perfect solitude, which yet brought forth in his sight 95 young ones. The same experiment being made on one of the individuals of this family, soon after it was produced, the new hermit soon multiplied like its parent; and one of this third generation, in like manner brought up in solitude, proved no less fruitful than the former. Repeated experiments, in this respect, as far as the fifth or sixth generation, all uniformly presenting the observer with fecund virgins, were communicated to the Royal Academy of Sciences; when an unforeseen and very strange suspicion, imparted by Mr. Trembley to Mr. Bonnet, engaged him anew in a series of experiments. Mr. Bonnet therefore reared to the amount of the tenth generation of solitary aphides, and had the patience to keep an account of the days and hours of the births of each generation. In short, it was discovered, that they are really distinguished by sexes: that there are males and females amongst them, whose amours are the least equivocal of any in the world: that the males are produced only in the tenth generation, and are but few in number: that these, soon arriving at their full growth, copulate with the females: that the virtue of this copulation serves for ten generations: that all these generations, except the first, (from the fecundated eggs) are produced viviparous; and all the individuals are females, except those of the last generation, as already observed. These circumstances have been confirmed by other naturalists. In particular, we have a curious and accurate detail of them by Dr. Richardson of Rippon, in the Philosophical Transactions, vol. xi. art. 22. the perusal of which we earnestly recommend to our readers.

APHORISM, a maxim or principle of a science, or a sentence which comprehends a great deal in a few words. The term is seldom used but in medicine and law.

APHRACTI, in the maritime affairs of the antients, were open vessels without any decks.

APHRODISIA, in antiquity, festivals kept in honour of Venus, the most remarkable of which was that celebrated by the Cyprians.

APHRODITA, in zoology, one of the naked sea-insects, of an oval shape, and aculeated, with a perforation in the middle of the back.

APHTHÆ, in medicine, small, round, and superficial ulcers, arising in the mouth. The principal seat of this disease, is the extremity of the excretory vessels, salival glands, and in short all glands that furnish a humour like the saliva, as the lips, gums, &c.

APHYA COBITES, in ichthyology, a species of gobius, called in English the sea-loch.

APHYLLANTHES, LEAFLESS FLOWER, or BLUE MONTPELLIER PINK: a genus of the monogynia order, belonging to the hexandria class of plants: and in the natural method ranking under the 5th order, tetrapetaloidæ. In character it differs not from the juncus or rush, but in having a calyx of six petals, whereas the juncus has no calyx. There is only one species; viz.

Aphyllanthes Monspeliensis, a native of France. The root consists of a number of slender fibres: the radical leaves are very numerous, two inches long. The stalk is round, smooth, without a joint or knot, naked, and tolerably firm; at its top stands a single and very beautiful blue flower, but for which it would be a rush.

APIARY, a place where bees are kept, which should be properly defended from high winds, as well as from poultry, hogs, &c. whose dung is extremely offensive to the bees.

APIS, the *bee*, in zoology, a genus of insects belonging to the order of insecta hymenoptera. The mouth is furnished with two jaws, and a proboscis enfolded in a double sheath; the wings are four in number, the two foremost covering those behind when at rest; in the anus or tail of the female and working bees, there is a hidden sting. These insects are distinguished into several species, each of which has its peculiar genius, talent, manners, and disposition. Variety prevails in the order of their architecture, and in the nature of their materials. Some live in society, and share their toils; such are the common bee. Others dwell and work in solitude, building the cradles of their families, as the leaf-cutter bee does with the rose-tree leaf, the upholsterer with the gaudy tapestry of the corn-rose, the mason bee with a plaister, the woodpiercer with sawdust. All are employed in their little hermitage, with the care of providing for their offspring. The species enumerated by Linnæus, are no fewer than 55; of which the following are the most remarkable:

1. Apis *Brasilianorum*, or pale red hairy bee, with the basis of the thighs black. This is a very large bee, every where covered with a testaceous skin. It is a native of America.

2. Apis *cariosa* is a yellowish hairy bee; and the feet and front are of a bright yellow colour. It builds in the rotten trees of Europe.

3. Apis *centuncularis*, leaf-cutter, or black bee, having its belly covered with yellow down. The nests of this species are made with leaves, curiously plaited in the form of a mat or quilt. There are several varieties of the leaf-cutting bees, all equally industrious. They dig into the ground and build their nests, of which some have the form and size of thimbles inserted one within another, others the size and shape of goose quills. These nests are composed of pieces of leaves. Each sort of bees cut into its own materials; some the rose-tree leaf, others the horse-chesnut. A careful observer may discover rose-tree leaves, cut as with a pinking iron; and there he may procure himself the pleasure of seeing with what dexterity a bee, destitute of any mathematical instrument, cuts out a circular piece, fit to be either the bottom or the lid of one of those nests; others it cuts out into ovals and semi-ovals, which form the sides of the nests, into each of which it deposits one egg with ready-prepared victuals.

4. Apis *dentata*, or shining green bee, with black wings, and a kind of teeth on the hind thighs. The tongue of this bee is as long as its body.

5. Apis *ferruginea*, or smooth black bee, with the feelers, mouth, belly, and feet, of an iron colour. This is a small bee, and supposed to be of an intermediate kind between the bee and wasp. It is a native of Europe.

6. Apis *florisomnis*, or black bee with a cylindrical incurvated belly, having two tooth-like protuberances at the anus, and a kind of prickles on the hind legs. This bee sleeps in flowers; whence the name.

7. Apis *lapidaria*, or red hairy bee, with a yellow anus, builds in holes of rocks.

8. Apis *muscorum*, or yellow hairy bee with a white belly, builds in mossy grounds. The skill displayed by these builders is admirable. In order to enjoy the pleasure of seeing their operations, let a nest be taken to pieces, and the moss conveyed to a distance. The bees will be seen to form themselves into a chain, from their nest to the place where the moss has been laid. The foremost lays hold of some with her teeth, clears it bit by bit with her feet (which circumstance has also procured them the name of *carding bees*), then, by the help of her feet, she drives the unravelled moss under her belly; the second, in like manner, pushes it on to the third. Thus there is formed an uninterrupted chain of moss, which is wrought and interwoven with the greatest dexterity by those that abide by the nest; and that their nest may not be the sport of the winds, and may shelter them from rain, they throw an arch over it, which they compose with a kind of wax, which dissolved in oil of turpentine, may be used in taking off impressions.

9. Apis *rostrata* is distinguished by the upper lip being inflected and of a conical shape, and by the belly being invested with blueish belts. They build their nests in high sandy grounds, and there is but one young in each nest.

10. Apis *terrestris* is black and hairy, with a white belt round the breast, and a white anus; it builds its nest very deep in the earth.

11. Apis *variegata:* the breast and belly are variegated with white and black spots; the legs are of an iron colour. In Plate Nat. Hist. fig. 25, 26, and 28 are represented the *hirsuta*, *nidulans*, and *socialis*; and fig 27 is a section of the nest of the nidulans.

12. Apis *violacea* is a red bee, and very hairy, with blueish wings. The violacea is said to perforate trees, and hollow them out in a longitudinal direction; they begin to build their cells at the bottom of these holes, and deposit an egg in each cell, which is composed of the farina of plants, and honey or a kind of gluten. Plate Nat. Hist. fig 29.

13. Apis mellifica, the domestic honey bee. This wonderful insect requires a threefold description; under its various characters of queen bee, drone bee, and working bee; for though this last kind is, strictly speaking, the only honey bee, yet all the three kinds are found and seem to be necessary in every community or hive of bees. The drones may easily be distinguished from the common or working bees: they are both larger and longer in the body: their heads are round, their eyes are full, and their tongues short. The form of the belly differs from those of both queen and common bees; and their colour is darker than either. They have no sting, and they make a much greater noise when flying, than either the queen or the common bees; a peculiarity of itself sufficient to distinguish them. If a hive is opened in the beginning of spring, not a single drone will be found in it; from the middle of May till the end of June, there will be found commonly from 200 or 300 to 1000; but from August to the following spring it would be in vain to seek for them. They go not out till 11 in the morning, and return before six in the evening. But their expeditions are not those of industry. Their rostrum and feet are not adapted for collecting wax and honey, nor indeed are they obliged to labour. They only hover upon flowers to extract the sweets, and all their business is pleasure. Their office is thought to be to impregnate the eggs of the queen after they are deposited in the cells; and while their presence is thus necessary, they are suffered to enjoy life; but as soon as they become useless in the hive, the working bees declare a war of extermination against them. This war affects not only the drones already in life, but even the eggs and maggots in the drone cells; for after the season proper for increasing the number of bees is past, every vestige of the drones is destroyed, to make room for honey. Mr. Bonner, however, one of the latest and best writers on the subject, doubts the long established doctrine of the fecundating powers of the drones. He urges the following, among many, arguments: "That the queen stands in no need of their assistance to fecundate or impregnate her, appears from this consideration; that she lays eggs, which produce young bees, without having had any previous communication with the drones. I will not, however, suppose that the drones are of no use in the hive; but that the queen lays eggs which produce young bees, without so much as seeing a drone, I can with the utmost confidence affirm. The advocates for the old doctrine, that the drones are males, allege, that they impregnate the queen, before their brethren kill them. According to this theory, she should continue for no less a period than 7 or 8 months, with about 12,000 impregnated eggs in her ovarium, which would certainly make her appear very large during the whole of that period. But it is unnecessary to waste arguments in refutation of this doctrine, as I have repeatedly had queens breed and lay eggs, and those eggs become bees, although these queens were bred 7 months after all the drones were dead, and some weeks before any new ones were hatched. These experiments, I think, are sufficient to silence all the arguments advanced by the advocates for the drone system. Mr. Debraw, indeed, creates little drones, and gives them power to live all the year, and to impregnate the queen at pleasure. But as room does not permit me to narrate the experiments whereby he attempts to prove this, I shall content myself with stating his sentiments in as few words as possible. He asserts, that, besides the common large drones, which every person acquainted with bees, knows at first sight, there is a small kind of drones, which are, to all appearance, like the common bees, there being no visible difference, except that they have no sting, which he discovers by immersion in water, and pressure. After relating an experiment on this head, he says, 'I once more immersed all the bees (of a small swarm) in water, and when they appeared to be in a senseless state, I gently pressed every one of them between my fingers, in order to distinguish those armed with stings from those that had none, which last I might suspect to be males. Of these I found fifty-seven exactly of the size of common bees, yielding a little whitish liquor on being pressed between the fingers.' In answer to this, I shall here narrate an experiment I made several years ago. On the 1st of Sept. 1788, I took all the bees out of a hive that was breeding very fast, and in which I found only four drones: these I killed. I put the bees into a hive that had

nothing in it but empty combs. After waiting ten days, upon looking between the combs, I found maggots, newly sealed up, in the cells. I then took out all the bees, and shook them into a tub full of water, from which immersion I recovered them gradually, and while doing this, I pressed each bee individually, to try if I could discover any of those stingless little drones; but not one appeared, all of them having stings, to the number of 3000. After this I searched the old hive I had taken them out of, and cut out all the combs that had eggs or young in them; among which I found some cells that had new eggs in them; others whose eggs were converted into a small worm, and other some with maggots in them. I then restored the queen, and all the bees, putting them into the same hive again, but without leaving a single egg in it. During the succeeding 20 days, I inspected the hive, and found the bees, in fine weather, working with great alacrity, a sure sign that the queen was breeding again. After this, on turning up the hive, and cutting out one of the brood combs, I found new-laid eggs in some of them; others containing maggots; besides some young bees, almost ready to emerge from their cells. I made another experiment, about the same time, upon a hive that had some brood combs, but had not had a large drone for several weeks preceding. This hive did not contain above 500 bees, a circumstance that was in my favour; as being less numerous, the trouble was proportionally less. I carried the hive into a close room in my house, that not a single bee might escape me; but after repeating the former experiment of immersing them in water, recovering, and pressing them one by one, I found that every one of them had a sting.

"The queen, (adds Mr. Bonner,) is easily distinguished from all the other bees in the hive, by the form, size, and colour of her body. She is considerably longer, and her wings are much shorter in proportion to her body, than those of the other bees. The wings of both common bees and drones cover their whole bodies, whereas those of the queen scarcely reach beyond the middle, ending about the third ring of her belly. Her hinder part is far more tapering than those of the other bees: her belly or legs are yellower, and her upper parts of a much darker colour than theirs. She is also furnished with a sting, though some authors assert that she has none, having been induced to form this opinion, because she is extremely pacific; so much so, indeed, that one may handle her, and even teaze her as he pleases, without provoking her resentment. For my part, I never can excite a queen bee to draw her sting, nor could I even get a sight of it, but when I pressed her body. A young queen is a great deal smaller in size than a full grown one, being not much longer than a common bee, and is therefore not so easily observed when sought for. When only three or four days old, she is very quick in her motions, and runs very fast; but when pregnant with eggs, she becomes very large, and her body is heavy. Almost all writers are of opinion that the queen lays three different kinds of eggs, viz. one kind for the production of a queen bee, another species for that of the working bee, and a third for producing the drones. It was also long a received opinion, that no queen could lay eggs that were capable of producing bees, without the assistance of drones. Schirach refutes this doctrine, and entirely denies such an use of the drones. He advances this opinion, that 'the queen lays eggs which produce young bees, without any communication with the drones; and affirms that all the working bees are females in disguise; every one of whom, in an early stage of her existence, was capable of becoming a queen; from a knowledge of which fact, swarms may artificially be obtained from the early months of spring, and in any succeeding month, even to November.' He asserts, which is indeed the grand and decisive proof, that 'the practice of this art, (of raising artificial queens) has already extended itself through Upper Lusatia, the Palatinate, Bohemia, Bavaria, Silesia, and several parts of Germany, and even of Poland."

These experiments were repeated by Mr. Bonner, and the result of them is summed up in the following words:

"Having repeated the experiment again and again, I can now affirm, with the utmost confidence and certainty, that the common or working bees, are endowed with the powerful faculty of raising a queen bee from an egg in a common cell, when their community stands in need of one. Their method is this: they make choice of a common cell with an egg in it, and inject some white liquid matter from their proboscis, of a thickish substance. They then begin to build upon the edges of the cell, and enlarge it. On the third day it appears fairly on the outside of the comb, in the form of a royal cell, and may now be properly so denominated. On the fifth day, the cell being now greatly enlarged, and a great deal of the whitish matter thrown into it, the royal maggot appears in the form of a semicircle, not unlike a new moon, being biggest in the middle part, and small at each end. In this form it is to be seen for two days swimming on the top, and in the midst of the matter in the cell; and on the seventh day it is sealed up. During this period she undergoes various metamorphoses. I have opened the royal cell on the 10th day, and have found the maggot still on the top of the white liquor; and having taken it into my hand to show it to any friend, it would move for a short time, although at this period it had not the smallest resemblance to a bee, being still only a maggot. But on the 14th or 15th day, the metamorphosis is so complete, that instead of a gross white worm, it comes forth a charming young queen bee."

When a queen dies by any accident, the bees of her hive immediately cease working, consume their own honey, fly about their own and other hives at unusual hours, when other bees are at rest, and pine away if not soon supplied with another sovereign. Her loss is proclaimed by a clear and uninterrupted humming. This sign should be a warning to the owner of the bees to take what honey remains in the hive, or to procure them another queen. In this last case the flock instantly revives, and pleasure and activity are apparent through the whole hive. The dissection of the queen bee shows evidently that she lays many thousand eggs. It is computed that the ovaria of a queen bee contain more than 5000 eggs at one time; and therefore it is not difficult to conceive that a queen bee may produce 10,000 or 12,000 bees, or even more, in the space of two months.

"The working, or common bee," says Mr. Bonner, "is smaller than either the queen or the drone bee. They have four wings fastened to their middle part, by which they are not only enabled to fly with heavy loads, but also to make those well-known sounds and hummings to each other, which are supposed to be their only form of speech. They have also six legs fastened to their middle. The two foremost of these are the shortest, and with these they unload themselves of their treasures. The two in the middle are somewhat longer, and the two last are longest. On the outside of the middle joint of these last, there is a small cavity in the form of a marrow-spoon, in which the bees collect by degrees those loads of wax they carry home to their hives: this hollow groove is peculiar to the working bee. Neither the queen nor the drones have any resemblance of it. Each foot terminates in two hooks, with their points opposite to each other; in the middle of these hooks there is a little thin appendix, which when unfolded enables the insects to fasten themselves to glass or the most polished bodies. This part they likewise employ for transmitting the small particles of crude wax which they find upon flowers, to the cavity in their thighs. The honey-bladder is a reservoir, in which is deposited the honey that the bee sips from the cups of the flowers, after it has passed through the proboscis, and through the narrow pipes that connect the head, breast, and belly of the bee. This bladder, when full, is of the size of a small pea, and is so transparent that the colour of the honey can be distinguished through it. The sting is situated at the extremity of the belly, and the head or root of it is placed contiguous to the small bladder that contains the venom. It is connected to the belly by certain small muscles, by means of which the bee can dart it out and draw it in with great force and quickness. In length it is about the 6th part of an inch. It is of a horny substance; is largest at the root, and tapers gradually towards the point, which is extremely small and sharp; and when examined by the microscope, appears to be polished exceedingly smooth. It is hollow within like a tube, that the venomous liquor may pass through it when it strikes any animal, which it does the very instant that the sting pierces the skin, and insinuates itself into the wound, which proves mortal to many small insects, as well as to the bee herself when she leaves her sting in the wound; as it draws after it the bladder, and sometimes part of the entrails of the bee. These working bees may be said to compose the whole community, except in the season of the drones, which hardly lasts three months. During all the other nine months, there are no other bees in the hive, except them and the queen."

In the Philosophical Transactions, No. clxxii. vol. i. we have an account of a species of honey bee found in some parts of America, very different in form and manners from the common bee of Europe. Their combs are composed of a series of small bottles or bladders of wax, of a dusky brown or blackish colour; and each nearly of the size and shape

of a Spanish olive. They hang together in clusters, almost like a bunch of grapes, and are so contrived that each of them has its aperture, while the bees are at work upon it; but as soon as it is filled with honey, this aperture is closed, and the bees leave it and go to work upon another vessel. Their lodgings are usually taken up in the hollow of an old tree, or in some cavity of a rock by the sea-side. They are sagacious in choosing the most secure retreats, because their honey is so delicious a bait that they are hunted after by many animals; and they have no power of defending themselves, having no stings as our bees have. The combs are brittle, and the honey is clear and liquid like rock water. It is used by the natives rather as a drink with their food than as honey. They use it also in medicine as a purge, drinking half a pint of it in the morning fasting.

With regard to the age of bees, the drones live but a little while, being destroyed without mercy by the working bees, probably to save honey. As to the age of the working bees, writers are not agreed. Some maintain that they are annual, and others suppose that they live many years. Many of them, it is well known, die annually of hard labour; and though they may be preserved by succession in hives or colonies for several years, the most accurate observers are of opinion that their age is but a year, or no more than two summers at the utmost.

These industrious insects, Mr. Bonner remarks, "have their vices as well as their virtues." The most savage Indian tribes do not wage more deadly wars, than the bees of different hives, and sometimes of the same hive, occasionally do. Their fighting and plundering one another ought chiefly to be imputed, as Mr. Thorley observes, to their perfect abhorrence of sloth and idleness, or to their insatiable thirst for honey; for when, in spring or autumn, the weather is fair, but no honey can be collected from plants, and is to be found only in the hives of other bees, they will venture their lives to get it there. Sometimes one of the queens is killed in battle. In this case the bees of both hives unite as soon as her death is generally known among them.

The command which some persons have obtained over bees is very extraordinary. Mr. Wildman, some years ago, surprised the whole kingdom. He caused swarms to light where he pleased almost instantaneously: he ordered them to settle on his head, then removed them to his hand, and commanded them to depart and settle on a window, table, &c. at pleasure. We subjoin this method of performing these feats, in his own words: 'Long experience has taught me, that as soon as I turn up a hive, and give it some taps on the sides and bottom, the queen immediately appears to know the cause of this alarm; but soon retires again among her people. Being accustomed to see her so often, I readily perceive her at first glance; and long practice has enabled me to seize her instantly, with a tenderness that does not in the least endanger her person. When possessed of her, I can without injury to her, or exciting that degree of resentment that may tempt her to sting me, slip her into my other hand, and, returning the hive to its place, hold her there, till the bees missing her, are all on wing, and in the utmost confusion. When the bees are thus distressed, I place the queen wherever I would have the bees to settle. The moment a few of them discover her, they give notice to those near them, and those to the rest; the knowledge of which soon becomes so general, that in a few minutes they all collect themselves round her; and are so happy in having recovered this sole support of their state, that they will long remain quiet in their situation. Nay, the scent of her body is so attractive of them, that the slightest touch of her, along any place or substance, will attach the bees to it, and induce them to pursue any path she takes."

When the bees begin to work in their hives, they are said to divide themselves into four companies; one of which roves in the fields in search of materials; another employs itself in laying out the bottom and partitions of their cells; a third is employed in making the inside smooth from the corners and angles; and the fourth company brings food for the rest, or relieves those who return with their respective burdens. But they are not kept constant to one employment; they often change the tasks assigned them; those that have been at work being permitted to go abroad, and those that have been in the fields already take their places. They seem even to have signs by which they understand each other; for when any one of them wants food, it bends down its trunk to the bee from whom it is expected, which then opens its honey-bag, and lets some drops fall into the other's mouth, which is at that time opened to receive it. Their diligence and labour are so great, that, in a day's time, they are able to make cells, which lie upon each other, numerous enough to contain 3000 bees.

As the combs would be apt, when full, to overcome by their weight all the security which the bees can give them against falling, those who prepare hives set in them crosswise, sticks, which serve as props to the combs, and save the bees great labour.

The habitations of bees ought to be very close; and what their hives want from the negligence or unskilfulness of man, these animals supply by their own industry. For this purpose they make use of a resinous gum, which is more tenacious than wax, and differs greatly from it. This the ancients called *propolis*. It will grow considerably hard in the hive, though it will in some measure soften by heat, and is often found different in consistence, colour, and smell. It has generally an agreeable aromatic odour when it is warmed; and by some it is considered as a most grateful perfume. When the bees begin to work with it, it is soft; but it acquires a firmer consistence every day, till at length it assumes a brown colour, and becomes much harder than wax. The bees carry it on their hinder legs; and some think it is met with on the birch, the willow, and poplar.

Bees anxiously provide against the entrance of insects into the hive, by gluing up with wax or propolis the smallest holes in it. Some stand as sentinels at the mouth of the hive, to prevent insects of any kind from getting in. But if a snail or other large insect should get in, notwithstanding all resistance, they sting it to death; and then cover it over with a coat of propolis, to prevent the bad smell or maggots which might proceed from the putrefaction of such a large animal.

Bees seem to be warned of the appearance of bad weather by some particular feeling. It sometimes happens, even when they are very assiduous and busy, that they on a sudden cease from their work; not a single bee stirs out; and those that are abroad hurry home in such prodigious crowds, that the doors of their habitations are too small to admit them. On such occasions, if we look up to the sky, we shall soon discover some of those black clouds which denote impending rain. So correct is their instinct, that it exceeds the sagacity of the philosopher.

When a hive of bees is become too much crowded by the addition of the young brood, a part of the bees think of finding themselves a more commodious habitation, and with that view single out the most forward of the young queens. A new swarm is therefore constantly composed of one queen at least, and of several thousand working bees, as well as of some hundreds of drones. The working bees are some old, some young. Scarcely has the colony arrived at its new habitation, when the working bees labour with the utmost diligence to procure materials for food and building. They make more wax during the first fortnight, if the season is favourable, than they do all the rest of the year. Other bees are at the same time busy in stopping all the holes and crevices they find in the new hive, in order to guard against the entrance of insects which covet their honey, their wax, or themselves; and also to exclude the cold air, for it is indispensably necessary that they be lodged warm. When the bees first settle in swarming, indeed when they at any time rest themselves, there is something very particular in the method of taking their repose. It is done by collecting themselves in a heap, and hanging to each other by their feet.

When a swarm divides into two or more bands, which settle separately, this division is a sure sign that there are two or more queens among them. One of these clusters is generally larger than the other. The bees of the smaller cluster or clusters detach themselves by little and little, till at last the whole, together with the queen, unite with the larger cluster. As soon as the bees are settled, the supernumerary queen or queens must be sacrificed to the peace and tranquillity of the hive. This execution generally raises a considerable commotion in the hive; and several other bees, as well as the queen, lose their lives. Their bodies may be observed on the ground near the hive. The queen that is chosen is of a more reddish colour than those which are destroyed: so that fruitfulness seems to be a great motive of preference in bees; for the nearer they are to the time of laying their eggs, the bigger, redder, and more shining are their bodies.

The balls which we see attached to the legs of bees returning to the hives, are not wax, but a powder collected from the stamina of flowers, not yet brought to the state of wax. The substance of these balls, heated in any vessel, does not melt as wax would, but becomes dry, and hardens: it may even be reduced to a coal. If thrown into water it will sink; whereas wax swims. To reduce this crude substance into wax, it must first be digested in the body of the bee. Every bee, when it leaves the hive to collect

this precious store, enters into the cup of the flower, particularly such as seem charged with the greatest quantities of this yellow farina. As the animal's body is covered over with hair, it rolls itself within the flower, and quickly becomes quite covered with the dust, which it soon after brushes off with its two hind legs, and kneads into two little balls. In the thighs of the hinder legs there are two cavities, edged with hair; and into these, as into a basket, the animal sticks its pellets. Thus employed, the bee flits from flower to flower, increasing its store, and adding to its stock of wax, until the ball upon each thigh becomes as big as a grain of pepper: by this time having got a sufficient load, it returns, making the best of its way to the hive. After the bees have brought home this crude substance, they eat it by degrees; or, at other times, three or four bees come and ease the loaded bee, by eating each of them a share, the loaded bee giving them a hint so to do. Hunger, however, is not the motive of their thus eating the balls of waxy matter, especially when a swarm is first hived; but it is their desire to provide a speedy supply of real wax for making the combs. At other times, when there is no immediate want of wax, the bees lay this matter up in repositories, to keep it in store; and it is then known by the name of bee-bread.

It is agreed by the most judicious observers that the apiary, or place where bees are kept, should face the south, and be situated in a place neither too hot nor too much exposed to the cold; that it be near the mansion-house, on account of the convenience of watching them; but so situated as not to be exposed to noisome smells, or to the din of men or cattle; that it be surrounded with a wall, which, however, should not rise above three feet high; that, if possible, a running stream be near them; or, if that cannot be, that water be brought near them in troughs; as they cannot produce either combs, honey, or food for their maggots, without water: and that the garden in which the apiary stands, be well furnished with such plants as afford the bees plenty of good pasture. Furze, broom, mustard, clover, heath, &c. have been found excellent for this purpose.

Hives have been made of different materials, and in different forms, according to the fancy of people of different ages and countries. Not only straw, which experience now proves to be rather preferable to every thing else, but wood, horn, glass, &c. have been used for the construction of them. Single box-hives, however, when properly made, answer very well, and when painted last long. They have several advantages above straw hives: they are quite cleanly, and always stand upright; they are proof against mice; and are cheaper in the end than straw hives, for one box will last as long as three of them. They are, however, rather colder in winter; but a proper covering will prevent all danger from that quarter. Straw hives are easiest obtained at first, and have been used and recommended by the best of bee-masters. If the swarm be early and large, it will require a large hive; but if otherwise, the hive should be proportionably less. If the bees appear to want more room, it can easily be enlarged, by putting a roll or two below it; but if it be heavy enough for a stock hive, it will do, although it should not be quite full of combs.

Any person (says Mr. Bonner) who intends to erect an apiary, must take particular care to have it filled with proper inhabitants. He must be peculiarly attentive to this, as all his future profit and pleasure, or loss and vexation, will, in general, depend upon it. He must therefore pay the utmost attention to the choice of his stock hives; for the man who takes care to keep good stock hives will soon gain considerably by them; but he who keeps bad ones, will, besides a great deal of trouble, and little or no success, soon become a broken bee-master. In September every stock hive ought to contain as much honey as will supply the bees with food till June following; and as many bees as will preserve heat in the hive, and thereby resist the severity of a cold winter, and act as so many valiant soldiers to defend the community from the invasions of foreign enemies in spring. They should be full of combs, and well stored with bees and honey, and should weigh at least 30lb. each; if heavier, so much the better; for light hives run a great risk of perishing by famine, unless the bees are supplied with food; whereas a well-chosen hive of 30lb. weight, allowing 12lb. for the empty hive, bees, combs, &c. will contain 18lb. of honey, which will supply the bees with food till June: a time when, it may be presumed, they will find abundance of provisions for themselves among the flowers. When a choice can be obtained, the youngest hive should always be preferred, because old hives are liable to vermin, and other accidents. But although a hive should be four or five years old, it should not be rejected, if it possess these two essential qualities, plenty of bees, and abundance of honey.

Bees first swarm in May, or in the end of April, but earlier or later according to the warmth of the season. They seldom swarm before ten in the morning, and seldom later than three in the afternoon. We may know when they are about to swarm, by clusters of them hanging on the outside of the hive. But the most certain sign is, when the bees refrain from going into the fields, though the season be inviting. Just before they take flight there is an uncommon silence in the hive; after this, as soon as one takes flight, they all follow. Before the subsequent swarmings there is a great noise in the hive, which is supposed to be occasioned by a contest, whether the young or the old queen should go out. When the bees of a swarm fly too high, they will descend lower, upon throwing handfuls of sand or dust among them, which they probably mistake for rain. For the same purpose it is usual to beat on a kettle or frying-pan: this practice may have taken its rise from observing that thunder, or any great noise, prompts bees in the fields to return home. As soon as the swarm is settled, the bees which compose it should be got into a hive with all convenient speed, to prevent their taking wing again. If they settle on a small branch of a tree, easy to come at, it may be cut off and laid upon a cloth, the hive being ready immediately to put over them. If the branch cannot be conveniently cut, the bees may be swept from off it into the hive. Lodge but the queen into the hive, and the rest will soon follow. If the bees must be considerably disturbed in order to get them into a hive, the most advisable way is to let them remain in the place where they have pitched till the evening, when there is less danger of their taking wing. If it be observed that they still hover about the tree they first alighted upon, the branches may be rubbed with rue, elder leaves, or any other thing distasteful to them, to prevent their returning to it. The hive employed on this occasion should be cleaned with the utmost care, and its inside rubbed with fragrant herbs or flowers, the smell of which is agreeable to the bees, or with honey. The hive should not be immediately set on the stool where it is to remain, but kept near the place at which the bees settled, till the evening, lest some stragglers should be lost. It should be shaded either with boughs or with cloth, that the too great heat of the sun may not annoy the bees. We sometimes see a swarm of bees, after having left their hive, and even alighted upon a tree, return to their first abode. This never happens but when the young queen did not come forth with them, for want of strength, or perhaps courage to trust to her wings for the first time; or possibly from a consciousness of her not being impregnated.

When a swarm is too few in number for a hive, another may be added. The usual method of thus uniting swarms is very easy. Spread a cloth at night upon the ground close to the hive in which the two casts or swarms are to be united; lay a stick across this cloth; then fetch the hive with the new swarm, set it over the stick, give a smart stroke on the top of the hive, and all the bees will drop down upon the cloth in a cluster. This done, throw aside the empty hive, take the other from off the stool, and set this last over the bees, who will soon ascend into it, mix with those already there, and become one and the same family. Others, instead of striking the bees down upon the cloth, place with its bottom upmost the hive in which the united swarms are to live, and strike the bees of the other hive down into it. The former of these hives is then restored to its natural situation, and the bees of both hives soon unite. If some bees still adhere to the other hive, they may be brushed off on the cloth, and they will soon join their brethren. Or we may take the following method, which gives less disturbance to the bees. Set with its mouth upmost the hive into which the young swarm has been put, and set upon it the other hive. The bees in the lower hive, finding themselves in an inverted situation, will soon ascend into the upper. A large swarm may weigh 8lb., and so gradually less to 1lb.: consequently a very good one may weigh 5 or 6lb. All such as weigh less than 4lb. should be strengthened, by uniting to each of them a less numerous swarm.

Providence has ordained that insects which feed on leaves, flowers, and green succulent plants, are in an insensible or torpid state, from the time that the winter's cold has deprived them of the means of subsistence: thus the bees during the winter are in so lethargic a state, that little food supports them: but as the weather is very changeable, and every warm or sunny day revives them, and prompts them to return to exercise, food becomes necessary on these occasions. Many hives of bees which are thought to die of cold in winter, in truth die

of famine, when a rainy summer has hindered the bees from laying in a sufficient store of provisions. The hives should therefore be carefully examined in autumn, and should then weigh at least 18 pounds. The common practice is, to feed them in autumn, giving them as much honey as will bring the whole weight of the hive to near 20 pounds. The easiest and most rational method is, to set under the hive a plate of liquid honey, with a paper pierced full of holes, through which the bees will suck the honey without daubing themselves. In case honey cannot be procured, a mixture of brown sugar, wetted with strong beer, will answer every purpose. Another circumstance which may render it very necessary to feed the bees is, when several days of bad weather ensue immediately after they have swarmed; for then, being destitute of every supply beyond what they carried with them, they may be in great danger of starving. In this case, honey should be given them in proportion to the duration of the bad weather.

In this country it is usual, in seizing the stores of these little animals, to rob them also of their lives. The common method is, that when those which are doomed for slaughter have been marked out, (which is generally done in September,) a hole is dug near the hive; and a stick, at the end of which is a rag that has been dipped in melted brimstone, being stuck in that hole, the rag is set on fire, the hive is immediately set over it, and the earth is instantly thrown up all around, so that none of the smoke can escape. In a quarter of an hour, all the bees are seemingly dead; and they are rendered soon after irrecoverably so, by being buried in the earth that is returned back into the hole. By this last means it is that they are absolutely killed; for it has been found by experiment, that all the bees, which have been affected only by the fume of the brimstone, recover again, excepting such as have been singed or hurt by the flame. Hence it is evident, that the fume of brimstone might be used for intoxicating the bees, with some few precautions. The heaviest and the lightest hives are alike treated in this manner; the former, because they yield the most profit, with an immediate return; and the latter, because they would not be able to survive the winter. Those hives which weigh from 15 to 20 pounds are thought to be the fittest for keeping.

Mr. Wheler, in his Journey into Greece, (p. 411) tells us, that at Mount Hymethus they have a method of saving the bees, which is as follows: The hives they keep the bees in are made of willows or osiers, fashioned like our common dust baskets, wide at top and narrow at the bottom, and plaistered over with clay. They are set with the wide end uppermost. The tops are covered with broad flat sticks, which are also plaistered over with clay; and, to secure them from the weather, they cover them with a tuft of straw, as we do. Along each side of these sticks, the bees fasten their combs: so that a comb may be taken out whole, without the least bruising, and with the greatest ease imaginable. To increase them in spring time, that is, in March or April, until the beginning of May, they divide them; first separating the sticks on which the combs and bees are fastened, from one another, with a knife; so, taking out the first comb and bees together on each side, they put them into another basket, in the same order as they were taken out, until they have equally divided them. After this, when they are both again accommodated with sticks and plaister, they set the new basket in the place of the old one, and the old one in some new place. All this they do in the middle of the day, at such time as the greatest part of the bees are abroad; who, at their coming home, without much difficulty, by this means divide themselves equally. This device hinders them from swarming and flying away. In August, they take out their honey; which they do in the day-time also, while they are abroad; the bees being thereby, say they, disturbed least: at which time they take out the combs laden with honey, as before; that is, beginning at each outside, and so taking away, until they have left only such a quantity of combs, in the middle, as they judge will be sufficient to maintain the bees in winter; sweeping those bees that are on the combs into the basket again, and then covering it with new sticks and plaister. Various methods have also been adopted in England, to attain the desirable end of getting the honey and wax without destroying the bees; the most approved of which is Mr. Thorley's, who in his Inquiry into the Nature, Order, and Government of Bees, thinks colonies preferable to hives. He tells us, that he has in some summers taken two boxes filled with honey from one colony; and yet sufficient store has been left for their maintenance during the winter, each box weighing forty pounds. His boxes are made of deal, and an octagon, being nearer to a sphere, is better than a square form; for as the bees, in winter, lie in a round body near the centre of the hive, a due heat is then conveyed to all the out parts. The dimensions which Mr. Thorley, after many years experience, recommends for the boxes, are ten inches in depth, and twelve or fourteen inches in breadth in the inside. The best and purest honey is that which is gathered in the first five or six weeks: and in boxes of less dimensions we may take within a month, provided the season be favourable, a boxfull of the finest honey. The top of the box should be made of an entire board, a full inch thick after it has been planed; and it should project on all sides, at least an inch beyond the dimensions of the box. In the middle of this top there must be a hole five inches square, for a communication between the boxes; this hole should be covered with a sliding shutter, of deal or elm, running easily in a groove over the back window. The eight pannels, nine inches deep, and three quarters of an inch thick when planed, are to be let into the top so far as to keep them in their proper places; to be secured at the corners with plates of brass, and to be cramped with wires at the bottom to keep them firm; for the heat in summer will try their strength. There should be a glass window behind fixed in a frame, with a thin deal cover, two small brass hinges, and a button to fasten it. This window will be sufficient for inspecting the progress of the bees. Two brass handles, one on each side, are necessary to lift up the box; these should be fixed in with two thin plates of iron, near three inches long, so as to turn up and down, and put three inches below the top board, which is nailed close down with sprigs to the other parts of the box. Those who choose a frame within, to which the bees may fasten their combs, need only use a couple of deal sticks of an inch square, placed across the box. One thing more, which perfects the work, is, a passage four or five inches long, and less than half an inch deep, for the bees to go in and out at the bottom of the box. In keeping bees in colonies, a house is necessary, or at least a shade; without which the weather, especially the heat of the sun, would soon rend the boxes to pieces. The house may be made of any boards, but deal is the best; and it must be painted, to secure it from the weather. The length of it for six colonies, should be full twelve and a half feet, and each colony should stand a foot distant from the other. It should be three and a half feet high, to admit four boxes one upon another; but if only three boxes are employed, two feet eight inches will be sufficient. Its breadth in the inside should be two feet.

The best time to plant the colonies is, either in spring with new stocks full of bees, or in summer with swarms. If swarms are used, procure if possible two of the same day: hive them either in two boxes, or in a hive and a box: at night, place them in the bee-house, one over the other; and with a knife and a little lime and hair, stop close the mouth of the hive or upper box, so that not a bee may be able to go in or out but at the front door. Within a week or ten days the combs will appear in the boxes; but if it be an hive, nothing can be seen till the bees have wrought down into the box. Never plant a colony with a single swarm. When the second box, or the box under the hive, appears full of bees and combs, it is time to raise the colony. This should be done in the dusk of the evening, and in the following manner. Place the empty box, with the sliding shutter drawn back, behind the house, near the colony that is to be raised, and at nearly the height of the floor: then lifting up the colony as quickly as possible, let the empty box be put in the place where it is to stand, and the colony upon it; and shut up the mouth of the then upper box with lime and hair, as directed before. When upon looking through the windows in the back of the boxes, the middle box appears full of combs, and a quantity of honey sealed up in it, the lowest box half full of combs, and few bees in the uppermost box, proceed thus. About five o'clock P. M. drive close with a mallet the sliding shutter under the hive or box that is to be taken from the colony. If the combs are new, the shutter may be forced home without a mallet; but be sure it is close, that no bees may ascend into the hive or box to be removed. After this shut close the doors of the house, and leave the bees thus cut off from the rest of their companions, for half an hour or more. In this space, having lost their queen, they will fill themselves with honey, and be impatient to be set at liberty. If, in this interval, upon examining the box or boxes beneath, all appears to be quiet in them, it is a sign that the queen is there and in safety. Hereupon raise the back part of the hive or box so far, by a piece of wood slipped under it, as to give the prisoners room to come out, and they will return to their fellows: then lifting the box from off the colony, and turning its bottom upmost, cover it with a cloth all night; and the next morning.

when this cloth is removed, the bees that have remained in it will return to the colony. Thus a box of honey is procured, and all the bees are preserved. If the bees do not all come out in this manner, Dr. Warder's method may be followed, especially if it be with a hive: viz. to place the hive with the small end downward in a pail, peck, or flower-pot, so as to make it stand firm; then to take an empty hive, and set it upon the former, and to draw a cloth tight round the joining of the two hives, so that none of the bees may get out: after this, to strike the full hive so smartly as to disturb the bees that are in it, but with such pauses between the strokes as to allow them time to ascend into the empty hive; which must be held fast whilst this is doing, lest it fall off by the shaking of the other. When by the noise of the bees in the upper hive, it is perceived that they are got into this last, carry it to a cloth spread for this purpose before the colony, with one end fastened to the landing-place, and knock them out upon it: they will soon crawl up the cloth, and join their fellows, who will gladly receive them.

Mr. Thorley's method of preserving bees in common hives, is incorporation, or uniting two stocks into one, by the help of a peculiar fume or opiate, which will put them entirely in the beemaster's power for a time to divide and dispose of at pleasure. But as that dominion over them will be of short duration, he must be expeditious in this business. The queen is immediately to be searched for, and killed. Hives which have swarmed twice, and are consequently reduced in their numbers, are the fittest to be joined together, as this will greatly strengthen and improve them. If a hive is both rich in honey and full of bees, it is but dividing the bees into two parts, and putting them into two boxes instead of one. Examine whether the stock, to which the bees of another are to be joined, have honey enough to maintain the bees of both: it should weigh full 20 pounds. The narcotic, or stupifying fume, is made with the fungus maximus or pulverulentus, the large mushroom, commonly known by the name of bunt, puck-fist, or frog-cheese. It is as big as a man's head, or bigger when ripe; it is of a brown colour, turns to powder, and is exceedingly light. Put one of these pucks into a large paper, press it to $\frac{2}{3}$ or near half the bulk of its former size, and tie it up very close; then put it into an oven some time after the household bread has been drawn, and let it remain there all night: when it is dry enough to hold fire, it is fit for use. The manner of using it is this: cut off a piece of the puck, as large as a hen's egg, and fix it in the end of a small stick slit for that purpose, and sharpened at the other end; which place so that the puck may hang near the middle of an empty hive. This hive must be set with the mouth upward, in a pail or bucket which should hold it steady, near the stock intended to be taken. This done, set fire to the puck, and immediately place the stock of bees over it, tying a cloth round the hives, that no smoke may come forth. In a minute or little more, the bees will be heard falling like drops of hail into the empty hive. Then beat the top of the full hive gently, to get out as many of them as possible: after this, loosing the cloth, lift the hive off to a table, knock it several times against the table, several more bees will tumble out, and perhaps the queen among them. She often is one of the last that falls. If she is not there, search for her among the main body in the empty hive, spreading them for this purpose on a table. Proceed in the same manner with the other hive, with the bees of which these are to be united. One of the queens being secured, put the bees of both hives together, mingle them thoroughly, and drop them among the combs of the hive which they are intended to inhabit. Then cover it with a coarse cloth which will admit air, and let them remain shut up all that night and the next day. It will easily be known when they are awaked from this sleep. The second night after their union, in the dusk of the evening, gently remove the cloth from off the mouth of the hive, and the bees will immediately sally forth with a great noise; but being too late, they will soon return: then inserting two pieces of tobacco-pipes to let in air, keep them confined for three or four days, after which the door may be left open. The best time for uniting bees is, after their young brood are all out, and before they begin to lodge in the empty cells. As to the hour of the day, Mr. Thorley advises young practitioners to do it early in the afternoon, in order that having the longer light, they may the more easily find out the queen. He never knew such combined stocks conquered by robbers. They will either swarm in the next summer, or yield an hiveful of honey.

Boxes placed laterally will answer every purpose of these of Mr. Thorley, and they may be made square and in the simplest manner.

Bees have various enemies; mice should be guarded against, by diminishing the entrance into the hives when the cold comes on, and the bees are less able to defend themselves; and the hives may be placed in such a manner, that it will be impossible for the mice to reach them. Spiders and caterpillars are very destructive to bees; a species of the latter, called the wax-worm, or wax-moth, because it feeds on wax, lays its eggs in the hive, which turn to maggots that are very noisome and prejudicial. Hives of bees that have swarmed more than once, and such as contain little honey, are most exposed to these insects; for the empty combs serve them for shelter, and the wax supplies them with food. These hives should be cleaned at least once a week; and the stools on which they rest, where the moths are laid by the bees, should be cleaned every morning. But they cannot be entirely destroyed, without taking away the infected hive, removing the bees, and cleansing it of the moths, before it is restored to its former occupiers. Bees are often troubled with lice, which may be destroyed by strewing tobacco over them. The depredations of birds, and particularly of the house-lark and swallow, should be carefully prevented. Ants, woodlice, and earwigs, are also enumerated among the enemies of the bees. Mr. Keys says, "the earwigs steal into the hives at night, and drag out bee after bee, sucking out their vitals, and leaving nothing but their skins or scalps like so many trophies of their butchery." Wasps and hornets are, however, the most formidable enemies that bees have to encounter.

Wasps are very destructive to bees, on account of their superior strength and prodigious numbers, especially in a year favourable to their breeding. They are most numerous in July and August. Soon after that the workers die; but the mothers survive the winter, and commence breeding about April. If cold and wet weather ensues, the greater part of the brood are starved; because the workers cannot fly out for forage, and wasps never lay up any store. Wet is very injurious to their nests, and therefore, in a long season of heavy rain, few wasps will appear till September; but a mild winter, succeeded by a hot spring, will so favour the increase of wasps, that without the greatest vigilance many stocks will fall victims to their power.

One wasp is a match for three bees. They are very bold, and frequently encounter the most evident danger, undauntedly opposing a host of bees, to obtain a belly-full of honey. Therefore, when cold weather commences, knowing that the bees keep no guard then, great numbers get quietly in, and carry off abundance of honey; and having once tasted of the sweets, they will not desist till they possess the whole. Perhaps the same method of destroying them, in this case, as directed for bee-robbers, would prove as effectual against wasps.

In the spring the mother wasps may be seen about old timber, with the splints of which they compose their nests. On the blossoms of goosberries and raspberries they will be found often, and may easily be knocked down and destroyed. Their death, at that time, will prevent a like number of nests from existing the next summer. A nest of wasps is said to consist of 30,000. Effectually to destroy a nest; in the evening, when the wasps have done labour, repair to the place, and stop all the holes of their egress or regress. Introduce a squib into the chief passage, and instantly stopping it with a sod, &c. they will presently be suffocated. Dig the nest up, and burn it. Perhaps a wild-fire of damp gunpowder placed on a piece of wood, and introduced, would answer the same purpose.

Hornets, in the spring, will watch the bees as they issue from the hives. When they are seen about the hives, they should be knocked down and trodden upon. They may be trepanned, by placing an empty hive, with its inside smeared with honey, among the stocks. Allured by this, the mother hornets will begin to build in it. In the evening lift up the hive, which may be done with safety, if the mother is there; then set it down again, and in about half an hour after have a vessel with water ready; take the hive and plunge it a little way into the water; then strike smartly on the top of the hive, and the hornets will fall into the water, and by a pair of tongs may be crushed to death. Or, the hive may be closely stopped up till morning; and then taking it into a room, raise the edge next the window; the hornet will fly directly to it, and may readily be destroyed. Their nests are usually hung on the rafters, beams, or roofs of barns, or out-houses, or fixed in hollow trees. They resemble a globe of brownish paper.

The nest may be taken by preparing a large-mouthed bag, with a running string to draw the mouth close. On a rainy day, or in an evening, put on the bee-dress, and with great stillness approach the nest, and draw the bag gently over it, instantly pulling the mouth so close that not a hornet may escape.

APIS, or MUSCA, in astronomy, a southern constellation, containing four stars.

APIUM, PARSLEY, in botany, a genus of the digynia order, belonging to the pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The fruit is of an oval shape, and streaked; the involucrum consists of one leaf; and the petals are inflected. There are only two species, the culture of which are well known, viz.

1. Apium graveolens, or smallage, or celery, a native of England; and

2. Apium petroselinum, or common parsley, a native of Sardinia.

Smallage, when improved by culture, is termed celery, and there is scarcely a more desirable root, especially as it is a winter sallad. It is aperient and tonic.

With respect to the 2d sort, the roots and seeds of the petroselinum are used in medicine. The root of parsley is one of the five aperient roots; if liberally used, it is apt to occasion flatulencies; and thus, by distending the viscera, produces a contrary effect to that intended by it: the taste of this root is somewhat sweetish, with a light degree of warmth and aromatic flavour. The seeds are an ingredient in the electuary of bay-berries, are moderately aromatic, and were formerly used as carminatives. The common parsley is also reckoned an effectual cure for the rot in sheep, provided they are fed with it twice a week for two or three hours each time; but hares and rabbits are so fond of this herb, that they will come from a great distance to feed upon it; so that whoever has a mind to have plenty of hares in their fields, may draw them from all parts of the country by the cultivation of parsley.

APLANATIC, a term applied to that kind of refraction which entirely corrects the aberration of the rays of light, and the colour depending on it, in contradistinction to the word achromatic, in which there is only a partial correction of colour.

APLUDA, a genus of the monœcia order, belonging to the polygamia class of plants; and in the natural method ranking under the 4th order, gramina. The calyx is a bivalved gluma: the floscules of the female are sessile, and the male floscules are furnished with pedunculi; the female has no calyx; the corolla has a double valve; there is but one stylus, and one covered seed. The male has three stamina. There are 4 species.

APOCYNUM, (Κυων, a dog, because the ancients believed this plant would kill dogs,) DOGSBANE: A genus of the digynia order, belonging to the pentandria class of plants; and in the natural method ranking under the 30th order contortæ. The essential characters are: the corolla is bell-shaped; and the filaments are five, alternate with the stamina. Of this genus botanical writers enumerate 17 species; of which the following are the most remarkable:

1. Apocynum cordatum and villosum, natives of New Spain, and both climbers.

2. Apocynum speciosissimum, a native of Jamaica and of Savannah, whence it has the name of Savannah flower. It rises three or four feet high: the flowers are produced from the sides of the branches, and are very large, and of a bright yellow colour.

3. Apocynum ventum; there are two varieties of this; one with a purple, and the other with a white flower. This species is hardy enough to live in England.

All the species of this plant abound with a milky juice, which flows out from any part of their stalks and leaves when they are broken; this is generally supposed to be hurtful if taken inwardly, but does not blister the skin when applied to it as the juice of spurge and other acrid plants do. The pods of all the sorts are filled with seeds, which have each a long plume of a cottony down fastened to their crowns. This down is in great esteem in France, for stuffing of easy chairs, making quilts, &c. for it is exceedingly light and elastic.

APOCOPE, among grammarians, a figure which cuts off a letter or syllable from the end of a word, as ingeni for ingenii.

APOCRISIARIUS, in antiquity, an officer who delivered the messages of the emperor. He became afterwards chancellor, and kept the seals. It was also a title given to a bishop's resident at court, to the pope's deputy at Constantinople, and to the treasurer of a monastery.

APOGEE, that point of the orbit of a planet, or the sun, which is farthest from the earth.

APOLLINARIAN GAMES, in Roman antiquity, an appellation given to certain theatrical entertainments, celebrated annually in honour of Apollo.

APPOLLINARIANS, or APOLLINARISTS, in church history, a sect of heretics who maintained, that Jesus Christ had neither a rational human soul, nor a true body.

APOLLONIA, in antiquity, an annual festival celebrated by the Ægialians in honour of Apollo.

APOLLO BELVIDERE, a very celebrated antique statue, esteemed by artists the most excellent and sublime of all the antient productions. It was found in the 15th century, about 12 leagues from Rome, in the ruins of ancient Antium, and purchased by pope Julius II. who removed it to the Belvidere of the Vatican, whence it takes its name, and where it remained 300 years, but it is now in the musæum at Paris. See SCULPTURE.

APOLOGUE, in matters of literature, an ingenious method of conveying instruction by means of a feigned relation, called a moral fable.

The only difference between a parable and an apologue is, that the former being drawn from what passes among mankind, requires probability in the narration: whereas the apologue being taken from the supposed actions of brutes, or even of things inanimate, is not tied down to the strict rules of probability. Æsop's fables are a model of this kind of writing.

APONEUROSIS, among physicians, a term sometimes used to denote the expansion of a nerve or tendon in the manner of a membrane; sometimes for the cutting off a nerve; and, finally, for the tendon itself.

APOPHYSIS, in anatomy, an excrescence from the body of a bone, of which it is a true continuous part, as a branch is of a tree. See ANATOMY.

APOPLEXY, a distemper in which the patient is suddenly deprived of the exercise of all the senses, and of voluntary motion; while a strong pulse remains with a deep respiration, attended with a stertor, and the appearance of a profound sleep. See MEDICINE.

APOSIOPESIS, in rhetoric, the suppressing or omitting to relate a part of the subject: thus the poet omits the circumstance of Dido's killing herself.

Dixerat, atque illam media inter tallia ferro
Collapsam adspiciunt.

APOSTATE, among the Romanists, signifies a man who, without a legal dispensation, forsakes a religious order of which he had made profession. Hence,

APOSTATA CAPIENDO, in the English law, a writ which formerly lay against a person who, having entered into some order of religion, broke out again, and wandered up and down the country.

APOSTILICI, an early sect of Christians, who pretended to lead their lives in imitation of the apostles. They condemned marriage.

APOSTROPHE, in rhetoric, a figure by which the orator addresses a person either absent or dead as if he was present; or appeals to angels and to men, to rocks, groves, &c. Thus Adam in Milton's Paradise Lost,

O woods, O fountains, hillocks, dales,
and bowers,
With other echo, &c.

APOSTROPHE, in grammar, a mark placed over a letter to shew that a vowel is cut off, as call'd for called, th' audience, for the audience.

APOTACTITES, in church-history, a name given to the apostolici, from the shew they made of renouncing the world more than other men.

APOTHECARY, one who practises the art of pharmacy. In London, the apothecaries are one of the city companies, and by an act which was made perpetual in the ninth year of George I. are exempted from serving upon juries, or in ward and parish offices. They are obliged to make up their medicines according to the formulas prescribed in the college dispensatory, and are liable to have their shops visited by the censors of the college, who are impowered to destroy such medicines as they think not good.

APOTHEOSIS, in antiquity, a ceremony by which the antient Romans complimented their emperors and great men after their death, with a place among the gods. It is described as follows. After the body of the deceased had been burnt with the usual solemnities, an image of wax, exactly resembling him, was placed on an ivory couch, where it lay for seven days, attended by the senate and ladies of the highest quality in mourning; and then the young senators and knights bore the bed of state through the via sacra to the old forum, and thence to the campus Martius, where it was deposited upon an edifice built in form of a pyramid. The bed being thus placed, amidst a quantity of spices and other combustibles, and the knights having made a procession in solemn measure round the pile, the new emperor, with a torch in his hand, set fire to it, whilst an eagle, let fly from the top of the building, and mounting in the air with a firebrand,

was supposed to convey the soul of the deceased to heaven, and thencefo ward he was ranked among the gods.

APOTOME, in geometry, the difference between two incommensurable lines: such is the difference between 2 and 1, and such is the excess of the diagonal of a square above its side.

APOTOME, in music, the difference between a greater and lesser semi-tone, expressed by the ratio 128: 125.

APPARENT, among mathematicians and astronomers, denotes things as they appear to us, in contradistinction from real or true; thus we say, the apparent diameter, distance, magnitude, place, figure, &c. of bodies.

APPARITION, in astronomy, signifies a star or other luminary's becoming visible, which before was hid. It stands opposed to occultation.

APPARITOR, among the Romans, a general term to comprehend all attendants of judges and magistrates appointed to receive and execute their orders. Apparitor, with us, is a messenger, that serves the process of a spiritual court, or a beadle in an university, who carries the mace.

APPEAL, in law, the removal of a cause from an inferior to a superior court or judge, when a person thinks himself aggrieved by the sentence of the inferior judge. Appeals lie from all the ordinary courts of justice to the house of lords. In ecclesiastical causes, if an appeal is brought before a bishop, it may be removed to the archbishop; if before an archdeacon to the court of arches, and thence to the archbishop; and from the archbishop's court to the king in chancery.

Appeal, in our old common law, is taken for the accusation of a murderer by a person who had interest in the party killed; of a felon by an accomplice; or for rape or mayhem by the party injured. It was prosecuted either by writ or by bill: by writ, when a writ was purchased out of the chancery by one person against another, commanding him to appeal some third person of felony, and to find pledges for doing it effectually: by bill, when the person himself gave in his accusation in writing, offering to undergo the burden of appealing the person therein named. The extreme nicety of conducting appeals has caused them to be wholly disused, and the proceeding is now always by indictment. 4 Black. 313.

APPEARANCE, in law, signifies a defendant's filing common or special bail, on any process issued out of a court of judicature. In actions by original, appearances are entered with the philazer of the county; and by bill, with the prothonotary.

In perspective, appearance is the projection of a figure or body on the perspective plane.

In astronomy it signifies the same as phænomena or phases; and in physiology, the same as phasmata.

APPELLANTS, in church-history, an appellation given to such of the Roman catholic clergy, as appealed from the constitution unigenitus, to a general council.

APPELLATIVE, in grammar, a noun which is applicable to a whole species or kind, as man, horse; in contradistinction to a proper noun.

APPENDANT, in law, any thing that is inheritable, belonging to some more worthy inheritance; as an advowson, common, or court, may be appendant to a manor, land to an office, &c. but land cannot be appendant to land, for both are corporeal inheritances, and one thing corporeal cannot be appendant to another.

APPLICATION, in geometry, is used for applying one quantity to another, whose areas, but not figures, shall be the same; or for transferring a given line into a circle, or other figure, so that its ends shall be in the perimeter of the figure.

By application it is proved in Euclid's elements that two triangles having two sides of one equal to two sides in the other, and the included angles equal, are equal in all respects.

APPLICATION is used in arithmetic for division; thus 16 applied to, or divided by 4, gives 4.

APPLICATION, of one science to another, signifies the use that is made of the principles of the one for augmenting and perfecting the other. Thus algebra has been applied to geometry, and vice versa, and both are made use of in illustrating and demonstrating the principles of mechanics, astronomy, navigation, &c. See GEOMETRY.

APPOINTEE, in heraldry, the same as aguisee: thus we say, a cross appointee, to signify that which has two angles at the end cut off, so as to terminate in points.

APPORTIONMENT, in law, the division of a rent into parts, in the same manner as the land out of which it issues is divided: for example, if a person leases three acres of land for a certain rent, and afterwards grants away one acre thereof to another, the rent shall be apportioned between them.

APPOSAL of sheriffs, the charging them with money received on their accounts in the exchequer.

APPOSITION, in grammar, the placing two or more substantives together, in the same case, without any copulative conjunction between them; as Ardebat Alexim delicias domini.

APPRAISING, the valuing or setting a price on goods. This is usually done by a sworn appraiser, who, if he values the goods too high, is obliged to take them at the price appraised.

APPREHENSION, in logic, denotes the simple attention of the mind to an object presented either to our senses or our imagination, without passing a judgment, or making any inference. The word is also used to express an inadequate and imperfect idea.

APPRENTICE, a young person bound by indenture to some tradesman, in order to be instructed in the mystery or trade. By the laws of England, a master may be indicted for not providing for, or for turning away his apprentice: and upon complaint from a master, that he neglects his duty, an apprentice may be committed to Bridewell, or be bound over to the sessions. By 5 Eliz. no person can exercise any trade in any part of England, without having served a regular agprenticeship of at least seven years. No trades, however, are held to be within the statute but such as were in being at the making of it in the reign of Elizabeth. Apprenticeships are not necessary to carry on a trade in a country village. And following a trade seven years, either as master or servant, without effectual prosecution, is sufficient without an apprenticeship.

A duty of 6d. in the pound is granted for every sum of 50*l.* or under, and 12d. in the pound for sums not exceeding 50*l.* given with all apprentices, except such as are placed out by church-wardens, &c.

APPRISING, in Scots law, the name of an action by which a creditor formerly became invested with the estate of his debtor for payment.

APPROACH, curve of equable, is of such a nature, that a body descending in it by the sole power of gravity, approaches the horizon equally in equal times. See CURVE.

APPROACHES, method of, in mathematics, a name given to a mode of resolving certain problems relating to square numbers, by first assigning certain limits to the quantities required, and then approaching nearer and nearer till a coincidence is obtained. The double rule of false position may be considered as a method of approaches.

APPROACHES, in fortification, the works thrown up by the besiegers, in order to get nearer a fortress, without being exposed to the enemy's cannon: such, in a more particular manner, are the trenches, which, should be connected by parallels, or lines of communication.

APPROACHING, in fowling, a method of getting near the birds by means of a machine, made of hoops and boughs of, trees within which the sportsman conceals himself.

APPROPRIARE COMMUNIAM, in law, is to discommon, or inclose any parcel of land that before was open and common.

APPROPRIATION, the annexing a benefice to the proper and perpetual use of a religious house, bishopric, college, &c. Where the king is patron, he may make appropriations himself; but in other cases, after obtaining his licence in chancery, the consent of the ordinary, patron, and incumbent, is requisite. Appropriations cannot be assigned over, but those to whom they are granted may make leases of the profits. There are in England 2345 impropriations.

APPROVEMENT, in law, is the inclosing part of a common by the lord of the manor.

APPROVER, in law, one who before imprisonment, confessing that he has committed a felony, accuses one or more of his accomplices. Approvers, also, signify bailiffs of lords in their franchises, sheriffs, and likewise such persons as have the letting the king's demesnes in small manors.

APPROXIMATION, in arithmetic and algebra, the coming nearer and nearer to a root or other quantity sought, without expecting to be ever able to find it exactly. There are several methods for doing this, to be found in mathematical books, being nothing but infinitely coverging series, some approaching quicker, others slower towards the truth.

By such an approximation the value of a quantity may be found, though not to the utmost degree of exactness, yet sufficiently so for practice. Thus $\sqrt{2} = 1.41421356$, &c. = the approximating series $1 + \frac{4}{10} + \frac{1}{100} + \frac{4}{1000} + \frac{2}{10000} +$, &c. or supposing $x = \frac{1}{10}$, equal to the series $1 \times \frac{4}{x} + \frac{1}{x^2} + \frac{4}{x^3} + \frac{2}{x^4} +$, &c. $= x + 4x^{-1} + x^{-2} + 4x^{-3} + 2x^{-4} +$, &c.

The most easy and general method of approximation, is perhaps by the rule of Double Position, or, what is sometimes called, the Method of Trial-and-error; which method see under its own name. And among all the methods

for the roots of pure powers, of which there are many, the best is that which was discovered by Dr. Hutton, and given in the first volume of his Mathematical Tracts, in point of ease, both of execution and for remembering it. The method is this: if N denote any number, out of which is to be extracted the root whose index is denoted by r, and if n be the nearest root first taken; then shall $\frac{r+1.N+r-1.nr}{r-1.N+r+1.nr} \times n$ be the required root of N very nearly; or as $r-1$ times the given number added to $r+1$ times the given number added to $r-1$ times the nearest power, so is the assumed root n, to the required root, very nearly. Then this last value of the root, so found, if one still nearer is wanted, is to be used for n in the same theorem, to repeat the operation with it. And so on, repeating the operation as often as necessary. Which theorem includes all the rational formulæ of Halley and De Lagny.

For example, suppose it were required to double the cube, or to find the cube root of the number 2. Here $r=3$; consequently $r+1=4$, and $r-1=2$; and therefore the general theorem becomes $\frac{4N+2n^3}{2N+4n^3} \times n$ or $\frac{2N+n^3}{N+2n^3} \times n$ for the cube root of N; or as $N+2n^3 : 2N+n^3 :: n :$ the root sought nearly. Now, in this case, $N=2$, and therefore the nearest root n is 1, and its cube $n^3=1$ also: hence $N+2n^3=2+2=4$, and $2N+n^3=4+1=5$; therefore, as $4 : 5 :: 1 : \frac{5}{4}$ or $1\frac{1}{4}=1.25$ the first approximation. Again, taking $r=\frac{5}{4}$, and $r^3=\frac{125}{64}$; hence $N+2n^3=2+\frac{250}{64}=\frac{378}{64}$, and $2N+n^3=4+\frac{125}{64}=\frac{381}{64}$; therefore, as 378 : 381, or as 126 : 127 :: $\frac{5}{4}$: $\frac{635}{504}=1.259921$, which is the cube root of 2, true in all the figures. And by taking $\frac{635}{504}$ for a new value of n, and repeating the process, more figures may be found.

APPROXIMATION, *of the roots of equation, by.* Sir Isaac Newton's method for approximating roots is this: first take a value of the root as near as may be, by trials, either greater or less; then assuming another letter to denote the unknown difference between this and the true value, substitute into the equation the sum or difference of the approximate root and this assumed letter, instead of the unknown letter or root of the equation, which will produce a new equation having only the assumed small difference for its root or unknown letter; and, by any means, find, from this equation, a near value of this small assumed quantity. Assume then another letter for the small difference between this last value and the true one, and substitute the sum or difference of them into the last equation, by which will arise a third equation, involving the second assumed quantity; whose near value is found as before. Proceeding thus as far as we please, all the near values, connected together by their proper signs, will form a series approaching still nearer and nearer to the true value of the root of the first or proposed equation. The approximate values of the several small assumed differences, may be found in different ways: Sir I. Newton's method is this; as the quantity sought is small, its higher powers decrease more and more, and therefore neglecting them will not lead to any material error. He therefore neglects all the terms having in them the second and higher powers, leaving only the first power and the absolute known term; from which simple equation he always finds the value of the assumed unknown letter nearly, in a very neat and easy manner.

For example, let it be required to find the root of the equation $x^2-5x=31$, or $x^2-5x-31=0$: Here the root x, it is evident, is nearly $=8$; for x therefore take $8+z$, and substitute $8+z$ for x in the given equation, and the terms will be thus;

$$\begin{aligned} x^2 &= 64+16z+z^2 \\ -5x &= -40-5z \\ -31 &= -31 \end{aligned}$$

the sum is $-7+11z+z^2=0$.

Then, rejecting z^2, it is $11z-7=0$, and $z=\frac{7}{11}=.6363$, &c., or $=.6$ nearly.

Assume now $z=.6+y$: then

$$\begin{aligned} z^2 &= .36+1.2y+y^2 \\ 11z &= 6.6+11y \\ -7 &= -7 \end{aligned}$$

the sum $-.04+12.2y+y^2=0$,

where $y=\frac{.04}{12.2}=.003278$ nearly.

Assume it $y=.003278-v$: then

$$\begin{aligned} y^2 &= .000010745284-.006556v+v^2 \\ 12.2y &= .0399916-12.2\,v \\ -.04 &= -.04 \end{aligned}$$

the sum $.000002345284-12.206556v+v^2=0$,

where $v=\frac{.000002345284}{12.206556}=.000000192133$.

Hence, then, collecting all the assumed differences, with their signs, it is found that $x=8+z+y-v=8+.6+.003278-.000000192133=8.6003277807867$ the root of the equation required, by Newton's method.

Example 2. Again, taking the cubic equation $y^3-2y-5=0$; Newton proceeds thus:

y is nearly $=2$; take it therefore $y=2+p$;

$$\begin{aligned} y^3 &= 8+12p+6p^2+p^3 \\ -2y &= -4-2p \\ -5 &= -5 \end{aligned}$$

the sum $-1+10p+6p^2+p^3=0$;

hence $p=\frac{1}{10}=.1$ nearly.

Assume it $p=.1+q$;

$$\begin{aligned} p^3 &= 0.001+0.03q+0.3q^2+q^3 \\ +6p^2 &= 0.06+1.2q+6q^2 \\ +10p &= 1+10q \\ -1 &= -1 \end{aligned}$$

the sum $0.061+11.23q+6.3q^2+q^3=0$;

hence $q=-0.0054$ nearly.

Assume it $q=-0.0054+r$;

$$\begin{aligned} q^3 &= -0.000000157464+0.00008748r, \text{&c.} \\ +6.3q^2 &= +0.000183708-0.06804r, \text{&c.} \\ +11.23q &= -0.060642+11.23r \\ +0.061 &= +0.061 \end{aligned}$$

the sum $+0.000541550536+11.16204748r$;

hence $r=-0.000048517$, &c.

Hence, $y=2+p+q+r$

$=2+0.1-0.0054-0.000048517$

$=2.094551483$,

the root of the equation $y^3-2y=5$. And in the same manner Sir I. Newton performs the approximation for the roots of literal equations.

APPUI, in the manege, the sense of the action of the bridle in the horseman's hand.

APPULSE, in astronomy, the approach of a planet towards a conjunction with the sun, or any of the fixed stars.

APPURTENANCES, in common law, signify things corporeal and incorporeal that appertain to another thing as principal; as hamlets to a manor, and common of pasture and fishery. Things must agree in nature and quality to be appurtenant, as a turbary, or a seat in a church, to a house.

A PRIORI, a kind of demonstration.

APRON, in gunnery, the piece of lead which covers the touch-hole of a cannon.

APSIS, in astronomy, a term used indifferently for either of the two points of a planet's orbit, where it is at the greatest or least distance from the sun or earth. Hence the line connecting these points is called the line of the apsides.

APTENODYTES, in ornithology, a genus of birds that seems to hold the same place in the southern parts of the world as the awks do in the northern. According to Latham, this is the genus penguin. It is seen only in the temperate and frigid zones on that side of the equator which it frequents. The same is observed of the awk in opposite latitudes. See ALCA.

APTERA, in the Linnæan system of zoology, the seventh and last order of insects, the distinguishing characteristic of which is, that the insects comprehended in it have no wings: such are the louse, the flea, the podura, the monoculus, the acarus, the spider, the scorpion, and the crab.

APTOTE, among grammarians, an indeclinable noun, or one which has no variation of cases.

APUS, *avis indica*, a constellation of the southern hemisphere, near the pole, which, according to Bayer's catalogue, contains 12 stars; the largest is of the fifth magnitude.

AQUA, *water*, a term frequently met with in the writings of physicians, chemists, &c. for certain medicines or menstruums, in a liquid form, distinguished from each other by peculiar epithets, as aqua alexiteria, aqua aluminosa, aqua fortis, &c. Though formerly thought an element, pure or distilled water is now found to be a compound body of three parts hydrogen and one of oxygen. See AIR, &c.

AQUA FORTIS, nitric acid. See CHEMISTRY.

AQUA MARINA, or AQUA MARINE, a name by which the jewellers call the beryl, on account of its sea-green colour.

AQUA REGIA, a combination of nitric and muriatic acids. In the new nomenclature it is called nitro-muriatic acid; it is called aqua regia, as the only acid formerly known to dissolve gold.

AQUA *secunda*, aquafortis diluted with water, and employed in the arts.

AQUA *vitæ*, answers to the *eau de vie* of the French, *usquebaugh* of the Irish, whisky of the Scotch, and is a name familiarly applied to native distilled spirits.

AQUÆDUCT, in hydraulics and architecture, a conveyance made for carrying water from one place to another. Those of the antient Romans were surprisingly magnificent. That which Lewis XIV. built near Maintenon, for carrying the Eucq to Versailles, is perhaps the greatest now in the world: it is seven thousand fathoms long, with two thousand five hundred and sixty fathoms of elevation, and contains two hundred and forty-two arcades.

AQUARIANS, in church history, an antient sect of christians, who, under pretence of abstinence, made use of water instead of wine in the eucharist.

AQUARIUS, in astronomy, a constellation, which makes the eleventh sign in the zodiac, marked thus, ♒. It consists of forty-five stars in Ptolemy's catalogue, of forty in Tycho's, and in the Britannic catalogue of 108.

AQUARTIA, in botany, a genus of the class and order, tetandria monogynia. The essential character is, calyx bell-shaped, corolla wheel-shaped, with linear divisions, berry many seeded. There is one species, a native of South America.

AQUATINTA, a method of engraving which very much resembles drawing in Indian ink. This process consists in corroding the copper with aqua-fortis, in such a manner, that an impression from it has the appearance of a tint laid on the paper. This is effected by covering the copper with a substance, which takes a granulated form, so as to prevent the aquafortis from acting where the particles adhere, and by this means cause it to corrode the copper partially, and in interstices only. When these particles are extremely minute, and near to each other, the impression from the plate appears to the naked eye like a wash of Indian ink. But when they are larger, the granulation is more distinct; and as this may be varied at pleasure, it is capable of being adapted to a variety of purposes and subjects.

The matter generally used for this purpose, is composed of equal parts of asphaltum and transparent rosin, reduced to powder and sifted on the plate, (which has been previously greased) through a fine sieve. The plate is then heated so as to make the powder adhere, and the artist scrapes it away when a very strong shade is wanted, and covers those parts with varnish where he wishes a very strong light to appear. The aqua fortis properly diluted with water, is then put on within a fence of wax, as in common etching for engraving, and by repeated applications, covering the light parts still with varnish, the effect is produced.

AQUEOUS humour, in anatomy, called also the albugineous matter, is the front of the three humours of the eye, and fills up the space between the cornea and crystalline.

AQUILA, in astronomy, a constellation of the northern hemisphere, consisting of fifteen stars in Ptolemy's catalogue, of seventeen in Tycho's, and of seventy-one in the Britannic catalogue.

AQUILARIA, a genus of the class and order decandria monogynia. The essential character is, calyx five cleft; corolla, none; nectarium pitcher shaped, half five cleft with bifid clefts; capsula superior, woody, two celled, two valved; seeds solitary.

There is only one species, a large tree, a native of the mountains of Malacca and Cochin China. The lignum aloes, or aloes wood, is a resinous matter produced by a disease in this tree, which finally kills it. The lignum aloes is highly esteemed in the east as a perfume, and from the bark of this tree is made the common paper, which the Cochin-Chinese use for writing.

AQUILEGIA, Columbine, in botany, a genus of the pentagynia order, belonging to the polyandria class of plants; and, in the natural method, ranking under the sixteenth order, Multisiliquæ. It has no calyx; the petals are five, with a horn-like nectarium inserted between each; and there are five separate capsules. There are five species:

1. Aquilegia Alpina, grows naturally in Yorkshire. The flowers are much larger than those of the garden columbine.

2. Aquilegia Canadensis, or Canada columbine, flowers almost a month before the other sorts.

3. Aquilegia Inversa, or garden columbine. Of this there are great varieties; the colours are chesnut, blue, red, and white, and some are finely variegated.

4. Aquilegia Vulgaris, or wild columbine, with blue flowers, is found growing wild in some woods of England.

5. Aquilegia, viridiflora.

AQUILICIUM, or Aquiliciana, in Roman antiquity, sacrifices performed in times of excessive drought, to obtain rain of the gods.

ARA, in astronomy, a southern constellation, containing eight stars.

ARABESQUE, or Moresque, denotes a style of painting, or of sculpture, so called from the Arabians and Moors, who employed certain ornaments for want of human and animal representations, which their religion prohibited them from using.

ARABIC characters or figures, are the numerical characters made use of in all our arithmetical computations.

Arabic, gum, the name of a gum which distils from a species of mimosa. It is very common among us, but little is to be met with genuine; that is accounted the best which is in smaller pieces, and almost of a white colour. It is useful in all kinds of fluxes, paritcularly catarrhs.

ARABICI, a sect of christians, who held that the soul both dies and rises again with the body.

ARABIS, bastard tower-mustard: a genus of the siliquose order, belonging to the tetradynamia class of plants; and in the natural method ranking under the 39th order, siliquose. The generic mark consists in 4 nectiferous glands which lie on the inside of each leaf of the calyx. There are 14 species; but none of them remarkable for their beauty or their properties. Only one of these, viz.

Arabis thaliana, or the mouse-ear, is a native of Britain. It grows naturally on sandy ground, or old walls.

ARACHIS, in botany, a genus of the diadelphia-decandria class of plants, the flower of which is papilionaceous, and consists of three petals; and its fruit is an oblong unilocular pod, contracted in the middle. There are 2 species chiefly cultivated in Peru, Brasil, and Carolina, for the seed, which constitutes a considerable article of food for the negroes. This seed is a kind of nut, which is perfected in a most extraordinary manner; for as soon as the flower falls off, the germ thrusts itself into the ground, and there the pod is formed and ripened, whence the popular name ground-nuts.

ARACHNOIDES, in zoology, a name given to shose *echini marini*, or sea-hedgehogs, which are of a circular form, but variously indented at the edges.

Arachnoides, is a also a species of Madrepora, found fossil. The stars are very small, crowded, and flattened; rays undulated, short and equal.

Arachnoides, in anatomy, an appellation given to several different membranes, in the tunic of the crystalline humour of the eye, the external lamina of the pia mater, and one of the coverings of the spinal marrow.

ARÆOMETER, an instrument to measure the gravity of liquors, which is usually made of a thin glass ball, with a taper neck, sealed at the top, there being first as much mercury put into it as will keep it swimming in an erect posture. The neck is divided into parts, which are numbered, that so by the depths of its descent into any liquor, its lightness may be known by these divisions, for that fluid in which it sinks the least, must be heaviest, and that in which it sinks lowest is the lighest. See Hydrometer.

ARÆOSTYLE, in architecture, a term used by Vitruvius, to signify the greatest interval which can be made between columns, which consists of eight modules or four diameters.

ARAIGNEE, in fortification, signifies the branch, return, or gallery of a mine.

ARALIA, in botany, a genus of plants with roaceous flowers, and succulent berries, containing each a single oblong, and hard seed. It belongs to the *pentandria-pentagynia* class of Linnæus. The essential character is flowers, in an umbellule, with an involucrum; cal. 5 toothed superior; cor. 5 petalled; berry 5 seeded. There are 9 species, most of them shrubs and natives of China and America; some are hardy enough to stand our climate in sheltered situations.

ARAMPO, or *Man-eater*, a name given by the negroes on the coast of Africa, to a long slender animal, in shape resembling a weasel, with a long tail, and large brush at its extremity. It takes its name from digging up graves and devouring human flesh.

ARANEA concha, the spider-shell, a name given to several kinds of murex.

Aranea, a genus of apterous insects, well known by the common name of spider. The mouth is furnished with short horny jaws; lip rounded at the apex; feelers two, incurved, jointed, very acute at the tip, clubbed with the genitalia in the male; no antennæ; the eyes are eight, or rarely six; feet eight, the anus furnished with papillæ, or teats for spinning. They fix the ends of their threads by applying these nipples to any substance, and the thread lengthens in proportion as the animal recedes from it. They can stop the issuing of the threads by contracting the nipples, and reascend by means of the claws on their feet, much in the same manner as sailors warp up a rope.

The darting out of long threads, which has been observed by naturalists, and by means of which some species of spiders can convey themselves to great distances, deserves particular notice. Dr. Lister tells us, that attending closely to a spider weaving a net, he observed it suddenly to desist in the midwork; and turning its tail to the wind, it darted out a thread with the violence and stream we see water spout out of a jet: this thread, taken up by the wind, was immediately carried to some fathoms long; still issuing out of the belly of the animal. By-and-by the spider leaped into the air, and the thread mounted her up swiftly. After this discovery, he made the like observation on near thirty different species of spiders; and found the air filled with young and old, sailing on their threads, and doubtless seizing gnats and other insects in their passage, there being often manifest signs of slaughter, legs, and wings of flies, &c. on these threads, as well as in their webs below. The matter of which the spider's threads are formed, is a viscid juice, elaborated in the body of the

animal. The young no sooner quit their egg than they begin to spin. Indeed their threads can scarcely be perceived, but the webs may; and no wonder, there being often 400 or 500 little spiders concurring to the same work. There are some kinds of spiders so small at their birth, that they are not visible without a microscope. There are usually found an infinity of these in a cluster, and they only appear like a number of red points: and yet there are webs found under them, though almost imperceptible. What must be the tenuity of one of these threads? Mr. Lewenhock has computed that 100 of the single threads of a full grown spider are not equal to the diameter of the hair of his beard; and consequently, if the threads and *hair* are both round, ten thousand such threads are not bigger than such a hair.

Garden-spiders, (Plate, Nat. Hist. fig. 30.) particularly the short-legged species, yield silk which has been judged scarcely inferior to that of the silk worm. Mr. Bon of Languedoc, about 70 years ago, contrived to manufacture from it a pair of silk stockings and mittens, of a beautiful natural grey colour, which were almost as handsome and strong as those made with common silk; and he published a dissertation concerning the discovery. But M. Reaumur, being appointed by the Royal Academy to make a farther enquiry into this new silk work, raised several objections and difficulties against it. The sum of which amounts to this. The natural fierceness of the spider renders them unfit to be bred and kept together. Four or five thousand being distributed into cells, 50 in some, 100 or 200 in others, the big ones soon killed and eat the less, so that in a short time there were scarcely left one or two in each cell; and to this inclination of mutually eating one another M. Reaumur ascribes the scarcity of spiders, considering the vast numbers of eggs they lay. But he affirms, that the silk of the spider is not one-fifth of the strength of that of the silk-worm. Add to this, that the spider's thread cannot be wound off as that of the silk-worm may, but must of necessity be carded; by which means being torn in pieces, its evenness which contributes much to the lustre, is destroyed. Again, spiders furnish much less silk than the worms: the work of 12 spiders only equals that of one silk-worm; and a pound of silk will require at least 27,648 spiders.

The species of aranea enumerated by naturalists amount to upwards of 50; of which it may here suffice to mention a few of the most remarkable.

1. Aranea aquatica, or the water-spider, frequents the fresh waters of Europe. But it is in some sort amphibious: for it can live on land as well as in the water, and comes often on shore for its food; yet it swims well in water, both on its belly and back: it is distinguishable by its brightness. In the water its belly appears covered with a silver varnish, which is only a bubble of air attached to the abdomen by means of oily humours which transpire from its body, and prevent the immediate contact of the water. This bubble of air is made the substance of its dwelling, which it constructs under water: for it fixes several threads of silk, or such fine matter, to the stalks of plants in the water; and then ascending to the surface, thrusts the hinder part of its body above water, drawing it back again with such rapidity, that it attaches underneath a bubble of air, which it has the art of detaining under water, by placing it underneath the threads, and which it binds like a covering almost all around the air bubble. Then it ascends again for another air bubble; and thus proceeds until it has constructed a large aerial apartment under water, which it enters into or quits at pleasure. It lodges during the winter in empty shells, which it dextrously shuts up with a web.

2. Aranea Avicularia, is a native of America, and feeds upon small birds, insects, &c. The bite of this spider is accounted as venomous as that of the serpent.

3. Aranea calycina, lives in the cups of flowers, after the flower-leaves have fallen off; and catches bees, and other flies, when they are in search of honey.

4. Aranea Cucurbitina has a globular yellow belly, with a few black spots. It lives in the leaves of trees, and incloses its eggs in a soft net.

5. Aranea Diadema is the largest spider which this country produces. The abdomen is of an oval form, downy, and of a ruddy yellow colour. The upper part is beautifuly adorned with black and white circles and dots, having a longitudinal band in the middle, composed of oblong and oval shaped pearl coloured spots, so arranged as to resemble a fillet, similar to those worn by the eastern kings. The legs are of a fine pale green colour; annulated with dark purple or black. It inhabits the birch tree.

6. Aranea Fasciata, with yellow bands round the belly, and dusky rings on the legs, is a native of Barbary, and is as large as the thumb. It inhabits hedges and thickets: its webs have large meshes, and it resides in the centre. Twelve of these spiders, by way of experiment, were shut up together; and, after a battle of eight days, the strongest only remained alive.

7. Aranea Fimbriata, has a black oblong belly, with a white line on each side, and dusky coloured legs. It lives in water, upon the surface of which it runs with great swiftness.

8. Aranea Holosericea, has an oval belly covered with a down, like velvet; at the base, or under part, it has two yellow spots. It is found in the folded leaves of plants.

9. Aranea Labyrinthica, with a dusky oval belly, a whitish indented line, and a forked anus. The web of this species is horizontal, with a cylindrical well or tube in the middle.

10. Aranea Ocellata, has three pair of eyes on its thighs. It is about the same size with the tarantula, of a pale colour, with a black ring round the belly, and two large black spots on the sides of the breast. It is a native of China.

11. Aranea Saccata, lives in the ground, and carries a sack with its eggs, wherever it goes. This sack it glues to its belly, and will rather die than leave it behind.

12. (1) Aranea Tarantula has the breast and belly of an ash-colour; the legs are likewise ash coloured, with blackish rings on the under part; two of its eyes are larger than the other, red, and placed in the front; four other eyes are placed in a transverse direction towards the mouth. It is a native of Italy, Cyprus, Barbary, and the East Indies. It lives in bare fields, where the lands are fallow, but not very hard. Its dwelling is about four inches deep, and half an inch wide; at the bottom it is curved, and there the insect sits in wet weather, and cuts its way out if water gains upon it. It weaves a nest at the mouth of the hole. These spiders do not live quite a year. In July they shed their skin. They lay about 730 eggs, which are hatched in the spring; but the parent does not live to see her progeny, as she expires early in the winter. The ichneumon fly is their greatest enemy.

The bite of the tarantula is said to occasion an inflammation in the part, which in a few hours brings on sickness, difficulty of breathing, and universal faintness; the same symptoms return annually, in some cases, for several years; and at last terminate in death. Music, it has been pretended, is the only cure. Such are the circumstances that have been generally related, and long credited, concerning the bite of this animal. But it is now generally agreed, that no such effects attend this bite; and that the exhibitions of dancing to music by persons pretending to be so affected, are only villainous deceptions to excite the compassion and extract the money of the spectators. Plate Nat. Hist. fig. 31.

13. Aranea Viatica, or wanderer, is generally of a yellow colour, more or less deep. It is found upon plants; and is a lively, active, indefatigable hunter. Without any motion of the head, which is furnished with immoveable eyes, it perceives all the flies that hover round about, does not scare them, but stretches over them its arms, furnished with feathers, which prove nets in which their wings entangle. It is said to sit on its eggs; which, however, it often carries about with it, wrapt up in a ball of white silk.

ARANEA, in mineralogy, a silver ore found only in the mines of Potosi. It owes its name to the faint resemblance it bears to a cobweb, being composed of threads of pure silver, which to the sight appear like silver lace, when burnt to separate the silk from it.

ARBITER, in civil law, a judge nominated by the magistrate, or chosen voluntarily by two parties, in order to decide their differences according to law.

The civilians make this difference between arbiter and arbitrator: though both ground their power on the compromise of the parties, yet their liberty is different; for an arbiter is to judge according to the usages of the law, but the arbitrator is permitted to use his own discretion, and accommodate the difference in the manner that appears to him most just and equitable.

ARBITRATION, a power given by two or more contending parties, to some person or persons to determine the dispute between them. Matters relating to a freehold, debts due on bond, and criminal offences, are not to be arbitrated. If the party injured by a criminal act, however, proceeds by way of civil action, as in assault or libel, &c. the damages may be submitted to arbitration; also in case of a breach of promise of marriage. The *submission* to arbitration given by the parties must be an agreement or bond upon a stamp, and must not be construed strictly but largely according to the intent of the parties submitted. It commonly contains a clause to protect the arbitrators from

any suit in equity that might be brought against them in consequence of their award; also one to enable them in case they cannot agree, to call in a third arbitrator, by mutual agreement, who is called an umpire. An action of debt may be brought for money adjudged to be paid by arbitrators.

ARBOR, in mechanics, the principal part of a machine which serves to sustain the rest: also the axis or spindle on which a machine turns, as the arbor of a crane, windmill, &c.

ARBORIBONZES, wandering priests of Japan, who subsist on alms. They dwell in caverns, and cover their heads with bonnets made of the bark of trees.

ARBUTUS, the strawberry-tree, in botany, a genus of plants with a one-leaved bell-fashioned flower, and a berry or fruit resembling a large strawberry. See plate

The strawberry-tree belongs to the decandria monogynia class of Linneus. The essential character is, calyx five parted; corolla, ovate, diaphonous at the base; capsule five celled. There are ten species of this beautiful shrub, all of them tolerably hardy, but they will not bear fruit, except when they are sheltered from the cold winds. The fruit is eatable.

ARC, in geometry, any part of the circumference of a circle, or curved line, lying from one point to another, by which the quantity of the whole circle or line, or some other thing sought after, may be gathered.

ARCH *of a Circle*, the length of an arch may be found by this rule: as 180° is to the number of degrees in the arc, so is 3.1416 times the radius to the length: for when radius is 1-half, the circumference is 3.14159, &c.; therefore, $\frac{3.14159}{180}$, &c. = .01745329, &c. = the length of an arch of 1 degree. Hence $r \times .01745$, &c. = the length of 1° to the radius r; and therefore $r \times 0.1745$, &c. × the number of degrees in any arc = the length of that arch.

The length of circular archs may be found in the following manner:

The radius of a circle being 1; and of any arc a, if the tangent be t, the sine s, the co-sine c, and the versed sine v: then the arc a will be truly expressed by several series, as follow, viz. the arc

$$a = t - \tfrac{1}{3}t^3 + \tfrac{1}{5}t^5 - \tfrac{1}{7}t^7 + \tfrac{1}{9}t^9 \text{ &c.}$$

$$a = \frac{s}{c} - \tfrac{1}{3}\cdot\frac{s^3}{c^3} + \tfrac{1}{5}\cdot\frac{s^5}{c^5} - \tfrac{1}{7}\cdot\frac{s^7}{c^7} \text{ &c.}$$

$$a = s + \frac{1}{2.3}s^3 + \frac{1.3}{2.4.5}s^5 + \frac{1.3.5}{2.4.6.7}s^7 \text{ &c.}$$

$$a = \sqrt{2v} \times \left(1 + \frac{1}{2.3}\cdot\frac{v}{2} + \frac{1.3}{2.4.5}\cdot\frac{v^2}{2^2} + \frac{1.3.5}{2.4.6.7}\cdot\frac{v^3}{2^3} \text{ &c.}\right)$$

$$a = \frac{3.14159 \text{ &c.}}{180}\, d = .01745329 \text{ &c.} \times d;$$

where d denotes the number of degrees in the given arc. Also, $a = \frac{8c - c}{3}$ nearly; where c is the chord of the arc, and c the chord of half the arc; whatever the radius is.

To investigate the length of the arc of any curve. Put x = the abscis, y = the ordinate, of the arc x, of any curve whatever. Put $\dot{z} = \sqrt{\dot{x}^2 + \dot{y}^2}$; then, by means of the equation of the curve, find the value of $\dot{x}$ in terms of $\dot{y}$, or of $\dot{y}$ in terms of $\dot{x}$, and substitute that value instead of it in the above expression $\dot{z} = \sqrt{\dot{x}^2 + \dot{y}^2}$; hence, taking the fluents, they will give the length of the arc z, in terms of x or y. See FLUXIONS.

ARCH *of equilibration*, is that which is in equilibrium in all its parts, having no tendency to break in one part more than in another, and which is therefore safer and stronger than any other figure. Every particular figure of the extrados, or upper side of the wall above an arch, requires a peculiar curve for the under side of the arch itself, to form an arch of equilibration, so that the incumbent pressure on every part may be proportional to the strength or resistance there. When the arch is equally thick throughout, a case that can hardly ever happen, then the catenarian curve is the arch of equilibration; but in no other case; and therefore it is a great mistake in some authors to suppose that this curve is the best figure for arches in all cases; when in reality it is commonly the worst. This subject is fully treated in Dr. Hutton's Principles of Bridges, prob. 5, where the proper intrados is investigated for every extrados, so as to form an arch of equilibration in all cases whatever. It there appears that, when the upper side of the wall is a straight horizontal line, as in the figure (Plate IX. fig. 3.), the equation of the curve is thus expressed,

$$y = b \times \frac{\text{log. of } \frac{a + x + \sqrt{2ax + xx}}{a}}{\text{log. of } \frac{a + r + \sqrt{2ar + rr}}{a}}$$

where x = DP, y = PC, r = DQ, b = AQ, and a = DK. And hence, when a, b, r, are any given numbers, a table is formed for the corresponding values of x and y, by which the curve is constructed for any particular occasion, Thus, supposing a or DK = 6, b or AQ = 50, and r or DQ = 40; then the corresponding values of KI and IC, or horizontal and vertical lines, will be as in this table.

Table for constructing the Curve of Equilibration.

Value of KI.	Value of IC.	Valne of KI.	Value of IC.	Value of KI.	Value of IC.
0	6.000	21	10.381	36	21.774
2	6.035	22	10.858	37	22.948
4	6.144	23	11.368	38	24.190
6	6.324	24	11.911	39	25.505
8	6.580	25	12.489	40	26.894
10	6.914	26	13.106	41	28.364
12	7.330	27	13.761	42	29.919
13	7.571	28	14.457	43	31.563
14	7.834	29	15.196	44	33.299
15	8.120	30	15.980	45	35.135
16	8.430	31	16.811	46	37.075
17	8.766	32	17.693	47	39.126
18	9.168	33	18.627	48	41.293
19	9.517	34	19.617	49	43.581
20	9.934	35	20.665	50	46.000

ARCS, similar. If the arc of one curve contains the same number of degrees as the arc of another; or if the radius of one curve is to the radius of another, as the arc of one curve is to its corresponding one, then these two arcs are similar.

ARCS, equal, those which contain the same number of degrees, and whose radii are equal.

ARC, diurnal, that part of a circle described by a heavenly body, between its rising and setting; as the nocturnal arch is that described between its setting and rising; both these together are always equal.

ARC of progression or direction, an arch of the zodiac, which a planet seems to pass over, when its motion is according to the signs.

ARC of retrogradation, an arch of the zodiac, described by a planet, while it is retrograde, or moves contrary to the order of the signs.

ARCA, in conchology, a genus of *bivalves*, the animal of which is supposed to be a tethys: the valves are equal; and the hinge beset with numerous sharp teeth, inserted between each other. The species are divided into two sections; the first has an entire margin, and in the other the margin is crenulated.

ARCADE, *in architecture*, is used to denote any opening in the wall of a building forming an arch.

ARCH, in architecture, a concave building, with a mold bent in form of a curve, erected to support some structure. See ARCHITECTURE.

ARCHBUTLER, one of the great officers of the German empire, who presents the cup to the emperor, on solemn occasions. This office belongs to the king of Bohemia.

ARCHCHAMBERLAIN, an officer of the empire, much the some with the great chamberlain in England. The elector of Brandenburgh was appointed, by the golden bull, archchamberlain of the empire.

ARCHCHANCELLOR, an high officer, who, in antient times, presided over the secretaries of the court. Under the two first races of the kings of France, when their territories were divided into Germany, Italy, and Arles, there were three archchancellors; and hence the three archchancellors still subsisting in Germany, the archbishop of Mentz being archchancellor of Germany, the archbishop of Cologn of Italy, and the archbishop of Treves of Arles.

ARCHDEACON, an ecclesiastical dignitary or officer, next to a bishop, whose jurisdiction extends either over the whole diocese, or only a part of it. We have sixty archdeacons in England.

ARCHDUKE, a title given to dukes of greater authority and power than other dukes.

ARCHED legs, a fault in a horse, when his knees are bent arch-wise.

ARCHER, in the antient military art, one who fought with bows and arrows.

The English archers were esteemed the best in Europe, to whose prowess and dexterity the many victories over the French were in a great measure owing.

ARCHERY, the art of shooting with a bow and arrow. This art either as an instrument in war or an object of amusement, may be traced in the history of almost every country. Our own was in its earliest periods highly celebrated for its skill in archery; and it appears that the English monarchs took great pains to encourage the exercise of the long bow. Edward III. ordered a complaint to be lodged against the sheriff of London, for permitting other useless games to be pursued, when the leisure time of his people upon holidays ought to be spent in the recreations of archery. In the reign of Ed. IV. an act was made that every Englishman should have a bow of his own height to be made of yew, hazel, ash, &c.: and mounds of earth were ordered to be made in every township, and the inhabitants to practise archery, under certain penalties. During the reigns of Henry VII. and VIII. archery was also encouraged; in the third of Henry VIII. a statute was made commanding every father to provide a bow and two arrows for his son, when he was seven years old. By the found-

er of Harrow-school, shooting with bow and arrow was insisted upon as a fundamental part of the regulations.

ARCHES, or Court of Arches, the supreme court belonging to the archbishop of Canterbury, to which appeals lie from all the inferior courts within his province.

ARCHIL, a moss of a grey colour, which grows on the rocks in many parts of the Archipelago, and on the western coast of England. It yields a purple tincture, fugitive indeed, but very beautiful, which is the best chemical test for acids and alkalis, and is known by the name of tincture of litmus. By the addition of tin it is rendered durable as a dye, and it then approaches to scarlet. Archil is however most commonly used to give a bloom to pinks and other colours. It readily gives out its colouring matter to water or any spirit.

ARCHILOCHIAN, a term in poetry applied to a sort of verses, of which Archilochus was the inventor, consisting of seven feet, the four first whereof are ordinarily dactyls, though sometimes spondees, the three last trochees: as in Horace,

Solvitur acris hyems, gratâ vice veris & Favoni.

ARCHITECT (Αρχιτεκτων, of ἀρχὸς chief, and τεκτων an artificer or builder), a professor of the art of building. The architect's business and his glory, is the designing of a work, and his genius is displayed, as well in the general symmetry, ornaments, and magnificence of his plan, as in the useful arrangement of its internal distribution.

The necessary qualifications of a great and perfect architect, are numerous and hard of attainment. He should be profoundly skilled in the knowledge of the properties of the materials he employs, the strength and durability of them, the method of connecting them together in the nearest direction to that in which they can be employed with their full strength; and this implies geometrical skill as well as physical knowledge.

He should be skilled in perspective; and it is necessary that he should be a quick and correct, though he may not attain to be a fine, draftsman. Some of the time employed by young architects in practising this art, would be much more usefully spent in acquiring a general knowledge of natural philosophy.

He should have a full knowledge of the various practised modes of combining together the materials of his building; to guide his mathematical reasoning, on the variety of new combinations his own practice may acquire: he should not merely design his roof, and trust to the carpenter for the judicious execution; nor plan the figure of his stair, and let the mason find out the safe means of sustaining its weight, with regular and proportionate solidity.

In our climate, he should perfectly understand the best means of generating, distributing, and retaining warmth in his building, and plan his apartments with this material object in view. He should be able to direct the unscientific mere manufacturer, of grates and contrivances to contain the necessary fuel for this purpose. He should never build an imperfect chimney to infest his house with smoke in the apartments, and counteract the tendency of the fire, to carry it off into the atmosphere. In warmer regions his skill must be displayed in arranging the facilities for cooling his apartments.

He should have a perfect knowledge of the proportions of the beautiful models of antiquity, and genius to animate and direct him in the application of his acquirements.

Vitruvius, Palladio, Vignola, Inigo Jones, de Lorme, Sir Christopher Wren, the Earl of Burlington, and Sir William Chambers, were very celebrated architects.

ARCHITECTURE, the art of building, or a science which teaches how to erect buildings, either for habitation or defence. The origin of this noble science may be traced in the Indian's hut and the Greenlander's cave; they shew the rude beginning from which it has grown to its present perfection and magnificence. It is an art of the first necessity, and almost coeval with the human species. Man, from seeking shade and shelter under the trees of the forest, soon felt the necessity and saw the utility of bending them to more commodious forms than those in which he found them disposed by nature. To huts made of trees and branches leaning together at top, and forming a conical figure plaistered with mud, succeeded more convenient, square, roofed habitations. The sides of these habitations, and the inner supports for the cross beams of the roofs, being trunks of trees; from them were derived those beautiful, symmetrical columns, *the Orders* of *Architecture*.

Though the art of building was cultivated by the ancient Egyptians, Assyrians, and Persians, with great success in the production of such gigantick structures as the pyramids of Egypt which exist to this day, and the Labyrinth seen by Herodotus, with other works of extraordinary and vast magnificence; yet we owe to the Greeks, the first structures, in which elegance and symmetry were combined with comfort and convenience in the plan.

The established five orders of architecture, the Tuscan, the Doric, the Ionic, the Corinthian, and the Composite, were brought to perfection under the Greeks and Romans. Modern efforts have added little or nothing to the beauty and symmetry of these columns, and the parts dependant on them; but much has been done in the internal improvement of mansions and houses.

Roman and Grecian architecture, which teaches the proportions and arrangement of the orders invented by them, being called ancient; modern, or practical architecture, will chiefly relate to the art of distributing the apartments with more attention to domestic economy, convenience, and comfort. And if we have not surpassed the taste of the ancients, in external design and ornament, nor equalled them in the durability and vast extent of their buildings, the ruins of which astonish us this day; yet doubtless the natural and first purposes of the art are more completely answered, and the people in general are more comfortably lodged.

A practice of raising up houses of a too expensive and heavy solidity, is unfavourable to the general improvement of the art in respect of domestic economy and convenience. Accordingly the facility of procuring stone, and the want of brick earth, has produced in the capital of France, houses of enormous strength, and the buildings last too long; while the slighter ones of London are more easily susceptible of the changes necessarily introduced by improvements in the arts, and inventions for promoting domestic economy and comfort. The speculations of needy or avaricious builders, however, lead us into the opposite extreme but too often, and buildings are erected which very soon after they are finished require essential repairs to keep them up during the terms of the leases.

Besides ancient and modern architecture, a third style of building may be traced from the same source with the former. Amongst the northern nations of Europe originated the style called Gothic; which after the destruction of the Roman empire by these people, they introduced in Europe to the exclusion of the Greek and Roman manner of architecture. Like the ancient Egyptians, they sometimes seem to have been more studious to astonish the eye with great and vast masses of stone, than to please by symmetry of design, or beauty of ornament.

But there are two species of Gothic; the Saxon, heavy, plain, and robust, like the Tuscan; the other, like Corinthian or Composite architecture, light, airy, and ornamental, received its finish from the hand of the Normans, and was by them introduced into this country.

A grove of tall trees, meeting at top with interweaved branches, is the natural and beautiful model from which the aisle of the Norman Gothic cathedral is derived.

A mistaken prejudice has prevented the due study of this style of building, though the most exquisite remains of it adorn our island; in the structures of which, much mathematical and geometrical skill may be observed: and we cannot help observing with bishop Warburton, that "our Gothic ancestors had juster and manlier notions of magnificence on Grecian and Roman ideas, than those enemies of taste, who profess to study only classic elegance."

Sir William Chambers remarks, "that to those usually called Gothic architects we are indebted for the first considerable improvements in construction;"—"that there is a lightness in their works, an art and boldness of execution, to which the ancients never arrived, and which the moderns comprehend and imitate with difficulty." But to this manner of building, modern improved distribution is not easily adapted; though it seems peculiarly proper for religious edifices.

OF THE FIVE ORDERS.

The Tuscan Order.

Although there are no ancient remains of it, this order is generally placed first on account of its plainness; and Vitruvius only mentions in an indistinct manner the general proportions of it. The Trajan and Antonine columns at Rome are commonly called of the Tuscan order, though they have eight diameters for their height, and the torus and capitals do not exhibit Tuscan plainness. It is highly probable the Tuscan is only a simplification of the Doric, of which there are so many very ancient remains; but to Tuscany it evidently owes its name, from being employed there, in several large edifices.

Its proportions are, fourteen modules or seven diameters for the height of the column; three modules and a half for the whole entablature, which being divided into ten equal parts, three are for the height of the architrave, three for the frize, and four for the cornice: the capital

is in height one module. The base, including (as is peculiar to the measurement of this order) the lower cincture of the shaft, is one module; and the shaft with its upper cincture and astragal is twelve modules. For interior use the height of the column may be fourteen modules and a half, or fifteen modules, and the increase may be in the column only. It is customary to diminish this order one quarter, but the diminution of one eighth or sixth would better accord with its character of strength.

The Doric Order.

Of the Doric order, the very ancient remains exhibit proportions so dissimilar to the practice of latter times, that they must have been produced before experience had matured the rules of art. In several parts of the ruins of Athens, these columns are seen of a height not exceeding four diameters, and four and a half. Strength was more regarded than elegance of design in these low proportions. Columns of near six diameters may be found in the temples of Minerva and Theseus, at the same place; and the columns of the more ancient temple of Apollo, at Delos, have five diameters, and are fluted in the neck, and on the foot. There are columns of upwards of six diameters in height found in other buildings at Athens; and the temple of Hercules at Cora, has columns of eight diameters and three quarters, and they are on bases, which the others are not.

Vitruvius, allowing it to be the most ancient order, ascribes its origin to Dorus, who built a temple to Juno, in the ancient city of Argos. But afterwards, Ion, who built a temple to Apollo in Asia, fixed the proportions of this order; and being guided by the example of nature in the structure of man, gave six times the length of the foot, or diameter of its base, for the height.

The practice of the moderns allows eight diameters, with a base; an addition to the ancient plan of this column, no less useful than elegant. Some of the most ancient columns of this order are fluted, and some squared off, or wrought with pans instead of hollows. The cracks, or divisions, in the bark of the trees originally employed for pillars, very naturally suggested fluting when any ornament was desired.

The place and form of the triglyph, an ornament peculiar to this order, are both evidently derived from the ends of projecting joints, laid from the inner to the outer walls of buildings. When as much of the timber as appeared unhandsome was cut off, tablets like the triglyphs now in use were fastened on the sawed ends, and produced a pleasing effect. The triglyphs, interjoists, and metope, in Doric work, had their origin from the disposition of the timbers in the roof; afterwards, in other works, some made the rafters that were perpendicular over the triglyphs to project outward, and carved their projecture; hence as the triglyphs arose from the disposition of the joists, so the mutules under the corona, were derived from the projecture of the rafters; wherefore in stone or marble structures, the mutules are represented declining in imitation of the rafters; and also on account of the droppings from the eaves, it is proper they should have such declination. This also explains the situation and form of the guttæ or drops. The ornaments on the metope, or space between the triglyphs, may have been originally trophies of the deity, or implements of sacrifice placed there: the bull's skull is peculiar to the Doric order.

According to the modern proportions of this order, let the height of the column, including its capital and base, be sixteen modules, the height of the entablature four modules, which being divided into eight parts, two are for the architrave, three for the frize, and three for the cornice: the base will be one module in height, the capital thirty-two minutes, or a little more.

The Ionic Order.

To the before-mentioned Ion, is ascribed by Vitruvius, the origin of this more delicate or feminine order; of which the volutes of the capital, ornamented with festoons, are like locks of hair decorated with flowers. Succeeding architects much approving the taste and ingenuity of this design, allowed eight diameters and a half to the order. The celebrated Hermogenes, when building the temple of Bacchus at Teos, rejected the Doric after all the marbles were cut, and adopted the Ionic instead. And indeed the difficulties of adjusting the mutules, metope, and triglyphs, with propriety in Doric structures, and the massive appearance of the order, caused a frequent preference of the Ionic. Denteles belong to the Ionic cornice: they represent the assers, or smaller rafters, supporting the tiles.

On the antique Ionics, the volutes are generally placed parallel, and to Michael Angelo is attributed, as a new invention, the executing them on an angular plan, though some ancient examples of this manner may be seen. It has been attempted to prove, that the accidental pleasing forms of convolution in shells, gave the first idea of the Ionic volute.

Eighteen modules are given, as a modern proportion for the height of the column of this order; and for the entablature, four modules, or four and a half, which is less than the antique Ionics. The capital is twenty-one minutes, and the base thirty minutes in height; the shaft may be plain, or fluted with twenty or twenty-four flutings, whose plan should be a trifle more than a semicircle, and the breadth of the fillet between them should not be more than one third of the flute. The ornaments of the capital are to correspond with the flutings of the shaft, and there must be an ove above the middle of each fluting. The entablature being divided into ten equal parts, three are for the architrave, three for the frize, and four for the cornice. In interior work, where delicacy is required, the height of the entablature may be reduced to one fifth of the height of the column.

The Corinthian Order.

The Corinthian order has arisen out of the two former, and has nothing but the capital peculiar to itself; of which the origin, from the leaves of a root of acanthus springing round a basket, and curling in the manner of a volute against a tile which covered it (which answers to the abacus) is recorded by Vitruvius. This pleasing accidental combination, was copied by Callimachus; who saw it, and was struck with the elegance and novelty of the effect. The other members placed on the Corinthian pillar, are common to the Doric and Ionic orders.

The many examples existing amongst the fragments of antiquity, evince the great prevalence of the Corinthian order, amongst the ancients: but the Romans annihilated every vestige of it in Corinth, where it had its origin, in their barbarous destruction of that rival city.

The moderns have adopted these proportions: the columns are twenty modules in height; the entablature, five modules; the base one module, and may be either attic or Corinthian. The capital has seventy minutes in height; the proportion of the members in the entablature, is the same as in the Tuscan and Ionic orders. If the entablature is enriched, the shaft of the column may be fluted, and the flutings may be filled to one third part of their height with cabling; and in very rich decorations, the cabling may be composed of reeds, husks, ribbons, flowers, &c.

The capital is enriched with olive-leaves, as are almost all the antiques of this order at Rome; the acanthus being seldom employed, but in the composite. The entablature may be reduced to two ninths or one fifth of the height of the column: in which case it is best to use the Ionic entablature, or reduce the denteles of the cornice.

The Composite Order.

In a successful attempt at pleasing variety and novelty, the Romans produced the composite order, by combining the proportions and enrichments of the Corinthian, with the angular volute of the Ionic.

The omission of the upper row of leaves in the capital, and the addition of the Ionic volute, give it a bolder aspect than the Corinthian: uniting elegance and a very pleasing projection. In the triumphal arches of Rome, erected at the very height of its splendour, it was used with a happy effect, as well as in many other examples in that city.

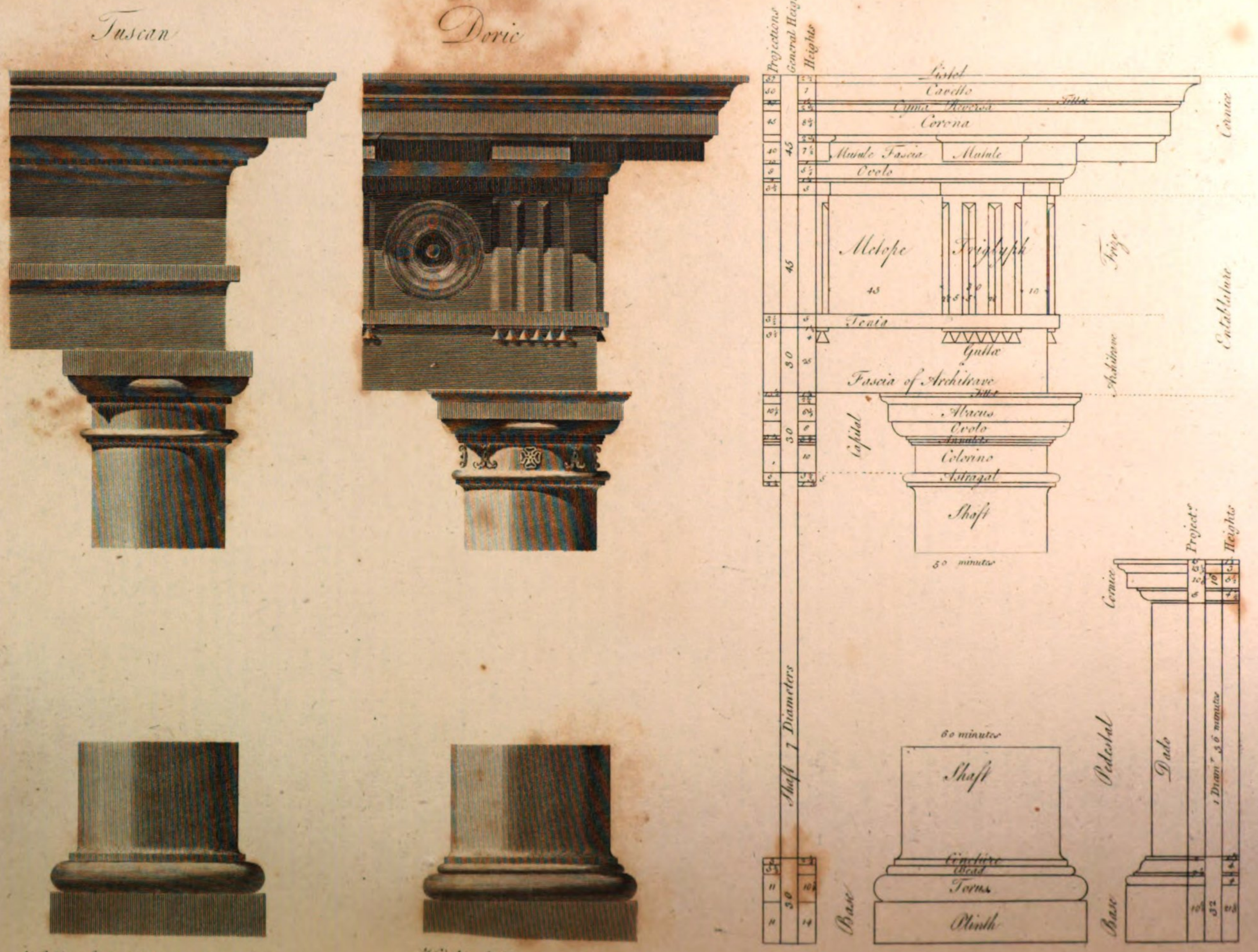
The height of the column is twenty modules, according to modern proportions; that of the entablature five modules; the capital has seventy minutes in height. The base measures the same as in the Doric and Ionic orders; and as the module is less all its parts will be more delicate. The shaft may be enriched with twenty or twenty-four flutings, and the principal members of the entablature may have the same proportions as in the two former orders.

If we class the orders of architecture according to their destination, we shall limit them to three: the first class, including the Tuscan and Doric, for supporting plain and massy buildings; one for buildings of a more elegant and light form, and one between these two. The Ionic and the Corinthian, with their varieties, will compose the last classes.

The cyma and cavetto are constantly used as finishings by the antients, and never applied where strength is required. The ovolo and talon are always employed as supporters to the essential members of the composition, such as the modillions, denteles, and corona. The chief use of the torus and of the astragal, is to strengthen the tops and bottoms of columns, and sometimes of pedestals, where they are frequently cut in the form of ropes. The scotia is employed only to separate the members of bases. The fillet is also used for this purpose in all kind of profiles, as well as in bases.

An assemblage of essential parts and mouldings is called a profile: the best are composed of few mouldings, varied in form and size, fitly applied; the straight and curved ones placed alternately. Every profile should have a predominant member, which the others should seem made to support, fortify, or shelter from the injuries of the weather: as in

ARCHITECTURE.



Height of the Column ... 7 Diameters
Height of the Entablature 1 Diameter & 3/4

Height of Column ..... 8 Diam.s
Entablature ..... 2 Diam.s

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a cornice, where the corona is principal, the cyma or cavetto cover it, and the modillions, denteles, ovolo, and talon, support it.

When ornaments are employed to adorn the mouldings, all of them must not be carved, that the eye may find a proper repose on the plain ones, or the figure of the profile will be lost. The square members being generally either principal in the composition, or used as boundaries to other parts, should rarely be carved.

When mouldings of the same size and form occur in one profile, they should be enriched with the same kind of ornament. The addition of rusticated cinctures to columns, is an ungraceful modern invention; but rustic work is introduced with great propriety and effect into gates, large entrances, grottos, baths or fountains, and for low-basement stories.

To each order belongs a particular base: the Tuscan has only a torus and a plinth: the Doric base has an astragal more than the Tuscan; the torus is larger, on a double scotia, with two astragals between them on the Ionic base. The Corinthian base has two toruses, two scotias, and two astragals; the Composite base has one astragal less than the Corinthian.

Columns are generally diminished one-sixth part of their lower diameter, which diminution begins at one-third part of their height. Some architects allow a small swell in the lower part of the middle division of the pillar.

But in columns from fifteen to twenty feet high, the lower diameter being divided into six parts and a half, take five parts and a half for the diameter at the top. Columns from twenty to thirty feet high are diminished one-seventh. From thirty to forty feet, the lower diameter being divided into seven parts and a half, six and a half may be taken for the upper diameter: and from forty to fifty feet high, they may be diminished one-eighth part, and so on in proportion.

Pedestals consist of three principal parts, the base, the dye, and the cornice, and are used only to elevate the columns to a necessary height. No particular proportions can be assigned for them; but it is common to give them from one-third to one-quarter of the height of the column and entablature, which being divided into nine parts, two are for the base, one for the cornice, and six for the dye of the pedestal, which is of equal dimensions with the plinth of the column. The enrichments are of course regulated by those of the entablature of the particular order which the pedestal may carry. One pedestal only is necessary for two columns placed together, and a continued pedestal with projections in the cornice, under each column, must be used for a colonnade or peristyle; but if other circumstances permit, columns the whole necessary height, without pedestals, should be used, and will always have a more majestic appearance.

Pilasters follow in their parts the orders of columns, and admit of a like diminution, but are square instead of round in their plan. They are however to be seen, not diminished, in antient and modern works, and chiefly so, when they occur on outer corners.

Pilasters are employed in internal decorations to save room, and seldom project beyond the solid wall, above one quarter of their diameter; and sometimes they are seen on the external part of buildings, alone and with columns. When placed behind, and very near columns, they need not project above one-eighth part of their diameter. Pilasters are adorned like columns, and the profile of their capitals is nearly the same.

Attics.—In Athens, where it was for many ages a rule to conceal the roofs of buildings, attics had their origin. A line of low columns and pedestals, or of columns and balusters, may be employed for this purpose. They should be less in height than one-third of the order on which they are placed, but not lower than one-quarter. If the attic is composed of a low order, the base and cornice may have the same mouldings as the pedestals of the columns, and with the dye, bear the same proportion to each other; and when they form pilasters over the columns of the building, the breadth of the bases must not exceed the upper diameter of the columns which they surmount.

Caryatides.—Representations of the human figure, the male called Persians, and the female Carians, or Caryatides, have been employed to support the entablatures of buildings. These were invented and used in memory of the captivity of the Persians and Carians by the Athenians. The Persians may be of any size, with a Doric entablature, bearing the same proportion to the figure as to columns of the same height; but the Caryatides or female figures, ought to have Ionic or Corinthian entablatures, and not to be larger than life.

Termini, figures which owe their origin to the stones used by the antients to distinguish the limits of their possessions, are employed to support the entablatures of monuments, chimney-pieces, and such small compositions, and as ornaments in gardens or fields.

Of the temples of the antients.

Of the many remaining sacred buildings of the antients, seven orders may be distinguished.

Antis.—The first order has antæ or pilasters in front, at the corners of the walls which form the cell (or inclosed space within the walls), and between the pilasters in the middle, two columns which support the pediment or porch.

The prostyle is the same as the antis, only columns are added opposite the pilasters of each corner, which support a chapiter or architrave, as in the antis.

The amphiprostyle has only a postern, or back-front added, with columns and pediment, like the prostyle.

The peripteral has in the front and hinder porch six columns, and eleven, including the corner ones on each side; and these columns are placed with the space of an intercolumniation between them and the wall of the building, leaving an ambulatory round the cell of the edifice.

In the pseudo-dipteral the columns are so placed, that in front and behind there are eight, and on each side fifteen with the corner columns; and the walls of the cell must correspond with the four centre columns before and behind, leaving the space of two intercolumniations, and the thickness of one column between the walls and the outer column.

The dipteral is octostyle, or eight-columned before and behind, but it has a double row of columns round the cell.

The hypæthral is decastyle, or ten-columned before and behind, having the other parts the same as the dipteral; but it has a double row of columns within, all round, one above another, resembling a porch, which is called a peristyle: the middle has no roof, and it has folding-doors before and behind.

Of round temples.—Some are monopteral, without cells, and built on columns; others are called peripteral, and have an ascent of two steps, on which the pedestals of the columns are placed. The wall of the cell is distant one-fifth part of the diameter of the temple from the pedestals of the columns. The monopteral have a tribunal or throne, and are ascended by steps; and the columns placed on pedestals are as high as the diameter of the temple, taken at the outside of the pedestals.

On the proper disposition of columns, depend the elegance and grandeur of a building, for which Vitruvius lays down the rules observed by the antients, and admitted by the moderns.

The five species of buildings, according to the disposition of the columns, are the pycnostyle, thick of columns; the systyle, with columns wider apart; the diastyle, still wider; the araeostyle, more distant than is proper; and the eustyle, with columns at a proper distance.

In the pycnostyle, the distance of the intercolumniation is one diameter and a half of the column. The systyle has two diameters. The diastyle has three diameters of the column for the intercolumniation, but the architrave, on account of the distance, is liable to break. In the araeostyle the beams are made of durable timber. The eustyle is formed by allowing the distance of two diameters and a quarter for the intercolumniations, except the middle one, which must have three diameters.

For the eystyle, the rule is, that the front of a building, if it is tetrastyle (of four columns), is divided into eleven parts and a half, without reckoning the projection of the base of the column. If hexastyle (of six columns), into eighteen parts. If octostyle (of eight columns), into twenty-four parts and a half. Of these parts each shall be equal to the diameter of a column. Each intercolumniation must be two and a quarter of these parts; but three must be allowed for the middle one; and for the height, eight diameters and a half. The columns to the araeostyle should have for their thickness one-eighth part of their height. For the diastyle, the height of the column is to be divided into eight parts and a half, and one part taken for the thickness of the column. For the systostyle, the height must be divided into nine parts and a half; one part being the thickness of the column. In the pycnostyle, the height shall be divided into ten parts, each equal to the diameter of the column. The eustyle is also divided into eight parts and a half, like the diastyle. As the space between the columns increases, so ought the thickness of the columns. If it is araeostyle, and they should have only a ninth or tenth part for their thickness, they will appear tall and slender, on account of the breadth of the intervals. If it is pycnostyle, and the columns have an eighth part for their thickness, they will, on the contrary, have a heavy and ungraceful appearance. The

thickness of corner columns must be increased one-fiftieth part, for the great surrounding space will diminish their effect on the eye, and make them appear smaller than they really are.

It must not, however, be omitted that the antients did not always rigidly adhere to these rules of Vitruvius for the disposition of columns, which therefore should not fetter the genius, nor hinder the researches, of moderns.

Of the private buildings of the antients, Vitruvius says, (describing the houses of persons of distinction), the Greeks used no atrium or hall, but from the gate of entrance made a passage of no great breadth, on one side of which was the stable, and on the other the porter's rooms; and these were terminated by the inner gate. Passing on, was the peristylium, having porticos on three sides. On the south side were two antæ, which support and form a passage, within which, to the right and left, were the great œci, in which the mistress of the family and the work-women resided. To the right and left were cubiculi or chambers, of which one was called thalamus, the other amphithalamus; and under the porticos of the peristyle, were the common dining-rooms, chambers, or family rooms. This part of the edifice was called gnyæconitis.

Through the passage, with the antæ, was a larger house, with a more spacious peristyle, in which were four porticos of equal height: or sometimes the one which looked towards the south had higher columns, and this peristyle which had one portico higher than the rest was called Rhodian. These houses had elegant vestibules, magnificent gates, and the porticos of the peristyle were ornamented with stucco, plaister, and lacunariæ (compartments). In the portico which looks to the north, were the Cyzican triclinium, and the pinacœtheca; to the east the libraries; to the west the exhedræ; and in those looking to the south, were the square æci for dining, and a spacious place for the use of the games. This peristylium and part of the house were called andronitides, because here the men only were invited, without being accompanied by the women.

On the right and left, small houses were erected for the reception and entertainment of strangers on their arrival.

The usual mode of distribution of the houses of magistrates among the Romans was; from the vestibulum, which we call portico, you entered the atrium or hall, at the extremity of which was the tablinum, or repository for books or records. From the sides of the atrium, you passed by alæ or aisles, to the cavædium, which was an open court, surrounded by a portico or piazza, at the extremity of which was the basilica or place to administer justice in. The triclinia or dining-rooms, with their procœton, or room for attendants, the cubicula or chambers, with the baths, were disposed on the side of the cavædium; also on the sides of the basilica were the pinacætheca, or rooms for pictures and library. Passing all these apartments, you entered the peristylium, which was as spacious as possible, surrounded with a portico or piazza; this was always of an oblong form. At the extremity of the peristylium were the œci or halls, of which Vitruvius mentions the Corinthian, the tetrastyle, the Egyptian, and the Greek or Cyzican.

The Corinthian œci had columns placed either on the podium (dado) or on the floor, and above have an architrave and cornice; the Egyptian had the columns detached from the wall, in the manner of a peristyle: the space between the columns and the wall formed a walk round. This range of columns supported an entablature, on which was placed another range of columns, one-fourth part smaller than the former, between which were the windows.

The Greek or Cyzican œci were situated towards the north, and generally had a view of the garden, with folding doors to the middle, and to the right and left. The tetrastyle œci, from the name, appear to have had only four columns, and were consequently of a less-enriched form.

Roman villas consisted of three parts: urbana, where the master and his family dwelt; rustica, for the uses of husbandry; and fructuaria, or receptacle for the fruits of the earth. Having only the lapis specularis, a species of talc, and an expensive substitute for glass, the Romans were obliged to be very particular in the choice of situation and aspect for their buildings, that rooms unfurnished with this kind of expensive windows might be inhabitable in bad weather.

Vitruvius says the winter dining-room and bath should face the winter's declining sun, that they may have the benefit of his rays in the evening; but the bed-chambers and libraries should look to the east, for there the morning light is required, and south and west rooms are more exposed to damps and worms, which humid winds generate and nourish. The spring and autumn dining-room should look to the east, for the windows being turned from the sun, these places will be temperate at the time they are used. The summer dining-room should look to the north, that it may remain cool and temperate for use. To the same aspect, the pinacotheca (picture rooms) should be disposed, to preserve the colours from the too strong effect of the sun's light.

Some adequate idea of the extent, grandeur, and accommodation, of the villas of the Romans, may be formed from Pliny's description of his at Laurentinum, which was considered as on a small scale, but would be called a mansion in modern language. He says "The part which first presents itself is the atrium, (court-yard) plain but not mean; then the portico, in form of the letter O, which surrounds a small but pleasant area: this is an excellent retreat in bad weather, being sheltered by glazed windows, but more by the projection of the roof. Beyond the portico is a pleasant cavædium (open court), passing which is a handsome triclinium, which advances upon the shore, so that it is gently washed by the waves when the south-west wind blows. On every side there are folding doors, or windows as large, so that from the sides and front you enjoy a prospect as it were of three seas, and backwards are seen the cavædium, the portico, and the area; again the portico and atrium, terminated by woods and distant mountains. On the left of the triclinium, but not so forward, is a large cubiculum (or chamber), and then a smaller one, where one window admits the rising, and another the setting sun. From here you view the sea, more distant, but more securely. This cubiculum and triclinium, by their projecture, form an angle, which not only retains, but augments, the heat of the sun's rays.

"Here is my hybernaculum (winter apartment) and the gymnasium (place for exercise) for my family, which is never incommoded by any winds but such as bring cloudy weather, and destroy the otherwise serene situation of the place. Adjoining to this angle is a cubiculum, of a curved or round form, the windows of which admit the sun, in consequence, during its whole course. In the walls are inserted library-presses, furnished with books, more for amusement than study; close to this is the dormitorium (sleeping-room), separated by a space having a covering of wood work, which collects and distributes the vapours to the room in salubrious temperament. The remainder of this wing is allotted to servants and slaves.

"On the right side of the triclinium is a most elegant cubiculum, with another large cubiculum, or moderate cænation (common eating or supper room), which receives light both from the sun and the sea; after this is a cubiculum, with a procaton (servants' room), for height a summer, but for shelter, a winter apartment, being screened from all winds: a wall only separates another cubiculum, with a procœton; there you enter the spacious and extensive cella frigidaria of the bath, against the walls of which are two projecting baptisteria, sufficiently large to swim in; joining this is the unctuarium, the hypocaustum, and propnigeon of the baths, and two other cells more elegant than sumptuous. Skilfully contrived adjoins the callida piscina (warm bath), where those who swim enjoy a view of the sea; not far distant is the sphræisterium (tennis-court, of a circular form), which enjoys the warmest rays of the declining sun.

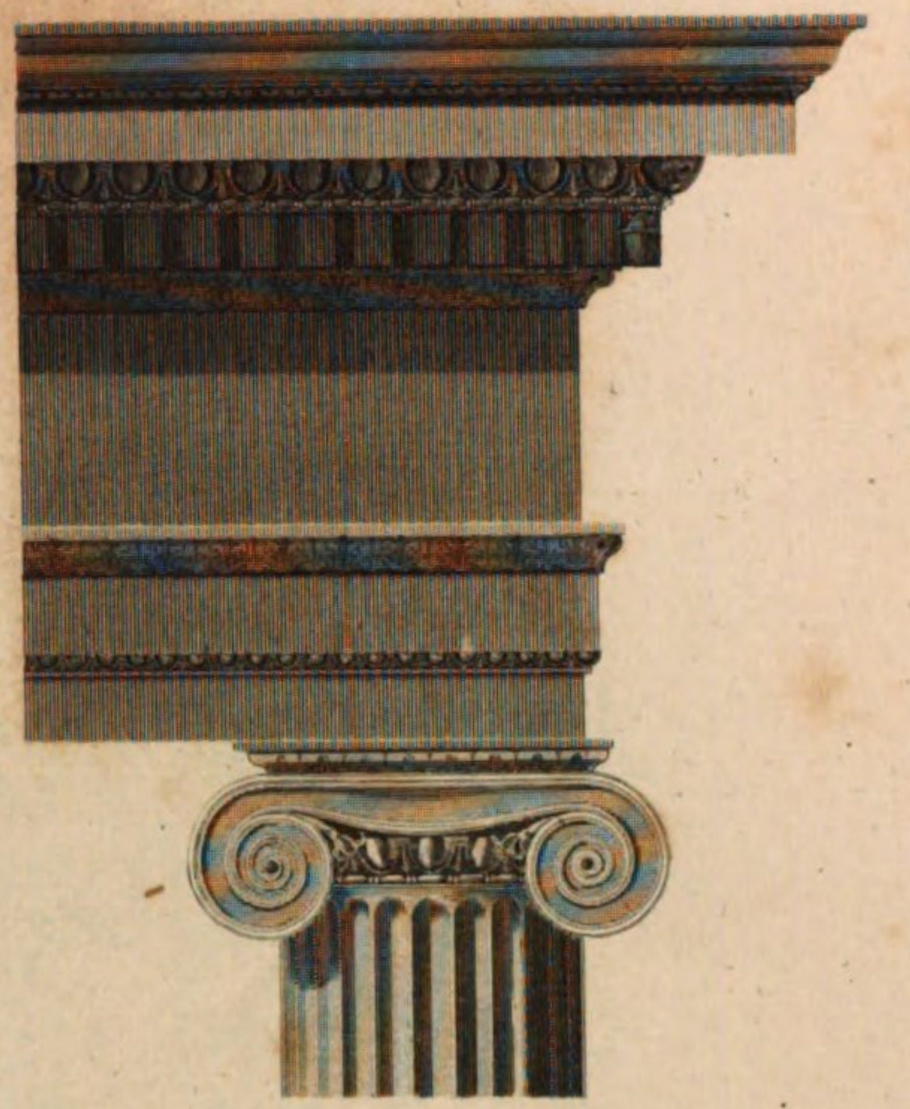
"Here rises a turris (pavilion or summer-house), under which are two diætæ (suite or set of apartments), and also two above, besides a cœnatio, from which is a beautiful prospect of the sea; there is also another turris, containing a cubiculum, exposed to the rising and setting sun; behind this is an apotheca, and horreum (cabinets or store-rooms), and under, a triclinium, where the noise of the sea is only faintly heard in storms. This looks on the gestatio (or place of exercise on horseback or in a carriage), and the surrounding garden. The prospect here, not less pleasant than that of the sea, is enjoyed from a cœnatio, rather distant from the sea; on the back it is encompassed with two diætæ, whose windows look to the vestibule of the villa, and to a kitchen-garden.

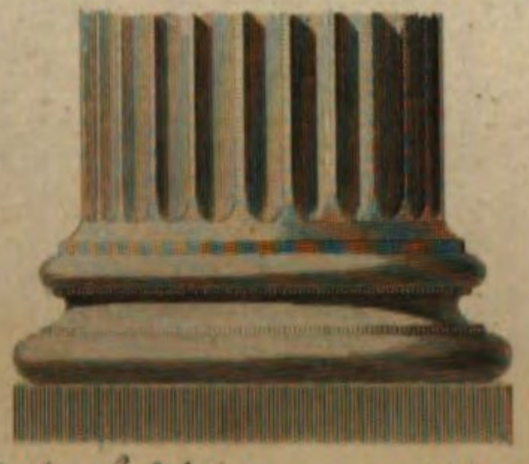
"Hence a crypto-porticus (a long inclosed room or portico) extends, for size comparable to a public building, with windows on both sides, those next the sea the most numerous; on the garden side they are single, with fewer in the upper row. Before the crypto-porticus is a xystus (a spacious place for exercise), or a terrace.

"At the top of the xystus, projecting from the crypto-porticus, is the diæta of the garden. In this is an heliocaminus (an apartment made warm by the sun); from the folding doors is seen the cubiculum, from the windows the crypto-porticus; on the side next the sea, and opposite the wall, a very

ARCHITECTURE

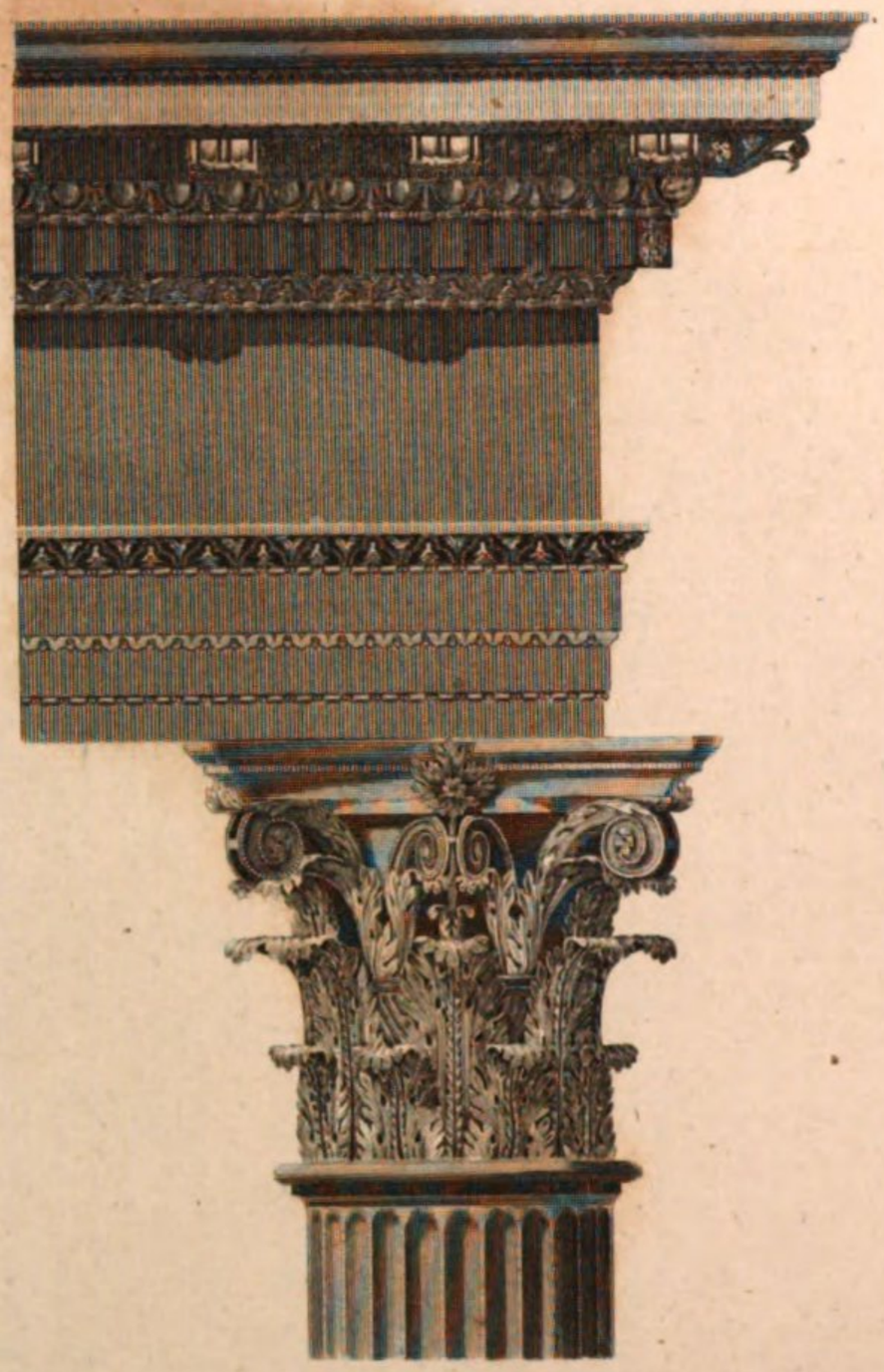
Ionic

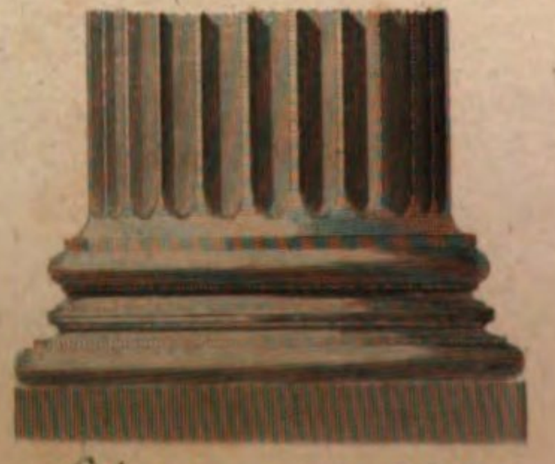




Height of Column ..... 9 Diam.r
Entablature ..... 2 Ditto.

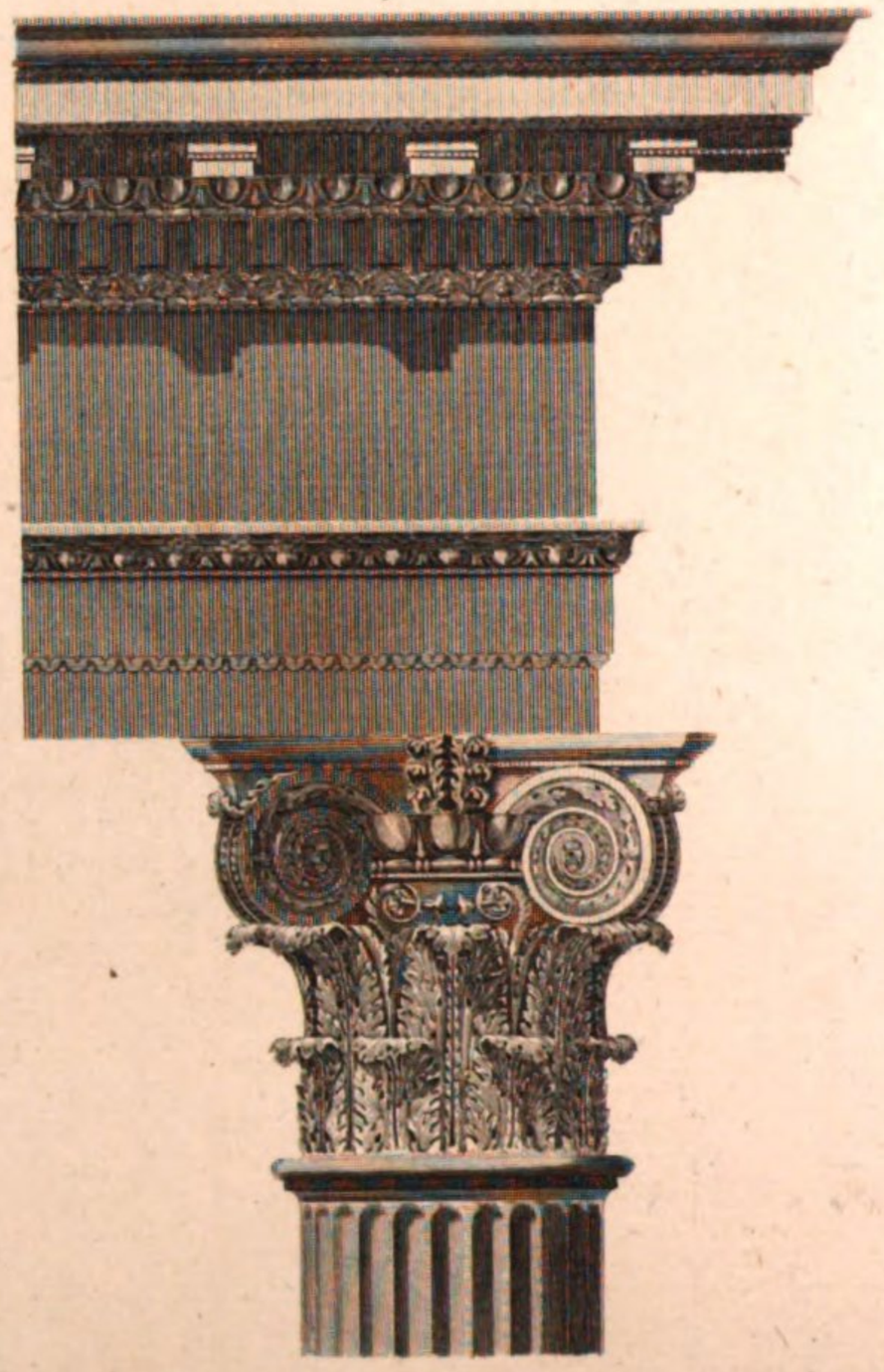
Corinthian

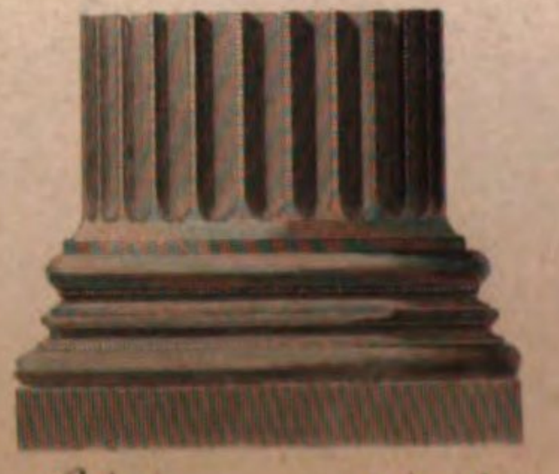




Column ..... 10 Diam.r
Entablature ..... 2 Ditto.

Composite





Column ..... 10 Diam.r
Entablature ..... 2 Ditto.

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elegant zothera (closet or small room) recedes, to which a cubiculum is either added or separated, by means of glazed windows and curtains. Adjoining is a cubiculum for night and sleep, protected from noise by an andron, an open court or space, which is between the wall of the cubiculum, and that of the garden.

"Close to the cubiculum is a small hypocaustum (stove), the heat from which, by a small window, may be regulated at pleasure. Thence a procœton and cubiculum extend into the sun." These latter apartments were the retiring places of the philosophic owner of the villa, where he pursued his studies without interrupting the diversions of his servants, or being disturbed by them. There are no remains of this villa nor of others, the descriptions of which have come down to us.

REFERENCES TO THE PLATES.

Plate I. Architecture,—represents the Tuscan and Doric orders, the latter with the triglyphs and guttæ on the frize and architrave, and an outline expressing the names of the parts of the orders.

Plate II. represents the antient Ionic order, with parallel volutes. The disposition of the volutes of the modern Ionic is seen in those of the composite order.

The Corinthian order.

The composite order.

The proportions of these columns are treated of, under the proper heads, in the preceding pages.

Of the architecture commonly called Gothic.

It is not necessary to seek abroad for the origin of the pointed arch, the gradations of which we can distinctly trace at home in the twelfth century, that age of improvement and magnificence, and among a people great in arts and arms. About that time many illustrious Norman prelates, chiefly in our own country, exhausted their talents and their wealth in carrying the magnificence of their churches, and other buildings, to the highest degree. But above all, our Henry of Winchester probably contributed most to the improvements which gradually changed the early Norman into the architecture commonly distinguished by the name of Gothic.

The Normans admired height no less than length in the construction of their churches, and were accustomed to pile arches and pillars on each other. By way of ornament and variety they often imitated these arches and pillars on their walls, and they sometimes caused these plain round arches to intersect each other, as on the upper part of the south transept of Winchester cathedral, which is probably the most antient instance of this intersecting ornament to be met with in this kingdom. They were probably not then aware of the happy effect of this intersection in forming the pointed or lancet arch, until de Blois, having resolved to ornament the whole sanctuary of this cathedral with these intersecting semicircles, after richly embellishing them with mouldings and pellet ornaments, conceived the idea of opening them as windows, to the number of four above the altar, and of eight on each side of the choir, which at once produced a series of highly-pointed arches. Pleased with this first essay at the east end, we may suppose he tried the effect of that form in various other windows and arches, which we find amongst many that are circular in various parts of the church or tower. However that may be, and wherever the pointed arch was first produced, its gradual ascent naturally led to a long and narrow form of window and arch, instead of the broad circular ones which had hitherto obtained. It was necessary that the pillars belonging to them should be proportionally tall and slender. Hence the adoption of Purbeck marble for this purpose, and the multiplication of these slender columns, which was found necessary for supporting the incumbent weight, produced the cluster column. The windows being made very narrow at the first adoption of the pointed arch, it became necessary sometimes to place two of them close to each other. This disposition of the two lights occasioning a dead space between their heads, a trefoil, or quatrefoil, one of the simplest and most antient kinds of ornaments, was introduced between them, as in the west door of the present church of St. Cross, near Winchester. The happy effect of this simple ornament caused the upper part of it to be introduced into the heads of the arches themselves, so that there is hardly a small arch, or resemblance of an arch of any kind, from the days of Edward the Second, down to those of Henry the Eighth, which is not ornamented in this manner. The trefoil by an easy addition became a cinquefoil, and being made use of in circles and squares, produced fans and Catherine-wheels. In like manner, large east and west windows beginning to obtain, about the reign of Edward the First, it was necessary they should have numerous divisions, or mullions, which, as well as the ribs and transoms of the vaulting, began to ramify into a great variety of tracery, according to the architect's taste; all of them uniformly ornamented with the trefoil or cinquefoil head. That most magnificent object, a grove of tall trees, was very naturally and beautifully imitated in the aisles of the cathedrals of this light architecture: the ribs of the vaulting, springing from the tops of the tall pillars, and meeting in the pointed arch in the roof, produced a happy effect; and pursuing this idea, the lightness of all the parts, and the rich variety of tracery, contributed to make the resemblance more perfect. The painted windows, the gloom and perspective of these edifices, concur in affecting the imagination with pleasure and delight, in filling it with awe and devotion. The aspiring form of the pointed arches, the lofty pediments, and the tapering pinnacles, which adorn our cathedrals, contribute to produce an effect of height beyond their real elevation. In like manner the perspective of uniform columns, ribs, and arches, repeated at equal distances, as they are seen in the aisles of these fabrics, produces an artificial infinite in the mind of the spectator, when the same extent of plain surface would perhaps hardly affect it.

For a similar reason, the effect of antient cathedrals is greatly helped by the variety of their constituent parts and ornaments, though all finished in one uniform style: for the eye is quickly satiated by any object, however great and magnificent, which it can take in at once, as the mind is with what it can completely comprehend; but when the former, having wandered through the intricate and interminable length of a pointed vault in an antient cathedral, discovers two parallel lines of equal length and richness; thence proceeding discovers the transepts, the side chapels, the choir, the sanctuary, and the Lady chapel, all equally interesting for their design and execution: the eye is certainly much more entertained, the mind more dilated and gratified, than it could possibly be by any single view.

Durham cathedral, supported by massive columns and circular arches, is the grandest specimen of the Saxon or early Norman manner, before the invention of the pointed arch introduced that exquisite lightness to be seen in the west end of the cathedral church of Westminster. The sumptuous vaulting of the chapel of Henry the Seventh at the east end of the latter cathedral, enriched with clusters of pendant ornaments, like the natural roof of a beautiful grotto, exceeds any other specimen of the kind.

The pointed arch, which may be described from two centres, taken at two angles of an equilateral triangle, was well adapted for the raising up of spires to a great height, and generally for lofty buildings, as it required little centring, lighter key-stones, and less buttament. Indeed, in many instances, no stones larger than a man could carry were used; and the same elevation was attained with much less labour and expence than it could have been in the Grecian and Roman manner.

Of domes or cupolas.

The towers which the early architects of Christian churches were in the habit of raising over the intersection of the cross aisles of cathedrals, no doubt, suggested the sublime idea of raising a vault or dome in the same place, on churches built after the Grecian or Roman manner, in order to preserve an uniform character or style in the building. This is an effort of architectural skill which we have no reason to believe the antients ever attempted; for all the domes raised by them were directly sustained by numerous arches and pillars, or placed on circular walls. Of domes raised in the modern manner, those of St. Peter's at Rome, and St. Paul's London, are the most celebrated.

Of modern or practical architecture.

In considering architecture or building in its most practical and useful point of view, the situation of the edifice presents itself first to our attention. A neighbourhood where cattle thrive, and where the inhabitants look ruddy and cheerful, should be chosen. For the precise spot, that which is moderately elevated, if it be contiguous to some river, will be best adapted for health, pleasure, and convenience. It is injudicious to build a country-house too near a fen or standing water, or close to a great stream, because unwholesome fogs and mists rise from large rivers, early in a morning, before day-light. It is most important to choose a good air and soil; and always useful to look towards the south. The conveniences of water, fuel, and ways to arrive at the mansion, of easy access, are indispensable. A prospect not too extensive, of land and water diversified, will most agreeably entertain the sight. A fair entrance, with an easy ascent, gives grace to a building; and the hall should

not be too large, that the effect of the capacity of the principal apartments may not be injured by it.

Having fixed on a situation, with the assistance of some one who is acquainted with the theory and practice of building, let a plan be made, with the necessary elevations. For small buildings this may be a sufficient guide; but it is advisable for large buildings to have a perfect model of the intended structure, with all its minute parts; and that this model be plain, without colours, or other beautifying, that the pleasure of the eye may not prejudice the judgment.

In the choice of the materials we must employ, we are necessarily influenced by the circumstances of the situation. Where stone is plenty, it will be preferred in the construction of a stately edifice; for though bricks retain their beauty longest, they do not easily admit of proper architectural ornaments.

The circular form of building is strongest, but does not admit of a convenient distribution of light; and is besides more expensive and less commodious. Though there exists at Caparole a celebrated building by Vignola, in the form of a pentagon, the same objections apply to it, and the architect had great difficulties to contend with.

A rectangular, but not exactly square figure, is useful in many cases: when the length does not exceed the breadth more than one-third, the proportion is good.

Mixed figures, including uniformity and variety, are most applicable for the plans of large edifices: a centre and principal part with wings, is a form that combines convenience with elegance.

When houses are planned too long, much room is consumed in passages; and it is difficult to light them. Sir William Chambers, in the plan of Somerset-house, has succeeded very well in lighting and disposing of the passages that were necessary for the easy communication of so many offices; but his methods will seldom be applicable, except to public buildings of the same nature.

Palladio says, the ground for the foundation should be penetrated to a sixth part of the whole height of the building, in order to ascertain its firmness; which done, the first course of stone or brick should be laid, at least twice the breadth or thickness of the wall, and on a horizontal line and level surface. If the building has internal walls, their foundations must be level with the principal wall. The nature and solidity of the soil will be best ascertained by the use of a well-digger's borer.

If the ground is sandy, or marshy, or has been lately dug up, it will be necessary to take many precautions. The loose earth either must be dug away, till you come to sound ground; or if that is not to be had, put pieces of good oak across the breadth of the trench in which the wall is to stand, at about two feet apart, which being firmly bedded and rammed down, lay long planks on them, about four inches wider than the basis or first course of the wall is to be, and spike them down to the pieces of oak.

If the earth is very bad, it will be necessary to drive piles of such a length as will reach the good ground; but if it is faulty only here and there, arches may be turned over the loose places.

Sound ground, fit to carry a building, is of divers kinds; in some places very hard, in others very stiff: sometimes it is to be found blackish, and the whiter kinds are accounted the weakest. Some foundations are like chalk, others sandy: but of all these, that is the best which requires most labour in cutting or digging, and which when wet, does not quite lose all consistency.

In masonry, the stones must be so cut, as to lie in the same direction as they did in the quarry, in order that their strength and solidity may be fully employed; for if their position be changed, and they are placed vertically, they are apt to split; and the smallest crevice in the foundation will produce a great cleft in the superstructure of a building.

It is very useful always to lay a platform of good board in the trench dug for the foundation; and quite necessary that the first course of stone or brick should be laid closely without mortar, for mortar corrodes the timber.

The walls should be of bound masonry or brickwork, standing perpendicularly, with the heaviest materials lowest; and they must be judiciously diminished in thickness as they rise. Certain courses of more strength than the rest must be laid to help to sustain the fabrick, should a faulty part give way: this is done by bond timbers in brick walls. Particular attention is necessary to make the angles firm, which is sometimes done in brick edifices with great neatness and effect, by building the corners of squared stones.

Walls, if not connected with others at right angles, or nearly so, as the partition or separating walls of a house stand in respect to the front, should have an angle set out of about two feet, at every twenty foot distance, which will make them stand firmer than if twice the materials had been used.

In building walls, the bricks should be laid, in summer as wet, in winter as dry, as possible; that in warm weather the mortar may not harden too fast, and in winter, care must be taken to protect them from rain, snow, and frost. They should be laid point and joint in the wall as little as may be, that the whole may be well bonded together.

It is not adviseable to raise any wall above eight feet high before the one adjoining be wrought up to it; but the front and party-walls should be carried up as nearly as possible together.

When all the materials are ready, a good workman with his labourer will in one day lay 1000 or 1200 bricks. Walls are less solid when the joints of mortar are too large.

Of the apertures in the walls, doors should be mentioned first. External doors should be as few in number as possible, and seldom less than four feet and a half in breadth, in middling-sized buildings, for the principal entrance. Double doors, having a sufficient space between them to allow them to open, are essentially useful in preserving the temperature of a house and preventing the admission of cold winds.

The modern mode of uniting when necessary two or more principal rooms of a good house into one, on the occasion of entertainments, by throwing back the folding doors which separate them, is a very great improvement. For by this means a small house may have some part of the convenience and magnificence of the largest ones, with less expence of space and materials.

The hall or entrance, the dimensions of which are determined by the scale of the building, should always be furnished with a fire-place; and if it is connected with the stair-case, the warmth produced there will tend very strongly and effectually to regulate the temperature of the whole house.

Of the stairs in sumptuous buildings, the steps should not be less than four, nor more than six inches high; not more than eighteen nor less than twelve inches broad; not less than six feet, nor more than fifteen feet long. In ordinary houses they may be somewhat higher and narrower, and they must be much shorter in general. But eight, or even seven inches, is too high for an easy ascent; and they ought never to be less than nine or ten inches broad, nor shorter than three feet. The steps should be laid somewhat sloping, or a little higher behind, which is found to diminish in some degree the apparent labour of ascending.

The construction and placing of the stairs is one of the most difficult works in building. Sufficient ease of ascent being obtained, the admission of an ample portion of light is a next consideration. This is obtained most advantageously in houses of a moderate size by windows at each turning, which give an uniform light, and a more airy and spacious appearance to the whole. Well-stairs, lighted by a skylight in the roof, are only magnificent and convenient in large mansions, and for the ascent to the first or principal floor, where the light is not broken by a repetition of the flight of steps to the next story.

The small uniform modern ramp or hand-rail is a very great improvement and addition to stairs, as well as the light iron-work by which the rail is supported; this in many cases may be advantageously constructed of cast iron.

Ingenious architects have displayed their invention and their skill in the construction of stairs more curious than useful. Double and quadruple winding stairs have been built, rising in parallel spirals; so that two or four persons or companies may go up and down within the same stair-case, and see one another without meeting.

It is an old fault in the distribution of lodging rooms, to dispose them so that, when the doors are all open, one may see through the whole house. The modern mode of placing a bed-chamber and dressing-room together with a door of communication between them, each room having besides only a door into the stair-case or passage, is much more convenient and rational. The drawing-rooms however should be disposed so uniformly, as to be converted into one room, on the opening of folding-doors between them. This contrivance, so useful in small buildings, is admissible in the largest. If two or more rooms thus laid into one, have in the middle of the wall at each end door-cases filled with looking-glasses, placed in a true position opposite each other: the appearance of the apartment will be artificially multiplied, and the effect when illuminated very splendid.

This arrangement is not necessary for the dining-rooms, where we have chiefly to attend to the convenience of easy access for servants who wait at table; and the fire-place may be so disposed, as to warm the room as uniformly as possible.

In the building of chambers regard ought

to be had, as well to the place of the bed, which is generally six or seven feet square, and the passage, as to the situation of the chimney; which for this consideration, ought not to be placed just in the middle, but distant from it about two feet, or two and a half, to the end that it may leave room for the bed; and the inequality is hardly discernible in buildings of four-and-twenty feet within the work; in such houses it may be placed just in the middle.

All precautions should be taken to prevent as much as possible the communication of sound to the bed-rooms. To this end, the best method is to fill the space between the joints of the floor above the bed-room (if there should be any rooms there) with sawdust; which must be sustained by short pieces of board nailed between the joists, just above the cieling of the lower apartment.

In arranging servants' rooms, we have only to consult the facilities our general plan admits of; and, if possible, to make no chambers without fire-places.

In country mansions, we are generally not confined in placing the kitchen, and have only to contrive it as near the dining apartment as other circumstances will admit; and to arrange so that the effluvia produced by the cooking may not be inclined to penetrate to the dining-room, by the covered passage, which should always form the communication between these two apartments.

But in town houses, the kitchen must always be beneath the parlour floor; and being nearer the dining-room than we would place it in a country mansion, and on a lower level; the lighter, warmed air, charged with the smell of the various operations of cookery, is more apt to annoy us.

A separate funnel, like the kitchen chimney, carried up in the stack with the rest, and next to that of the kitchen, will almost always afford an effectual remedy against this inconvenience. This funnel, to be used only for this purpose, must have its throat or opening level with the cieling of the kitchen; and, of course, higher than the mantle of the fire-place used for the cooking. The lighter air charged with the vapours of the cooking will then pass off into the atmosphere by this opening, instead of collecting under the cieling in the kitchen, and forming a stratum of air, as low as the top of the kitchen-door, and then passing off, and ascending through the house by the stairs and passages. The opening of this funnel or pipe may be closed by a hinged door, when no operation is going on in the kitchen, which can create a disagreeable smell.

The modern improvement of traps, made of cast iron and other materials, or pipes bent down, so as to form an elbow, which always contains, and is filled in its whole diameter by, the last portion of fluid thrown down, effectually prevents the ascent of air charged with the noisome effluvia of drains, and courses for waste water. This neater invention renders superfluous the advice of the Italian builders, who prescribe upright vents or channels rising through the house like chimneys for carrying off these smells. Upon this principle is the invention of water-closets, which are now brought to such perfection, that they may be placed without inconvenience in any necessary part of a house, and are subject to no accidents except the bursting of the water-pipes and bason belonging to them in frosty weather. But this danger may be, in some degree, removed, provided the whole building is planned with due attention to the economical distribution of heat, and the pipes are so disposed as to receive the benefit of the warmth; which may easily be done.

The offices connected with the kitchen should generally be placed towards the north; in town houses we cannot always do this, but are governed by the circumstances of the situation. The larder should however be carefully placed out of the influence of the heat of the kitchen stoves.

In the plan and construction of fire-places, more attention should be paid to their best form for reflecting into the apartments the heat generated in them, and carrying off into the atmosphere the smoke which arises from the combustion of the fuel, than to any proportions prescribed by architects who had nothing in view but the symmetry of the apartment according to their ideas. Indeed a neater form may be obtained in following strictly the rules founded on the rational theory, and accurate experiments of the count Rumford; and the invention of a good architect will hardly stumble, at making that low compact dimension agree with the other members of the most magnificent apartment.

The due inclination of the inner sides of the jaumbs of the chimney, forming a very obtuse angle with the back, is most important, as well as the colour and material of which those jaumbs are composed, for the purpose of obtaining as much reflected heat as possible from the combustion of a certain quantity of fuel. The breadth of chimney fire-places is not important, but they should not be narrow, that the sides may stand with their greatest power of reflection towards the room. But the height should seldom exceed two feet six inches to the under part of the mantle; the whole depth of the chimney should not be more than twelve or fourteen inches; and the throat, or opening where the funnel begins, not more than four inches wide, with a part of the back moveable to allow of sweeping. The size of the flue or funnel should not be less than twelve inches in diameter; and circular is the best form, but most expensive in building. The flues should never contract or taper as they rise, but rather increase in internal capacity; and they should always be made with a view to the use of the new machinery for sweeping, approved of by the Society of Arts, and confirmed by experience. Stone and brick are the best possible materials for the sides and the back of a chimney fire-place. Architects however do not always think it a part of their business, or their duty, to enter into the arrangement of these details, relative to the internal comfort of a building. If it were not so necessary to harmonise the whole together, they present field enough for a separate profession; but the possibility of completing these essential, though minute parts, upon the principles of true philosophy and experience, with a view to economy and comfort, will in great measure depend on the general plan of the building.

Besides the precaution of double external doors, to preserve the internal temperature of a house, double windows, with a certain space between, should be used to winter apartments; for it is no less useful to confine the heat generated by the fuel consumed in a house, than it is to place it so that it shall give out in the apartments its full portion of warmth.

It is hardly necessary to say that windows should be made perpendicularly one above another, and not too near the angles of a building. No particular proportions can be assigned for them; but their jaumbs should be bevelled off on the inside, so that the full benefit of the real size of the window may be received, in light spread over the apartment. A window so expanded will admit to diffuse in the room as much light as if its whole internal size had been equal to its increased inner breadth, gained by cutting off the right angular corner of the wall.

Till lately architects have neglected to avail themselves, by this means, of the full benefit of the openings of their windows, and to admit as much light as possible, with as little diminution of strength to the wall. The immense thickness of the walls of old Gothic edifices generally obliged the antient architects to do it; but in the more modern brick buildings, which succeeded, it was omitted.

Lofty windows, descending nearly to the floor, are most graceful, noble, and airy; and balconies, railed with cast iron for buildings not of the most superb class, are a very great ornament and convenience. Ballusters of stone may agree more than iron railings for these projections, where the ornaments of the front are bold and solid.

Sky-lights, in our climate, so subject to damps, driving rains, and to snow, are productive of many inconveniences, and should never be admitted but for stairs, halls, passages, or large public rooms. Unless they are doubled by a horizontal frame of glass beneath them, to produce a cavity of confined air, they waste the heat generated in a house very much; as without this precaution the warmed air of the house escaping directly upwards to the glass, easily mixes its acquired heat with the cold external air of the atmosphere. To which operation a single pane of glass, however thick (though glass is a bad conductor of heat) affords but little retardation.

When sky-lights are necessary, the apertures through the roof should spread as much as possible in descending, that the rays of light may not be confined from spreading as they would be were the sides vertical.

For the form and proportion of rooms, we may observe that an oblong plan is most agreeable to the eye, and generally more convenient than a square, or any other form. The length of a well-proportioned room should be equal to the breadth and a half of the same, and never more; and for the height, take three-fourths of the breadth. An error in favour of height is preferable to making a room too low.

The height of rooms on the second story may be one-twelfth part less than that of the chambers below; and if there is a third story, divide the height of the second into twelve equal parts, of which take nine for the height of these rooms.

The length of galleries may be five times their breadth; and a gallery should rarely exceed eight times its width in length.

When the walls of a building have been raised to the desired height, the vaults made,

the joists laid, and the stairs brought up, then the roof is to be raised; which embracing every part of the building, with its weight equally pressing upon the walls, acts as a band to all the work. Its weight, within certain limits, is of service to the building; but too much charge will make a house top-heavy, which is a great fault.

The pitch of a roof is regulated according to the climate we build in, and the materials employed to defend the timbers from the weather. Roofs covered with lead may be nearly flat: but this method is not much in use, and is very expensive. For tiles a roof must be higher than the pediment pitch, which is one-fourth of the whole building. This pitch is rarely high enough for slates. Copper coverings have lately come much into use in this country, and may be laid on roofs of a low pitch.

Whoever plans a building to be erected within the limits of the building-act, must necessarily consult it before he can arrange his design.

ARCHITECTURE, *aquatic*. See BRIDGE.

ARCHITECTURE, *military*. See FORTIFICATION.

ARCHITECTURE, *naval*. See SHIP-BUILDING.

ARCHITECTURE, *counterfeit*: that which consists of projectures, painted in black or white, or in colours, after the manner of marble, which is also called scene-work, in the painting of columns, &c. for the decoration of theatres,

ARCHITECTURE, in perspective, a sort of building, the members of which are of different modules, and diminish proportionably to their distance, in order to make the work appear longer to the view than it really is.

ARCHITRAVE, in architecture, that part of a column, or order of columns, which lies immediately upon the capital, being the lowest member of the entablature, and so called from its representing the principal beam in timber buildings. Over a chimney, this member is called the mantle-piece; and over doors or windows, the hyperthyron.

ARCHIVE, or archives, an apartment in which are deposited the records, charters, and other papers, of a state or community. The archives of the court of chancery are in the rolls office.

ARCHMARSHAL, the grand marshal of the empire, a dignity belonging to the elector of Saxony.

ARCHON, in Grecian antiquity the chief magistrate of Athens, after the abolishing of monarchy; and also the appellation given to several officers, both civil and religious, under the Greek empire. Thus we read of the archon of the gospel, the archon of the walls, &c.

ARCHONTICI, in church-history, a branch of Valentinians, who maintained that the world was not created by God, but by angels called archontes.

ARCHTREASURER, the great treasurer of the German empire, a dignity belonging to the duke of Brunswic, king of Great Britain, but also claimed by the elector-palatine.

ARCTIC, in astronomy, an epithet given to the north pole; and likewise to a circle of the sphere, parallel to the equator, and 23 degrees 28 minutes distant from the north-pole.

ARCTIUM, burdock, a genus of the polygamia order, and syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ capitatæ: the calyx is globular, with scales having hooks reflected at the tops. There are three species, viz.

1. Arctium lappa; 2. Arctium personata; and 3. Arctium tomentosum. They are all troublesome weeds. The tender stems of the lappa, or common burdock, however, deprived of the bark, may be boiled and eaten like asparagus. When raw, they are good with oil and vinegar. Boys catch bats by throwing the prickly heads of this species into the air. The seeds, which have a bitterish subacrid taste, are recommended as very efficacious diuretics, given either in the form of emulsion, or in powder, to the quantity of a drachm. The roots, which taste sweetish, with a slight austerity and bitterishness, are esteemed aperient, diuretic, and sudorific; and said to act without irritation, so as to be safely ventured upon in acute disorders.

ARCTOMYS, marmot, a genus of quadrupeds. The generic character is; front teeth two in each jaw, strong, sharp, and cuneated; grinders in the upper jaw five on each side, in the lower jaw four; clavicles, or collar-bones, in the skeleton. The genus arctomys or marmot differs from that of mus in so few particulars, as to make it somewhat doubtful whether it ought to be kept separate or not. These animals are of a thick form, with large, roundish, and somewhat flattened heads, small mouths, the fissure having a somewhat perpendicular appearance; ears very short, and sometimes none; a short villous tail; tetradactyle fore-feet, with a very small thumb, and pentadactyle hind-feet: the skeleton is furnished with clavicles, or collar bones; and the cæcum or appendicular intestine is very large. They are diurnal animals; and feed on roots, grain, &c. which they often collect into heaps. They reside in subterraneous holes or burrows, and sleep during the winter. There are 7 species, as follows.

1. Marmot alpine is a native of the Alps and Pyrenean mountains, and is most frequent in those of Savoy and Swisserland, inhabiting the higher regions, and feeding on various roots, plants, insects, &c. It climbs readily, and can ascend the rocky eminences and fissures with great facility. Its general size is somewhat larger than that of a rabbit, measuring about 16 inches to the tail, which is about six inches long. The colour of the marmot, on the upper parts, is a brownish or rather tawny ash-colour; the legs and under parts being of a bright tawny or ferruginous tinge; the head is rather large, and flattish; the ears short, and hid in the fur, and the tail thick and bushy. It is an animal which delights in the regions of frost and snow, and is found only on the tops of high mountains. In such situations several individuals unite in forming a place of retreat, which is contrived with great art, and consists of an oval cavity or general receptacle, large enough to contain several of the animals, and having a large canal or passage, which divaricates in such a manner as to present two outlets to the surface of the ground. These recesses are prepared on the declivities of elevated spots, and the cavern or receptacle is well lined with moss and hay, which they prepare during summer, as if conscious of the necessity of providing for their long hybernal sleep. In fine weather they are seen sporting about the neighbourhood of their burrows; and delight in basking in the sunshine, frequently assuming an upright posture, sitting on their hind-feet. When assembled in this manner, it is observed, that one of the exterior number seems to act as a sentinel, and on the approach of any danger, alarms the fraternity by a loud and shrill whistle, on which they instantly retire to their cavern. These animals make no provision for winter; but as soon as the autumnal frosts commence, they carefully stop up the entrances to their mansions, and gradually fall into a state of torpidity, in which they continue till the arrival of spring, when they again awake, and recommence their excursions. Before they retire to their winter quarters they are observed to grow excessively fat; and, on the contrary, appear greatly emaciated on first emerging from them. If carefully dug up during the winter, from their holes, they may be conveyed away in their sleeping state; and when brought into a warm chamber, gradually awaken, nearly in the same manner as the hamster. If kept in a warm situation, they do not become torpid in winter. They breed early in the summer, and the litter commonly consists of three or four, the growth of which is observed to be very rapid. See Plate Nat. Hist. fig. 33.

2. Marmot Maryland is a North American animal, and is principally found in Virginia and Pennsylvania. It also occurs in the Bahama islands; and in its way of life resembles the European or Alpine marmot, living on vegetable substances, retiring into hollows under the roots of trees, &c. in winter, and falling into a temporary state of torpidity; it is doubtful, however, whether this is the case in those which are found in the Bahama islands. The size of this species is nearly that of the rabbit; its colour is a ferruginous brown above, and paler or inclining to whitish beneath; the muzzle, as far as the eyes, is of a pale bluish ash-colour; the ears are short and rounded; the eyes are rather large and black, and the snout sharpish; the tail is longer than in others of this genus, being nearly half the length of the body, and covered with longish or rather bushy hair, of a deep brown or blackish colour; the feet are blackish, and are furnished with large and sharp claws.

3. Marmot Quebec is said to be found in various parts of North America, but it appears to be most frequent in Hudson's-bay and Canada. Its size is that of a rabbit, or rather larger, and its colour is brown on the upper parts, undulated with whitish or pale grey, the tips of the hairs being of that colour; the legs and under parts of the body are rufous or ferruginous; the face is dusky; the nose black and obtuse, the cheeks grey, and the tail short and dusky, especially at the tip. In its manners it is supposed to resemble the rest of its congeners.

4. Arctomys bobac. (See Plate, Natural History, figure 32.) The bobac is of the size of the Alpine marmot, and is a native of the high but milder and sunny sides of mountainous countries, which abound with fissile or free-stone rocks, where it is found in dry situations, and such as are full of springs, woods, or sand. It abounds in Poland and Russia, among the Carpathian hills. Its colour is grey above, with the throat, insides of the limbs, and under parts of the body, fulvous or ferruginous; the tail is short, rather

slender, and full of hair. Its manner of life extremely resembles that of the common or Alpine marmot, with which, indeed, it appears to have been sometimes confounded by naturalists. The holes or receptacles of these animals are lined with the finest hay, and it is said that the quantity found in one nest is sufficient for a night's provender for a horse. They are fond of sporting about in the sunshine near their holes, like the common marmot, set up a similar whistle when disturbed, and retire with precipitation to their receptacle. They may be easily rendered domestic, like that species, and are of a mild and gentle disposition. In winter they lie torpid, unless kept in warm rooms. They breed early in the spring, and are said to produce six or eight young.

5. Arctomys pruinosa, or hoary marmot. This species is about the size of the monax, or Maryland marmot, and is of a hoary ash-colour; the hair, which is long and rather coarse, being cinereous at the roots, black in the middle, and white at the tips; the tip of the nose, legs, and tail, are black; the cheeks whitish, and the top of the head dusky, with a ferruginous cast. It is a native of North America.

6th. Arctomys maulina, or mauline marmot. This animal was discovered in the province of Maule, in Chili, where it inhabits woods. It is said to be about twice the size of the common or Alpine marmot, nearly of the same colour, but has pointed ears, lengthened nose, four rows of whiskers, and a longer tail than the common marmot. On each foot are also said to be five toes. It is represented as a strong animal, and not easily conquered by dogs which happen to attack it.

7. Arctomys gundi, or gundi marmot. This species is a native of Barbary, towards mount Atlas, near Masuffin. It is about the size of a small rabbit, and is entirely of a testaceous red colour; the ears are truncated, with large apertures; the tail short, the upper teeth truncated, and the lower slender and pointed. It is called by the Arabs gundi. Its particular history seems as yet to be not fully understood.

Arctomys citillus, or variegated marmot. Of all the marmots this is the most elegant in its appearance, exhibiting generally a beautiful variegation of yellowish brown and white, the former constituting the ground-colour, and the latter the variegations, which are sometimes in the form of spots, and sometimes of transverse undulations; the legs and under parts of the body are of a yellowish white; the tail is short, well covered with hair, and is brown above and ferruginous beneath; there is scarce any appearance of external ears, but merely an edging to the auditory canal. The length of the animal is about a foot, and of the tail four inches and a half; but this species varies as much in size as in colours, some of the varieties are scarce larger than a water rat, while others are nearly equal in size to the marmot.

The variegated marmot inhabits Bohemia, Austria, Hungary, and from the banks of the Volga to India and Persia, through Siberia and Great Tartary to Kamtschatka, some of the intervening isles, and even the continent of America. It is sometimes found in woods, but seems principally to delight in dry hilly places, where the herbage is of short growth. They form subterraneous burrows, in which they deposit heaps of grain, roots, nuts, &c. for their winter food; for it does not appear that they sleep during that period, like some others of this genus. They breed in the spring, and produce from five to eight at a time. They are extremely irrascible and quarrelsome among themselves; their bite is very severe. They are extremely cleanly, and after feeding, generally wash their faces, like cats, and clean their fur with the greatest diligence.

ARCTOPHYLAX, a constellation, otherwise called bootes.

ARCTOPUS, in botany, a genus of the polygamia dicœcia class and order, and in the natural method ranking under the 45th order, umbellatæ. The umbella of the male is compound; the involucrum consists of five leaves; the corolla has five petals; the stamina are five; and two pistilli; the umbella of the hermaphrodite is simple; the involucrum is divided into four parts, is spinous, large, and contains many male flowers in the disk. There is but one species of arctopus, viz.

Arctopus echinatus, a native of Ethiopia.

ARCTOTIS, in botany, a genus of the polygamia necessaria order, belonging to the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ-discoites. The receptacle is bristly; the corona of the pappus is pentaphyllous; and the calyx is imbricated with scales loose at the top. There are 11 species; natives of Ethiopia, or the Cape of Good Hope. Of these,

1. Arctotis angustifolia, with spear-shaped leaves; and

2. Arctotis aspera, with wing-shaped woolly leaves, are most remarkable for their beauty. They are treated with us as green-house plants.

ARCTURUM, a small star, of the seventh or eighth magnitude to the south of arcturus.

ARCTURUS, a fixed star of the first magnitude in the skirt of boötes.

ARCTUS, in astronomy, the Greek name for the ursa major and minor, whence the words arctic, arctic circle, &c.

ARCUATION, in gardening, the raising of trees by layers, which is done thus: strong mother plants, or stools, must be planted in a clean border, and when they have shot five or six main branches from the root, and as many collateral branches, these main branches must be bent to the ground; for which reason, some cut them half through, and peg them fast down. The small branches must be covered three inches thick upon the joints, and have a large bason of earth made round them to hold the water. Some persons give the branches a twist, to make them root the sooner.

ARCUTIO, a machine consisting of hoops used in Florence by nurses, in order to prevent the child from being overlaid. Every nurse is obliged to lay her child in an arcutio, under pain of excommunication.

ARDASSES, the coarsest of all the silks in Persia.

ARDEA, the heron, a genus of the order of grallæ. The general characters of this order are; the bill is straight, sharp, long, and somewhat compressed, with a furrow that runs from the nostrils towards the point; the nostrils are linear, and the feet have four toes. Under this genus Linnæus comprehends the grus or crane, the ciconia or stork, and the ardea or heron. There are 79 species, of which the following are the most remarkable.

1. Ardea americana, or hooping crane of Edward's, is a native of America. The crown of the head and temples are naked and papillous; the forehead, nape of the neck, and prime wing feathers, are black, but the body is white. This species is often seen at the mouths of the Savanna, Aratamaha, and other rivers near St. Augustine. They lay two white eggs, like those of the swan, and sit 20 days; the young are at first yellow, changing to white by degrees.

2. Ardea argil, or hurgil, of Ives, is a very large species; from tip to tip of the wings, measuring 14 feet 10 inches, and from the tip of the bill to the claws 7 feet and a half; the bill is 16 inches round at the base, of different colours, and nearly of a triangular shape; the feathers of the back and wings are of an iron colour, those of the breast long; over the belly a great deal of down, of a dirty white; the legs and half the thighs are naked; the naked parts full three feet in length. This monster inhabits Bengal. On opening one of these, a terapin, or land-tortoise, 10 inches long, was found in its craw, and a large male black cat was found entire in its stomach. One of these, a young bird, about five feet in height, was brought up tame, and presented to the chief of the Bananas, where Mr. Smeathman lived; and being accustomed to be fed in the great hall, soon became familiar, duly attending that place at dinner time, and placing itself behind its master's chair, frequently before any of the guests entered. The servants were obliged to watch it narrowly, and defend the provisions with switches in their hands; but notwithstanding this, it would frequently snatch off somewhat; and it once purloined a whole boiled fowl, which it swallowed in an instant. The individual abovementioned used to fly about the island, and roost very high among the silk-cotton trees, whence at two or three miles distance it could spy the dinner carrying across the yard, when, darting from its station, it would enter promiscuously with the women who carried in the dishes. It sometimes stood for near half an hour after dinner, with the head turning alternately, as if listening to the conversation.

3. Ardea ciconia, or white stork of Ray, has naked eye-balls, and black prime wing feathers. The skin below the feathers, as also the beak, feet, and claws, are of a blood-colour. It is a native of Europe, Asia, and Africa, and feeds upon amphibious animals. It is such an enemy to serpents, that it is reckoned almost a crime to kill a stork. From this favourable treatment, they are seen in Holland and the Low Countries walking unconcerned in the middle of the streets. Storks are birds of passage; they spend the summer in Europe go off to Egypt, Ethiopia, &c. all at once before winter, and do not return till about the middle of March.

4. Ardea garzetta, or egret, is crested behind; the body is white, the beak black, and the feet greenish. It is a most elegant bird. It weighs about one pound, and the length is 24 inches, to the end of the legs 32. It is a native of the east. But that formerly it was very frequent in Britain, appears by some of

the old bill of fare. In the famous feast of archbishop Neville, we find no less than 1000 asterides, egrets or egrittes, as the word is differently spelt.

5. Ardea grus, or common crane of English authors, has a naked papillous crown; the prime feathers of the wings are black; the body is ash-coloured. This species is far spread, being met with in great flocks throughout northern Europe and Asia. It seems to have been formerly a native of Britain. They feed on reptiles of all kinds, as well as on green corn, which last they make such havock of, as to ruin the farmers wherever flocks of them alight.

6. Ardea herodias, or cristata maxima of Catesby, is crested behind, has a dusky-coloured back, reddish thighs, and the breast speckled with oblong black spots. It is four feet and a half when erect. It is a native of Virginia, and feeds upon fish, frogs, lizards, efts, &c.

7. Ardea leucogeranos of Pallas, or the Siberian crane of Pennant, is four feet and a half when standing erect. The bill is of a red colour; the irides are white; the plumage is white as snow, except the 10 first greater quills, with the coverts of them, which are black; the legs are long and red. This species inhabits the vast marshes and lakes in Siberia. It makes its nest among the reeds, seldom accessible by man, upon rising green grassy tufts, made up of herbs and grass heaped together; and lays two ash coloured eggs, spotted with brown. They are shy birds, and always upon their guard against an enemy; having a sentinel to warn them of an approach; on the least alarm they cry aloud, not unlike the swan, and fly off directly. The sportsman finds, in course, much difficulty in approaching them. Sometimes indeed he approaches them under the cover of a stalking horse, or other objects; at other times a small dog will divert their attention, as they will without fear attack the dog, while his master gets within reach. In breeding time, however, they are more bold, as they will then defend their young even against men.

8. Ardea major, or common heron, has a black crest depending from the back part of the head, an ash coloured body, and a black line and belt on the neck and breast. It is a native of Europe. It perches and builds in trees, and sometimes in high cliffs over the sea, commonly in company with others, like rooks. It was formerly in this island game, heron-hawking being a favourite diversion of our ancestors. Not to know the hawk from the heronshaw was an old proverb, (since absurdly corrupted to 'He does not know a hawk from a handsaw,') taken originally from this diversion, but in course of time served to express great ignorance in any science. This bird was formerly much esteemed as food; made a favourite dish at great tables, and was valued at the same rate as a pheasant. It is said to be very long-lived; by Mr. Keysler's account it may exceed 60 years.

9. Ardea pavonia, or the crowned crane, has an erect bristly crest, with the temples and two wattles naked. It is a native of Africa, particularly of the coast of Guinea, as far as Cape Verd; at this last place they are said to be exceedingly tame, and will often come into the court yards to feed with the poultry. Their chief food is supposed to be worms, and such other insects as the heron tribe usually feed on, with vegetables of all kinds. See Plate Nat. Hist. fig. 34.

10. Ardea stellaris, or the bittern, has a smooth head, and is variegated through the body with dark coloured spots of different figures and sizes. It is a native of Europe, and inhabits the fen countries. It will suffer persons to come very near it without rising, and has been known to strike at boys and at sportsmen, when wounded and unable to make its escape. It flies principally about the dusk of the evening, and then rises in a very singular manner, by a spiral ascent, till it is quite out of sight. It builds its nest with the leaves of water plants on some dry clump among the reeds, and lays five or six eggs of a cinerous green colour. This bird and the heron are very apt to strike at the fowler's eyes when only maimed. The food of the bittern is chiefly frogs; not that it rejects fish, for small trouts have been met with in their stomachs. In the reign of Henry VIII. it was held in much esteem at our tables, and valued at one shilling. Its flesh has the flavour of a hare, and nothing of the fishiness of that of the heron.

11. Ardea violacea, or crested bittern of Catesby, has a white crest; the body is variegated with black and white, and bluish below. These birds are seen in Carolina in the rainy seasons; but in the Bahama islands they breed in bushes growing among the rocks in prodigious numbers. They are called by the Bahamians crab-catchers, crabs being what they mostly subsist on; yet they are well tasted, and free from any rank or fishy savour.

12. Ardea virgo, has a straight greenish bill and crimson irides. The crown of the head is ash-coloured; the rest of the head, the upper, and all the under parts, to the breast, black; the back, and all the under part from the breast, of a bluish ash colour; behind each eye springs a tuft of long white feathers, which decline downwards. It is found in many parts of Asia and Africa. See Plate Nat. Hist. fig. 35.

ARDENT spirits, those distilled from fermented vegetables, so called because they will take fire and burn, such as brandy, rum, &c.

ARDISIA, a genus of the tentandria monogynia class and order. The essential character is, calyx five class, corolla one petalled, five patred, reflex, stigma simple berry round one seeded.

There are seven species, all trees or shrubs, chiefly natives of the West Indies.

ARDUINA, a genus of the pentandria monogynia class and order. The essential character is; cor. one petalled; stigma bifid; berry two celled; seeds solitary. There is one species, a native of the Cape, which with us is treated as a green-house plant.

AREA, in geometry, denotes the superficial content of any figure: thus, if we suppose a parallelogram six inches long, and four broad, its area will be $6 \times 4 = 24$ square inches.

The method of finding the areas of different figures, as triangles, circles, &c. will be given hereafter.

ARECA, the Fausel-nut, in botany, a genus of the order of the palmæ pennatifoliæ. The male has no calyx, but three petals, and nine stamina: the female has no calyx; the corolla has three petals, and the calyx is imbricated. There are three species, viz.

1. Areca cathecu, a native of India. It has no branches, but its leaves are very beautiful; they form a round tuft at the top of the trunk, which is as straight as an arrow. It grows to the height of 25 or 35 feet, and is a great ornament in gardens. The shell which contains the fruit is smooth without, but rough and hairy within; in which it pretty much resembles the shell of the cocoa nut. Its size is equal to that of a pretty large walnut. Its kernel semblance without, and has also the same whitish veins within when cut in two. In the centre of the fruit, when it is soft, is contained a greyish and almost liquid substance, which grows hard in proportion as it ripens. The extract of this nut has been supposed to be the terra japonica of the shops: but according to later observations, the genuine drug seems to be obtained from the mimosa catechu. The fruit when ripe is astringent, but not unpalatable, and the shell is yellowish. Of this fruit there is a prodigious consumption in the East Indies. The chief use that is made of it is to chew it with the leaves of betel, mixing with it lime made of sea shells.

2. Areca oleracea, Plate Nat. Hist. fig. 36, or true cabbage palm, is the most beautiful, and perhaps the tallest, of all trees. The trunk is perfectly straight, and marked with rings at the vestigiæ of the footstalks of the leaves. Near the ground it is about seven feet in circumference; but tapers as it ascends, and attains the height of 170 or 200 feet. The bark is of an ash colour, till within 25 or 30 feet of the extremity of the tree; when it alters at once to a deep sea-green, which continues to the top. About five feet from the beginning of the green part upwards, the trunk is surrounded with its numerous branches, in a circular manner; all the lowermost spreading horizontally with great regularity; and the extremes of many of the higher branches bend wavingly downwards, like so many plumes of feathers. These branches, when full grown, are 20 feet long, more or less; and are thickly set on the trunk alternately, rising gradually superior one to another: their broad curved sockets so surround the trunk, that the sight of it, whilst among these, is lost, which again appears among the uppermost branches, and is there inveloped in an upright green conic spire, which beautifully terminates its great height. As there are many thousand leaves upon one tree, every branch bearing many scores upon it, and every leaf being set at a small and equal distance from one another, the beauty of such a regular lofty group of waving foliage, susceptible of motion, by the most gentle gale of wind, is not to be described. The middle rib, in each leaf, is strong and prominent, supporting it on the under side, the upper appearing smooth and shining. The pithy part of the leaf being scraped off, the inside texture appears to be so many longitudinal thread-like filaments. These, being spun in the same manner as they do hemp, or flax, are used in making cordage of every kind. Upon removing the large leaves, or branches, which surround the top of the trunk, a little way above the beginning of the green bark, what is called the cabbage is discovered lying in many thin, snow white, brittle flakes, in taste resembling an almond, but sweeter. This substance, which cannot be procured without destroying the tree, is boiled, and eaten with mutton by the inhabitants of the

West Indies, in the same manner as turnips and cabbage are with us. What is called the cabbage flower, grows from that part of the tree where the ash-coloured trunk joins the green part already described. Its first appearance is a green husky spatha, growing to above 20 inches long, and about four broad. As this husky spatha is opening while thus young, the farinaceous yellow seed in embryo, resembling fine sawdust, is very plentifully dispersed among stringy filaments, which answer the use of apices in other more regular flowers: these filaments being cleared of this dust, are pickled, and esteemed among the best pickles either in the West Indies or in Europe. But if this spatha is not cut down and opened whilst thus young; if it be suffered to continue on the tree, till it grows ripe and bursts; then the inclosed part, which whilst young and tender is fit for pickling, will by that time have acquired an additional hardness, become soon after ligneous, grow bushy, consisting of very small leaves, and in time produce a great number of small oval thin-shelled nuts, about the size of unhusked coffee berries: these, being planted, produce young cabbage trees. The sockets or grooves, formed by the broad part of the footstalks of the branches, are used by the negroes as cradles for their children. On the inner side of the very young footstalks are tender pellicles, which when dried, it is said, make a writing paper. The trunks serve as gutterings; the pith makes a sort of sago; and the nuts yield oil by decoction. In the pith also, after the trees are felled, there breeds a kind of worm or grub, which is eaten and esteemed a great delicacy by the French of Martinico, St. Domingo, and the adjacent islands.

3. Areca oryzæformis. This is a native of Cochin China, Amboina, &c. It is a slender elegant palm, and the fruit is used for chewing with the betel leaf as well as that of the first species.

ARENA, in Roman antiquity, a place where the gladiators fought; so called from its being always strewed with sand, to conceal from the view of the people the blood spilt in the combat.

ARENA, in architecture, the middle or body of a temple, that comprehends the whole space between the antæ, and the extreme wall of the building.

ARENARIA, in ornithology, called the turnstone or sea dotterel by English writers: also a species of tringa that inhabits the sandy shores of Europe and the Caspian Sea.

ARENARIA, in botany, sandwort: a genus of the decandria trigynia class; and in the natural method ranking under the 22d order, caryophyllæ. The calyx has five open leaves; the petals are five, and entire; the capsule is trilocular, and contains many seeds. There are 20 species, only seven of which are natives of Britain, viz.

1. Arenaria laricifolia, larch-leaved sandwort.
2. Arenaria peploides, sea sandwort.
3. Arenaria rubra, purple-flowered sandwort.
4. Arenaria saxatilis, mountain sandwort.
5. Arenaria serpyllifolia, least sandwort.
6. Arenaria tenuifolia, fine-leaved sandwort.
7. Arenaria trinervis, plantain-leaved sandwort.

ARENARII, in antiquity, gladiators who combated with beasts in the arena or amphitheatre. They were slaves of the lowest order, and not capable of becoming Roman citizens.

ARENARIUM, a cemetery or burying ground. The arenaria were a kind of pits in which the ancient christians buried their dead, and held their religious assemblies in times of persecutions.

ARENARIUS, in ornithology, a species of tetrao, called also the sand grous, found only in the deserts towards the Caspian Sea. It is common about Astrachan in summer, and passes the winter in Persia. They drink much water, and go to the pools thrice every day; when they are so eager, that they do not mind the sportsmen, though at other times they are very shy.

ARENATION, a kind of dry bath, in which the patient sits with his bare feet on hot sand.

AREOPAGUS, or Aræopagus, in Grecian antiquity, a sovereign court at Athens, so famous for the justice and impartiality of its decrees, that the gods themselves are said to have submitted their quarrels to its determination.

ARETHUSA, in botany, a genus of the gynandria diandria class; and in the natural method ranking under the seventh order, orchideæ. The generic character is taken from the nectarium, which is tubular, situated at the bottom of the corolla, and the inferior labium fixed to the stylus. There are seven species, all natives of America.

ARETIA, in botany, a genus of the pentandria monogynia class; and in the natural method ranking under the 21st order, pretiæ. The corolla is divided into five parts; the tube of the corolla is ovated; and the capsule is globular, and consists but of one cell. There are three species.

ARGEA, or Argei, in Roman antiquity, thirty human figures, made of rushes, thrown annually by the priests, or vestals, into the Tiber, on the day of the ides of May.

ARGEMONE, prickly poppy, a genus of the monogynia order, belonging to the polyandria class of plants; and in the natural method ranking under the 27th order, rhæadeæ. The corolla consists of six petals; the calyx is tryphillous; and the capsule is semivalved. Of this genus there are three species, one of which is common in many parts of the West Indies, and called by the Spaniards the devil's fig; but they are of no use, and have very little beauty.

ARGENT, in heraldry, the white colour in the coats of gentlemen, knights, and baronets: the white in the arms of the sovereign princes is called luna, and that in the arms of the nobility, pearl: this is expressed in engraving, by the parts being left plain, without any strokes from the graver. See HERALDRY.

ARGENTEUS *codex*, a M.S. of the four gospels, that derives its name from its silver letters, supposed to be a copy of the Gothic version made by Ulphilas, the apostle of the Goths, in the fourth century. It is 4to. the leaves violet-colour parchment; and on this ground the letters, which are all capitals, were painted in silver, except the initials, and a few passages, in gold. It is now in the university of Upsal.

ARGENTINA, in ichthyology, a genus of fishes belonging to the order of abdominales. —The generic characters are these: the teeth are in the tongue, as well as the jaws; the branchiostege membrane has eight radii or rays; the anus is near the tail; and the belly fins consist of many rays. There are two species of argentina, viz.

1. Argentina carolina has likewise 15 rays in the fin near the anus; the tail is forked, and the lateral lines are straight. It inhabits the fresh waters of Carolina. See Plate Nat. Hist. fig. 38.

2. Argentina sphyræna has 15 rays in the fin at the anus; the air bladder of this species is conical on both sides, and shines like silver: false pearls are sometimes made of it.

ARGENTUM *arborescens*. Most metallic substances are capable of decomposing a nitric solution of silver. The separation of this metal by mercury, on account of the phenomena which it presents, has been called the argentum arborescens, or more commonly the arbor Dianæ. It is obtained by the following process: mix together six parts of a solution of silver, and four of a solution of mercury, both made with nitric acid, and completely saturated; add to them a little distilled water, and put the mixture into a conical vessel, into which has been previously introduced six parts of an alloy made in the proportion of seven parts of mercury and one of silver. At the end of a few hours there will be formed, at the surface of the small mass of alloy, a vegetation in the form of a bush, as in Plate Nat. Hist. fig. 37. To obtain a beautiful specimen, it is necessary that all the ingredients be very pure: the glass best adapted to the purpose is conical or cylindrical.

ARGILLA, clay, in natural history. See CHEMISTRY.

ARGO, in astronomy, a constellation of fixed stars in the southern hemisphere: the number of stars in Ptolemy's catalogue is 8, in Tycho's 11, and in Mr. Flamsteed's 25.

ARGO, the vessel in which the Argonauts, of whom Jason was the chief, made an expedition in quest of the golden fleece.

ARGONAUTA, in conchology, the name of one of the Linnæan genera: animal a sepio or clio; shell univalve, spiral, involuted, membranaceous, and containing only one shell. There are two species, the most remarkable of which is the argonauta argo. (See Plate Natural History, fig. 39.) The animal which is the inhabitant of this shell attracted the notice of the earliest writers on natural history. It is a native of the Mediterranean and Indian seas, and is supposed to have taught mankind the use of sails, and the art of navigation: it is the nautilus of English collectors. When this little creature intends to sail, it discharges a quantity of water, by which operation its specific gravity is rendered less than that of sea water; and rising to the surface, erects its arms, and expands a membrane between them, by means of which it is driven before the wind, like a vessel under sail; at the same time that two of its arms, which hang over the side of the shell, serve for oars and a rudder. In this manner it sports on the water in calm weather; but on the first indication of a storm, it lowers its sail, draws in its arms, takes in water, and sinks.

ARGOPHYLLUM, in botany, white-leaf. A genus of the monogynia order, belonging to the pentandria class of plants. The capsule is trilocular; the nectarium is pyramidal, pentagonous, and the length of the corolla. There is but one species, viz.

ARGOPHYLLUM nitidum, or the glossy argophyllum, a native of New Caledonia. This species has some affinity with the ivy.

ARGUMENT, argumentum, in rhetoric and logic, an inference drawn from premises, the truth of which is indisputable; or at least highly probable.

ARGUMENT, in astronomy, denotes a known arch, by means of which we seek another one unknown.

The argument of the moon's latitude is her distance from the node; and the argument of inclination is an arch of a planet's orbit, intercepted between the ascending node and the place of the planet from the sun, numbered according to the succession of the signs of the zodiac.

ARGUMENT of inclination, or argument of latitude, of any planet, is an arch of a planet's orbit, intercepted between the ascending node and the place of the planet from the sun, numbered according to the succession of the signs.

ARGUMENT, menstrual, of latitude, is the distance of the moon's true place from the sun's true place.—By this is found the quantity of the real obscuration in eclipses, or how many digits are darkened in any place.

ARGUMENT, annual, of the moon's apogee, or simply, annual argument, is the distance of the sun's place from the place of the moon's apogee; that is, the arc of the ecliptic comprised between those two places.

ARGUS-SHELL, a species of porcelain-shell, beautifully variegated with spots resembling, in some measure, those in a peacock's tail.

ARGYTHAMNIA, in botany, a genus of the class and order monœcia tetandria; the essential character is, male cal. four-leaved; cor four-petalled; fem. cal. five-leaved, cor. none, styles dicchotomous, caps. nicoceous, solitary seeds. There is one shrubby species, a native of Jamaica.

ARIADNE, a beautiful statue of Parian marble, which was for nearly 300 years one of the chief ornaments of Belvidere, where it was placed by pope Julius II. It is now in the museum of Paris. Ariadne is represented sleeping on the rocks of Naxos, where she has been ungratefully left by Theseus.

ARIANS, in church-history, a sect of ancient christians, who denied the three persons in the Holy Trinity to be of the same essence, and affirmed Christ to be a creature; that he was inferior to the Father as to his deity; that he was neither co-eternal, nor co-equal with him; also, that the Holy Ghost was not God, but a creature of the Son. In their doxologies, they ascribed glory to the Father in the Son, through the Holy Ghost.

The term Arian, in modern times, is applied to all who believe in the pre-existence of Christ, but who consider him as inferior and subordinate to the Father.

ARIDAS, a kind of taffety, manufactured in the East Indies, from a shining thread which is got from certain herbs, whence they are styled aridas of herbs.

ARIDED, a fixed star of the second magnitude, in the extremity of the swan's tail.

ARIDULLAM, in natural history, a kind of zarnich found in the East Indies.

ARIES, in zoology. See RAM.

ARIES, or the Ram, in astronomy, one of the constellations of the northern hemisphere, and the first of the old twelve signs of the zodiac, and marked ♈ in imitation of a ram's head. It gives name to a twelfth part of the ecliptic, which the sun enters commonly about the 20th of March. The stars of this constellation, in Ptolemy's catalogue, are 18; in Tycho Brahe's 21; in Helvelius's 27; and in Flamsteed's 66: but they are mostly very small, only one being of the 2d magnitude, two of the 3d magnitude, and all the rest smaller.

ARILLUS, in botany, the proper or exterior coat or covering of the seed, which drying, falls off spontaneously. All seeds have not this appendage

ARISH, a Persian long measure, containing about 38 English inches.

ARISTA, among botanists, a long needle-like beard, which stands out from the husk of a grain of corn, grass, &c.

ARISTEA, in botany, a genus of the triandria monogynia class and order. The essential character is, petals six, style declinate, stigma funnel-shaped gaping, caps. inferior with many seeds. There is one species, a native of the Cape.

ARISTIDA, in botany, a genus of the class and order triandria digynia. The essential character is, calyx two-valved, corolla one-valved, with three terminal awns. There are six species, all of them natives of the East and West Indies.

ARISTOLOCHIA, birthwort, a genus of the hexandria order, belonging to the gynandria class of plants; and in the natural method ranking under the 11th order, sarmentaceæ. It has no calyx; the corolla consists of one entire petal; and the capsule, which is below the flower, has six cells. The species are twenty-one; but only the following merit description.

ARISTOLOCHIA Indica, or contrayerva of Jamaica, is a native of that island, where its roots are used instead of the true contrayerva. It has long trailing branches, which climb upon the neighbouring plants, and sometimes rise to a considerable height. The flowers are produced in small clusters towards the upper part of the stalks, which are of a dark purple colour.

ARISTOLOCHIA serpentaria is a native of Virginia and Carolina, whence the radix serpentaria, or snake-root, so much used in medicine, is brought over. The leaves grow close to the ground on footstalks an inch long, of a singular shape, and of a dark purple colour. A round canulated capsule succeeds the flower. It is filled with seeds, which are ripe in May. When planted in gardens, in countries where they are natives, they increase so much in two years, that one can scarce grasp the stalk of a single one. This species is usually found in woods near the roots of great trees.

The usual price of the root, when dried, is 6d. per lb. both in Virginia and Carolina; and the negro slaves employ a great part of the time allowed them by their masters in search after it.

Another species is the *clematitis*, the root of which has an aromatic bitterness, which is by no means unpleasant. This root is deservedly esseemed as a remedy in the malignant fevers and epidemic diseases of warm climates. It is given in substance in doses of from ten to thirty grains, and in infusions, from one to two drams.

ARITHMETIC is the science of numbers, and teaches the art of computing by them.

At what time this science was introduced into the world cannot be easily determined. History fixes neither the author nor the time. The Greeks very early made use of the letters of the alphabet to represent their numbers. The 24 letters, taken according to their order, at first denoted the numbers 1, 2, 3, 4, 5, 7, 8, 9, 10, 20, 30, 40, 50, 60, 70, 80, 100, 200, 300, 400, 500, 600, 700, and 800; to which they added the three following, ϛ, ϟ, ϡ), to represent 6, 90, and 900.

The Romans followed a like method; and besides characters for each rank of classes, introduced others for five, fifty, and five hundred. Their method is still used for distinguishing the chapters of books, and some other purposes. Their numeral letters and values are the following:

I	V	X	L	C	D	M
One,	five,	ten,	fifty,	one hundred,	five hundred,	one thousand.

Any number may be represented by repeating and combining these according to the following rules.

(1) When the same letter is repeated twice, or oftener, its value is represented as often. Thus II signifies two; XXX thirty, CC two hundred.
(2) When a numeral letter is placed after one of greater value, their values are added: thus XI signifies eleven, LXV sixty-five, MDCXXVIII one thousand six hundred and twenty-eight.
(3) When a numeral letter is placed before one of greater value, the value of the less is taken from that of the greater: thus IV signifies four, XL forty, XC ninety, CD four hundred.

Sometimes IↃ is used instead of D for 500, and the value is increased ten times by annexing Ↄ to the right hand.

Thus, IↃ signifies 500
IↃↃ - 5000
IↃↃↃ - 50000
Also, CIↃ is used for 1000
CCIↃↃ for 10000
CCCIↃↃↃ for 100000

Sometimes thousands are represented by drawing a line over the top of the numeral, $\overline{V}$ being used for five thousand, $\overline{L}$ for fifty thousand, $\overline{CC}$ two hundred thousand.

About the year of Christ 200, a new kind of arithmetic, called sexagesimal, was invented probably by Ptolemy, to remedy the difficulties of the common method, especially with regard to fractions. Every unit was supposed to be divided into 60 parts, and each of these into 60 others, and so on. Thus from one to 59 were marked in the common way: then 60 was called a sexagesima prima, or first sexagesimal integer, and had one single dash over it; so 60 was expressed thus I′; and so on to 59 times 60, or 3540, which was thus expressed LIX′. He now proceeded to 60 times 60, which he called a sexagesima secunda, and was thus expressed I″. In like manner, twice 60 times 60, or 7200, was expressed by II″; and so on till he came to 60 times 3600, which was a third sexagesimal, and expressed thus I‴. If any number less than 60 was joined with these sexagesimals, it was added in its proper characters without any dash: thus I′XV represented 60 and 15, or 75; I′VXXV is four times 60 and 25, or 265; X″II′XV is ten times 3000, twice 60 and 15, or 36, 135, &c. Sexagesimal fractions were marked by putting the dash at the foot, or on the left-hand of the letter: thus $I_{,}$ or ′I; denoted $\frac{1}{60}$; $I_{,,}$ or ″I, $\frac{1}{3600}$, &c. So nearly did the inventor of this method approach the Arabic, or common mode of notation; instead of sexagesimal progression, it was

required only to substitute decimal, to make the signs of numbers from 1 to 9 simple characters, and to introduce the 0, a character which signifies nothing of itself, but which serves to fill up places. Though the sexagesimal whole numbers were soon laid aside after the introduction of the Arabic notation, sexagessimal fractions continued till the invention of decimals, and are even still used in the subdivisions of circular arcs and angles.

The method of notation, which we now use, came into Europe from the Arabians, by the way of Spain. The Arabs, however, do not pretend to be the inventors of the characters, but acknowledge that they received them from the Indians. Some imagine that they were found out by the Greeks, which is not probable; as Maximus Planudes, who lived towards the close of the 13th century, is the first Greek who makes use of them: and Dr. Wallis is of opinion that these characters must have been used in England at least as long ago as the year 1050, if not in ordinary affairs, at least in mathematical ones, and in astronomical tables.

The oldest treatises extant upon the theory of arithmetic, are the seventh, eighth, and ninth books of Euclid's Elements, which treat of proportion and of prime and composite numbers. Nicomachus the Pythagorean, wrote a treatise on the theory of arithmetic, consisting chiefly of the distinctions and divisions of numbers into classes, as plain, solid, triangular, quadrangular, and the rest of the figurate numbers as they are called, numbers odd and even, &c. with some of the more general properties of the several kinds. His arithmetic was published at Paris in 1538. The next remarkable writer on this subject is Boethius, who is supposed to have copied most of his work from Nicomachus.

From this time no remarkable writer on arithmetic appeared till about the year 1200, when Jordanus of Namur wrote a treatise on this subject, which was published and demonstrated by Joannes Faber Stapulensis in the 15th century: and, as learning advanced in Europe, the number of writers on arithmetic increased. About the year 1464, Regiomontanus, in his triangular tables, divided the radius into 10,000 parts instead of 60,000; and thus tacitly expelled the sexagesimal arithmetic; which, however, still remains in the division of time. Ramus, in his arithmetic, written about the year 1550, and published by Lazarus Schonerus in 1586, uses decimal periods in carrying on the square and cube roots to fractions. The same had been done before by our countrymen Buckley and Record; but the first who published an express treatise on decimals was Simon Stevinius, about the year 1582. Dr. Wallis is the first who took much notice of circulating decimals, and the honour of inventing logarithms is unquestionably due to lord Napier, baron of Merchiston in Scotland, about the end of the 16th or beginning of the 17th century. Arithmetic has thus advanced to a degree of perfection which the ancients could never have imagined possible, much less hoped to attain; and it may now be reckoned one of those few sciences which is in its nature capable of little further improvement.

The following marks are used as abbreviations in arithmetic.

$=$ is the sign of equality.

$+$ signifies Addition thus; $2 + 3 = 5$, is 2 added to 3 equal to 5.

$-$ signifies Subtraction thus; $5 - 2 = 3$, is 5 less 2 equal to 3.

$\times$ signifies Multiplication; $9 \times 5 = 45$, is 9 multiplied by 5 is equal to 45.

$\div$ signifies Division; $54 \div 9$, is 54 divided by 9 is equal to 6.

$\sqrt{\ }$ signifies the Square Root, $\sqrt{9}$ is the square root of 9, which is equal to 3.

Notation and Numeration.

The first elements of arithmetic are acquired during our infancy: small numbers are most easily apprehended: a child soon understands what is meant by two, or three, or four, but has no distinct notion of twenty or thirty. Experience removes this difficulty, and enables us to form many units into a class, and several of these smaller classes into one of a higher kind, and thus to advance through as many ranks of classes as occasion requires. If a boy arrange an hundred stones in one row, he would be tired before he could reckon them; but if he place them in ten rows of ten stones each, he will reckon an hundred with ease; and if he collect ten such parcels, he will reckon a thousand.

There does not seem to be any number naturally adapted for constituting a class of the lowest, or any higher rank to the exclusion of others. However, as ten has been generally used for this purpose by most nations who have cultivated this science, it is probably the most convenient for general use. Other scales may be assumed: thus, if eight were the scale, 6 times 3 would be two classes and two units, and the number of 18 would then be represented by 22. If 12 were the scale, 5 times 9 would be three classes and nine units, and 45 would be represented by 39, &c. By not observing the same scale in the various kinds of monies, weights, and the like, much of the difficulty in the practice of arithmetic arises.

All numbers are represented by the ten following characters.

1	2	3	4	5	6	7	8	9	0
One,	two,	three,	four,	five,	six,	seven,	eight,	nine,	cypher.

The nine first are called significant figures or digits. When placed singly, they denote the simple numbers subjoined to the characters. When several are placed together, the first or right-hand figure only is to be taken for its simple value: the second signifies so many tens, the third so many hundreds, and the others so many higher classes, according to the order in which they stand. And the cypher in any place denotes the want of a number in that place: thus, 20 denotes two tens and no units or simple number.

The following table shows the names and divisions of the classes.

8.	4	3	7,	9	8	2.	5	6	4,	7	3	8.	9	7	2,	6	4	5
Trillions	Hundred thousand of billions	Ten thousand of billions	Thousand billions	Hundred billions	Ten billions	Billions.	Hundred thousand of millions	Ten thousand of millions	Thousand millions	Hundred millions	Ten millions	Millions	Hundred thousands	Ten thousands	Thousands	Hundreds	Tens	Units

The first six figures from the right hand are called the unit period, the next six the million period, after which the trillion, quadrillion, quintillion, sextillion, septillion, octillion, and nonillion periods, follow in their order.

The whole art of arithmetic is comprehended in two operations, Addition and Subtraction. But as methods have been invented for facilitating these operations, and distinguished by the names of Multiplication and Division; these four rules are the foundation of all arithmetical operations.

Addition.

Addition is that operation by which several numbers of the same denomination are collected into one total.

	Example.
Rule. Write the numbers distinctly,	468632
units under units, tens under tens, and	767345
so on. Then reckon the amount of the	234672
right-hand column. If it be under ten,	142131
mark it down. If it exceed ten, mark	223164
the units only, and carry the tens to the	389879
next place. In like manner, carry the	796543
tens of each column to the next, and	
mark down the full sum of the left-	3022366
hand column.	

The best method of proving the truth of sums in Addition, is to add up the lines in a contrary direction: thus, if I begin at the bottom of the lines, when the sum is done, I add the figures again together, beginning each line from the top; and if the total in both cases correspond, it may be supposed right.

Compound Addition.

Compound Addition teacheth to collect several numbers of different denominations into one total.

Rule. (1) Place the numbers so that those of the same denomination may stand directly under each other, and draw a line below them. (2) Add up the figures in the lowest denomination, and find how many ones of the next higher denomination are contained in their sum. (3) Write down the remainder, and carry the ones to the next denomination; with which proceed as before; and so on, through all the denominations to the highest, whose sum must be all written down; and this sum, together with the several remainders, is the total sum required.

The method of proof is the same as in simple addition.

£.	s.	d.	£.	s.	d.
34	15	$2\frac{1}{4}$	51	18	$9\frac{1}{4}$
27	12	$9\frac{1}{2}$	15	9	$11\frac{1}{2}$
30	9	$11\frac{1}{2}$	76	4	9
79	15	$4\frac{1}{4}$	59	19	$7\frac{1}{2}$
172	13	$3\frac{3}{4}$	203	13	$1\frac{1}{4}$

The reason of this rule is evident: for, in addition of money, as 1 in the pence is equal to 4 in the farthings; 1 in the shillings to 12 in the pence; and in the pounds to 20 in the shillings; carrying as directed is nothing more than providing a method of digesting the money arising from each column properly in the scale of denominations: and, this reasoning will hold good in the addition of numbers of any denomination whatsoever. Thus to take an example in Troy weight, where 24 grains make a pennyweight, 20 pennyweights one ounce, and 12 ounces a pound.

lb.	*oz.*	*dwts.*	*gr.*	*lb.*	*oz.*	*dwts.*	*gr.*
45	11	19	22	54	9	17	15
53	9	17	15	97	8	15	7
24	10	18	23	41	3	19	23
99	9	10	8	88	11	7	16
224	6	6	20	282	10	0	13

Hence it is evident, that for a person to be expert in compound addition requires only a knowledge of the several tables of weights and measures: if, for instance, I have to pay for the carriage of four packages, marked A, B, C, and D; A weighing 4 tons, 16 cwt. 3 qrs.; B 1 ton, 14 cwt. 2 qrs. 24 lb.; C 12 cwt. 3 qrs. 25 lb.; and D 3 tons, 17 cwt. 0 qr. 26 lb.; to be able to ascertain the weight of the whole, it is necessary that I should know the Avoirdupoise Table, of which a part is, that 28 lb. make 1 quarter of a hundred weight, 4 quarters 1 hundred weight, and 20 hundred 1 ton; then I proceed as follows:

Tons.	*cwt.*	*qr.*	*lb.*
4	16	3	0
1	14	2	24
0	12	3	25
3	17	0	26
11	1	2	19

And I now find that I have to pay for 11 tons, 1 cwt. 2 qr. 19 lb.

Subtraction.

Subtraction is the operation by which we take a less number from a greater, and find their difference. The greater is called the *minuend*, and the less the *subtrahend*.

If any figure of the subtrahend be greater than the corresponding figure of the minuend, and having found and marked the difference, we add one to the next place of the subtrahend. This is called borrowing ten, because adding one to the subtrahend produces the same effect as taking one from the minuend.

Rule. Subtract units from units, tens from tens, and so on. If any figure of the subtrahend be greater than the corresponding one of the minuend, borrow ten.

Example.		
Minuend	5173694	47386414
Subtrahend	2421453	23792352
Remainder	2752241	23594062

To prove subtraction, add the remainder and subtrahend together; if their sum be equal to the minuend, the sum is right.

Or subtract the remainder from the minuend. If the difference be equal to the subtrahend, the sum is right.

Rule for Compound Subtraction. "Place like denominations under like, and borrow, when necessary, according to the value of the higher place."

lb.	*oz.*	*dwts.*	*grs.*	£.	*s.*	*d.*
45	8	14	15	95	7	$6\frac{1}{2}$
29	8	17	17	59	16	$9\frac{3}{4}$
15	11	16	22	35	10	$8\frac{1}{2}$

The reason for borrowing is the same as in simple subtraction. Thus in subtracting pence, we add 12 pence when necessary to the minuend, and at the next step, we add one shilling to the subtrahend.

The learner should acquire the habit, when two numbers are marked down, of placing such a number under the less, that, when added together, the sum may be equal to the greater. The operation is the same as subtraction, though conceived in a different manner, and is useful in balancing accounts, and on other occasions in the concerns of life.

Multiplication.

Multiplication is a compendious mode of addition, and teacheth to find the amount of any given number by repeating it any proposed number of times. Thus, 8 multiplied by 5, or 5 times 8, is 40. The given numbers (8 and 5) are called factors; the first (8) the multiplicand, the second (5) the multiplier; and the amount (20) the product.

Ex. 76859 mult. by 4, or 76859 added 4 times.

4	76859
	76859
307436	76859
	307436

If the multiplier be 10, we annex a cypher to the multiplicand. If the multiplier be 100, we annex two cyphers; and so on. The reason is obvious, from the use of cyphers in notation.

Rule. Place the multiplier under the multiplicand, and multiply the latter successively by the significant figures of the former; placing the right-hand figure of each product under the figure of the multiplier from which it arises; then add the product.

Ex. (a)	7329	37846	93956
	365	235	8704
	36645	189230	375824
	43974	113538	657692
	21987	75692	751648
	2675085	8893810	817793024

A number which cannot be produced by the multiplication of two others is called a prime number; as 3, 5, 7, 11.

A number which may be produced by the multiplication of two or more smaller ones, is called a composite number. For example, 27, which arises from the multiplication of 9 by 3; and these numbers (9 and 3) are called the component parts of 27.

If the multiplier be a composite number, we may multiply successively by the component parts.

Ex.] 7638 by 45, or 5 times 9

45	9
38190	68742
30552	5
343710	343710

Because the second product is equal to five times the first, and the first is equal to nine times the multiplicand, it is obvious that the second product must be five times nine, or forty-five times, as great as the multiplicand.

If the multiplier be 5, which is the half of 10, we may annex a cypher and divide by 2. If it be 25, which is the fourth part of 100, we may annex two cyphers, and divide by 4. Other contractions of the like kind will readily occur to the learner.

To multiply by 9, which is one less than 10, we may annex a cypher; and subtract the multiplicand from the number it composes. To multiply by 99,999, or any number of 9's, annex as many cyphers, and subtract the multiplicand. The reason is obvious; and a like rule may be found, though the unit place be different from 9.

Multiplication is proved by repeating the operation, using the multiplier for the multiplicand, and the multiplicand for the multiplier. Or it may be done by casting out the nines; that is, cast out the nines of the multiplier and multiplicand, and set down the remainders. Multiply the remainders together, and if the excess of nines in their product be equal to the excess of 9's in the total product, the work may be deemed right: thus, in Ex. (a) above, the excess of nines in the multiplicand is 3, and in the multiplier it is 5, and $3 \times 5 = 15$, or 6 above nine, which I find is the excess of nines in the total product. The best method of proving Multiplication is by division; and if that be adopted, the two rules must be learnt at the same time. Then the proof of each example in Multiplication becomes a sum in Division, and *vice versa*.

Compound Multiplication.

Compound Multiplication teacheth to find the amount of any given number of different denominations, by repeating it any proposed number of times.

Rule. (1) Place the multiplier under the lowest denomination of the multiplicand. (2) Multiply the number of the lowest denomination by the multiplier, and find how many ones of the next higher denomination are contained in the product. (3) Write down the excess, and carry the ones to the product of the next higher denomination, with which proceed as before; and so on, through all the denominations to the highest; whose product, together with the several excesses, taken as one number, will be the whole amount required.

Examples of Money.

9 lb. of tobacco, at 4s. $8\frac{1}{2}$d. per lb.

	4	$8\frac{1}{2}$
		9
£.	2	2 $4\frac{1}{2}$ the answer.

The product of a number consisting of several parts, or denominations, by any simple number whatever, will evidently be expressed by taking the product of that simple number and each part by itself as so many distinct questions; thus, 25*l.* 12*s.* 6*d.* multiplied by 9, will be 225*l.* 108*s.* 54*d.* = (by taking the shillings from the pence, and the pounds from the shillings, and placing them in the shillings and pounds respectively) 230*l.* 12*s.* 6*d.* which is the same as the rule; and this will be true when the multiplicand is any compound number whatever.

Case I. If the multiplier exceed 12, multiply successively by its component parts, instead of the whole number at once, as in simple multiplication.

Ex.] 16 cwt. of cheese, at 1*l.* 18*s.* 8*d.* per cwt.

1*l.*	18*s.*	8*d.*
		4
7	14	8
		4

30*l.* 18*s.* 8*d.* the answer.

Case II. If the multiplier cannot be produced by the multiplication of small numbers, find the nearest to it, either greater or less, which can be so produced; then, multiply by the component parts as before, and for the odd parts, add or subtract according as is required.

Ex.] 17 ells of holland, at 7*s.* $8\frac{1}{2}$*d.* per ell.

7*s.*	$8\frac{1}{2}$*d.*	
	4	
1	10	10
		4
6	3	4
	7	$8\frac{1}{2}$

6*l.* 11*s.* $0\frac{1}{2}$*d.* the answer.

Division.

Division teacheth to find how often one number is contained in another of the same denomination, and thereby performs the work of many subtractions.

The number to be divided is called the dividend.

The number you divide by is called the divisor.

The number of times the dividend contains the divisor is called the quotient.

If the dividend contains the divisor any number of times, and some part or parts over, those parts are called the remainder.

Rule. (1) On the right and left of the dividend draw a curved line, and write the divisor on the left hand, and the quotient as it arises on the right. (2) Find how many times the divisor may be had in as many figures of the dividend as are just necessary, and write the number in the quotient. (3) Multiply the divisor by the quotient figure, and set the product under that part of the dividend used. (4) Subtract the last-found product from that part of the dividend under which it stands, and to the right hand of the remainder bring down the next figure of the dividend; which number divide as before; and so on, till the whole is finished.

When the divisor does not exceed 12, the whole computation may be performed without setting down any figures except the quotient.

Ex.] 7)35868(5124 or 7)35868

5124

When the divisor is a composite number, and one of the component parts also measures the dividend, we may divide successively by the component parts.

EXAMPLE I.	EXAMPLE II.
30114 by 63	975 by $105 = 5 \times 7 \times 3$
9)30114	5)975
7)3346	3)195
Quotient 478	7)65
	Quotient $9\frac{2}{7}$

This method might be also used, although the component parts of the divisor do not measure the dividend; but the learner will not under-

stand how to manage the remainder till he be acquainted with the doctrine of vulgar fractions.

When there are cyphers annexed to the divisor, cut them off, and cut off an equal number of figures from the dividend; annex these figures to the remainder.

Ex.] To divide 378643 by 5200.

52'00)3786'43(72 $\frac{4243}{5200}$.
364

146
104

4243

The reason will appear by performing the operation at large, and comparing the steps.

Compound Division.

Compound Division teacheth to find how often one given number is contained in another of different denominations.

Rule. (1) Place the numbers as in simple division. (2) Begin at the left hand, and divide each denomination by the divisor, setting the quotients under their respective dividends. (3) But if there be a remainder, after dividing any of the denominations except the least, find how many of the next lower denomination it is equal to, and add it to the number, if any, which was in this denomination before; then divide the sum as usual, and so on till the whole is finished.

The method of proof is the same as in simple division.

Examples of Money.

Divide 225*l.* 2*s.* 4*d.* by 2.

2)225*l.* 2*s.* 4*d.*

112*l.* 11*s.* 2*d.* the quotient.

Case I. If the divisor exceed 12, divide continually by its component parts, as in simple division.

Ex.] What is cheese per cwt. if 16 cwt. cost 30*l.* 18*s.* 8*d.*

4)30*l.* 18*s.* 8*d.*

4) 7*l.* 14*s.* 8*d.*

1*l.* 18*s.* 8*d.* the answer.

Case II. If the divisor cannot be produced by the multiplication of small numbers, divide by it after the manner of long division.

Ex.] Divide 74*l.* 13*s.* 6*d.* by 17.

17) 74*l.* 13*s.* 6*d.*(4*l.* 7*s.* 10*d.* the quotient.
68

6
20

133
119

14
12

174
170

4

Reduction.

Reduction teaches to bring numbers from one name or denomination to another, without changing their value.

Rule. All great names are brought into smaller ones by multiplying with so many of the next less as make one of the greater, adding to the product the parts of the less name, if the number to be reduced be a compound one;—and all small names are brought into greater by dividing by as many of the less as make one of the greater.

EXAMPLES.

1. Reduce 255*l.* 6*s.* 9*d.* into pence.

20

5106
12

61281

Here it is evident that 61281 pence is equal to 255*l.* 6*s.* 9*d.*

2. How many pounds are there in 122562 pence?

12)122562

20)10213 — 6

Answer £. 510 13 6

The Rule of Three Direct.

The Rule of Three Direct teacheth, by having three numbers given, to find a fourth, that shall have the same proportion to the third as the second has to the first.

Rule. (1) State the question: that is, place the numbers so, that the first and third may be the terms of supposition and demand, and the second of the same kind with the answer required. (2) Bring the first and third numbers into the same denomination, and the second into the lowest name mentioned. (3) Multiply the second and third numbers together, and divide the product by the first, and the quotient will be the answer to the question, in the same denomination you left the second number in; which may be brought into any other denomination required.

The method of proof is by inverting the question.

Ex. If 12*lb.* of cheese cost 9*s.* 6*d.* what will 4 cheeses cost, each weighing 1*qr.* 6*lb.*?

If 12*lb.* : 9*s.* 6*d.* :: 1*qr.* 5*lb.* × 4.

12 — 28

114 — 33

4

132

114

528

1452

12)15048

12)1254 pence

20)104 6

£. 5 4 6

Note. This rule, on account of its great and extensive usefulness, is oftentimes called The Golden Rule of Proportion; for, on a proper application of it, and the preceding rules, the whole business of arithmetic, as well as every mathematical enquiry, depends. The rule itself is founded on this obvious principle, that the magnitude or quantity of any effect varies constantly in proportion to the varying part of the cause: thus, the quantity of goods bought is in proportion to the money laid out; the space gone over by an uniform motion is in proportion to the time, &c.—As the idea annexed to the term proportion is easily conceived, it would be more perplexing than instructive to explain, in this place, what is meant by it, in a strict geometrical sense. It may be sufficient, therefore, to observe, that, independent of the precise meaning of that word, and its deducible properties, the truth of the rule, as applied to ordinary enquiries, may be made very evident, by attending only to principles already explained.—It is shewn in multiplication of money, that the price of one multiplied by the quantity is the price of the whole: and in division, that the price of the whole divided by the quantity is the price of one. Now, in all cases of valuing goods, &c. where one is the first term of the proportion, it is plain that the answer found by this rule will be the same as that found by multiplication of money; and where one is the last term of the proportion, it will be the same as that found by division of money. In like manner, if the first term be any number whatever, it is plain that the product of the second and third terms will be greater than the true answer required, by as much as the price in the second term exceeds the price of one, or as the first term exceeds an unit. Consequently this product divided by the first term will give the true answer required, and is the rule.

The Rule of Three Inverse.

The Rule of Three Inverse teacheth by having three numbers given, to find a fourth, that shall have the same proportion to the second as the first has to the third.

If more require more, or less require less, the question belongs to the rule of three direct.

But if more require less, or less require more, it belongs to the rule of three inverse.

Rule. (1) State and reduce the terms as in the rule of three direct. (2) Multiply the first and second terms together, and divide their product by the third, and the quotient is the answer to the question, in the same denomination you left the second number in.

The method of proof is by inverting the question.

Ex.] What quantity of shalloon, that is 3 quarters of a yard wide, will line 7½ yards of cloth, that is 1¼ yard wide?

1 yd. 2 qrs. : 7 yds. 2 qrs. :: 3 qrs.

4 — 4

6 — 30

6

3)180

4)60

15 yards, the answer.

More requiring more, is when the third term is greater than the first, and requires the fourth term to be greater than the second.

And less requiring less, is when the third term is less than the first, and requires the fourth term to be less than the second.

In like manner, more requiring less, is when the third term is greater than the first, and requires the fourth term to be less than the second.

And less requiring more, is when the third term is less than the first, and requires the fourth term to be greater than the second.

The reason of this rule may be explained from the principles of compound multiplication and division, in the same manner as the direct rule. For example: If 6 men can do a piece of work in 10 days, in how many days will 12 men do it?

As 6 men : 10 days :: 12 men : $\frac{6\times10}{12}$ = 5 days,

the answer. And here the product of the first and second terms, i. e. 6 times 10, or 60, is evidently the time in which one man would perform the work: therefore 12 men will do it in one twelfth part of that time, or 5 days; and this reasoning is applicable to any instance whatever.

Compound Proportion.

Compound Proportion teacheth to resolve such questions as require two or more statings by simple proportion; and that whether they are direct or inverse.

Rule. (1) Let that term be put in the second place which is of the same denomination with the term sought. (2) Place the terms of supposition, one above another, in the first place; and the terms of demand, one above another, in the third place. (3) The first and third term of every row will be of one name, and must be reduced to the same denomination. (4) Examine every row separately: by saying, if the first term give the second, does the third require more or less? If it require more, mark the less extreme with a cross; but if less, mark the greater extreme. (5) Multiply all those numbers together which are marked for a divisor, and those which are not marked for a dividend, and the quotient will be the answer sought.

Note. When the same numbers are found in the divisor as in the dividend, they may be

thrown out of both. Or any numbers may be divided by their greatest common divisor, and the quotients taken instead of them.

Ex.] If 16 horses can eat up 9 bushels of oats in 6 days, how many horses will eat up 24 bushels in 7 days at the same rate?

$$\begin{matrix} +\ 9 \text{ bushels} \\ 6 \text{ days} \end{matrix} \vdots \begin{matrix} 16 \text{ horses} \\ \hline \end{matrix} :: \begin{matrix} 24 \text{ bushels} \\ 7 \text{ days} + \end{matrix}$$

$\frac{6 \times 16 \times 24}{9 \times 7}$, by contraction $= \frac{2 \times 16 \times 24}{3 \times 7}$ $= \frac{2 \times 16 \times 8}{1 \times 7} = \frac{256}{7} = 36\frac{4}{7}$ horses, the answ.

The reason of this rule may be readily shown from the nature of direct and inverse proportion: for every row in this case is a particular stating in one of those rules; and therefore if all the separate dividends be collected together into one dividend, and all the divisors into one divisor, their quotient must be the answer sought. Thus, in the example:

As 9 bush. : 16 horses :: 24 bush. : $\frac{24 \times 16}{9}$

by rule of three direct. As 6 days : $\frac{24 \times 16}{9}$ horses :: 7 days : $\frac{24 \times 16 \times 6}{9 \times 7}$ by rule of 3 inverse, which is the same as the rule.

Practice.

Practice is a contraction of the rule of three direct, when the first term happens to be an unit, or one; and has its name from its daily use amongst merchants and trademen, being an easy and concise method of working most questions that occur in trade and business.

The method of proof is by the rule of three direct.

An aliquot part of any number, is such a part of it, as being taken a certain number of times doth exactly make the number.

General Rule.

(1) Suppose the price of the given quantity to be 1l. or 1s. as is most convenient; then will the quantity itself be the answer at the supposed price. (2.) Divide the given price into aliquot parts, either of the supposed price, or of another, and the sum of the quotients belonging to each will be the true answer required.

Ex.] What is the value of *526* yards of cloth, at 3s. $10\frac{1}{4}$d. per yard.

		526			Ans. at 1l.			
3s. 4d.	is $\frac{1}{6}$	87	13	4	ditto at	0	3	4
4d.	is $\frac{1}{10}$	8	15	4	ditto at	0	0	4
2d.	is $\frac{1}{2}$	4	7	8	ditto at	0	0	2
$\frac{1}{4}$	is $\frac{1}{8}$	0	10	$11\frac{1}{2}$	ditto at	0	0	$0\frac{1}{4}$
		101	7	$3\frac{1}{2}$	ditto at	0	3	$10\frac{1}{4}$

the full price.

In the above example, it is plain that the quantity *526* is the answer at 1l. c; consequently, as 3s. 4d. is the $\frac{1}{6}$ of a pound, $\frac{1}{6}$ part of that quantity, or 87l. 13s. 4d. is the price of 3s. 4d. in like manner, as 4d. is the $\frac{1}{10}$ part of 3s. 4d. so $\frac{1}{10}$ of 87l. 13s. 4d. or 8l. 15s. 4d. is the answer at 4d. And by reasoning in this way 4l. 7s. 8d. will be shewn to be the price at 2d. and 10s. $11\frac{1}{2}$d. the price at $\frac{1}{4}$. Now as the sum of all these parts is equal to the whole price (3s. $10\frac{1}{4}$d.), so the sum of the answers belonging to each price will be the answer at the full price required. And the same will be true in any example whatever.

Vulgar Fractions.

In order to understand the nature of Vulgar Fractions, we must suppose unity (or the number 1) divided into several equal parts. One or more of these parts is called a fraction, and is represented by placing one number in a smaller character above a line, and another under it: For example, a two fifth part is written thus, $\frac{2}{5}$. The number under the line (5) shows how many parts unity is divided into, and is called the denominator. The number above the line (2) shows how many of these parts are represented, and is called the numerator.

It follows from the manner of representing fractions, that when the numerator is increased, the value of the fraction becomes greater; but, when the denominator is increased, the value becomes less. Hence we may infer, that, if the numerator and denominator be both increased, or both diminished, in the same proportion, the value is not altered; and, therefore, if we multiply both by any number whatever, or divide them by any number which measures both, we shall obtain other fractions of equal value. Thus, every fraction may be expressed in a variety of forms, which have all the same signification.

A fraction annexed to an integer, or whole number, makes a mixed number: For example, five and two third-parts, or $5\frac{2}{3}$. A fraction, whose numerator is greater than its denominator, is called an improper fraction: For example, seventeen third-parts, or $\frac{17}{3}$. Fractions of this kind are greater than unity. Mixed numbers may be represented in the form of improper fractions, and improper fractions may be reduced to mixed numbers, and sometimes to integers. A whole number may be treated as a fraction by making its denominator unity.

"To reduce mixed numbers to improper fractions: Multiply the integer by the denominator of the fraction, and to the product add the numerator. The sum is the numerator of the improper fraction sought, and is placed above the given denominator."

Examples. $7\frac{1}{4}$: $8\frac{3}{5}$: $9\frac{1}{2}$

4	5	2
29	43	19

The answers are $\frac{29}{4}$, $\frac{43}{5}$, and $\frac{19}{2}$.

Because one is equal to two halves, or 3 third-parts, or four quarters, and every integer is equal to twice as many halves, or four times as many quarters, and so on; therefore, every integer may be expressed in the form of an improper fraction, having any assigned denominator. The numerator is obtained by multiplying the integer into the denominator. Hence the reason of the foregoing rule is evident. *5*, reduced to an improper fraction, whose denominator is 3, makes $\frac{15}{3}$, and this added to $\frac{2}{3}$, amounts to $\frac{17}{3}$.

"To reduce improper fractions to whole or mixed numbers: Divide the numerator by the denominator."

Examples. $\frac{57}{9}$: $\frac{84}{11}$: $\frac{91}{18}$.

9)57	11)84	18)91($5\frac{1}{18}$
$6\frac{3}{9}$	$7\frac{7}{11}$	90
		1

The answers are $6\frac{3}{9}$, $7\frac{7}{11}$, and $5\frac{1}{18}$.

This problem is the converse of the former, and the reason may be illustrated in the same manner.

"To reduce fractions to lower terms: Divide both numerator and denominator by any number which measures both, and place the quotients in the form of a fraction."

Examples. $\frac{84}{27}$: $\frac{256}{16}$: $\frac{270}{360}$.

The answers are $\frac{28}{9}$; 16; $\frac{3}{4}$; for both the numerator and denominator of the first fraction is divisible by 3; of the second by 16; and of the third by 90: but the answers are of precisely the same value as the original fractions.

To find the greatest common measure of two numbers: Divide the greater by the less, and the divisor by the remainder continually, till nothing remain; the last divisor is the greatest common measure.

Ex. Required the greatest number which measures 475 and 589?

475)589(1
475
114)475(4
456
19)114(6
114
0

Here divide 589 by 475, and the remainder is 114; then divide 475 by 114, and the remainder is 19; then 114 by 19, and there is no remainder: from which we infer, that 19, the last divisor, is the greatest common measure.

To explain the reason of this, we must observe, that any number which measures two others, will also measure their sum, and their difference, and will measure any multiple of either. In the foregoing example, any number which measures 589 and 475, will measure their difference 114, and will measure 456, which is a multiple of 114; and any number which measures 475, and 456, will also measure their difference 19. Consequently, no number greater than 19 can measure 589 and 475. Again 19 will measure them both, for it measures 114, and therefore measures 456, which is a multiple of 114 and 475, which is just 19 more than 456: and, because it measures 475, and 114, it will measure their sum 589. To reduce $\frac{475}{589}$ to the lowest possible terms, we divide both numbers by 19, and it comes to $\frac{25}{31}$.

If there be no common measure greater than 1, the fraction is already in the lowest terms.

If the greatest common measure of 3 numbers be required, we find the greatest measure of the two first, and then the greatest measure of that number, and the third. If there be more numbers, we proceed in the same manner.

"To reduce fractions to others of equal value that have the same denominator: 1st. Multiply the numerator of each fraction by all the denominators except its own. The products are numerators to the respective fractions sought." 2d. "Multiply all the denominators into each other; the product is the common denominator."

Ex. $\frac{4}{5}$ and $\frac{7}{9}$ and $\frac{3}{8} = \frac{288}{360}$ and $\frac{280}{360}$ and $\frac{135}{360}$.

$4 \times 9 \times 8 = 288$ first numerator.
$7 \times 5 \times 8 = 280$ second numerator.
$3 \times 5 \times 9 = 135$ third numerator.
$5 \times 9 \times 8 = 360$ common denominator.

Here we multiply 4, the numerator of the first fraction, by 9 and 8, the denominators of the two others; and the product 288 is the numerator of the fraction sought, equivalent to the first. The other numerators are found in like manner, and the common denominator 360, is obtained by multiplying the given denominators 5, 9, 8, into each other. In the course of the whole operation the numerators and denominators of each fraction are multiplied by the same numbers, and therefore their value is not altered.

Addition of Vulgar Fractions.

Rule. Reduce them, if necessary, to a common denominator; add the numerators, and place the sum above the denominator.

Ex. 1. $\frac{3}{5} + \frac{2}{9} = \frac{27}{45} + \frac{10}{45} = \frac{37}{45}$.

2. $\frac{3}{7} + \frac{8}{9} + \frac{9}{10} = \frac{450}{630} + \frac{560}{630} + \frac{567}{630}$ $= \frac{1577}{630}$.

The numerators of fractions that have the same denominator signify like parts; and the reason for adding them is equally obvious, as that for adding shillings or any other inferior denomination.

Subtraction of Vulgar Fractions.

Rule. "Reduce the fractions to a common denominator; subtract the numerator of the subtrahend from the numerator of the minuend, and place the remainder above the denominator."

Examples. Subtract $\frac{3}{7}$ from $\frac{11}{12}$: and $\frac{5}{11}$ from $\frac{3}{4}$.

$\frac{11}{12} - \frac{3}{7}$ $\quad$ $\frac{3}{4} - \frac{5}{11}$

$11 \times 7 = 77$ $\quad$ $3 \times 11 = 33$

$3 \times 12 = 36$ $\quad$ $5 \times 4 = 20$

41 $\quad$ 13 rem.

$12 \times 7 = 84$ $\quad$ $4 \times 11 = 44$

The answers are $\frac{41}{84}$, and $\frac{13}{44}$.

To subtract a fraction from an integer: Subtract the numerator from the denominator, and place the remainder above the denominator; prefix to this the integer diminished by unity.

Ex. Subtract $\frac{3}{5}$ from 12. Remainder $11\frac{2}{5}$.

Multiplication of Vulgar Fractions.

Rule. "Multiply the numerators of the factors together for the numerator of the product, and the denominators together for the denominator of the product."

Ex. 1st. $\frac{2}{3} \times \frac{5}{7} = \frac{10}{21}$

$2 \times 5 = 10$ numerator

$3 \times 7 = 21$ denominator.

Ex. 2. $8\frac{2}{3} \times 7\frac{3}{4} = \frac{1302}{20} = 65\frac{2}{20}$

$8\frac{2}{3} = \frac{42}{5}$

$7\frac{3}{4} = \frac{31}{4}$

$42 \times 31 = 1302$

$5 \times 4 = 20$

To Multiply $\frac{5}{7}$ by $\frac{2}{3}$ is the same as to find what two-third parts of $\frac{5}{7}$ comes to; if one-third part only had been required, it would have been obtained by multiplying the denominator 7 by 3, because the value of fractions is lessened when their denominators are increased; and this comes to $\frac{5}{21}$; and, because two-thirds were required, we must double that fraction, which is done by multiplying the numerator by 2, and comes to $\frac{10}{21}$. Hence we infer that fractions of fractions, or compound fractions, such as $\frac{2}{7}$ of $\frac{3}{5}$, are reduced to simple ones by multiplication. The same method is followed when the compound fraction is expressed in three parts or more.

If a number be multiplied by any integer, its value is increased. If it be multiplied by 1, or taken one time, it undergoes no alteration. If it be multiplied by a proper fraction, or taken for one half, two-thirds, or the like, its value is diminished, and the product is less than the number multiplied.

Division of Vulgar Fractions.

Rule. (1) "Multiply the numerator of the dividend by the denominator of the divisor. The product is the numerator of the quotient." (2) "Multiply the denominator of the dividend by the numerator of the divisor. The product is the denominator of the quotient."

Ex. Divide $\frac{2}{5}$ by $\frac{7}{9}$. $\quad$ Quotient $\frac{18}{35}$.

$2 \times 9 = 18$

$5 \times 7 = 35$

To explain the reason of this operation; suppose it required to divide $\frac{2}{5}$ by 7, or to take one-seventh part of $\frac{2}{5}$. This is obtained by multiplying the denominator by 7 (for the value of fractions is diminished by increasing their denominators), and it comes to $\frac{2}{35}$. Again, because $\frac{7}{9}$ is nine times less than seven, the quotient of any number divided by $\frac{7}{9}$ will be nine times greater than the quotient of the same number divided by 7. Therefore we multiply $\frac{2}{35}$ by 9, and obtain $\frac{18}{35}$.

If the divisor and dividend have the same denominator it is sufficient to divide the numerators.

Ex. $\frac{12}{17}$ divided by $\frac{3}{17}$ quotes 4.

The quotient of any number divided by a proper fraction is greater than the dividend. It is obvious, that any integer contains more halves, more third parts, and the like, than it contains units; and, if an integer and fraction be divided alike, the quotients will have the same proportion to the numbers divided; but the value of an integer is increased when the divisor is a proper fraction; therefore the value of a fraction in the like case is increased also.

The foregoing rule may be extended to every case, by reducing integers and mixed numbers to the form of improper fractions.

Decimal Fractions.

A decimal fraction is a fraction whose denominator is ten or some power of ten: but instead of writing down the denominator, a comma is placed before the number, to mark the fraction; and whatever number of figures follows the comma, the same is the index of the power of ten in the denominator, or there must be as many cyphers after unit in the denominator, as figures after the comma.

Thus 4,7 is 4 and $\frac{7}{10}$.

.47 signifies Forty-seven hundredth parts.

.047 Forty-seven thousandth parts.

.407 Four hund. and 7 thousandth parts.

4.07 Four, and seven hundredth parts.

4.007 Four, and seven thousandth parts.

To reduce vulgar fractions to decimal ones: "Annex a cypher to the numerator, and divide it by the denominator, annexing a cypher continually to the remainder."

EXAMPLES.

$\frac{12}{75} = .16$

75)120(16

75

450

450

0

$\frac{5}{64} = .078125$

64)500(078125

448

520

512

80

64

160

128

320

320

$\frac{2}{3} = .666$ &c.

3)20(666

18

20

18

20

18

20.

The reason of this operation will be evident, if we consider that the numerator of a vulgar fraction is understood to be divided by the denominator; and this division is actually performed when it is reduced to a decimal.

Some vulgar fractions may be reduced to decimals, and are called finite decimals. Others cannot be exactly reduced, because the division always leaves a remainder; but, by continuing the division, we shall perceive how the decimal may be extended to any length whatever. These are called infinite decimals.

Lower denominations may be considered as fractions of higher ones, and reduced to decimals accordingly.

The value of decimal places decreases like that of integers, ten of the lower place in either being equal to one of the next higher; and the same holds in passing from decimals to integers. Therefore, all the operations are performed in the same way with decimals, whether placed by themselves or annexed to integers, as with pure integers. The only peculiarity lies in the arrangement and pointing of the decimals.

In addition and subtraction, "Arrange units under units, tenth-parts under tenth-parts, and proceed as in integers."

Add		from	
	32.035		13.348
	186.374	take	9.2993
	160.63		4.0487
	12.3645		
	341.4035		

In multiplication, "Allow as many decimal places in the product as there are in both factors. If the product has not so many places, supply them by prefixing cyphers on the left hand."

Ex. 1st. 1.37 $\quad$ 2d. .1572

1.8 $\quad$ .12

1096 $\quad$ .018864

137

2.466

The reason of this rule may be explained, by observing that the value of the product depends on the value of the factors: and since each decimal place in either factor diminishes its value ten times, it must equally diminish the value of the product.

To multiply decimals by 10, move the decimal point one place to the right; to multiply by 100, 1000, or the like, move it as many places to the right as there are cyphers in the multiplier.

In division, "Point the quotient so that there may be an equal number of decimal places in the dividend as in the divisor and quotient together."

Ex. Divide 14 by .7854.

.7854)14.000000(17.82 &c.

7854

61460

54978

64820

62832

19880

Therefore, if there be the same number of decimal places in the divisor and dividend, there will be none in the quotient.

Ex. Divide .75 by .25. Answer 3, which is a whole number.

If there be more in the dividend, the quotient will have as many as the dividend has more than the divisor. See above.

If there be more in the divisor, we must annex (or suppose annexed) as many cyphers to the dividend as may complete the number of decimals in the divisor, and all the figures of the quotient are integers.

Ex. Divide 8 by .125.

.125)8.000(64 Answer in whole numbers.

7.50

500

500

0

To reduce numbers of different denominations to their equivalent decimal values: Rule. (1) Write the given numbers perpendicularly under each other, beginning at the least. (2) Opposite each dividend, on the left hand, place such a number for a divisor as will bring it to the next superior name, and draw a perpendicular line between them. (3) Begin with the highest; and write the quotient of each division, as decimal parts, on the right hand of the dividend next below it, and so proceed to the last; and the last quotient is the decimal sought.

Ex. Reduce 15s. $9\frac{1}{4}$d. to the decimal of a £.

4 | 3.

12 | 9.75

20 | 15.8125

.790625 the decimal required.

To find the value of any given decimal in terms of the integer. Rule. Multiply the decimal by the number of parts in the next less denomination, and cut off as many places for a remainder, to the right hand, as there are places in the given decimal; and so proceed with the rest.

Ex. What is the value of .375 of a £.

.375

20

s. 7.500

12

d. 6.000 $\quad$ Answer 7s. 6d.

If the divisor leave a remainder, the quotient may be extended to more decimal places;

but those are not regarded in fixing the decimal point. See above.

The reason for fixing the decimal point as directed, may be inferred from the rule followed in multiplication. The quotient multiplied by the divisor produces the dividend; and therefore the number of decimal places in the dividend is equal to those in the divisor and quotient together.

Some decimals, though extended to any length, are never complete; and others, which terminate at last, sometimes consist of so many places, that it would be difficult in practice to extend them fully. In these cases, we may extend the decimal to three, four, or more places, according to the nature of the articles, and the degree of accuracy required. In this manner we may perform any operation with ease by the common rules, and the answers we obtain are sufficiently exact for any purpose in business.

On the Extracting of Roots.

The root is a number, whose continual multiplication into itself produces the power; and is denominated the square, cube, 4th, 5th, root, &c. according as it is, when raised to the 2d, 3d, 4th, 5th, &c. power, equal to that power. Thus 2 is the square root of 4, because $2 \times 2 = 4$; and 4 is the cube root of 64, because $4 \times 4 \times = 64$; and so on.

Although there is no number of which we cannot find any power exactly, yet there may be many numbers of which a precise root can never be determined. But, by the help of decimals, we can approximate towards the root, to any assigned degree of exactness.

The roots which approximate are called surd roots, and those which are perfectly accurate are called rational roots.

Roots are sometimes denoted, as in algebra, by writing the character $\surd$ before the power, with the index of the root against it: thus, the third root of 70 is expressed $\sqrt[3]{70}$, and the second root of it is $\surd 70$, the index 2 being always omitted when the square or second root is designed.

If the power be expressed by several numbers, with the sign + or − between them, a line is drawn from the top of the sign over all the parts of it; thus, the third root of 28 − 13 is $\sqrt[3]{28 - 13}$.

Sometimes roots are designed like powers, with fractional indices; thus, the square root of 5 is $5^{\frac{1}{2}}$, the third root of 19 is $19^{\frac{1}{3}}$, and the fourth root of 40 − 12 is $\overline{40 - 12}^{\frac{1}{4}}$, &c.

To extract the Square Root.

Rule. (1) Distinguish the given number into periods of two figures each, by putting a point over the place of units, another over the place of hundreds, and so on. (2) Find a square number either equal to, or the next less than, the first period; and put the root of it to the right hand of the given number, after the manner of a quotient figure in division, and it will be the first figure of the root required. (3) Subtract the assumed square from the first period, and to the remainder bring down the next period for a dividend. (4) Place the double of the root already found, on the left hand of the dividend, for a divisor. (5) Consider what figure must be annexed to the divisor, so that, if the result be multiplied by it, the product may be equal to, or the next less than, the dividend, and it will be the 3d figure of the root. (6) Subtract the product from the dividend, and to the remainder bring down the next period, for a new dividend. (7) Find a divisor as before, by doubling the figures already in the root; and from these find the next figures of the root, as in the last article; and so on through all the periods to the last.

Note. If there are decimals in the given number, it must be pointed both ways from unity, and the root be made to consist of as many whole numbers and decimals as there are periods belonging to each; and when the figures belonging to the given number are exhausted, the operation may be continued at pleasure by adding cyphers.

examples.

Required the square root of 5199025.

$\dot{5}\dot{1}\dot{9}\dot{9}\dot{0}\dot{2}\dot{5}$(2345 the root.
4

43)149
129

464)2090
1856

4685)23425
23425

0

Extraction of the Cube Root.

Rule. (1) Find by trial the nearest rational cube to the given number, and call it the *assumed* cube. (2) Then, as twice the assumed cube added to the given number, is to twice the given number added to the supposed cube, so is the root of the supposed cube to the root required nearly. (3) By taking the cube of the root thus found for the supposed cube, and repeating the operation, the root may be had to a still greater degree of exactness.

Ex. 1. What is the cube root of 12484?

By trial I find the nearest root, less than the given number, is 23, the cube of which is 12167.

Then $12167 \times 2 + 12484 = 36818$, and $12484 \times 2 + 12167 = 37135$. Therefore as $36818 : 37135 :: 23 : 23.198$, and 23.198 is the root required nearly.

2. What is the cube root of 2?

As the nearest rational root is 1, we have $1 \times 2 + 2 = 4$, and $2 \times 2 + 1 = 5$.

Then $4 : 5 :: 1 : \frac{5}{4} = 1.25 =$ root nearly.

Again, the cube of $\frac{5}{4} = \frac{125}{64}$, therefore $\frac{125}{64} \times 2 + 2 : 2 \times 2 + \frac{125}{64} :: \frac{5}{4}$, or $\frac{378}{64} : \frac{381}{64} :: \frac{5}{4} : \frac{635}{504} = 1.2599$, &c.

To extract the Roots of Powers in General.

Rule 1. Prepare the given number for extraction, by pointing off from the units place as the root required directs.

2. Find the first figure of the root by trial, and subtract its power from the given number.

3. To the remainder bring down the first figure in the next period, and call it the dividend.

4. Involve the root to the next inferior power to that which is given, and multiply it by the number denoting the given power for a divisor.

5. Find how many times the divisor may be had in the dividend, and the quotient will be another figure of the root.

6. Involve the whole root to the given power, and subtract it from the given number as before.

7. Bring down the first figure of the next period to the remainder for a new dividend, to which find a new divisor, and so on till the whole is finished.

Ex. What is the cube root of 53157376?

$\dot{5}\dot{3}\dot{1}\dot{5}\dot{7}\dot{3}\dot{7}\dot{6}$(376?
$27 = 3^3$

$3^2 \times 3 = 27)261$ dividend.

$50653 = 37^3$

$3^2 \times 3 = 4107)25043$ second dividend.
53157376

0

The reason of the process in the Extraction of Roots may be seen in Algebra, p. 58.

Thus have we gone over all the principal rules in common arithmetic, giving under each an example or examples, by the assistance of which the reader may invent any number of others for his own improvement in the branch of science. We have not touched upon simple interest, discount, loss and gain, &c. because these are but modifications of the Rule of Three; and may be done either by the rules there given, or by Practice. We doubt not that this article, if followed by that under the word Algebra, (which though first in order in a dictionary necessarily comes last in practice) will be found sufficient for almost all purposes in common life.

ARITHMETIC, decimal, that containing the doctrine of decimal fractions. See Arithmetic.

Arithmetic of infinites, the doctrine of infinite series. See Series.

Arithmetic, instrumental, that performed by means of instruments, as the abacus or counting-board, Napier's bones, &c.

Arithmetic, literal, the same with specious. See Algebra.

Arithmetic, logarithmetical, that performed by means of logarithms. See Logarithm.

Arithmetic, logistical, the same with sexagesimal.

Arithmetic, sexagesimal, the doctrine of sexagesimal fractions.

Arithmetic, specious, the same with algebra. See Algebra.

ARITHMETICAL *complement of a logarithm*, the sum or number which a logarithm wants of 10,000000: thus the arithmetical complement of the logarithm 8.154032 is 1.845968.

Arithmetical *progression*. See Algebra, p. 54.

Arithmetical *proportion*. See Algebra, p. 54.

ARITHMOMANCY, a species of divination performed by means of numbers.

ARLEQUIN, an English trivial name applied to some birds, insects, shells, &c. remarkable for their striking colours.

ARM, in respect of the magnet. A loadstone is said to be armed when it is inclosed, capped, or set in iron or steel, in order to increase its magnetic virtue.

Arm, in sea language. A ship is said to be armed when fitted out and provided in all respects for war.

ARMADILLO. See Dysapus.

ARMED, in the sea language. A cross-bar shot is said to be armed when some rope-yarn or the like is rolled about the end of the iron bar which runs through the shot.

Armed, in heraldry, is used when the horns, feet, beak, or talons, of any beast or bird of prey, are of a different colour from the rest of their body. He bears a cock or a falcon armed or, &c.

ARMENIANS, in church history, a sect or division amongst the eastern Christians; thus called from Armenia, the country anciently inhabited by them. There are two kinds of Armenians; the one catholic, and subject to the pope, having a patriarch in Persia and another in Poland; the other makes a peculiar sect, having two patriarchs in Natolia. They are generally accused of being monophysites, only allowing of one na-

ture in Jesus Christ. As to the eucharist, they, for the most part, agree with the Greeks; they abstain rigorously from eating of blood, and meats strangled, and are much addicted to fasting.

ARMENTA. See Bos.

ARMIGER, an esquire, or armour-bearer.

ARMILLA *membranosa*, in anatomy, is that circular ligament which comprehends all the tendons belonging to the whole hand within a circle, in the region of the carpus.

ARMILLARY, ARMILLARIS, in a general sense, something consisting of rings, or circles, from *armilla*, a bracelet.

ARMILLARY *sphere*, an artificial sphere, composed of a number of circles, representing the several circles of the mundane sphere, put together in their natural order, to ease and assist the imagination in conceiving the constitution of the heavens, and the motions of the celestial bodies.

The armillary sphere turns upon its axis P *p*, Plate IX. Miscel. fig. 4. within a silvered horizon H O, which is divided into degrees, and moveable every way, upon a brass supporter. E Q represents the equinoctial, and A B the zodiac, which is a broad circle divided into degrees, and into twelve equal parts, marked with the twelve signs ♈, ♉, ♊, &c. P Q *p* E, is the meridian, likewise divided into degrees.

The other parts are the two tropics, and two polar circles, both delineated in the figure.

ARMINIANS, in church history, a sect of Christians, which arose in Holland, by a separation from the Calvinists. They are great asserters of free-will. They speak very ambiguously of the prescience of God. They look on the doctrine of the Trinity as a point not necessary to salvation; and many of them hold there is no precept in scripture by which we are enjoined to adore the Holy Ghost; and that Jesus is not equal to God the Father.

ARMOISIN, a silk stuff, or kind of taffety, manufactured in the East Indies, at Lyons in France, and Lucca in Italy. That of the Indies is slighter than those made in Europe.

ARMONIAC. See AMMONIA.

ARMONICA. See HARMONICA.

ARMORIAL. See HERALDRY.

ARMOUR denotes all such habiliments as serve to defend the body from wounds, especially of darts, a sword, a lance, &c. A complete suit of armour formerly consisted of a helmet, a shield, a cuirasse, a coat of mail, a gauntlet, &c. all now laid aside.

ARMS, *charged*, in heraldry, are such as retain their ancient integrity, with the addition of some new honourable bearing.

ARMS, *canting* or *vocal*, those in which there are some figures, alluding to the name of the family.

ARMS, *full* or *entire*, such as retain their primitive purity, without any alterations or abatements.

ARMS, *false*, such as are not conformable to the rules of heraldry.

ARMS, in falconry, the legs of a hawk from the thigh to the foot.

ARMS, *king at*, } see HERALD.
ARMS, *herald at*, }

ARMS, *poursuivant at*, see POURSUIVANT.

ARMS, *college of*, see COLLEGE *of arms*.

ARMY. An army is composed of squadrons and battalions, and is usually divided into three corps, and formed into three lines; the first line is called the van-guard, the second the centre or main body, and the third the rear-guard, or body of reserve. The middle of each line is possessed by the foot; the cavalry forms the right and left wing of each line; and sometimes they place squadrons of horse in the intervals between the battalions. When the army is drawn up in order of battle, the horse are placed at five feet distance from each other, and the foot at three. In each line the battalions are distant from each other 180 feet, which is nearly equal to the extent of their front; and the same holds of the squadrons, which are about 300 feet distant, the extent of their own front. These intervals are left for the squadrons and battalions of the second line to range themselves against the intervals of the first, that both may more readily march through those spaces to the enemy: the first line is usually 300 feet distant from the second, and the second from the third, that there may be sufficient room to rally, when the squadrons and battalions are broken.

An army sometimes acquires different appellations from the particular services in which it is employed. A *covering* army is that which covers a place, by lying encamped for the protection of the different passes which lead to the principal object of defence. An army is said to *blockade* a place when, being well provided with heavy artillery, &c. it is employed to invest a town for the purpose of reducing it by assault or famine. An army of *observation* is so called because, by its advanced positions and desultory movements, it is constantly employed in watching the enemy. Such is a body of troops engaged by besiegers to prevent relief being brought into a place, or the siege being raised by the enemy. An army of *reserve* is a sort of general *depot* for effective service. In cases of emergency, the whole, or part of an army of reserve, is employed, to recover a lost day, or to secure a victory. A *flying* army is a strong body of horse and foot, usually commanded by a lieutenant-general, which is always in motion, to cover its own garrisons, or to keep the enemy in perpetual alarm.

ARNICA, *leopard's bane*, in botany, a genus of the polygamia superflua order, belonging to the syngenesia class of plants; and in the natural method ranking under the forty-ninth order, *compositæ-discoides*. The receptacle is naked; the pappus is simple; and the filaments are five, without antheræ. There are twelve species, five of which are European, and have been used in medicine as discutients in chronic rheumatism, lumbago, &c.; also internally in intermittents.

ARNOLDISTS, in church history, sectaries so called from their leader Arnold of Bresia, who was a great declaimer against the wealth and vices of the clergy; and who is also charged with preaching against baptism and the eucharist.

AROLEC, an American weight, equal to twenty-five of our pounds.

AROMA, or the odorant principle of plants, is distinctly characteristic in each individual. Water impregnated with this principle, is termed the distilled water of the plant; of these a great variety is used in pharmacy.

AROMATICS, in pharmacy, substances that possess a fragrant penetrating smell, a strong pungent taste, and a considerable stimulating power on the system in general. See MATERIA MEDICA.

AROURA, a Grecian measure of fifty feet. It was more frequently used for a square measure of half the plethron. The Egyptian aroura was the square of one hundred cubits.

ARPENT, a term sometimes used to denote an acre.

ARRACHE'E, in heraldry, a term applied to the representations of plants torn up by the roots.

ARRACK, or RACK, a spirituous liquor imported from the East Indies, used by way of dram and in punch. The word arrack, according to Mr. Lockyer, is an Indian name for strong waters of all kinds; for they call our spirits and brandy English arrack. But what we understand by the name arrack, he affirms is properly no other than a spirit procured by distillation from a vegetable juice called toddy, which flows by incisions out of the cocoa-nut tree, like the birch juice procured among us. The toddy is a pleasant drink by itself, when new, but purges those who are not used to it; when stale, it is heady, and makes good vinegar. The English at Madras use it as leaven to raise their bread with.

There are, however, several kinds of arrack, distinguished by different names; such as Batavia arrack, a vinous spirit obtained by distillation from rice and sugar fermented with the juice of cocoa-nuts. It is a strong spirit; but being made in copper stills, is not so agreeable as Goa arrack. Bitter, black, and Columbo arrack, are hot spirits little valued, and seldom imported by Europeans.

The manner of making the Goa arrack is this: The juice of the trees is not procured in the way of tapping, as we do; but the operator provides himself with a parcel of earthen pots, with bellies and necks like our bird-bottles; he makes fast a number of these to his girdle, and any way else that he commodiously can about him. Thus equipped, he climbs up the trunk of a cocoa-tree; and when he comes to the boughs, he takes out his knife, and cutting off one of the small knots or buttons, he applies the mouth of the bottle to the wound, fastening it to the bough with a bandage; in the same manner he cuts off other buttons, and fastens on his pots, till the whole number is employed: this done in the evening, descending from the tree, he leaves them till the next morning; when he takes off the bottles, which are mostly filled, and empties the juice into the proper receptacle. This is repeated every night, till a sufficient quantity is produced; and the whole being then put together, is left to ferment, which it soon does. When the fermentation is over, and the liquor or wash is become a little tart, it is put into the still, and a fire being made, the still is suffered to work as long as that which comes over has any considerable taste of spirit. The liquor thus procured is the low wine of arrack; and this is so poor a liquor, that it will soon corrupt and spoil, if not distilled again, to separate some of its watery parts; they therefore immediately after pour back this low wine into the still, and rectify it to that very weak kind of proof-spirit, in which state we find it. The arrack we meet with, notwithstanding its being a proof test, according to the way of judging

by the crown of bubbles, holds but a sixth, and sometimes but an eighth, part of pure spirit; whereas our other spirits, when they show that proof, are generally esteemed to be one half pure spirit. There is a paper of observations on arrack, in the *Melanges d'Histoire Natur.* tom. v. p. 302. By fermenting, distilling, and rectifying the juice of the American maple, which has much the same taste as that of the cocoa, the author says he made arrack not in the least inferior to any that comes from the East Indies; and he thinks the juice of the sycamore and of the birch trees would equally answer the end.

Arrack is not to be sold in Great Britain but in warehouses entered as directed by 6th of Geo. I. cap. 21. upon forfeiture, and casks, &c.

ARRACK, *tungusian*, is a spirituous liquor made by the Tartars of Tungusia, of mare's milk, left to sour, and afterwards distilled twice or thrice between two earthen pots closely stopped, whence the liquor runs through a small wooden pipe. It is more intoxicating than brandy.

ARRAGONITE. See MINERALOGY.

ARRAIGNMENT, in law, the arraigning or setting a thing in order; as a person is said to arraign a writ of novel disseisin, who prepares and fits it for trial. It is most properly used to call a person to answer in form of law upon an indictment, &c. at the suit of the king.

ARRAY, in law, the ranking or setting forth of a jury or inquest of men impannelled on a cause.

ARRENTATION, in the forest-law, is the licensing an owner of lands in a forest, to inclose them with a low hedge, and a small ditch, in consideration of a yearly rent.

ARREST, the apprehending and restraining a person, in order to oblige him to be obedient to the law; which in all cases, except treason, felony, or breach of the peace, must be done by virtue of a precept out of some court. Outer doors may be broken open to arrest a felon; but in civil cases it is otherwise, unless it is in pursuit of one before taken.

Attorneys, &c. maliciously causing any person to be arrested, shall forfeit ten pounds and treble damages. The same penalty is incurred for arresting a person (except in criminal cases, and an escape-warrant) on Sundays; but arrests made in the night are equally lawful with those by day.

Peers of the realm, and members of parliament, may not be arrested for debt; nor can any other subject be arrested for less than 10*l.* on a process issued out of a superior court, or 40*s.* in an inferior one.

ARREST *of judgment*, the assigning just reasons why judgment should not pass; as want of notice of the trial, a material defect in the pleading, when the record differs from the deed pleaded, when persons are misnamed, when more is given by the verdict than is laid in the declaration, &c. This may be done either in criminal or civil cases.

ARRESTANDIS *bonis*, &c. a writ that lies for one whose cattle or goods are taken by another, who is likely to carry them away before the contest is decided.

ARRESTO *facto super bonis*, &c. a writ brought by a denizen against the goods of aliens found within this kingdom, as a recompence for goods taken from him in a foreign country.

ARRHABONARII, a sect of Christians who held that the eucharist is neither the real flesh nor blood of Christ, nor yet the sign of them, but only the pledge or earnest of them.

ARRHEPHORIA, a feast among the Athenians, instituted in honour of Minerva, and Herse daughter of Cecrops.

ARROBA, a weight used in Spain, in Portugal, at Goa, and throughout all Spanish America. The arroba of Portugal is 32 Lisbon lbs. of Spain 25 Spanish lbs.

ARRONDE'E, in heraldry, a cross, the arms of which are composed of sections of a circle: not opposite to each other, so as to make the arms bulge out thicker in one part than another; but the sections of each arm lying the same way, so that the arm is every where of an equal thickness, and all of them terminating at the edge of the escutcheon like the plain cross.

ARROW, in surveying, small sticks shod with iron, to stick into the ground at the end of the chain.

ARROW, in astronomy. See SAGITTA.

ARSCHIN, in commerce, a long measure used in China to measure stuffs. Four arschins make three yards of London.

ARSENIC, one of the semi-metals, in a combined state, or in the state of an ore, extremely fatal as a poison, whence its name: (composed of ανηρ, a man, and νικαω, to kill.) It is commonly seen in the state of a calx, oxide, or ore, the natural colour of which is white.

The white oxide of arsenic, or what is known in commerce by the name of arsenic, is mentioned by Avicenna in the eleventh century; but at what period the metal called arsenic was first extracted from that oxide is unknown. It was only in the year 1733 that this metal was examined with chemical precision. This examination, which was performed by Mr. Brandt, demonstrated its peculiar nature; and since that time it has always been considered as a distinct metal, to which the term *arsenic* has been appropriated.

Arsenic has a bluish-white colour not unlike that of steel, and a good deal of brilliancy. It has no sensible smell while cold, but when heated it emits a strong odour of garlic, which is very characteristic. Its specific gravity is 8.31. It is perhaps the most brittle of all the metals, falling to pieces under a very moderate blow of a hammer, and admitting of being easily reduced to a very fine powder in a mortar. Its fusing point is not known, because it is the most volatile of the metals, subliming without melting when exposed in close vessels to a heat of 540°. When sublimed slowly, it crystallizes in tetrahedrons, which Hauy has demonstrated to be the form of its integrant particles. It may be kept under water without alteration; but when exposed to the open air, it soon loses its lustre, becomes black, and falls into powder.

Arsenic is capable of combining with two doses of oxygen, and of forming compounds. When exposed to a moderate heat, in contact with air, it sublimes in the form of a white powder, and at the same time emits a smell resembling garlic. If the heat is increased, it burns with an obscure bluish flame. Arsenic, indeed, is one of the most combustible of the metals. The substance which sublimes was formerly called *arsenic* or *white arsenic*, and is still known by these names in the commercial world. It is a combination of arsenic and oxygen; and is now denominated *white oxyde of arsenic*, and by Fourcroy *arsenious acid*, because it possesses several of the properties of an acid. It is seldom prepared by chemists, because it exists native; and is often procured abundantly during the extraction of the other metals from their ores. When obtained by these processes, it is a white, brittle, compact substance, of a glassy appearance. It has a sharp acrid taste, which at last leaves an impression of sweetness, and is one of the most virulent poisons known. It has an alliaceous smell. It is soluble in 80 parts of water at the temperature of 60°, and in 15 parts of boiling water. This solution has an acrid taste, and reddens vegetable blues. When it is slowly evaporated, the oxide crystallizes in regular tetrahedrons. This oxide sublimes when heated to 283°: if heat is applied in close vessels, it becomes pellucid like glass; but when exposed to the air, it soon recovers its former appearance. The specific gravity of this glass is 5.000; that of the oxide, in its usual state, 3.706. This oxide is capable of combining with most of the metals, and in general renders them brittle. From the experiments of Proust it appears, that this oxide is composed of . . . 75.2 arsenic,
24.8 oxygen.

100.0

Arsenic is capable of combining with an additional dose of oxygen, and of forming another compound, first discovered by Scheele, known by the name of arsenic acid. The process prescribed by Scheele is, to dissolve three parts of white oxide of arsenic in seven parts of muriatic acid, to add five parts of nitric acid, to put the mixture into a retort, and distil to dryness. The dry mass is to be merely brought to a red heat, and then cooled again. It is solid arsenic acid.

Arsenic does not combine with carbon nor hydrogen. This last substance, however, when in the gaseous state, dissolves it; for when muriatic acid is boiled over arsenic, that metal is gradually oxidized and dissolved, and at the same time hydrogen gas is emitted, which has the smell and the poisonous qualities of arsenic. Sulphur combines readily with arsenic. If we put a mixture of these two bodies into a covered crucible and melt them, a red vitreous mass is obtained, which is obviously a sulphuret of arsenic. It may be formed also by heating together the white oxide of arsenic, or arsenic acid and sulphur. But in that case a portion of the sulphur absorbs the oxygen from the arsenic, and makes its escape in the form of sulphureous acid gas. If the white oxide of arsenic is dissolved in muriatic acid, and a solution of sulphureted hydrogen in water is poured into the liquid, a fine yellow-coloured powder falls to the bottom. This powder is usually called orpiment. It may be formed by subliming arsenic and sulphur by a heat not sufficient to melt them. This substance is also found native. It is composed of thin plates, which have a considerable degree of flexibility. Its specific gravity is 5.315.

Arsenic combines readily with phosphorus. The phosphuret of arsenic may be formed by distilling equal parts of its ingredients over

a moderate fire. It is black and brilliant, and ought to be preserved in water. It may be formed likewise by putting equal parts of phosphorus and arsenic into a sufficient quantity of water, and keeping the mixture moderately hot for some time.

Arsenic does not combine with azotic gas nor muriatic acid; neither is it readily oxidized by the action of that acid; but it unites with most metals, and in general renders them more brittle and fusible. Melted gold takes up 1-60th of arsenic. The alloy is brittle and pale, and much harder than gold. The alloy of platina and arsenic is brittle and very fusible. The arsenic may be separated by heat. It is by fusing platina and the white oxide of arsenic together that this untractable metal is formed into the utensils required. The mixture, after fusing, is hammered at a red heat into bars. The arsenic is gradually driven off, and carries along with it most of the baser metals which happen to be present. The platina is then sufficiently ductile to be wrought. Melted silver takes up 1-14th of arsenic. The alloy is brittle, yellow-coloured, and useless. Mercury may be amalgamated with arsenic by keeping them for some hours over the fire, constantly agitating the mixture. The amalgam is grey-coloured, and composed of five parts of mercury and one of arsenic. Copper may be combined with arsenic by fusing them together in a close crucible; while their surface is covered with common salt to prevent the action of the air, which would oxidize the arsenic. This alloy is white and brittle, and is used for a variety of purposes; but it is usual to add to it a little tin or bismuth. It is known by the names of white copper and white tombac. When the quantity of arsenic is small, the alloy is both ductile and malleable. Iron and arsenic may be alloyed by fusion. The alloy is white and brittle, and may be crystallized. It is found native; and is known among mineralogists by the name of mispickel. Iron is capable of combining with more than its own weight of arsenic. Tin and arsenic may be alloyed by fusion. The alloy is white, harder, and more sonorous than tin; and brittle, unless the proportion of arsenic is very small. An alloy, composed of 15 parts of tin, and one of arsenic, crystallizes in large plates like bismuth: it is more brittle than zinc, and more infusible than tin. The arsenic may be separated by long exposure of the alloy to heat in the open air. Lead and arsenic may be combined by fusion. The alloy is brittle, dark-coloured, and composed of plates. Lead takes up 1-6th of its weight of arsenic. Nickel combines readily with arsenic, and indeed is seldom found without being more or less contaminated by that metal. The compound has a shade of red, considerable hardness, and a specific gravity considerably under the mean. It is not magnetic. Arsenic possesses the curious property of destroying the magnetic virtue of iron, and all other metals susceptible of that virtue. Zinc may be combined with arsenic by distilling a mixture of it and of white oxide of arsenic. This alloy, according to Bergman, is composed of four parts of zinc and one of arsenic. Antimony forms with arsenic an alloy which is very brittle, very hard, and very fusible; and composed, according to Bergman, of seven parts of antimony and one part of arsenic. Bismuth may be combined with about 1-15th of its weight of arsenic; but the properties of this alloy have not been examined.

The affinities of arsenic, and of its oxides, are placed by Bergman in the following order:

Arsenic.	*Oxide of arsenic.*
Nickel,	Muriatic acid,
Cobalt,	Oxalic,
Copper,	Sulphuric,
Iron,	Nitric,
Silver,	Tartaric,
Tin,	Phosphoric,
Gold,	Fluoric,
Platina,	Saclactic,
Zinc,	Succinic,
Antimony,	Citric,
Sulphur,	Lactic,
Phosphorus.	Arsenic,
	Acetic,
	Prussic.

ARSIS and THESIS, in music. A point is said to move *per arsin et thesin*, which rises in one part and falls in another, and *vice versa*.

ARSON, in law, the same with house-burning, which is felony at common law and likewise by statute.

ART and PART, in the law of Scotland, is applied to an accomplice.

ARTEDIA, a genus of the digynia order, belonging to the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The involucra are pinnatifid; the floscules of the disc are masculine; and the fruit is hispid with scales. There is but one species.

ARTEL, a name given to a commercial association, consisting of a certain number of labourers, who voluntarily become responsible as a body for the honesty of each individual. The separate earnings of each man are put into a common stock; a monthly allowance is made for his support; and at the end of the year the surplus is equally divided. Hence arises the denomination of *artelschisks*, persons employed by the Russian merchants of St. Petersburgh to collect debts, &c. These are mostly natives of Archangel of the lowest class, yet their fidelity is rarely to be complained of.

ARTEMISIA, *mugwort*, *southernwood*, and *wormwood*, a genus of the polygamia superflua order, belonging to the syngenesia class of plants, and in the natural method ranking under the 49th order, *compositæ nucamentaceæ*. The receptacle is either naked or a little downy; it has no pappus; the calyx is imbricated with roundish scales; and the corolla has no radii. There are 44 species, of which the following are the most remarkable, viz.

1. Artemisia abrotanum, or southernwood, which is kept in gardens for the sake of its agreeable scent, is a low shrub, seldom rising more than three or four feet high, sending out lateral shrubby branches, growing erect, garnished with five bristly leaves, having a strong scent when bruised.

2. Artemisia absinthium, or common wormwood, grows naturally in lanes and uncultivated places, and is too well known to require any particular description.

3. Artemisia arborescens, or tree-wormwood, grows naturally in Italy and the Levant, near the sea. It rises, with a woody stalk, six or seven feet high, sending out many ligneous branches, with leaves somewhat like those of the common wormwood, but more finely divided, and much whiter.

4. Artemisia dracunculus, or tarragon, is frequently used in sallads, especially by the French, and is a very hardy plant, spreading greatly by its creeping roots.

5. Artemisia maritima, or sea wormwood, grows naturally on the sea-coasts in most parts of Britain, where there are several varieties, if not distinct species, to be found.

6. Artemisia Pontica, or Pontic wormwood, commonly called Roman wormwood, is a low herbaceous plant, whose stalks die in autumn, and new ones appear in the spring. They are garnished with finely-divided leaves, whose under sides are woolly; and the upper part of the stalks are furnished with globular flowers which nod on one side, having naked receptacles.

7. Artemisia santonicum produces the semen santonicum, which is much used for worms in children. It grows naturally in Persia, whence the seeds are brought to Europe. It has the appearance of our wild mugwort.

8. Artemisia vulgaris, or common mugwort, grows naturally on banks and by the sides of foot-paths in many parts of Britain. Most of these are easily propagated by slips or cuttings.

ARTERIOSE *canal*, a tube in the heart of a fœtus, that, with the foramen ovale, is of use to preserve the circulation of the blood, &c.

ARTERIOTOMY, the opening an artery with design to procure an evacuation of blood.

This operation is used only in extraordinary cases, as it is very dangerous; and must be practised in the temples, the forehead, or behind the ears, where the arteries are easily closed again.

ARTERY, in anatomy, a conical tube or canal which conveys the blood from the heart to all parts of the body. See ANATOMY.

ARTHRITIS, gout. See MEDICINE.

ARTHRODIA, in natural history, a genus of imperfect crystals, found always in complex masses; and forming long single pyramids, with very short and slender columns.

ARTHRODIA, a species of articulation, wherein a flat head of one bone is received into a shallow socket of another.

ARTICHOAK. See CINARA.

ARTICHOAK, *Jerusalem*, a species of sunflower. See HELEANTHUS.

ARTICLE, in grammar, a particle in most languages that serves to express the several cases and genders of nouns, when the languages have not different terminations to denote the different states and circumstances of nouns.

The Latin has no article; but the Greeks have their ὁ: the eastern languages have their *he emphaticum*; and most of the modern languages have had recourse to articles. The only articles made use of in the English tongue, are *a* and *the*; which, prefixed to substantives, determine their general signification to some particular thing. The use of *a* is in a general sense, and may be applied to any particular person or thing, and upon that account is called an *indefinite article*; but *the*, being a determinate article, is called definite or demonstrative, as applying the word to one individual. The French have three articles, *le*, *la*, and *les*; the Italians

have their *il*, *lo*, and *la*; and the Germans their *der*, *das*, and *dat*.

ARTICLES *of war*, are known regulations for the government of the army in the united kingdom, dominions beyond the seas, and foreign parts dependant upon this country. They may be altered at the pleasure of the sovereign; and in certain cases they extend to civilians: as when by proclamation any place shall be put under martial law, or when the people follow a camp or army for the sale of merchandize, or serve in any menial capacity. It is ordained that the articles of war shall be read in the circle of each regiment belonging to the British army every month, or oftener if thought proper. A soldier is not liable to be tried by a military tribunal unless the articles of war have been read to him.

ARTICULATE *sounds* are such sounds as express the letters, syllables, or words, of any alphabet or language: such are formed by the human voice, and by some few birds, as parrots, &c. Other brutes cannot articulate the sounds of their voice.

ARTICULATION, in anatomy, denotes the juncture of two bones intended for motion.

Articulation is of two kinds: the first is called diarthrosis, being that which has a manifest motion: that which only admits of an obscure motion is called synarthrosis. The former is subdivided into enarthrosis, arthrodia, and ginglymus. The latter is subdivided into symphysis, syntenosis, sutura, harmonia, syssarcosis, synchondrosia, and synneurosis. See ANATOMY.

ARTICULATION, in botany, jointed as the culm or stalk of reeds, corn, &c. It is also said of pods, like those of the hedyrarum or French honeysuckle, which when ripe divide into so many parts or joints.

ARTIFICER, a person whose employment it is to manufacture any kind of commodity, as in iron, brass, wool, &c.; such are smiths, weavers, carpenters, &c. If any such conspire not to work under certain prices, they are liable to divers penalties. Persons that contract with artificers in wool or metals to go out of the kingdom, shall be fined in any sum not exceeding 100*l*. and imprisoned for three months. If artificers that are abroad do not return in six months after warning, they shall be deemed aliens, and be incapable of inheriting lands by descent.

By several acts passed during the present reign, heavy penalties are inflicted on masters of ships assisting to seduce artificers to leave these realms.

ARTIFICER, in a military sense, he who prepares bombs, grenades, &c.

ARTIFICIAL *lines*, on a sector or other scale, are certain lines, contrived to represent the logarithmic sines and tangents; which, by the help of a line of numbers, will solve questions in trigonometry, navigation, &c.

ARTILLERY signifies all sorts of great guns or cannon, mortars, howitzers, petards, and the like; together with all the apparatus and stores thereto belonging, which are not only taken into the field, but likewise to sieges, and made use of both to attack and defend fortified places. It signifies also the science of artillery or gunnery.

ARTILLERY, *train of*, consists in an unlimited number of pieces of ordnance; such as 24 pounders, 18 pounders, 12, 9, 6, and 3 pounders; mortars from 13 to 8 inches diameter; besides royals and cohorns; howitzers of every denomination, mounted on their proper carriages and beds, &c. There is moreover attached to the train a sufficient quantity of horses, spare carriages, spare mortar-beds, &c.

The train of artillery is, or should be, divided into brigades, to which belong not only the officers of the regiments of artillery, but even the civil-list, such as comptrollers, commissaries of stores, clerks of stores, &c. The increase of artillery clearly demonstrates its great utility; for in the year 1500, an army of 50,000 men had only 40 pieces of cannon in the field; and in the year 1757, the same number of troops brought 200 pieces into the field, including mortars and howitzers.

At the battle of Jemappe, which was fought between the French and Austrians on the 6th of November 1792, the latter had 120 pieces of cannon disposed along the heights of Framery, whilst their effective force in men did not exceed 17,000. The French on this occasion brought nearly the same quantity of ordnance, some indeed of extraordinary calibre, but their strength in men was considerably more formidable.

ARTILLERY, *brigade of*, generally consists of 8 or 10 pieces of cannon, with all the machinery and officers to conduct them, and all the necessary apparatus thereto belonging.

ARTILLERY, *park of*, is that place appointed by the general of an army to encamp the train of artillery, apparatus, ammunition, as well as the battalions of the artillery, appointed for its service and defence. The figure of the park of artillery is that of a parallelogram, unless the situation of the ground renders another necessary.

The park of artillery is generally placed in the centre of the second line of encampment, and sometimes in the rear line, or corps of reserve. In both places the muzzles of the guns are in a line with the fronts of the serjeants' tents of the regiments of artillery and infantry. Some generals choose to place the park about 300 paces before the centre of the front line of the army. But let the situation be where it will, the manner of forming the park is almost every where the same. The most approved method is to divide the whole into brigades, placing the guns of the first to the right of the front line, and their ammunition behind them, in one or more lines. The different brigades should be all numbered, as well as every waggon belonging to them. This method will prevent confusion in the forming and breaking up of the park, as also on a march: besides, according to the numbers, the stores therein contained are known.

ARTILLERY, *field*, includes every requisite to forward the operations of an army, or of any part of an army acting offensively or defensively in the field. Field artillery may be divided into two distinct classes: field artillery properly so called, and horse artillery.

Regiments of artillery are always encamped half on the right and half on the left of the park. The company of bombardiers (when they are formed into companies) always takes the right of the whole, and the lieutenant-colonel's company the left; next to the bombardiers, the colonels, the majors, &c. so that the two youngest are next but one to the centre or park: the two companies next to the park are the miners on the right, and the artificers on the left.

The colours are placed in the centre of the front line of guns, in the interval of the two alarm-guns, in a line with the bells of arms of the companies.

The lieutenant-colonel's and major's tents front the centres of the second streets from the right and left of the regiment.

ARTILLERY, *march of*. The marches of the artillery are, of all the operations of war, the most delicate, because they must not only be directed on the object in view, but according to the movements the enemy make. Armies generally march in three columns, the centre column of which is the artillery: should the army march in more columns, the artillery and heavy baggage march nevertheless in one or more of the centre columns: the situation of the enemy determines this. If they are far from the enemy, the baggage and ammunition go before or behind, or are sent by a particular road; an army in such a case cannot march in too many columns. But should the march be towards the enemy, the baggage must be all in the rear, and the whole artillery form the centre column, except some brigades, one of which marches at the head of each column, with guns loaded, and burning matches, preceded by a detachment for their safety. The French almost invariably place their baggage in the centre.

A detachment of pioneers, with tools, must always march at the head of the artillery, and of each column of equipage or baggage.

If the enemy is encamped on the right flanks of the march, the artillery, &c. should march to the left of the troops, and *vice versa*. Should the enemy appear in motion, the troops front that way, by wheeling to the right or left by divisions; and the artillery, which marches in a line with the columns, passes through their intervals, and forms at the head of the front line, which is formed of the column that flanked nearest the dnemy, taking care at the same time that the baggage be well covered during the action.

ARTILLERY *company*, a regular battalion of infantry under the command of officers who are annually elected. It consists of gentlemen of character and property, bound by solemn declaration and obligation of attachment and fidelity to the king and constitution, and of readiness to join in supporting the civil authority, and of defending the metropolis. See the History of this Company, by A. Highmore, Esq.

ARTOCARPUS, (from αρτος, bread, and καρπος, fruit,) the BREAD-FRUIT TREE, a genus of the monandria order, belonging to the monœcia class of plants. It has a cylindric amentum or catkin, which thickens gradually, and is covered with flowers: the male and female in a different amentum. In the male, the calyx is two-valved, and the corolla is wanting. In the female, there is no calyx or corolla: the stylus is one, and the drupa is many-celled. There are two species, viz.

1. Artocarpus incisa. Though this tree has been mentioned by many voyagers, particularly by Dampier, by Rumphius, and by lord Anson, yet very little notice seems to have been taken of it, till the return of captain Wallis from the South Seas.

Captain Cook, in his Voyage, observes,

that this fruit not only serves as a substitute for bread among the inhabitants of Otaheite, and the neighbouring islands, but also, variously dressed, composes the principal part of their food. It grows on a tree that is about the size of a middling oak; its leaves are frequently a foot and a half long, of an oblong shape, deeply sinuated like those of the fig-tree, which they resemble in colour and consistence, and in the exsuding of a milky juice upon being broken. The fruit is about the size and shape of a new-born child's head, and the surface is reticulated, not much unlike a truffle; it is covered with a thin skin, and has a core about it as big as the handle of a small knife. The eatable part lies between the skin and the core; it is as white as snow, and somewhat of the consistence of new bread: it must be roasted before it is eaten, being first divided into three or four parts; its taste is insipid, with a slight sweetness, somewhat resembling that of the crumb of wheaten bread mixed with a Jerusalem artichoke. This fruit is also cooked in a kind of oven, which renders it soft, and something like a boiled potatoe; not quite so farinaceous as a good one, but more so than those of the middling sort. Of the bread-fruit they also make three dishes, by putting either water or the milk of the cocoa-nut to it, then beating it to a paste with a stone pestle, and afterwards mixing it with ripe plantains, bananas, or the sour paste which they call mahie.

The unripe artocarpus mahie, is likewise made to serve as a succedaneum for ripe bread-fruit before the season is come on. The fruit of the bread-tree is gathered just before it is perfectly ripe; and being laid in heaps, is closely covered with leaves: in this state it undergoes a fermentation, and becomes disagreeably sweet; the core is then taken out entire, which is done by gently pulling out the stalk, and the rest of the fruit is thrown into a hole which is dug for that purpose generally in the houses, and neatly lined on the bottom and sides with grass: the whole is then covered with leaves, and heavy stones laid upon them; in this state it undergoes a second fermentation, and becomes sour, after which it will suffer no change for many months. It is taken out of the hole as it is wanted for use; and being made into balls, it is wrapped up in leaves and baked: after it is dressed, it will keep for five or six weeks. It is eaten both cold and hot; and the natives seldom make a meal without it, though to Europeans the taste is as disagreeable as that of a pickled olive generally is the first time it is eaten.

To procure this principal article of their food, costs these happy people no trouble or labour, except climbing up a tree: the tree which produces it does not indeed grow spontaneously; but if a man plants ten of them in his life-time, which he may do in an hour, he will as completely fulfil his duty to his own and future generations, as the native of our less temperate climate can do, by ploughing in the cold of winter, and reaping in the summer's heat, as often as these seasons return: even if after he has procured bread for his present household, he should convert a surplus into money, and lay it up for his children.

2. Artocarpus integrifolia, with entire leaves. This is called in the East Indies the joccahee. It bears fruit like the other, but it seems to be of an inferior kind. It is said there are above 30 varieties of this tree.

ARTOTYRITES, in church history, a sect of Christians who used bread and cheese in the eucharist, or bread, perhaps, baked with cheese; urging, in defence of this practice, that in the first ages of the world, men offered to God the fruits of their flocks, as well as those of the earth.

ARTS are commonly divided into liberal and mechanical: the former comprehending poetry, painting, sculpture, architecture, &c. and the latter, the whole body of mechanical trades, as carpentry, masonry, turnery, &c.

ARTS, *fine*, a term synonimous with the French expression beaux arts, and perhaps imitated from it. The fine arts are painting, sculpture, architecture, engraving, drawing, and music; formerly classed under the more general and appropriate description of the liberal arts. See PAINTING, SCULPTURE, &c. &c.

ARVALES FRATRES, in Roman antiquity, a college of twelve priests, instituted by Romulus.

ARUM, WAKEROBIN, or CUCKOW-PINT, in botany, a genus of the polyandria order, belonging to the gynandria class of plants, and in the natural method ranking under the 2d order, piperitæ. The spatha is monophyllous. and cowl-shaped: the spadix is naked above, female below, and stamineous in the middle. There are 32 species, of which the most remarkable are the following:

1. Arum arborescens, or dumb-cane, is a native of the sugar islands and warm parts of America, where it grows chiefly on low grounds. All the parts of it abound with an acrid juice, so that if a leaf or part of the stalk is broken and applied to the tip of the tongue, it occasions a very painful sensation and a great defluxion of saliva. The stalks of this plant are sometimes applied to the mouths of the negroes by way of punishment.

2. Arum arisarium, as well as the arum proboscidium and arum tenuifolium, are all distinguished by the general name of friar's cowl, on account of the resemblance of their flowers to the shape of the cowls worn by friars. The flowers appear in April.

3. Arum colocasia, as well as the arum divaricatum, esculentum, peregrinum, and sagittifolium, have all mild roots, which are eaten by the inhabitants of the hot countries, where they grow naturally. Even the leaves of some of them, particularly those of the esculentum, which they call Indian kale, in those countries where many of the esculent vegetables of England are with difficulty produced, prove a good succedaneum.

4. Arum divaricatum has spear-shaped leaves.

5. Arum dracunculus, or the common dragons, grows naturally in most of the southern parts of Europe. It has a straight stalk, three or four feet high, which is spotted like the belly of a snake: at the top it is spread out into leaves, which are cut into several narrow segments almost to the bottom, and are spread open like a hand; at the top of the stalk the flower is produced, which is in shape like the common arum, having a long spathe of a dark purple colour, standing erect, with a large pistil of the same colour.

6. Arum Italicum is a native of Italy, Spain, and Portugal. The leaves rise a foot and a half high, terminating in a point; they are very large, and finely veined with white, interspersed with black spots, which, together with the fine shining green, make a pretty variety.

7. Arum maculatum, or common wakerobin, grows naturally in woods and on shady banks in most parts of Britain. The leaves are halberd-shaped, very entire and spotted; the berries numerous, growing in a naked cluster. The flowers appear in April; and their wonderful structure has given rise to many disputes among the botanists. The receptacle is long, in the shape of a club, with the seed-buds surrounding its base. The chives are fixed to the receptacle amongst the seed-buds, so that there is no occasion for the tips to be supported upon threads, and therefore they have none; but they are fixed to the fruit-stalk, and placed between two rows of tendrils: the point in dispute is, what is the use of those tendrils?

8. Arum trilobatum, or arum of Ceylon, is a native of that island and some other parts of India, and cannot bear cold. It is a low plant; the flower rises immediately from the root, standing on a very short footstalk: the spatha is long, erect, and of a fine scarlet colour, as is also the pistil.

The roots of the maculatum and dracunculus are used in medicine, and differ in nothing but that the latter is somewhat stronger than the former. This root is a powerful stimulant and attenuant. It is reckoned a medicine of efficacy in some cachectic and chlorotic cases, and in weakness of the stomach. Great benefit has been obtained from it in rheumatic pains, particularly those of the fixed kind, and which were seated deep. In these cases it may be given from 10 grains to a scruple of the fresh root twice or thrice a day, made into a bolus or emulsion with unctuous and mucilaginous substances.

ARUNDELIAN MARBLES, called also the Parian Chronicle, are antient stones, on which is inscribed a chronicle of the city of Athens, supposed to have been engraven in capital letters, in the island of Paros, 264 years before Christ. They take their name from the earl of Arundel, who procured them from the East, or from his grandson, who presented them to the university of Oxford. The authenticity of these marbles has led to a controversy between Mr. Robertson, who in his 'Parian Chronicle' questioned it, and Mr. Hewlett, who defended it in a 'Vindication of the Authenticity of the Parian Chronicle,' which see.

ARUNDO, in botany, the reed, a genus of the digynia order, belonging to the triandria class of plants, and in the natural method ranking under the fourth order, gramina. The calyx consists of two valves, and the floscules are thick and downy. There are 14 species; the most remarkable are:

1. Arundo bambos, or the bamboo, a native of the East Indies and some parts of America; where it frequently attains the height of 60 feet. The main root is long, thick, jointed, spreads horizontally, and sends out many cylindrical woody fibres, of a whitish colour, and many feet long. From the joints of the main root spring several round-jointed stalks to a prodigious height, and at about 10 or 12 feet from the ground send out at their joints several stalks joined together at their base: these run up in the

same manner as those they shoot out from. If any of these is planted with a piece of the first stalk adhering to them, they will perpetuate their species. They are armed at their joints with one or two sharp rigid spines, and furnished with oblong oval leaves, eight or nine inches long, seated on short footstalks. The flowers resemble those of the common reed. The young shoots are covered with a dark green bark: these when very tender are put in vinegar, salt, garlic, and the pods of capsicum, and thus afford a pickle which is esteemed a valuable condiment in the Indies, and is said greatly to promote the appetite and assist digestion. The stalks in their young state are almost solid, and contain a milky juice: this is of a sweet nature; and as the stalks advance in age they become hollow except at the joints, where they are stopped by a woody membrane, upon which this liquor lodges, and concretes into a substance called tabaxir, or sugar of Mombu; which was held in such esteem by the antients in some particular disorders, that it was equal in value to its weight in silver. The old stalks grow to five or six inches diameter, and are then of a shining yellow colour: and are so hard and durable that they are used in buildings, and for making all sorts of household furniture; and when bored through the membranes at their joints, are converted into water-pipes. The smaller stalks are used for walking-sticks, and the inhabitants of Otaheite make flutes of them about a foot long, with two holes only; which they stop with the first finger of the left hand and the middle one of the right, and then blow through their nostrils.

2. Arundo donax, or cultivated reed, is a native of warm countries, but will bear the cold of our moderate winters in the open air. The stalks of this are brought from Spain and Portugal, and are used by the weavers, as also for making fishing-rods.

3. Arundo orientalis is what the Turks use as writing pens; it grows in a valley near mount Athos, as also on the banks of the river Jordan.

4. Arundo phragmitis, or the common marsh-reed, grows by the sides of our rivers, and in standing waters.

The arundo versicolor, or Indian variegated reed, is supposed to be a variety of the donax, differing from it only in having variegated leaves; and the arundo picta, or striped grass, is a variety of the Canary grass.

ARUSPICES, or HARUSPICES, an order of priesthood among the Romans, that pretended to foretel future events by inspecting the entrails of victims killed in sacrifice.

ARYTÆNOIDES, in anatomy, the name of two cartilages, which, together with others, constitute the head of the larynx. It is also applied to some muscles of the larynx.

AS, in antiquity, a particular weight, consisting of twelve ounces, being the same with libra, or the Roman pound.

As was also the name of a Roman coin, which was of different matter and weight, according to the different ages of the commonwealth.

It is also used to signify an integer, divisible into twelve parts, from which last acceptation it signified a whole inheritance.

The as had several divisions: the principal of which were the uncia, or ounce, being the twelfth part of the as; sextans, the sixth part of the as; quadrans, the fourth part; triens, the third part; and semis, half the as, or six ounces. Bis was two-thirds of the as, or eight ounces; and dodrans, three-fourths of the as.

ASA, in the materia medica, a name given to two very different vegetable productions, distinguished by epithets expressive of their smell.

Asa fœtida is a very stinking gum, drawn, according to Kempfer, from the root of an umbelliferous plant, which grows in the province of Chorasan in Persia.

ASAPPES, or AZAPES, in the Turkish armies, a name given to the auxiliary troops which they raise among the Christians under their dominion, and expose to the first shock of the enemy.

ASARUM, ASARABACCA, a genus of the monogynia order, belonging to the dodecandria class of plants. The calyx is trifid or quadrifid, and rests on the germen; there is no corolla; the capsule is leathery and crowned. There are three species, viz.

1. Asarum Canadense, a native of Canada.
2. Asarum Europæum, grows naturally in some parts of England.
3. Asarum Virginicum, a native of America, has no remarkable properties.

The principal use of this plant among us is as a sternutatory. The root of asarum is perhaps the strongest of all the vegetable errhines, white hellebore itself not excepted. Snuffed up the nose, in the quantity of a grain or two, it occasions a large evacuation of mucus, and raises a plentiful spitting. The leaves are considerably milder, and may be used to the quantity of 3, 4, or 5 grains. Geoffery relates, that after snuffing up a dose of this errhine at night, he has frequently observed the discharge from the nose to continue for 3 days together, and that he has known a paralysis of the mouth and tongue cured by one dose.

ASBESTUS, in mineralogy. This mineral was well known to the antients. They even made a kind of cloth from one of the varieties, which was famous among them for its incombustibility. It is found abundantly in most mountainous countries, and no where more abundantly than in Scotland.

It is found in amorphous masses. Its texture is fibrous. Its fragments often long, splintery. Specific gravity from 2.995 to 0.6806. Absorbs water. Colour usually white or green. Fusible per se by the blow-pipe.

1st. Common asbestus. Specific gravity 2.547 to 2.995. Feels somewhat greasy. Cotain leek-green; sometimes olive or mountain green; sometimes greenish or yellowish grey. Streak grey. Powder grey.

Flexible asbestus.—Amianthus. Composed of a bundle of threads slightly cohering. Fibres flexible. Specific gravity, before it absorbs water, from 0.9088 to 2.3134; after absorbing water, from 1.5662 to 2.3803. Feels greasy. Colour greyish or greenish white; sometimes yellowish or silvery white, olive or mountain green.

Elastic asbestus.—Mountain cork. This variety has a strong resemblance to common cork. Its fibres are interwoven. Specific gravity, before absorbing water, from 0.6806 to 0.9933; after absorbing water, from 1.2492 to 1.3492. Feels meagre. Yields to the fingers like cork, and is somewhat elastic. Colour white; sometimes with a shade of red or yellow; sometimes of a yellow or brown colour.

Ligniform asbestus. Colour wood brown, which passes into yellow. Opaque. Very soft. Somewhat flexible, but not elastic. Adheres to the tongue. Feels harsh.

A specimen of the common asbestus, analysed by Bergman, contained

63.9 silica
16.0 carbonat of magnesia
12.8 carbonat of lime
6.0 oxide of iron
1.1 alumina

99.8

A specimen of the flexible asbestus yielded to the same chemist

64.0 silica
17.2 carbonat of magnesia
13.9 carbonat of lime
2.7 alumina
2.2 oxyde of iron

100.0

A specimen of the elastic asbestus contained, according to the same analysis,

56.2 silica
26.1 carbonat of magnesia
12.7 carbonat of lime
3.0 iron
2.0 alumina

100.0

Twelve different specimens of asbestus, analysed by Bergman, yielded the same ingredients, differing a little in their proportions.

Sp. 2. Actinote.

Strahlstein of Werner, except the glassy; Rayonante of Saussure and Brochante. Actinolite, asbestinite, asbestoid of Kirwan. Actinote of Hauy.

This mineral occurs in the primitive rocks, and is usually mixed with those stones which contain a notable portion of magnesia. It is found both massive and crystallised. The primitive form of its crystals, according to Hauy, is a four-sided prism whose bases are rhombs, and which he presumes to be the same with the primitive form of hornblende. It occurs in six-sided prisms, in needles, and in small plates. Colour most commonly greenish. Texture radiated, rays diverging from a centre. Fragments undeterminate. Transparency 1; often opaque. Difficult to break. Specific gravity 2.916 to 3.31. Fusible before the blow-pipe. It is divided into two subspecies.

ASCARINE, a genus of the dioecia monandria class and order. The essential character is, calyx ament, filiform: corolla none: male, anther worm-shaped: female, style none: stigma three-lobed drupe. There is one species, a native of the Society Isles.

ASCARIS, or ASCARIDES, a genus belonging to the class of vermes, and the order of vermes intestinæ. These insects are found in the bodies of animals; have a round and elastic body, tapering towards each extremity; three protuberances at the head; the tail obtuse or subulate; and the intestines spiral, milky white, and pellucid: they are of the two sexes, and very prolific; but their origin is still a matter of profound obscurity. There are two species, viz.

1. Ascaris lumbricoides is about the same length with the lumbricus terrestris, or common earthworm; but it wants the protuberant ring towards the middle of the body, the only mark by which they can properly be distinguished. The body of the lumbricoides is cylindrical, and subulated at each extremity; but the tail is somewhat triangular. The lumbricoides is the worm which is most commonly found in the human intestines. It is viviparous, and produces vast numbers.

2. Ascaris vermicularis, (See Plate Nat. Hist. fig. 42, 43,) with faint annular rugæ, and the mouth transverse, is about a quarter of an inch long, and thicker at one end than the other. It is found in boggy places, in the roots of putrid plants, and very frequently in the rectum of children and horses. It emaciates children greatly, and is sometimes vomited up.

ASCENDANT, ASCENDENT, or ASCENDING LINE, among lawyers, is meant of ancestors, or such relations as are nearer the root of the family. Such are the father, grandfather, great uncle, &c. Marriage is always forbidden between the ascendants and descendants in a right line.

ASCENDING, in astronomy, is said of such stars as are rising above the horizon, in any parallel of the equator. Thus likewise, 1. Ascending latitude, is the latitude of a planet when going towards the north pole. 2. Ascending node, is that point of a planet's orbit, wherein it passes the ecliptic, to proceed northward. This is otherwise called the northern node, and represented by this charater ☊.

ASCENDING *vessels*, in anatomy, those which carry the blood upwards, as the aorta ascendens, and vena cava ascendens. See ANATOMY.

ASCENSION, in astronomy, (the rising of the sun or a star, or any part of the equinoctial with it, above the horizon,) is either right or oblique.

Right ascension is that degree of the equator, reckoned from the beginning of Aries, which rises with the sun or a star, in a right sphere. It is found by the following proportion: as the radius, to the cosine of the sun or star's greatest declination, so is the tangent of the distance from Aries to Libra, to the tangent of right ascension.

Oblique ascension is that degree and minute of the equinoctial, counting from the beginning of Aries, which rises with the centre of the sun or a star, or which comes to the horizon at the same time as the sun or star, in an oblique sphere. In order to find the oblique ascension, we must first find the ascensional difference.

The arch of right ascension coincides with the right ascension itself, and is the same in all parts of the globe. The arch of oblique ascension coincides with the oblique ascension, and changes according to the latitude of places.

The sun's right ascension in time, is useful to the practical astronomer in observatories, who adjusts his clock by sidereal time. It serves to convert apparent to sidereal time; as that of an eclipse of Jupiter's statellites, in order to know at what time it may be expected to happen by his clock. For this purpose, the sun's right ascension at the preceding noon, together with the increase of right ascension from noon, must be added to the apparent time of the phenomenon set down in the ephemeris. The sun's right ascension in time serves also for computing the apparent time of a known star's passing the meridian: for, subtract the sun's right ascension in time at noon, from the star's right ascension in time, the remainder is the apparent time of the star's passing the meridian nearly; from which the proportion at part of the daily increase of the sun's right ascension from this apparent time from noon, being subtracted, leaves the correct time of the star's passing the meridian. The sun's right ascension in time is also useful for computing the time of the moon and planets passing the meridian.

ASCENSIONAL DIFFERENCE, the difference between the right and oblique ascension of any point in the heavens; or it is the space of time that the sun rises or sets before or after six o'clock.

The ascensional difference may be found by this proportion, viz. As the radius, is to the latitude of the place, so is the tangent of the sun's declination, to the sine of the ascensional difference; by subtracting of which from the right ascension, when the sun is in the northern signs, and adding it, when the sun is in the southern ones, you will find the oblique ascension.

ASCENT, in logic, a kind of argumentation, in which we rise from particulars to universals.

ASCETICS, in church history, such Christians in the primitive church as inured themselves to great degrees of abstinence and fasting, in order to subdue their passions. In short, every kind of uncommon piety laid claim to the name ascetic.

ASCII, an appellation given to those inhabitants of the earth, who, at certain seasons of the year, have no shadow: such are all the inhabitants of the torrid zone, when the sun is vertical to them.

ASCIDIA, the name of a genus of vermes, the body of which is fixed, roundish, and apparently issuing from a sheath; the apertures two, generally placed near the summit, one below the other. These creatures are more or less gelatinous, and have the power of contracting and dilating themselves at pleasure; some of them are furnished with a long stem, but most of them are sessile. There are six species, as the papiliosa, &c. See Plate Nat. Hist. fig. 40.

ASCITÆ a sect of Christians in the second century, who introduced a kind of bacchanals into their assemblies, and danced round an inflated bag or skin, saying "these are the new bottles, filled with new wine," as referred to by Jesus Christ.

ASCITES, in medicine, the common dropsy. See MEDICINE.

ASCIUM, a genus of the polyandria monogynia class and order. The essential character is, calyx five-leaved, coriaceous; corolla five-petalled; berry one-celled, many seeds. There is one species, a tree of Guiana.

ASCLEPIAD, in antient poetry, a verse composed of four feet, the first of which is a spondee, the second a choriambus, and the two last dactyls; or of four feet and a cæsura, the first a spondee, the second a dactyle, after which comes the cæsura, then the two dactyls, as

Mæcenas atavis edite regibus.

ASCLEPIAS, SWALLOW-WORT: a genus of the digynia order, and pentandria class of plants; and in the natural method ranking under the 30th order, *contortæ*. The generic character is taken from five oval, concave, horn-like nectaria, which are found in the flower. There are 34 species, of which the following are the most remarkable, viz.

1. Asclepias alba, or common swallow-wort, a native of the S. of France, Spain, and Italy.

2. Asclepias Curassavica, or bastard ipecacuanha, is a native of the warm parts of America. It rises to the height of five or six feet, with upright stems; the flowers are of a scarlet colour, and the horny nectariums in the middle are of a bright saffron, and there is a succession of flowers on the same plant from June to October. This species is tender, and must be preserved in a stove.

3. Asclepias Syriaca, or greater Syrian dogsbane, is a perennial plant; the flowers are a bright purple colour.

The root of the first species is used in medicine, and is esteemed sudorific and diuretic. Its sensible qualities resemble those of valerian, which is preferred to it. The milky juice of the plant is considered as poisonous.

ASCODRUTÆ, in church history, a sect of gnostics, who placed all religion in knowledge; and under pretence of spiritual worship, would admit of no external or corporeal symbols whatever.

ASCOLIA, in Grecian antiquity, a festival celebrated by the Athenian husbandmen in honour of Bacchus, to whom they sacrificed a he-goat, because that animal destroys the vines. Out of the victim's skin it was customary to make a bottle, which, being filled with oil and wine, fell as a reward to him who first fixed himself upon it with one foot.

ASCRIPTITI, or adscriptitii, were a description of villains, who, coming from abroad, settled in the lands of some new lord, whose servants or subjects they became, being annexed to the lands, and like other villains transferred and sold with him.

ASCYRUM, Peter's wort, a genus of the polyandria order, and polyadelphia class of plants; and in the natural method ranking under the 20th order, rotaceæ. The calyx consists of four leaves; the corolla has four petals; the filaments are numerous, and divided into four boundaries. There are three species, viz.

1. Ascyrum crux Andreæ. 2. Ascyrum hypericoides. 3. Ascyrum villosum: all natives of the West Indies or America.

ASH. See FRAXINUS.

ASH, *mountain*. See SORBUS.

ASH, *poison*. See RHUS.

ASHES, the earthy part of wood and other combustibles, remaining after they are consumed by fire. These, if produced from a vegetable, are of a white colour, and saltish taste, a few instances excepted; and when boiled with fair water, yield a lixivium of an acrimonious, alkaline, fiery, urinous taste. The ashes of all vegetables are vitrifiable, and are found to contain some iron.

Ashes of all kinds contain an alkaline salt, and are an excellent manure for cold and wet ground. They are also of considerable use in making lixiviums or lyes, for the purposes of medicine, bleaching, and for sugar works: and are distinguished by various names; as pot-ashes, pearl-ashes, wood-ashes, and weed-ashes. See POT-ASS, &c.

ASLANI, in commerce, a silver coin, worth from 115 to 120 aspers. See ASPER.

ASP, in zoology. See COLUBER.

ASPALATHUS, *African broom*: a genus of the decandria order, belonging to the dia-

delphia class of plants: and in the natural method ranking under the 32d order, papilionaceæ. The calyx consists of 5 divisions: the pod is oval, and contains 2 seeds. Of this genus there are 37 species; all of which are natives of warm climates, and must be preserved in stoves by those who would cultivate them here. The rose wood, whence the oleum Rhodii is obtained, is one of the species, but of which we have yet had no particular description. This wood was antiently in much repute, as an astringent; but it is now used chiefly as a perfume.

ASPARAGUS, a genus of the monogynia order and hexandria class of plants; and in the natural method, ranking under the 11th order, sarmentaceæ. The calyx is quinquepartite, and erect; the three inferior petals are bent outwards; the berry has three cells, and contains two seeds. There are 13 species; but the only one cultivated in the gardens is the common asparagus, with an upright herbaceous stalk, bristly leaves, and equal stipula. The other species are kept only for the sake of variety.

The garden asparagus is cultivated from seed. The manner of saving it is this: mark with a stick some of the fairest buds; and when they are run to berry, and the stalks begin to dry and wither, cut them up; rub off the berries into a tub, and pouring water upon them, rub them about with your hands; the husks will break and let out the seed, and will swim away with the water, in pouring it off; so that in repeating this two or three times, the seeds will be clean washed, and found at the bottom of the tub. These must be dried, and in the beginning of February, sown on a bed of rich earth. They must not be sown too thick, and must be trod into the ground, and the earth raked over them smooth; in October, when the stalks are withered and dry, a little rotten dung must be spread half an inch thick over the whole surface of the bed. Next spring, the plants will be fit to plant out; the ground must therefore be prepared for them by trenching it well, and burying a large quantity of rotten dung in the trenches, so that it may lie at least 6 inches below the surface of the ground: when this is done level the whole plot. The asparagus is to be planted out in the beginning of March, if the soil is dry, and the season forward; but in a wet soil, it is better to wait till the beginning of April, which is about the season that the plants are beginning to shoot. The season being now come, the roots may be placed two inches under the surface of the ground; and between every four rows, a space of two feet and a half should be left for walking in, to cut the asparagus. The second spring after planting, some of the young asparagus may be cut for the table. But the larger shoots should only be taken, and these should be cut at two inches under the ground. As some people however are very fond of early asparagus, the following directions are given, by which it may be obtained any time in winter: plant some good roots of one year old in a moist rich soil, about eight inches apart; the second and third year after planting, they will be ready to take up for hotbeds; these should be made pretty strong, about three feet thick, with new stable dung that has fermented a week or more; the beds must be covered with earth six inches thick; then against a ridge made at one end, begin to lay in your plants, without trimming or cuting the fibres, and between every row lay a little ridge of fine earth, and proceed thus till the bed is planted; then cover the bed two inches thick with earth, and encompass it with a straw band; and in a week, or as the bed is in the temper, put on the frames and glasses, and lay on three inches thick of fresh earth over the beds, and give them air and add fresh heat to them as it requires. These beds may be made from November till March.

ASPECT, in astronomy, denotes the situation of planets and stars, with respect to each other; whereof we find mention of five kinds: 1. Sextile aspect is when the planets or stars are 60 degrees distant, and marked thus ✱. 2. The quartile or quadrate when they are 90 degrees distant, marked □. 3. Trine when 120 degrees distant, marked △. 4. Opposition when 180 degrees distant, marked ☍. And, 5. Conjunction, when both in the same degree, marked ☌.

Kepler, who added eight new ones, defines aspect to be the angle formed by the rays of two stars meeting on the earth, whereby their good or bad influence is measured; for it ought to be observed, that these aspects being first introduced by astrologers, were distinguished into benign, malignant, and indifferent; the quartile and opposition being accounted malign, the trine and sextile benign or friendly, and the conjunction indifferent.

ASPECT, *double*, in painting, is used where a single figure is so contrived, as to represent two or more different objects, either by changing the position of the eye, or by means of angular glasses.

ASPECT, in a military sense, is the view or profile of land or coast, and contains the figure or representation of the borders of any particular part of the sea. These figures and representations may be found in all the rutiers or directories for the sea-coast. The Italians call them *demonstratione*. By means of this knowledge you may ascertain whether the land round the shore is high; if the coast itself is steep or sloping; bent in the form of an arc, or extended in staight lines; round at the top, or rising to a point. Every thing, in a word, is brought in a correct state before the eye, as far as regards harbours, bogs, gulphs, adjacent churches, trees, windmills, &c. &c.

ASPECT, *menacing*. An army is said to hold a menacing aspect, when by advanced movements or positions it gives the opposing enemy cause to apprehend offensive operations.

ASPECT, *military*. A country is said to have a military aspect, when its general situation presents appropriate obstacles or facilities for an army acting on the offensive or defensive.

ASPECT, *imposing*. An army is said to have an imposing aspect, when it appears stronger than it really is. This appearance is often assumed for the purpose of deceiving an enemy, and may not improperly be considered as a principal feint in war.

ASPEN-*tree*. See POPULUS.

ASPER, in grammar, an accent peculiar to the Greek language, marked thus (') and importing that the letters over which it is placed ought to be strongly aspirated, or pronounced as if an *h* was joined with them.

ASPER, or *aspre*, in commerce, a Turkish coin, three of which make a medine, and worth something more than our halfpenny.

ASPERIFOLIATE, or *asperifolius*, among botanists, such plants as are rough-leaved. Of this kind are bugloss, borage, &c.

ASPERUGO, *small wild bugloss*, a genus of the pentandria monogynia class; and in the natural method ranking under the asperifoliæ. The calyx of the fruit is compressed, with folds flatly parallel, and sinuous. There are two species, viz.

1. ASPERUGO *Ægyptiaca*, a native of Egypt.

2. ASPERUGO *procumbens*, or wild bugloss, a native of Britain; which is eaten by horses, goats, sheep, and swine; but cows are not fond of it.

ASPERULA, *woodroof*, a genus of the monogynia order and hexandria class of plants, and in the natural method ranking under the 47th order, stellatæ. The corolla is infundibuliform; and the capsule contains two globular seeds. There are eleven species, two of which grow wild in England, viz.

1. ASPERULA *cynanchica*, found on chalky hills. The roots are used for dyeing red in Sweden.

2. ASPERULA *odorata*, a low umbelliferous plant, growing wild in woods and copses, and flowering in May. It has an exceeding pleasant smell, which is improved by moderate exsiccation. It imparts its flavour to vinous liquors. Asperula is supposed to attenuate viscid humours, and is recommended in obstructions of the liver and biliary ducts, and by some in epilepsies and palsies; modern practice has nevertheless rejected it. The smell of it is said to drive away ticks and other insects.

ASPHALTUM. See BITUMEN.

ASPHODELUS, *asphodel*, or *king's spear*, a genus of the monogynia order, belonging to the hexandria class of plants. The calyx is divided into six parts; and the nectarium consists of six valves covering the nectarium. There are five species, viz.

1. ASPHODELUS *ramosus*, or *white asphodel*. The leaves are long; the stalks rise to above three feet high, and divide into several spreading branches; these are terminated by loose spikes of white flowers.

2. ASPHODELUS *luteus*, or *common yellow asphodel*, has strong round single stalks near three feet high, with yellow star-shaped flowers, which appear in June.

3. ASPHODELUS *fistulosus*, or *onion-leaved asphodel*, is an annual plant, the flowers of which are white.

ASPIRATE, in grammar, denotes words marked with the asper.

ASPIRATION, among grammarians, is used to denote the pronouncing a syllable with some vehemence; as these words beginning with the letter H, *hear*, *heat*, which are pronounced more softly without the H, as *ear*, *eat*.

ASPIS. See COLUBER.

ASPLENIUM, *milt-waste*, or *spleen-wort*, in botany, a genus of cryptogamious plants of the order filices, the fructification of which is arranged in clusters, an disposed in form of straight lines, under the disk of the leaf.

This genus comprehends 47 species, na-

28

Apis socialis

29

Apis violacea

32

Arctomys bobac

Arctomys Marmot
Alpine Marmot

33

34

Ardea pavonina
Crowned Heron

35

Ardea virgo
Numidian Crane

36

Aran oleracea

31

Aranea tarentula

30

Aranea domestica

39

Argonauta argo

40

Ascidia papillosa

37

Argentum arborescens

38

Argentina Carolina
Carolina Argentina

Heath sc.

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tives of different countries, some of which were formerly used in medicine, but are now rejected.

ASS, *feast of*, a festival, celebrated during the dark ages, in commemoration of the Virgin Mary's flight. On this occasion, a young girl, richly dressed, with a child in her arms, was set upon an ass. The beast was led to the altar, where mass was said with great pomp. The ass was taught to kneel, and a hymn was sung in his praise. As soon as the ceremony was ended, the priest and the people brayed in imitation of the ass. This was esteemed an act of devotion, and performed by authority of the church.

Ass, *asinus*, in zoology. See EQUUS.

ASSARON, or *omer*, a measure of capacity, in use among the Hebrews, containing five pints. It was the measure of manna which God appointed for every Israelite.

ASSAULT, in law, a violent injury offered to a man's person: it may be committed by offering a blow, or a threatening speech. In case a person threatens to beat another, or lies in wait to do it, if the other is hindered in his business, and receives loss, it will be an assault, for which an action may be brought, and damages recovered; or the party threatening may be bound over to the peace. Not only striking, but thrusting, pushing, casting stones, or throwing drink in the face of any person, are deemed assaults.

In all which cases, a man may plead in his justification, the defence of his person (but not of his goods), or of his father, mother, wife, child, master, &c.

ASSAYING, is the art of finding how much pure metal is contained in every ore, or the proportion of the several ingredients of any mixed metal, which is done in the following manner:

1. *Gold*. To obtain pure gold, we have only to dissolve the gold of commerce in nitro-muriatic acid, and precipitate the metal by dropping in a very diluted solution of sulphat of iron; the powder which precipitates, after being well washed and dried, is pure gold.

2. *Platinum*. Platinum can scarcely be obtained perfectly pure in the metallic state, at least in any considerable quantity; because a sufficient heat for melting it cannot be obtained. But its oxide may be procured quite pure from the muriat of platinum and ammonia, prepared by the rules to be hereafter laid down. This salt is to be decomposed by a violent heat, and the residuum, if necessary, may be redissolved in nitro-muriatic acid, and precipitated with soda.

3. *Silver*. Dissolve the silver of commerce in nitric acid, and precipitate with a diluted solution of sulphat of iron. The precipitate is pure silver. Or precipitate with common salt; form the precipitate into a paste with soda; put it into a crucible lined with soda, and fuse it with a brisk heat. This process gives a button of pure silver.

4. *Mercury* may be obtained pure by distilling a mixture of two parts cinnabar and one part of iron-filings in an iron retort. The mercury comes over, and the sulphuret of iron remains behind; or the oxy-muriat of mercury may be decomposed by ammonia, and the precipitate heated either by itself or mixed with oil.

5. *Copper* may be dissolved in muriatic acid, and the copper precipitated by a polished plate of iron; or the black oxide of copper, obtained by decomposing cuprated ammonia, may be melted with its own weight of pounded glass and pitch.

6. *Iron* can scarcely be obtained perfectly free from carbon. The processes for obtaining it as pure as possible will be given hereafter.

7. *Tin* may be obtained pure by solution in strong nitric acid; the white oxide of tin is formed, which is insoluble. Let it be digested first with muriatic acid, and afterwards with aqua regia. Mix the oxide thus purified with its weight of pitch and a little borax, and melt it in a crucible.

8. *Lead* may be obtained pure from the carbonat by solution in diluted nitric acid and precipitation by a cylinder of zinc; from the sulphuret by solution in nitric acid, mixing the solution with muriatic acid, and crystallizing. The crystals of muriat of lead are to be dissolved in boiling water, and then evaporated to dryness. The mass is to be melted in a crucible with $2\frac{1}{2}$ times its weight of black flux.

9. Chemists have hitherto failed in their attempts to obtain *nickel* in a state of absolute purity. The great difficulty is to separate it from cobalt; upon which all re-agents have nearly the same action. The following ingenious method has been lately proposed by Mr. Phillips: dissolve the nickel of commerce in nitric acid to saturation. Throw down the arsenic acid by nitrat of lead. Then, after filtration, add an excess of nitric acid, and introduce an iron rod into the solution to throw down the copper. After this, precipitate the whole by carbonat of potass, and digest the precipitate in liquid ammonia. The cobalt and nickel are taken up; the iron and lead remain. Dilute the solution with water; add an excess of ammonia; then pour potass into the solution. The cobalt remains in solution, but the nickel precipitates in the state of a pure oxide, and may be reduced by exposure to a strong heat with charcoal.

10. *Zinc* may be dissolved in sulphuric acid, and a plate of zinc allowed to remain for a considerable time in the solution. It is then to be filtred, and the zinc to be precipitated with soda. The precipitate, edulcorated and dried, is to be mixed with half its weight of pure charcoal, and distilled in an earthenware retort. The zinc is found pure in the neck of the retort.

11. *Antimony* may be dissolved in nitro-muriatic acid, and precipitated by the affusion of water. The precipitate is to be mixed with twice its weight of tartar, and fused in a crucible. A button of pure antimony is obtained.

12. *Bismuth*, if impure, may be dissolved in nitric acid, and precipitated by water. The edulcorated precipitate, formed into a paste with oil, and rapidly fused with black flux, gives a button of pure bismuth.

13. *Tellurium* was obtained pure by Klaproth, by forming its oxide into a paste with oil, and heating it to redness in a retort. The metal was rapidly revived.

14. *Arsenic*, in the state of white oxide, may be dissolved in muriatic acid, precipitated by the affusion of water, redissolved, and a plate of zinc inserted into the solution, mixing with it at the same time a little alcohol. The arsenic is precipitated in the metallic state.

15. *Cobalt* may be obtained pure in all likelihood by following the process proposed by Mr. Phillips for the purification of nickel. The following is a much cheaper process recommended by Trommsdorf: Mix a pound of the best smalt with four ounces of nitre and two ounces of charcoal powder, and throw the mixture at intervals into a red-hot crucible. This process is to be repeated three times. The mixture is then to be kept in a strong heat for an hour, stirred well, then mixed with four ounces of black flux, and kept in the strong heat of a forge for an hour longer. The cobalt, reduced by this treatment, is still impure. It is to be mixed again with thrice its weight of nitre, and deflagrated in a red-hot crucible by small portions at a time. By this process the iron is peroxidized, and the arsenic acidified. The mass is to be well washed, and the oxide of cobalt separated by filtration. This oxide is to be dissolved in nitric acid, and evaporated to dryness. A fresh portion of acid is to be added, and the mass exposed to a moderate heat. Dilute with water, and filtre to separate the remains of the iron. Precipitate by pure potass, and reduce the oxide.

16. *Manganese*. Digest the black oxide of manganese repeatedly in nitric acid; then mix it with sugar, and dissolve it in nitric acid. Filter the solution, precipitate by an alkali, form the white oxide thus obtained into a paste with oil, and put it into a crucible well lined with charcoal. Expose the crucible for an hour to the strongest heat of a forge.

17. *Tungsten* was obtained by Elhuyart by heating the yellow oxide violently in a crucible lined with charcoal: but this process has not succeeded wtih other chemists.

18. *Molybdenum* may be obtained by forming molybdic acid into a paste with oil, and heating it violently in a crucible lined with charcoal.

19. *Uranium* is procured by forming the yellow oxide of that metal into a paste with oil, drying it in a moderate heat, putting it into a crucible lined with charcoal, with a little lamp-black strewed over it. After luting on the cover, it is to be heated at first gently, and then violently, for three quarters of an hour.

20. *Titanium*, in a very small proportion indeed, was obtained in the metallic state, by mixing together 100 parts of the red oxide of the metal, 50 parts of borax, and five parts of charcoal, and forming the mixture into a paste with oil. This paste was put into a crucible lined with charcoal, and exposed for an hour and a half to the violent heat of a forge.

21. *Chromium* was obtained by Vauquelin in the metallic state, by putting a portion of chromic acid into a charcoal crucible, inclosed in a common crucible lined with charcoal, and exposing it for an hour to the violent heat of a forge.

ASSAYING of weights and measures, the examining the common weights and measures by the clerk of the market.

ASSEMBLY, in the military art, the second beating of a drum before a march; at which the soldiers strike their tents, roll them up, and stand to arms.

ASSEMBLIES of the clergy are called convocations, synods, councils; the annual meeting of the church of Scotland is called a general assembly.

ASSES, *order of*, a denomination of Mathurins, or Trinitarians; so called because they were obliged, in travelling, to ride on asses, not horses.

ASSESSOR, an inferior officer of justice, appointed chiefly to assist the ordinary judge with his opinion and advice.

Assessor is also one who assesses or settles taxes, and other public dues.

ASSETS, in law, goods or property in the hands of a person, with which he is enabled to discharge an obligation imposed upon him as executor, &c. Assets may be real or personal.

ASSIENTO, a Spanish word, signifying a farm, in commerce, is used for a bargain between the king of Spain and other powers, for importing negroes into the Spanish dominions in America, and particularly to Buenos Ayres. The first assiento was made by the French Guinea company; and by the treaty of Utrecht, transferred to the English, who were to furnish 4800 negroes annually.

ASSIGN, in common law, a person to whom a thing is assigned or made over.

ASSIGNEE, in law, a person appointed by another to do an act, transact some business, or enjoy a particular commodity.

Assignees may be by deed or by law: by deed, where the lessee of a farm assigns the same to another; by law, where the law makes an assignee, without any appointment of the person intitled, as an executor is assignee in law to the testator, and an administrator to an intestate. But when there is assignee by deed, the assignee in law is not allowed.

It is most commonly applied to those creditors of a bankrupt who are appointed by the rest to manage for them, and consequently have the bankrupt's estate assigned over to them.

ASSIGNING, in a special sense, is used to set forth and point at, as to assign an error, to assign false judgment, to assign waste; in which cases it must be shewn wherein the error is committed, where and how the judgment is unjust, and where the waste is committed.

ASSIGNMENT, in law, differs from a lease in this, that by a lease a man grants an interest less than his own; in assignment he grants the whole property. 2 Black. 326.

ASSIMILATION, in physics, is that motion by which bodies convert other bodies related to them, or at least such as are prepared to be converted, into their own substance and nature.

ASSISE, in old law books, is defined to be an assembly of knights and other substantial men, with the justice, in a certain place, and at a certain time: but the word in its present acceptation is used for the court, place, or time when and where the writs and processes, whether civil or criminal, are decided by judges and jury. In this signification, assise is either general, when judges make their respective circuits, with commission to take all assise; or special, where a commission is granted to particular persons for taking an assise upon one or two disseisins only. By Magna Charta, justices shall be sent through every county, once a year, who, with the knights of the several shires, shall take assise of novel disseisin: and as to the general assise, all the counties of England are divided into six circuits, and two judges are assigned by the king's commission to every circuit, who now hold the assises twice a year, in every county, except Middlesex, where the courts of record sit, and the counties palatine. These judges have five several commissions: 1. Of oyer and terminer, by which they are empowered to try treasons, felonies, &c. 2. Of gaol-delivery, which empowers them to try every prisoner *in gaol*, for whatever offence he be committed. 3. Of assise, which gives them power to do right upon writs brought by persons wrongfully thrust out of their lands and possessions. 4. Of nisi prius, by which civil causes come to issue in the courts above, are tried in the vacation by a jury of twelve men, in the county where the cause of action arises. 5. A commission of the peace in every county of the circuit: and all justices of peace of the county and sheriffs are to attend upon the judges, otherwise they shall be fined.

Assise is used in several other significations; as, 1. for a jury, where assises of novel disseisin are tried, and the pannels of assise shall be arraigned. See the next article. 2. For a writ for recovery of the possession of things immoveable, of which a person and his ancestors have been disseised. 3. For an ordinance or statute, as the assise of the forest, a statute concerning orders to be observed in the king's forest. 4. For a quantity of wheat, bread, &c. prescribed by a statute; as we say, when wheat is of such a price, bread shall be of such an assise.

Assise *of novel disseisin* is a writ that lies where a tenant in fee simple, fee tail, or for term of life, is put out and disseised of his lands, tenements, rents, common of pasture, common way, &c. A writ of assise may sometimes be had by a person, when he cannot have trespass *vi & armis*; as where a lord enters on lands, and distrains his tenant so often, when nothing is due, that the tenant is disturbed in manuring his lands; in such case he may have *assise de souvent fois distress*; but he cannot bring trespass against his lord.

Assise *of mort d'ancestor* is a writ which lies where a person's father, mother, brother, &c. died seised of lands and tenements in fee, and, after either of their deaths, a stranger abateth.

Assise *of utrum* lies for a parson against a layman, or a layman against a parson, for lands or tenements doubtful whether they are lay-fee or free-alms.

ASSOCIATION *of ideas* is where two or more ideas constantly and immediately follow one another, so that the one shall almost infallibly produce the other, whether there is any natural relation between them, or not.

Association, in law, is a writ or patent sent by the king, either of his own motion, or at the suit of the plaintiff, to the judges of assise, to have others associated to them, to take the assise, &c.

ASSONIA, in botany, a genus of the class and order monadelphia dodecandria. The essential character is, calyx double, outer one-leaved or three-leaved, inner one-leaved; corolla five-petalled, no tube affixed to the pitcher of stamens; filament connected in form of a pitcher, with petal-shaped straps between; style one or five; capsule five-celled; seeds not winged.

There are eleven species, the most remarkable of which is the A. populnea, a middle-sized tree, growing in the isle of Bourbon, and resembling the hibiscus populneus. The wood is sweet-scented, and blue in the middle.

ASSUMPSIT, a voluntary or verbal promise, whereby a person assumes, or takes upon him, to perform or pay any thing to another. All assumpsits must be for some valuable consideration; and they are either *express* or *implied*. Express is by direct agreement either by word or note without seal. Implied: when any person becomes legally indebted to another for goods sold, the law implies a promise that he will pay his debt; and if he does not pay it, the writ *indebitatus assumpsit* lies against him; and will lie for goods sold and delivered to a stranger, or third person, at the request of the defendant: but the price agreed on must be proved, otherwise that action does not lie.

ASSUMPTIVE arms, in heraldry, are such as a person has a right to assume, with the approbation of his sovereign, and of the heralds.

ASSURANCE, a contract by which the assurer undertakes, in consideration of a premium equivalent to the hazard run, to indemnify the person assured against certain perils or losses, or against some particular event. The practice of entering into such engagements, which originated about the year 1182, and has been greatly extended as its utility has become more understood, gives great security to the fortunes of private people, by dividing among many that loss which would ruin an individual.

The instrument by which this contract of indemnity is effected between the assurer and the assured is called a policy; and is not, like most contracts, signed by both parties, but only by the assurer, who on that account, it is supposed, is denominated an underwriter.

Assurances may be distinguished into marine assurances, assurances upon lives, and assurances against fire.

Marine assurance is an indemnity against those perils to which ships and goods are exposed in the course of their voyage from one place to another, whether arising from the dangers of the seas, fire, capture by enemies or pirates, detention by the government of any country, or from any fraudulent act of the master or mariners, such as running away with the ship, carrying her a course different from their orders, sinking her, deserting her, or embezzling the cargo. Assurances of this kind being of peculiar importance to the commercial interests of this country, and many frauds having been committed in this business by persons receiving premiums who were totally unable to fulfil their engagements, an act of parliament was passed in the reign of George I., establishing two corporations with adequate capitals for carrying on this business, and prohibiting any other society or partnership whatsoever from making marine assurances or lending money on bottomry. The two companies are, the Royal Exchange Assurance and the London Assurance, who both engage very extensively in this species of assurance; but as from their superior responsibility they generally require a somewhat higher premium than private underwriters, many persons prefer effecting their assurances with the latter; this business, in London, is carried on chiefly

in a set of rooms called Lloyd's coffee-house, over the Royal Exchange, where four or five hundred underwriters assemble daily. Persons having an assurance to make, generally employ a broker, who having prepared a policy, carries it to an underwriter, whom he considers a responsible person, who if he considers the risk offered an eligible one to undertake, signs his name at the bottom of the policy, mentioning the sum he agrees to be answerable for; it is then taken to another, and so on till the whole sum mentioned in the policy is completed. The premium paid depends on the length of the voyage, the condition of the vessel, the season of the year, peace or war, and many other circumstances; of course it is very different at different periods.

Life assurance is a contract by which the underwriter for a certain sum, proportioned to the age, profession, and other circumstances of the person whose life is the object of assurance, engages that if such person shall die within the time limited in the policy, he will pay a sum of money to him in whose favour the policy was granted. The advantages resulting from such assurances are very numerous, viz.

Persons deriving life incomes from church preferment, public offices, or any other civil or military employment, may thus, by appropriating part of their income to provide an annual payment, prevent the distress which their death would otherwise occasion to their family or dependents.

A person whose income depends on the life of another, may, by making an annual payment, secure an adequate sum to himself or representative, at the death of another person; or he may secure such sum to be paid only in case he survives such other person. For instance,

A person aged 20 pays annually

L.	*s.*	*d.*		
1	17	0	to secure 100*l.* to be paid him in case he survives another person aged	20
2	19	10		40
5	18	1		60

A person aged 60 pays annually

L.	*s.*	*d.*		
1	12	1	to secure 100*l.* to be paid him in case he survives another person aged	20
2	9	4		40
5	2	4		60

In cases, also, where a debtor cannot give adequate security to his creditor, an annual payment to the company will enable the creditor to receive his debt in the event of the death of the debtor. Tenants for life may thus obviate the difficulty of raising money on securities which must become void upon their decease.

Persons holding offices or employments depending on the lives of others, may in the same manner secure themselves from loss on the event of the death of the person on whose life their office or employments may depend.

Persons sinking a sum of money in the purchase of an employment or office, in establishing a trade or manufacture, or in carrying on agricultural improvements, may secure the repayment of such sum to their family or other representatives.

Persons entering into marriage, who, in consideration of the fortune received, may be required to settle a sum of money to be paid at their decease, may, by making an annual or single payment to the company, provide a fund for a marriage settlement, and thus secure a provision for a widow or children.

Persons holding leases on lives may provide the fine payable on the renewal of such leases.

Persons who are entitled, by purchase or otherwise, to an annuity on their own life, or the lives of others, or the joint lives of themselves and others, may secure the full value of such annuity, to be received at the death of the parties on whose lives the annuity depends.

Those who, on their surviving another, will become possessed of an estate, annuity, legacy, office, place, or preferment, ecclesiastical, military, or civil, may either provide a more adequate security than they could otherwise do for money advanced, or may secure an equivalent sum to their family, or other representative, to be paid in the event of such survivorship not taking place.

The premium paid for assuring a life, is computed from the probability of the failure of such a life, as deduced from bills of mortality, and the rate of interest at which money can be improved during the probable continuance of the life; those who wish to investigate this subject, may consult Simpson on Annuities and Reversions, Dr. Price's Treatise on Reversionary Payments, and the Doctrine of Annuities and Assurances on Lives, &c. by W. Morgan, actuary to the Society for Equitable Assurance on Lives and Survivorship. The premium for an assurance for a certain term of years, or for the whole continuance of life, is generally paid annually, but sometimes in a gross sum. The following is a specimen of the annual premium required for assuring 100*l.* by most of the societies that undertake this species of assurance:

Age.	One Year.			Seven Years.			Whole Life.		
	L.	*s.*	*d.*	*L.*	*s.*	*d.*	*L.*	*s.*	*d.*
10	0	17	9	1	1	5	1	17	7
15	0	17	11	1	2	11	1	18	7
20	1	7	3	1	9	5	2	3	7
25	1	10	7	1	12	1	2	8	1
30	1	13	3	1	14	11	2	13	5
35	1	16	4	1	18	10	2	19	10
40	2	0	8	2	4	1	3	7	11
45	2	6	8	2	10	10	3	17	11
50	2	15	1	3	0	8	4	10	8
55	3	5	0	3	12	0	5	6	4
60	3	18	1	4	7	1	6	7	4
65	4	15	2	5	10	10	7	16	9
70	6	6	1	7	14	4	10	0	4

Assurances on the lives of persons subject to any peculiar hazard; such as persons in the army and navy, or going to foreign parts, are charged with an additional premium proportionate to the extra risk.

The foundation of the contract for a life assurance, is generally, a warrantee that the life to be assured does not exceed a given age, and is in good health at the time of effecting the assurance. There is also usually a stipulation that the assurance shall become void if the person whose life is assured shall depart beyond the limits of Europe, shall die upon the seas, or shall engage in any military or naval service without the consent of the assurers; and when it is an assurance made by a person on his own life, it becomes void if he dies by suicide, duelling, or the hands of justice.

Any person making an assurance on the life of another must be interested therein, speculative assurances being prohibited by 14 George III. c. 48.

Assurances against fire, are made upon houses, warehouses, and all other buildings, household furniture, wearing apparel, merchandize, utensils and stock in trade, ships in harbour, in dock, or while building, and on all other property liable to be consumed by fire; except writings, notes, bonds, money, and a few other similar articles, which the assurers could not undertake to be answerable for, without rendering themselves liable to be grossly defrauded. Assurances against fire are made for a limited period, usually for one or more years, and are distinguished by the assurers into three classes, viz.

1. Common assurances are assurances on all manner of buildings, having the walls of brick or stone, and covered with slate, tile, or metal, wherein no hazardous trades are carried on, nor any hazardous goods deposited, and on goods and merchandizes not hazardous in such buildings.

2. Hazardous assurances are assurances on timber or plaister buildings, covered with slate, tile, or metal, wherein no hazardous trades are carried on, nor any hazardous goods are deposited; and on goods or merchandizes, not hazardous, in such timber or plaister buildings; and also on hazardous trades, such as cabinet and coach makers, carpenters, coopers, bread and biscuit bakers, ship and tallow chandlers, soap-makers, innholders, sail-makers, maltsters, and stable-keepers, carried on in brick or stone buildings covered with slate, tile, or metal; and on hazardous goods, such as hemp, flax, rosin, pitch, tar, and turpentine, deposited in such buildings; the stock in trade of apothecaries; also on ships, and all manner of water-craft, in harbour, in dock, or while building, and on thatched buildings which have not a chimney, and do not adjoin to any building having a chimney.

3. Doubly-hazardous assurances are assurances on any of the aforesaid hazardous trades carried on, or hazardous goods deposited in, timber or plaister buildings, covered with slate, tile, or metal; on glass, china, and earthenware; also in thatched buildings or goods therein (except as in the preceding class); and on saltpetre, with the buildings containing the same.

Assurances on buildings and goods are deemed distinct adventures, so that the premium on goods (so far as it is regulated by the sum assured) is not advanced by reason of any assurance on the building wherein the goods are kept, nor the premium on the building by reason of any assurance on the goods.

The annual premiums usually charged for fire assurances are: common assurances not exceeding 3000*l.* two shillings per cent; hazardous assurances not exceeding 2000*l.* three shillings per cent; doubly-hazardous assurances not exceeding 2000*l.* five shillings per cent.

In addition to this charge of the assurers, government have imposed a duty of 2*s.* 6*d.*

per cent. per annum on all sums assured against fire.

ASSUROR, a merchant or other person who signs a policy of assurance, and thereby insures a ship, house, or the like.

The assuror is not liable for what damages may arise from the negligence or other faults of the masters or mariners, or even from any defect in the things assured.

ASSURITANI, a branch of the Donatists, who held, that the Son was inferior to the Father, and the Holy Ghost to the Son: they rebaptized those who embraced their sect; and asserted that good men only were within the pale of the church.

ASTATI, a sect of Christians, who being the followers of one Sergius, revived the erroneous doctrines of the Manichees. They were remarkable for the inconstancy of their principles.

ASTER, in botany, *star-wort*, a genus of the polygamia superflua order and syngenesia class of plants, and in the natural method ranking under the 49th order, compositi radiati. The receptacle is naked, the pappus is simple, the rays of the corolla are more than ten, and the calyx is imbricated. There are 60 species. All of them may be raised from seed; but the greatest part of them being perennial plants, and increasing at the roots, are generally propagated by parting their roots early in the spring, and they will grow in almost any soil or situation; and the larger sorts increase so fast, that, if not prevented, they will in a little time run over a large space of ground. They grow best in the shade. The lower kinds do not run so much at the root, but should be taken up and transplanted every other year, which will make them produce much fairer flowers. Some few sorts, which are natives of warm climates, will require artificial heat to raise them, if not to preserve them.

ASTERIA, in natural history, a beautiful pellucid gem, of variable colours as viewed in different lights: called also *oculus cati*, or cat's eye.

The variable colours, which are a pale brown and white, seem to be lodged deep in the stone, and shift about as that is moved. It is nearly allied to the opals; from which, however, it is distinguished by its colour and superior hardness.

ASTERIA is also the name of an extraneous fossil, called in English the star-stone.

ASTERIAS, *star fish*, or *sea star*, in zoology, a genus of the order of vermes mollusca. It has a depressed body, covered with a coriaceous coat; is composed of five or more segments, running out from a central part, and furnished with numerous tentacula; and has the mouth in the centre. The conformation of the mouth is this: the under part of each lobe runs towards a point with the rest at the centre of the body; and these several productions of the rays make a sort of lips, the ends of each of which are armed with a number of sharp teeth, which serve to take and convey the food into the body. From this mouth there goes a separate canal to all or many of the rays, which runs through their whole length, and becomes gradually narrower as it approaches the extremity. The tentacula resemble the horns of snails, but serve the animal to walk with. They are capable of being contracted or shortened; and it is only at the creature's moving that they are seen of their full length: at other times no part of them is seen but the extremity of each, which is formed like a sort of button, being somewhat larger than the rest of the horn. Aristotle and Pliny called this genus ἀστηρ, and *stella marina*, from their resemblance to the pictured form of the stars of heaven; and they asserted that they were so exceedingly hot, as instantly to consume whatsoever they touched! The fossil world has been greatly enriched by the fragments and remains of the several pieces of star-fish which have been converted into stones. There are many species of this genus: some of 12, 13, and even 14 rays. Most of them are found in our seas. See Plate Nat. Hist. fig. 41.

1. ASTERIAS *caput Medusæ*, or arborescent sea-star, has five rays issuing from an angular body: the rays dividing into innumerable branches, growing slender as they recede from the base. These the animal, in swimming, spreads like a net to their full length; and when he perceives any prey within them, draws them in again, thus catching it with all the dexterity of a fisherman. It is an inhabitant of every sea; and is called by some the Magellanic star-fish and basket-fish. When it extends its rays fully, it forms a circle of near three feet in diameter. The fragments of these rays furnish the fossil entrochi. If we drown this animal in brandy or spirit of wine, and keep the rays flat and expanded in the execution, it is easy to extract by means of a pair of forceps the stomach of the animal whole and entire through the mouth.

2. ASTERIAS *clathatra*, or cancellated sea-star, with five short thick rays, hirsute beneath, cancellated above, is found on our coasts, but is rare.

3. ASTERIAS *decacnemos* has ten very slender rays, with numbers of long beards on the sides; the body is small, and surrounded beneath with ten filiform rays.

4. ASTERIAS *glacialis*, with five rays, depressed, broad at the base, yellow, and having a round striated operculum on the back, is the most common: it feeds on oysters, and is very destructive to the beds. See Plate Nat. Hist. fig. 42.

5. ASTERIAS *hispida*, with five rays, broad, angulated at top, and rough with short bristles, is of a brown colour, and is found about Anglesea.

6. ASTERIAS *oculata*, with five smooth rays, dotted or punctured, is of a fine purple colour, and is also found about Anglesea.

7. ASTERIAS *placenta*, with five very broad and membraneous rays, extremely thin and flat, is found about Weymouth.

8. ASTERIAS *spherulata*, with a pentagonal indented body; a small globular bead between the base of each ray; the rays slender, jointed, taper, and hirsute on their sides: is found off Anglesea.

ASTEROIDES, in astronomy, a name given by Dr. Herschel to the new planets, or three small planetary bodies, discovered by the foreign astronomers Piazzi, Olbers, and Harding, which are defined as "celestial bodies either of little or considerable excentricity round the sun, the plane of which may be inclined to the ecliptic in any angle whatever. The motion may be direct or retrograde; and they may or may not have considerable atmospheres, very small comas, disks, or nuclei." From the observations already made on these bodies, they appear to partake of the several properties by which the planets in general are known and described; and therefore, with justice, some astronomers have objected to this new definition of Dr. Herschel.

ASTEROPODIUM, a kind of extraneous fossil, of the same substance with the asteriæ, or star-stones, to which they serve as a base.

ASTHENIA, in medicine, a term employed to denote bodily debility. See MEDICINE.

ASTHMA, in medicine, a painful, difficult, and laborious respiration, occasioned by intolerable straitness of the lungs, which, as it disturbs the free circulation of the blood through the lungs, endangers a suffocation.

This disorder is attended with violent motions of the diaphragm, abdominal and intercostal muscles, to the very scapula and pinnæ of the nostrils. It is usually divided into pneumonic and convulsive; and is also either continual, or intermitting and periodical, and returns commonly when a sober regimen is not observed.

This disorder proves most violent while the patient is in bed, and in a prone posture, as in that case the contents of the lower belly bearing against the diaphragm, lessen the capacity of the breast, and leave the lungs less room to play. See MEDICINE.

ASTRAGAL, in architecture, a little round moulding, in form of a ring, serving as an ornament at the tops and bottoms of columns. See ARCHITECTURE.

ASTRAGAL, in gunnery, a round moulding encompassing a cannon, about half a foot from its mouth.

ASTRAGALUS, in botany, *milk vetch*, or *liquorice vetch*, a genus of the decandria order and diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ; the pod is gibbous and bilocular. Of this genus there are 63 species.

ASTRAGALUS *communis*. The common species grows wild upon dry uncultivated places, and is recommended by Mr. Anderson to be cultivated as proper food for cattle.

The astragalus tragacantha is a thorny bush growing in Crete, Asia, and Greece, which yields the gum tragacanth. This is of so strong a body, that a drachm of it will give a pint of water the consistence of a syrup, which a whole ounce of gum arabic is scarcely sufficient to do. Hence its use for forming troches, and for similar purposes, in preference to the other gums.

ASTRAGALUS, in anatomy, called also the *talus*, is the superior and first bone of the foot. See ANATOMY.

ASTRANTIA, *masterwort*, a genus of the digynia order and pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The involucrum is lanceolated, open, equal, and coloured. The species are five, but possess no remarkable properties.

ASTRARIUS *hæres*, in law, is where an ancestor, by conveyance, has settled his heir-apparent and family in a house in his life-time.

ASTRÆA, in astronomy, the same as Virgo.

ASTRINGENTS, *astringentia*, in pharmacy, medicines of the corroborative class. See PHARMACY.

Astringents are thought by some to act

nearly in a similar manner on the simple or dead animal fibre as on the living solid; in both cases thickening and hardening: when applied to the living solid, they produce increase of tone and strength, restrain inordinate actions, and check excessive discharges from any vessels or cavities; and to the dead fibre occasion that density, toughness, imperviousness to water in a greater or lesser degree, and insusceptibility to the common causes of putrefaction, in which consists the process of tanning, or preparation of leather. See TANNING.

ASTRODICTICUM, an astronomical instrument, by means of which many persons are able to view the same star at the same time.

ASTROITES, or *star stone*, in natural history, is so called on account of its resemblance to a star. It is controverted among naturalists, whether they are parts of a petrified marine animal, or, as is more probable, a species of coral buried in the earth. The corals forming these stars are sometimes round, sometimes angular, and their columns are sometimes separated, and sometimes the stria run into one another.

ASTROLABE, the name for a stereographic projection of the sphere, either upon the plane of the equator, the eye being supposed to be in the pole of the world; or upon the plane of the meridian, when the eye is supposed in the point of intersection of the equinoctial and horizon.

ASTROLABE is also an instrument for taking the altitude of the sun or stars at sea, being a large brass ring, A C B D (Plate IX. Miscel. fig. 5.), the limb of which, or a convenient part thereof A C, is divided into degrees and minutes, with a moveable index F G, which turns upon the centre, and turns two sights: at the zenith is a ring A, to hang it by in time of observation, when you need only to turn the index to the sun, that the rays may pass freely through both sights, and the edge of the index cuts the altitude upon the divided limb. This instrument, though not much in use now, if well made, and of great weight that it may hang the steadier, is as good as most instruments that are used at sea for taking altitudes, especially between the tropics, when the sun comes near the zenith, and in calm weather.

ASTROLOGY, a conjectural science, which absurdly pretended to foretel future events by the situation and different aspects of the heavenly bodies.

ASTROLUS, in natural history, a name given by authors to a white splendid stone, small in size, roundish, and resembling the eyes of fishes.

ASTROMETEOROLOGIA, the art of foretelling the weather and its changes from the aspect of the moon and stars. This is sometimes called meteorological astrology. There is however but little reason to believe that the heavenly bodies have any great influence on our atmosphere. See METEOROLOGY.

ASTRONIUM, in botany, a genus of the class and order dioecia pentandria. The essential character is, male, calyx five-leaved; corolla five-petalled; female, calyx five-leaved; corolla five-petalled; styles three; seed one.

There is but one species, a tree, a native of New Spain, abounding in a slight glutinous terebinthine juice, which has a disagreeable smell.

ASTRONOMICAL *place* of a star or planet, is its longitude or place in the ecliptic, reckoned from the beginning of Aries, according to the natural order of the signs.

ASTRONOMY, is a mixed mathematical science, which treats of the heavenly bodies, their motions, periods, eclipses, magnitudes, &c. and of the causes on which they depend.

History of Astronomy.—The origin of astronomy is very obscure, and appears to be also very antient. "There is no doubt," says Cassini, "that astronomy was known even from the commencement of the world. It was not only curiosity which led man to the study of astronomy, but it may be said that necessity itself obliged him to it. For if he did not observe the seasons which result from the apparent changes of the sun's place, it would be impossible to succeed in the practice of agriculture and other useful arts." But astronomy, even if it could be considered as useless to man, derives from its very nature a certain degree of dignity. It is, moreover, upon this that navigation, geography, and chronology, depend. By its aid man passes the seas, and penetrates into foreign climes, becomes acquainted with those which he inhabits, and regulates the dates of ages past.

Hipparchus laid the principal foundation of a methodical astronomy, 147 years before Christ. When an opportunity was given him to observe a new fixed star, he directly made a list of such stars, so that in the next age they were able to know if one had appeared more than usual. Ptolemy, about 280 years afterwards, added his observations to those of Hipparchus, and by the natural advantage which he possessed over his predecessor, he was enabled to rectify greatly the observations that he had made.

Astronomy was very much neglected from this period till after the middle of the 13th century, at which time Alphonsus, king of Castile, formed tables more exact than the preceding. Indeed, a celebrated astronomer having at an early period been sufficiently attentive to observe all the planets in one night, found not one in the place of another, but all according to the tables which had been made by order of the king of Castile. It was not, however, till the 16th century that astronomy derived fresh lustre from the system of Copernicus, published at Nuremberg in 1543, and brought to perfection by Kepler and Galileo; a system so bold and daring, that it produced general astonishment, and yet its truth has been confirmed by the observations of every succeeding age. The surface of the heavens seems to us to be studded with stars; between the fixed stars and us there seem to be other stars which change their situations respectively one towards another, and these all astronomers have agreed in calling *planets*, or wandering stars. The antient philosophers, who knew so very little even of the movements of the planets, had no evident means to know the true disposition of their orbits; and this is the reason that they vary so greatly in their opinions. They supposed, at first, the earth to be immoveable, as the centre of the universe, and that all the celestial bodies turned about her; which, indeed, was natural for them to believe, without having discussed the proofs to the contrary.

The Babylonians, however, and afterwards Pythagoras and his disciples, are said to have considered the earth as a planet, and the sun as immoveable, and the centre of our planetary system. Plato was the reviver of the system of the immobility of the earth, and many philosophers followed his sentiment; among others was Claudius Ptolemy, the celebrated astronomer and mathematician of Pelusium in Egypt, already mentioned, who lived in the beginning of the second century of the Christian æra. It is, however, incredible that the true system of the world having been once discovered, the hypothesis by which the earth is supposed to be the centre of the celestial movements should have again prevailed; for though this hypothesis accords with appearances, and seems to agree at first with the simplicity of nature, yet it is impossible on that system to account for the celestial movements. Ptolemy, who has given the name to this system, endeavours to prove that the Earth is truly immoveable as the centre of the universe; and he places the other planets round about her in the following order, beginning by those which he believes the next to the Earth; the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn, till he comes at length to the fixed stars. His principal reason for placing Mercury and Venus beneath the Sun, though they are often seen farther from the Earth than from the Sun, was, without doubt, because the duration of their revolution was shorter than the apparent revolution of the Sun. When, however, astronomers had begun to observe the planets, they remarked that Mercury and Venus are sometimes nearer, and sometimes farther, than we are from the Sun; and that Venus never departs from the Sun more than about 47 degrees and a half; and Mercury about 28 degrees and a half, and sometimes much less. But it is evident that if these two planets turned about the Earth, as they suppose the Sun himself turned, they would sometimes appear opposite to the Sun, or farther from him than 180 degrees, which never happens. This is the reason why the Egyptians regarded these two planets as satellites of the Sun, and thought that they turned about him, their orbits being carried with this star in his revolutions about the Earth. They therefore supposed the Earth immoveable, as the centre of the system; and they supposed the other celestial bodies to turn round her: first, the Moon; secondly, the Sun, about which they made Mercury and Venus turn, without ever touching the Earth in their revolution, till they come to Mars, Jupiter, and to Saturn, the whole of their movements being determined by the fixed stars.

At the present day, when we know the immense distances which separate these stars, both of these systems become insupportable, because of the prodigious rapidity which they require in the movements of the celestial bodies; for if we take a view of these distances, it will be found necessary for these stars to go through the whole course of their orbits in about 24 hours, and that the Sun should run through, in a second of time, more than the space of 2500 leagues. To-

wards the year 1530, Copernicus, with a view of obviating the inconveniences of the imaginary systems that preceded him, commenced at first by admitting the diurnal motion of the Earth, or her motion round her own axis; which rendered useless that prodigious celerity in the motions of the heavenly bodies, of which we have just spoken, and by these means simplified the system. This motion being once admitted, it was no violent step to admit a second motion of the Earth in the ecliptic. These two motions explain, with the utmost facility, the phenomena of the stations and motion of the planets. According to Copernicus, then, the Sun is the centre of our planetary system, and the planets turn about him in the order following: Mercury, Venus, the Earth, Mars, Jupiter, Saturn (to which we may add the Herschel), at a distance from the Sun nearly as the numbers 4, 7, 10, 15, 52, 95, 191. The Moon also he supposed to be carried round the Earth, in an orbit which goes along with the Earth in her annual motion round the Sun. In like manner about Jupiter, Saturn, and the Herschel, are the four satellites of the first, the seven satellites of the second, and the six satellites of the third. Although the celestial phenomena explain themselves with the greatest facility according to the system of Copernicus, and though observation and reason are equally favourable to it, yet he found in his time an able astronomer who rejected the evidence of his discoveries. Tycho-Brahe, from the experiment that a stone thrown from a high tower fell at its feet, argued that the Earth must be without motion; never reflecting that the Earth, in that case, is like a vessel in full sail; where if a stone is thrown from the mast, it will fall at the foot of that mast, provided the motion of the vessel was neither accelerated nor retarded. Tycho-Brahe, therefore, invented a system between that of Ptolemy and that of Copernicus. He supposed that the Earth was at rest, and that the other planets turn round the Sun, turning also with him round the Earth in twenty four-hours. It was towards the end of the sixteenth century that he proposed his system. He placed the Earth immoveable as the centre, and made the Moon turn round her, the Sun also, and the fixed stars: the planets, viz. Mercury, Venus, Mars, Jupiter, and Saturn, turning round the Sun, in orbits which are carried with him in his revolution round the Earth.

Celestial Phenomena.—Upon examining the heavens, the first and most obvious phenomenon that presents itself to observation, is the apparent diurnal motion of the sun, moon, and stars, or that by which they are seen to rise and set once in twenty-four hours.

If, to consider more attentively the circumstances of this diurnal motion, we place ourselves in an elevated situation, we shall perceive a circle terminating our view on all sides, by the apparent meeting of the earth and heavens. This circle is called the horizon: it divides the heavens into two parts; that which is above the horizon only is visible; and this appears to us like a concave hemisphere, which we call the sky, in which we see the heavenly bodies move. The sky is not a real substance; its blue colour is only owing to the refraction of the rays of light which pass through it.

On considering with attention for one or more nights the motions of the stars, we find each star describing a circle in about twenty-four hours. Those stars that appear northward describe smaller circles than those that are more to the south. If we look towards the south, we observe some stars just appearing above the horizon, grazing this circle, but not rising above it, and then vanishing; others a little farther from the south, rise above the horizon, making a small arc, and then go down; while some again describe a larger arc, and take a longer time in setting. If we now turn to the north, we shall find that some just skim the horizon, mount to the top of the heavens, and then descend, and again touch the horizon, and mount without ever disappearing. Others, that are higher, describe complete circles in the sky, without coming to the horizon; and these circles diminish, till at last we arrive at a star that scarcely seems to move from the point where it is stationed, the rest wheeling round it.

It may be easily conceived, that as there is a hemisphere above, there is also another beneath, though invisible; and that, of course, the horizon is a great circle of the sphere, dividing the concave heavens into two parts, the visible above, and the invisible below. The general appearance, therefore, of the starry heavens, is that of a vast concave sphere turning round two fixed points diametrically opposite to each other; the one in the northern hemisphere visible to us; and the other in the southern hemisphere.

The fixed points round which this sphere is supposed to turn, are the poles, and a line drawn from one to the other is called the axis of the sphere; and round this line the heavens seem to turn every day.

To understand this more clearly, we must have recourse to a figure, or diagram. Let H O (see Plate, Astronomy, fig. 1) represent the circle of the horizon, seen edgeways, when it will appear as a straight line; let H P F O R Q be the complete sphere of the heavens, of which we shall suppose H P E O to be the visible hemisphere, and H Q R O the invisible hemisphere: then P will be the pole, or fixed point, among the stars visible to us, round which they all appear to turn, and R will be the opposite pole, or fixed point, in the sphere; a line from P to R will be the axis of the sphere. If through the centre of the sphere C, there is drawn a line Q E, it will represent the edge of a great circle, at equal distances from both poles, and at right angles to the axis, called the equator, because it divides the heavens into two equal parts.

If H O be the horizon, the highest point, or that immediately over our heads, as M, is called the zenith; and the opposite point in the sphere, or lowest point N, is called the nadir.

The rising and setting of the sun are the two most remarkable circumstances to be observed in the heavens. He rises in the east, mounts to the highest point in the arch which he describes, and descends in the west. The highest point to which he reaches, is naturally called the mid-day point. If a great circle is traced through this point and the zenith, it is called the meridian of the place; and all the stars must cross this circle, or meridian, twice in the twenty-four hours; but those that go below the horizon are seen only to cross it once, because when they cross it a second time they are invisible.

Three great circles are now established in the heavens; the horizon, the equator, and the meridian. The first determines the rising and setting of the heavenly bodies; and also the altitude of any of them, at any time of their course. For this purpose we must suppose another great circle to pass through the star and the zenith; it will consequently be perpendicular to the horizon. This is called a vertical circle, and upon this circle we reckon the number of degrees which the star is distant from the horizon. The quadrant is an instrument for measuring the number of degrees of altitude which any body has.

The three great circles already mentioned form the basis of all observations upon the heavenly bodies, and to them all their situations must be referred. It is necessary, therefore, to determine the relative situations of these circles. If the polar star had been accurately at the pole of the heavens, nothing more would be necessary, in order to obtain the altitude of the pole, than to take the altitude of this star; but this star is situated two degrees distant from the pole; two degrees must therefore be added to this altitude, to find that of the pole.

The elevation of the pole being discovered, it is easy to find that of the equator. Thus, in the diagram (fig. 1.), H M O, or the visible part of the heavens, contains 180 degrees; but it is 90 degrees from the pole P, to E the equator. If we take away P E from the semi-circle H M O, there remains 90 degrees for the other two arcs; or, in other words, the elevation of the pole and the equator, are together equal to 90 degrees; so that the one being known, and subtracted from 90 degrees, it will give the other; therefore, the elevation of the pole at any place, is the complement of the elevation of the equator, or what that elevation wants of 90 degrees. Hence it follows, that the elevation of the equator is equal to the distance from the pole to the zenith; for the elevation of the equator is the difference between that of the pole and 90 degrees: the same elevation subtracted from 90 degrees gives its distance from the zenith. A little attention will soon convince us that the sun does not always rise at the same point of the heavens. Thus, if we commence our observations on the sun, for instance in the beginning of March, we shall find him appear to rise more to the northward every day, to continue longer above the horizon, and to be more vertical or higher at mid-day. This continues till towards the end of June, when he moves backward in the same manner, and continues this retrograde motion till near the end of December, when he begins to move forward, and so on. It is from this change in the sun's place, and from his height being so much greater in summer than in winter, that the different length of the days and nights, and the vicissitudes of seasons, are owing. We cannot observe the sun's motion among the fixed stars, because he darkens the heavens by his splendour, and effaces the feeble light of those stars that are in his neighbourhood; but we can observe the instant of his coming to the meridian, and his meridional altitude; we can also compute

what point of the starry heavens comes to the same meridian at the same time, and with the same altitude. The sun must be at that point of the starry heavens, thus discovered. Or we can observe that point in the heavens which comes to the meridian at midnight, with a declination as far from the equator on one side as the sun's is on the other side; and it is evident the sun must be in that part of the heavens which is diametrically opposite to this point. By either of these methods we may obtain a series of points in the heavens, through which the sun passes, forming a circle called the ecliptic. This circle has ts name from the circumstance, that all the eclipses of the sun and moon are performed either actually in, or very near, the circumference of that circle.

The ecliptic, or annual path of the sun, differs in situation from the equator; for the sun rises above the equator in summer, and does not rise so high in winter. The points of the ecliptic where the sun is situated when he is most distant from the equator, are called solstitial points; and the distance between the equator and the ecliptic at the solstitial points, is called the obliquity of the ecliptic; this is found to be about twenty-three and a half degrees. A B (fig. 1.) represents the ecliptic, inclined twenty-three and a half degrees to the equator E Q.

The equinoctial colure is the great circle which passes at right angles to the equator, through those two points of it that are intercepted by the ecliptic, called the equinoctial points. The solstitial colure is the other great circle at right angles to the equator, cutting it in the solstitial points. It passes through the poles of the ecliptic.

If smaller circlesof the sphere are described touching the solstitial points, and at right angles to the axis, as A C, B D, they are tropies; of which that on the south side of the equator is called the tropic of Capricorn, and that on the north side of the equator the tropic of Cancer. The two polar circles F G, I K, are at the same distance from the two poles as the tropics are from the equator; that is, twenty-three and a half degrees.

It is necessary here to mention the difference between what is called the sensible and rational horizon. If we suppose that part of the surface of the earth on which we stand to be a plane, and to be extended every way till it reaches the heavens, this plane forms the sensible horizon. The rational horizon is a circle, the plane of which is parallel to the former, but passing through the centre of the earth. Though the globe of the earth appears so large to those who inhabit it, yet it is so small when compared with the immense sphere of the heavens, that the distance between the sensible and rational horizons is nothing in comparison with it.

The zodiac is a broad portion of the heavens, which stretches about eight degrees on each side of the ecliptic; it is divided into twelve parts, called signs; and each sign into thirty parts, called degrees. If we imagine a number of great circles of the sphere standing at right angles to the plane of the ecliptic, and consequently intersecting each other in its poles, these are called circles of celestial longitude, and they will divide the ecliptic into equal parts. Upon the ecliptic is reckoned the longitude of any fixed star, beginning to reckon at that point where the ecliptic and the equator intersect each other in the vernal equinox, called the first point of Aries; and the arch of any of the circles of celestial longitude intercepted between a star and the ecliptic, is the latitude of that star. The equator is divided into degrees, but they are called degrees of right ascension, and from it to the poles the degrees of declination are reckoned upon the meridian of the place.

Having now described the principal lines and points on the celestial sphere, as generated by the apparent motions of the heavenly bodies, in which we have supposed what appears at first sight to be the case, viz. that the earth stands still while all the heavenly bodies revolve round it. This will make no difference with regard to these circles in the heavens; for it will be the same thing with respect to them, whether the earth is at rest, and the heavenly bodies move round it, or whether the latter remain still, and the earth, as we shall afterwards see, moves round on its axis once every twenty-four hours.

Of the Solar System If we examine the heavens in a clear night, we shall discover some stars which have brighter and steadier light than the rest; and if we continue to observe these for several nights, we shall find that they do not appear in the same place among the rest of the stars every night, but that they have motions peculiar to themselves. All the rest of the stars, rising and setting always exactly in the same places, are called fixed stars. Those wandering or moving stars, are called planets.

It is now fully proved, that these planets, with the earth which we inhabit, and also the moon, revolve round the sun, which is fixed in the centre of the system. There are two kinds of planets, primary and secondary. The first move round the sun, and respect him only as the centre of their motions. The secondary planets, called also satellites or moons, are smaller planets, revolving round the primary; while they, with the primary planets about which they move, are carried round the sun. The planets move round the sun at various distances, some being much nearer to him than our earth, and others being much farther off.

Of these, our earth is accompanied by one moon, Jupiter has four moons, Saturn has seven, and the Herschel planet has six moons. None of these moons, except our own, can be seen without a good telescope. The other five planets do not appear to have any satellites or moons.

There are ten primary planets, which are situated with respect to their distances from the sun as follows: Mercury ☿, Venus ♀, the Earth ⊕, Mars ♂, Ceres, Pallas, Juno, Jupiter♃, Saturn ♄, and the Herschel or Georgium Sidus ♅. See Astronomy Plate, Solar System.

All the planets move round the sun from east to west, and in the same direction do the moons revolve round their primaries; excepting those of the Herschel planet, which seem to move in a contrary direction. The paths in which they move round the sun are called their orbits. These orbits are elliptical; but the eccentricity of the ellipses is so small, that they approach very nearly to circles. They perform their revolutions also in very different periods of time. The time of performing their revolutions is called their year.

TABLE OF THE SOLAR SYSTEM.

	Apparent mean diameters, as seen from the Earth.	Mean diameters, in English miles.	Mean distances from the Sun, in round numbers of miles.	Diurnal rotations, or round their own axes.	Time of revolving round the Sun.	Inclination of the orbits of the Ecliptic.	Inclination of the axes to the orbits.
The Sun,	32′.1″,5	818,246	—	25d. 14h. 8m.	—	—	82° 44′ 0″
Mercury,	10″	3,224	37,000,000	unknown.	87d. 23h. 16m.	7° 0′ 0″	unknown.
Venus,	58″	7,867	68,000,000	0d. 23h. 21m.	224 16 49	3 23 35	unknown.
The Earth,	—	—	95,000,000	1d.	365 6 9	—	66° 32′ 0
The Moon,	31′.8″	2,180	95,000,000	29d. 17h. 44m. 3s.	—	5 9 3	88 17 0
Mars,	27″	4,189	144,000,000	0 24 39 22	686 23 30½	1 51 0	59 22 0
Ceres Ferdinandea,	1″	160	260,000,000	unknown.	unknown.	10 37 56	unknown.
Pallas,	0″,5	80	266,000,000	unknown.	1703d. 16h. 48m.	34 50 40	unknown.
Juno,	—	—	300,000,000	—	2012 0 0	21 0 0	unknown.
Jupiter,	39″	89,170	490,000,000	0d. 9h. 55m. 37s.	4332 14 27	1 18 56	90° 0′ 0″
Saturn,	18″	79,042	900,000,000	0 10 16 2	10759 1 51	2 29 50	60 9 0
Herschel,	3″.54	85,112	1,800,000,000	unknown.	30737 18 0	0 46 20	unknown.

The planets are evidently opaque bodies, and they shine only by reflecting the light which they receive from the sun; for Mercury and Venus, when viewed by a telescope, often appear to be only partly illuminated, and have the appearance of our moon when she is horned, having the illumined part always turned towards us. From the appearance of the boundary of light and shadow upon their surfaces, we conclude that they are spherical; which is confirmed by most of them having been found to turn periodically on their axes.

Venus and Mercury being nearer to the sun than our earth, are called inferior planets; and all the rest, which are without the earth's orbit, are called superior planets. That the first go round the sun is certain, because they are seen sometimes passing between us and the sun, and sometimes they

go behind it. That their orbits are within that of the Earth is evident, because they are never seen in opposition to the sun, that is, appearing to rise from the horizon when the sun is setting. On the contrary, the orbits of all the other planets surround that of the earth; for they sometimes are seen in opposition to the sun, and they never appear to be horned, but always nearly or quite full, though sometimes they appear a little gibbous, or somewhat deficient from full.

We mentioned above, that all the planets move round the sun in elliptical orbits. The sun is situated in one of the foci of each of them. That focus is called the lower focus. If we suppose the plane of the earth's orbit, which passes through the centre of the sun, to be extended in every direction, as far as the fixed stars, it will mark out among them a great circle, which is the ecliptic; and with this the situations of the orbits of all the other planets are compared.

The planes of the orbits of all the other planets must necessarily pass through the centre of the sun; but if extended as far as the fixed stars, they form circles different from one another, as also from the ecliptic; one part of each orbit being on the north, and the other on the south side of the ecliptic. The orbit therefore of each planet cuts the ecliptic in two opposite points, which are called the nodes of that particular planet, and different from the nodes of another planet. A line passing from one node of a planet to the opposite node, or the line in which the plane of the orbit cuts the ecliptic, is called the line of nodes. That node, where the planet passes from the south to the north side of the ecliptic, is called the ascending node. The angle which the plane of a planet's orbit makes with the plane of the ecliptic, is called the inclination of that planet's orbit. Thus (Astronomy, Plate II. fig. 2.) where F represents the sun, the points A and B represent the nodes, and the line A B the line of nodes formed by the intersection of the planes of the orbits C and D. The angle E F G is the angle of inclination of the planes of the two orbits to each other. The distance of either focus from the centre of the orbit, is called its eccentricity.

The two points in a planet's orbit which are farthest and nearest to the body round which it moves, are called the apsides; the former of which is called the higher apsis, or aphelion; the latter is called the lower apsis, or perihelion. The diameter which joins these two points, is called the line of the apsides. When the sun and moon are nearest to the earth, they are said to be in perigee. When at their greatest distance from the earth, they are said to be in apogee.

When a planet is situated so as to be between the sun and the earth, or so that the sun is between the earth and the planet, then that planet is said to be in conjunction with the sun. When the earth is between the sun and any planet, then that planet is said to be in opposition. It is evident that the two inferior planets must have two conjunctions with the sun; and the superior planets can have only one, because they can never come between the earth and the sun. When a planet comes directly between us and the sun, it appears to pass over the sun's disc, or surface, and this is called the transit of the planet. When a planet moves from west to east, viz. according to the order of the signs, it is said to have direct motion, or to be in consequentia. Its retrograde motion, or motion in antecedentia, is when it appears to move from east to west, viz. contrary to the order of the signs.

The place that any planet appears to occupy in the celestial hemisphere, when seen by an observer supposed to be placed in the sun, is called its heliocentric place. The place it occupies when seen from the earth, is called its geocentric place.

The planets do not move with equal velocity in every part of their orbits, but they move faster when they are nearest to the sun, and slower in the remotest part of their orbits; and they all observe this remarkable law, that if a straight line is drawn from the planet to the sun, and this line is supposed to be carried along by the periodical motion of the planet, then the areas which are described by this right line and the path of the planet, are proportional to the times of the planet's motion. That is, the area described in two days, is double that which is described in one day, and a third part of that which is described in six days; though the arcs, or portions of the orbit described, are not in that ratio.

The planets being at different distances from the sun, perform their periodical revolutions in different times; but it has been found that the cubes of their mean distances are constantly as the squares of their periodical times, viz. of the times of their performing their periodical revolutions.

These two last propositions were discovered by Kepler, by observations on the planets; but sir Isaac Newton demonstrated, that it must have been so on the principle of gravitation, which formed the basis of his theory. This law of universal attraction, or gravitation, discovered by Newton, completely confirms the system of Copernicus, and accounts for all the phenomena which were inexplicable on any other theory.

The sun, as the largest body in our system, forms the centre of attraction, round which all the planets move; but it must not be considered as the only body endued with attractive power, for all the planets also have the property of attraction, and act upon each other, as well as upon the sun. The actual point, therefore, about which they move, will be the common centre of gravity of all the bodies which are included in our system; that is, the sun, with the primary and secondary planets. But because the bulk of the sun greatly exceeds that of all the planets put together, this point is in the body of the sun. The attraction of the planets on each other, also disturbs their motions, and causes some irregularities.

It is this mutual attraction between them and the sun, that prevents them from flying off from their orbits by the centrifugal force which is generated by their revolving in a curve; while the centrifugal force keeps them from falling into the sun by the force of gravity, as they would do if it were not for this motion impressed upon them. Thus these two powers balance each other, and preserve order and regularity in the system.

It is an established maxim in philosophy, that if, when a body is projected in a straight line, it is acted upon by another force, drawing it towards a centre, it will be made to describe a curve, which will be either a circle or an ellipsis, according to the proportion between the projectile and centripetal force. If a planet at B (fig. 3.) gravitates or is attracted towards the sun S, so as to fall from B to y in the time that the projectile force would have carried it from B to X, it will describe the curve B Y, by the combined action of these two forces, in the same time that the projectile force singly would have carried it from B to X, or the gravitating power singly have caused it to descend from B to y; and these two forces being duly proportioned, the planet, obeying them both, will move in the circle B Y T V.

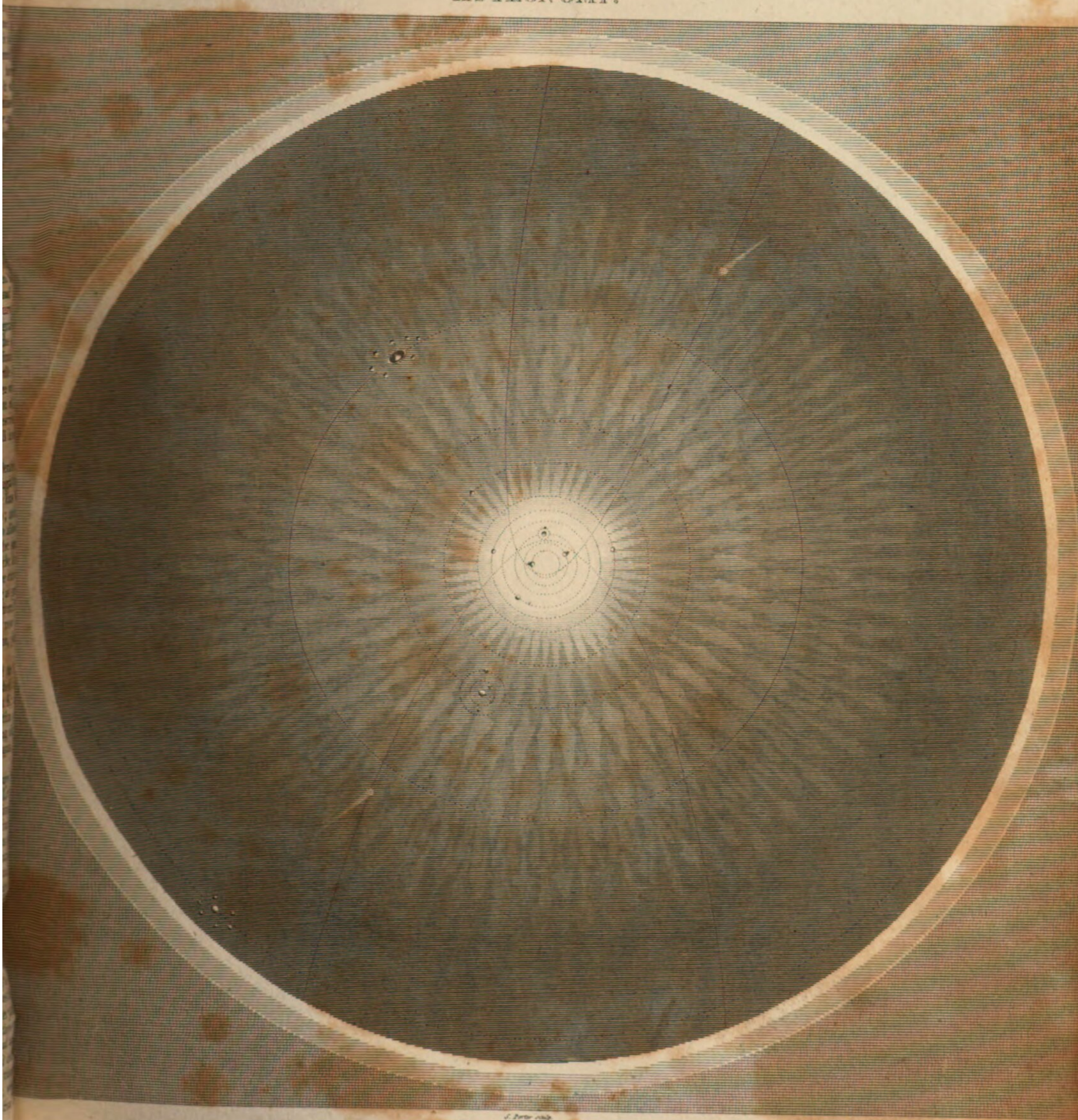
But if, whilst the projectile force would carry the planet from B to b, the sun's attraction should bring it down from B to 1, the gravitating power would then be too strong for the projectile force, and would cause the planet to describe the curve B C. When the planet comes to C, the gravitating power (which always increases as the square of the distance from the sun S diminishes) will be yet stronger for the projectile force, and by conspiring in some degree with it, will accelerate the planet's motion all the way from C to K, causing it to describe the arcs B C, C D, D E, E F, &c. all in equal times.

Having its motion thus accelerated, it thereby acquires so much centrifugal force, or tendency to fly off at K, in the line K k, as overcomes the sun's attraction; and the centrifugal force being too great to allow the planet to be brought nearer to the sun, or even to move round him in the circle k m n, &c. it goes off, and ascends in the curve K L M N, &c. its motion decreasing as gradually from K to B, as it increased from B to K; because the sun's attraction now acts against the planet's projectile motion, just as much as it acted with it before.

When the planet has got round to B, its projectile force is as much diminished from its mean state as it was augmented at K; and so the sun's attraction being more than sufficient to keep the planet from going off at B, it describes the same orbit over again, by virtue of the same forces or powers.

A double projectile force will always balance a quadruple power of gravity. Let the planet at B, have twice as great an impulse thence towards X, as it had before; that is, in the same length of time that it was projected from B to b, as in the last example, let it now be projected from B to c; and it will require four times as much gravity to retain it in its orbit; that is, it must fall as far from B to 4, in the time that the projectile force would carry it from B to c, otherwise it would not describe the curve B D, as is evident from the figure. But inasmuch time as the planet moves from B to C, in the higher part of its orbit, it moves from I to K, or from K to L, in the lower part of it; because from the joint action of these two forces, it must always describe equal areas in equal times throughout its annual course. These areas are represented by the triangles B S C, C S D, D S E, E S F, &c. whose contents are equal to one another from the properties of the ellipsis.

We have now given a general idea of the



S. Porter sculp.

The Solar System.

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solar system; and shall next describe the bodies that compose it.

Of the Sun. The Sun was long considered, from its constant emanation of heat and light, as an immense globe of fire. When viewed through a telescope, several dark spots are visible on its surface, which are of various sizes and duration. From the motion of these spots, the Sun has been found to move round its axis in twenty-five days, which is two days less than its apparent revolution, in consequence of the Earth's motion in its orbit in the same direction; and its axis is found to be inclined to the ecliptic, in an angle of about eighty-two degrees and a half.

Various opinions have been formed respecting these spots; they have been considered as opaque islands in the liquid igneous matter, and by some as pits or cavities in the body of the Sun. But from whatever cause they may arise, they evidently adhere to its surface: for if one of them appears upon the eastern limb or edge of the Sun's disc, it is seen to move thence towards the western edge in about thirteen days and a half, then the spot disappears, and in about the same time, it is seen again upon the eastern edge, and so continues to go round, completing its apparent revolution in twenty-seven days, during one half of which time we see it on the disc of the Sun, and during the other half it disappears, which could not happen if the spots did not adhere to the Sun. The following particulars respecting the Sun are given by sir Isaac Newton.

1. That the density of the Sun's heat, which is proportional to his light, is seven times as great in Mercury as with us, and that water there would be all carried off in the shape of steam; for he found, by experiments with the thermometer, that a heat seven times greater than that of the Sun's beams in summer will serve to make water boil.

2. That the quantity of matter in the Sun is to that in Jupiter nearly as 1100 to 1, and that the distance of that planet from the Sun is in the same ratio to the Sun's semi-diameter; consequently, that the centre of gravity of the Sun and Jupiter is nearly in the superficies of the Sun.

3. That the quantity of matter in the Sun is to that in Saturn as 2360 to 1, and that the distance of Saturn from the Sun is in a ratio but little less than that of the Sun's semi-diameter. And hence the common centre of gravity of Saturn and the Sun is a little within the Sun.

4. By the same method of calculation it will be found, that the common centre of gravity of all the planets cannot be more than the length of the solar diameter distant from the centre of the Sun.

5. The Sun's diameter is equal to 100 diameters of the Earth, and therefore its magnitude must exceed that of the earth one million of times.

6. If 360 degrees (the whole ecliptic) is divided by the quantity of the solar year, it will give $59' 8''$ which therefore is the medium quantity of the Sun's apparent daily motion; hence his horary motion is equal to $2' 27''$. By this method the tables of the Sun's mean motion are constructed as found in astronomical books.

Of the inferior planets. Mercury being the planet nearest to the Sun, and the least in magnitude, is very seldom visible. It never appears more than a few degrees from the Sun's disc, and is generally lost in the splendour of the solar beams. On this account, astronomers have had few opportunities of making accurate observations upon it; no spots have been observed upon it, consequently the time of its rotation on its axis is not known. Being an inferior planet, it must shew phases like the Moon, fig. 7; and it never appears quite full to us. It is seen sometimes passing over the Sun's disc, which is called its transit.

Venus is the brightest and largest to appearance of all the planets, and is distinguished from the rest by her superiority of lustre. It is generally called the Morning or Evening Star, according as it precedes or follows the apparent course of the Sun. Some have thought that they could discover spots upon its disc; but Dr. Herschel has not been able to see them; consequently, the time of rotation round its axis is not known. Venus also appears with phases; and transits sometimes take place, which are of very great importance in astronomy.

The *elongation* of any planet is its apparent distance from the sun.

An inferior planet is at its greatest elongation, when a line drawn from the Earth through the planet is a tangent to the orbit of the planet; when the planet is at M (fig. 4.) being in conjunction with the Sun, it has no elongation; as it moves from M to V, its elongation increases till at V, when EV drawn from the earth to the orbit of the planet is a tangent to that orbit, its apparent place in the ecliptic is C, and its elongation is SC, which is the greatest it can have, for in passing from V to N it decreases, and at N it is nothing. From N to U it increases, and at U the elongation is again at the greatest. This will hold equally in elliptical as in circular orbits. If the orbits of the planets were circular, the distance of each from the Sun would be to the Earth's distance, as the Sun at its greatest elongation to the radius, that is, as VS to ES. By examining the figure it will be seen, that the inferior planets are never in opposition to the Sun, and are never in quadrature. For in opposition, the Earth is between the Sun and the planets, which can never happen when the orbit of the planet M G B is included within that of the Earth. They are never in quadrature, because the greatest angle of elongation is contained by S E and E V, and if the angle S E V was a right angle, E V would be a tangent at E the Earth's orbit: but it is a tangent, as has been seen, to an orbit less than that of the Earth; it therefore makes an angle with S E, less than a right angle. Hence the reason that the inferior planets never appear far from the Sun; and as the orbit of Mercury is included within that of Venus, the former must, when visible, always appear nearer to the Sun, than the latter. We may also observe that the apparent velocity of Venus is greatest at the times of conjunction. Since the plane of her orbit is oblique to the Earth, those parts of it which are viewed by a spectator directly, will appear longer than other equal parts viewed obliquely. Of course, the motions of the planet, if uniform, will appear unequal.

The time when an inferior planet will come again into a given situation with respect to the Sun and the Earth, may be thus found. Whilst Venus performs one revolution, the Earth, whose periodical time is longer than that of Venus, will not have completed its revolution. Before Venus and the Earth can be again in the inferior conjunction, Venus must, therefore, besides its entire revolution, describe an arc equal to that which the Earth has passed over: consequently, the number of degrees passed over by each, or their angular motions, in the same time, will be reciprocally as their periodical times; that is, as the periodical time of the Earth is to the periodical time of Venus, so is the angular motion of Venus (which is equal to four right angles added to the angular motion of the Earth between two inferior conjunctions) to the angular motion of the Earth in the same time; whence (El. V. 17.) as the difference between the periodical times of the Earth and Venus, is to the periodical time of Venus, so are four right angles, or 360°, to the number of degrees over which the Earth passes in her orbit from one inferior conjunction to another. This is only true upon the supposition that the planets moved in circular orbits, in which case the following general rule would apply to the finding the time from conjunction to conjunction, or from opposition to opposition, of any two planets. "Multiply their periodic times together, and divide the product by their difference, and you have the time sought." For let $P =$ the periodic time of the earth, $p =$ that of the planet (suppose an inferior), $t =$ time required: then P: 1 day:: 360°: $\frac{360°}{P}$, the angle described by the earth in 1 day: for the same reason $\frac{360°}{p}$ is the angle described by the planet in 1 day: hence $\frac{360°}{p} - \frac{360°}{P}$ is the daily angular velocity of the planet from the Earth. Now if they set out from conjunction, they will return into conjunction again, after the planet has gained 360°: hence $\frac{360°}{p} - \frac{360°}{P}$: 360° :: 1 day : $t = \frac{P\,p}{P - p}$. For a superior planet $t = \frac{p\,P}{p - P}$.

When the inferior planets are passing from their greatest elongation V. (fig. 4.) through N their superior conjunction, to their greatest elongation U, they appear to a spectator on the earth to move from west to east; for when the planet is at G it will appear to have moved from C to H, and when at A and B it will appear to have passed from H through L to *a* and *b*; of course the motion of the planet is *direct*, or from west to east; but while it moves from U to V, its motion will appear to us retrograde or from east to west; for when it has passed from U to J and K, it will appear to have moved in the heavens from D through d to *b* and *a*, that is, from east to west. When the inferior planets are at their greatest elongation, they appear stationary; because when the planets are at U and V, the line drawn from E the Earth to the planet, is a tangent to the orbit, which so nearly coincides with a small arc of the curve, that a spectator at the Earth cannot distinguish the tangent from the curve, when the

planet is at V and U, of course it will in those positions seem to be stationary.

When Venus or Mercury is in its superior conjunction, or at N, the whole enlightened hemisphere is towards the earth, and its entire disc is visible: as it passes towards its inferior conjunction, its enlightened hemisphere turns by degrees, from the Earth, till at the inferior conjunction M, its enlightened part is wholly turned from the Earth, and the planet becomes invisible, unless it appears on the Sun's disc; it is then called a transit.

Of the Earth. The Earth which we inhabit is a globular body, as may be proved from a variety of circumstances, the chief of which we shall here enumerate. It is always observed by mariners, that as they sail from any high objects, such as mountains, steeples, &c. they first begin to lose sight of the lower part of those objects, and then gradually of the higher parts; also, persons on shore first discover the upper parts of the masts of approaching vessels. This could not be the case, if the Earth was a plane; but is very easily accounted for, on the supposition of its being a sphere, as will be easily understood by examining fig. 5. Various navigators have also sailed completely round the earth, by continuing in the same direction, at last coming to the same place from which they set out.

The Earth, however, is not a perfect sphere, but a spheroid, having its equatorial diameter longer than the polar diameter, or axis. It is consequently flattest at the poles, and more protuberant at the equator. The diameter at the equator is 7977 English miles; that at the poles is 7940 miles. The surface of the Earth is much diversified with mountains and valleys, land and water. The highest mountains in it, are the Andes in South America, some of which are about four miles in perpendicular altitude. About two-thirds of the globe are covered with water.

In consequence of the Earth's being a globe, people standing upon opposite sides of it, must have their feet towards each other. When in this situation they are called *antipodes* to each other. Hence it appears that there is no real *up* or *down*; for what is up to one country, is down to another. It must seem strange to those who are ignorant of the shape of the earth, to suppose that, if we could bore a hole downwards, deep enough, we should come to the other side of the world, where we should find a surface and sky like our own; yet if we reflect a moment, we shall perceive that this is perfectly true. As we are preserved in our situations by the power of attraction, which draws us towards the centre of the earth, we call that direction down, which tends to the centre, and the contrary.

We mentioned before, that the Earth has two motions; the one a diurnal motion, round its own axis, in twenty-four hours; the other an annual motion, round the Sun, in 365 days, 6 hours, 56 minutes, 4 seconds. It is the former which causes light and darkness, day and night; for when one side of the Earth is turned towards the Sun, it receives his rays, and is illuminated, causing day; on the contrary, when one side of the Earth is turned from the Sun, we are in darkness, and then we have night. By the diurnal revolution of the Earth round its own axis from west to east, the heavenly bodies appear to us to revolve in the same time from east to west. And since the Sun and fixed stars are bodies immensely larger than the Earth, and at almost inconceivably great distances from it, we see upon how much more simple principles the alternate succession of day and night is effected by the revolution of the earth about its axis, than by supposing the Earth fixed, and the Sun and stars whirled round it, with an indefinite velocity.

The natural days are not equal to one another; for a natural day is the time in which the Earth performs one revolution round its axis, and such a portion of the second revolution, as is equal to the space which the Sun has apparently travelled that day; but these spaces are unequal, therefore, the additional portion of the second revolution, will be sometimes greater and sometimes less, and consequently the times in which the natural days are completed will be unequal. Hence arises the difference between a sun-dial and a well regulated clock, as measures of time; the former measuring the length of the natural day, the latter dividing time into equal portions of twelve hours each: the clock will be *before* the dial, when the natural day is more than twenty-four hours; and after it, when the natural day is less than twenty-four hours; and they will be together, only when the natural day is exactly twenty-four hours.

The *equation* of time is the difference between the mean length of the natural day, or twenty-four hours, and the length of any single day measured by the sun's apparent motion, or between *mean* and *apparent* time. And the hour of the day by apparent time being known, in order to determine what is then true time, the equation is to be added to apparent time, if the day by the clock is shorter than the day by the dial: and the equation is to be subtracted from the apparent time when the day by the clock is longer than the day by the sun-dial. If the natural day is twenty-four hours three minutes long, the day by the clock being twenty-four hours in length, it will be 12 by a good clock 3 minutes before it is 12 by the dial; in this case mean time precedes apparent.

The difference between mean and apparent time, depends upon two causes: (1) the obliquity of the ecliptic with respect to the equator: and (2) the unequal motion of the earth in an elliptical orbit. The obliquity of the ecliptic to the equator would make the sun and clocks agree on four days of the year, viz. when the sun enters Aries, Cancer, Libra, and Capricorn. But the other cause which arises from his unequal motion in his orbit would make the sun and clocks agree only twice a year, that is, when he is in perigee, and apogee; consequently, when these two points fall in the beginnings of Cancer and Capricorn, or of Aries and Libra, they will concur in making the sun and clocks agree in those points. But the apogee, at present, is in the ninth degree of Cancer, and the perigee in the ninth degree of Capricorn; and, therefore, the sun and clocks cannot be equal at the beginnings of these signs, nor, indeed, at any time of the year, except when the swiftness and slowness of the equation resulting from one of the causes, just balances the slowness or swiftness arising from the other; which happens about the 15th of April, the 15th of June, the 31st of August, and the 24th of December; at all other times the sun is too fast or too slow for equal time by a certain number of minutes and seconds, which at the greatest is 16 minutes, 14 seconds, and happens about the first of November: every other day throughout the year having a certain quantity of this difference belonging to it, which, however, is not exactly the same every year, but only every fourth year, for which reason, it is necessary, where great accuracy is required, to have four tables of this equation, viz. one for each of the four years in the period of leap year. The following concise table, adapted to the second year after leap year, will always be found within about a minute of the truth, and therefore sufficiently accurate for common clocks and watches.

TABLE,

FOR THE EQUATION OF TIME.

Months.	Days.	Equation in Minutes.	Months.	Days.	Equation in Minutes.	Months.	Days.	Equation in Minutes.
Jan.	1	4+	Apr.	24	2—	Sept.	27	9—
	3	5		30	3		30	10
	5	6	May	13	4	Oct.	3	11
	7	7		29	3		6	12
	9	8	June	5	2		10	13
	12	9		10	1		14	14
	15	10		15	0		19	15
	18	11		*	—		27	16
	21	12		20	1+	Nov.	15	15
	25	13		25	2		20	14
	31	14		39	3		24	13
Feb.	10	15	July	5	4		27	12
	21	14		11	5		30	11
	27	13		28	6	Dec.	2	10
Mar.	4	12	Aug.	9	5		5	9
	8	11		15	4		7	8
	12	10		20	3		9	7
	15	9		24	2		11	6
	19	8		28	1		13	5
	22	7		31	0		16	4
	25	6		*	—		18	3
	28	5	Sept.	3	1—		20	2
Apr.	1	4		6	2		22	1
	4	3		9	3		24	0
	7	2		12	4		*	—
	11	1		15	5		26	1+
	15	0		18	6		28	2
	*	—		21	7		30	3
	19	1—		24	8			

Those columns that are marked +, shew that the clock or watch is, or ought to be, before the sun; and those marked —, that it is slower. To regulate a clock or watch on the 1st of January, the moment the sun-dial is 12, the clock or watch must be put 4 minutes after. On the 13th of May, when the dial is 12, the clock to be right must want 4 minutes of that hour. See Ferguson's Astronomy, ch. 13. Phil. Trans. vol. 54.

Twilight is owing to the refraction of the rays of light by our atmosphere, through which they pass; and which, by bending them, occasions some to arrive at a part of the earth that could not receive any direct rays from the sun, or so as to bring him into sight, every clear day, before he rises in the

horizon, and to keep him in view for some minutes after he is really set below it. The effect of this refraction is about six minutes every day at a mean rate.

From the same cause, the heavenly bodies appear higher than they really are, so that to bring the apparent altitudes to the true ones, the quantity of refraction must be subtracted. The higher they rise the less are the rays refracted, and when the heavenly bodies are in the zenith, they suffer no refraction, according to the principles of optics hereafter to be demonstrated. Tables of refractions have been calculated by various astronomers, as sir I. Newton, Mr. Thomas Simpson, Dr. Bradley, Mr. Mayer, &c. The following specimen is taken from Dr. Bradley's table, which is esteemed the most correct, and chiefly used by astronomers. For the method of calculating these tables, see Mr. Simpson's Dissert. p. 46, 4to. Gregory's Astron. Vol. I. Pa. 66, and Vince's Astron. Vol. I. 4to. ch. 7.

MEAN ASTRONOMICAL REFRACTIONS IN ALTITUDE.

App Alt.	Refraction.	App Alt.	Refraction.	App Alt.	Refraction.
0°	33′ 0″	22°	2′ 20″	44°	0′ 59″
1	24 29	23	2 14	45	0 57
2	18 35	24	2 7	48	0 51
3	14 36	25	2 2	50	0 48
4	11 51	26	1 56	52	0 44
5	9 54	27	1 51	55	0 40
6	8 28	28	1 47	58	0 35
7	7 20	29	1 42	60	0 33
8	6 29	30	1 38	62	0 30
9	5 48	31	1 35	65	0 26
10	5 15	32	1 31	68	0 23
11	4 47	33	1 28	70	0 21
12	4 23	34	1 24	72	0 18
13	4 3	35	1 21	75	0 15
14	3 45	36	1 18	78	0 12
15	3 30	37	1 16	80	0 10
16	3 17	38	1 13	82	0 8
17	3 4	39	1 10	85	0 5
18	2 54	40	1 8	88	0 2
19	2 45	41	1 5	89	0 1
20	2 35	42	1 3	90	0 3
21	2 27	43	1 1		

Dr. Keill, in his Lectures on Astronomy, observes, that it is entirely owing to the atmosphere that the heavens appear bright in the day time. For without it, only that part of the heavens would be luminous in which the sun is placed; and if we could live without air, and should turn our backs to the sun, the whole heavens would appear as dark as in the night. In this case also we should have no twilight, but a sudden transition from the brightest sun-shine to dark night immediately upon the setting of the sun; which would be extremely inconvenient, if not fatal to the eyes of mortals. See Keill's Astron. Lect. xx.

The twilight is longest in a parallel sphere, and shortest in a right sphere: and in an oblique sphere, the nearer the sphere approaches to parallel, the longer is the twilight.

In a parallel sphere, the twilight will continue till the sun's declination toward the depressed pole is 18°: but in this sphere his declination is never more than 23½ degrees; whence the twilight will only cease, whilst the sun's declination is increasing from 18° to 23½ degrees, and decreasing again till in its decrease it becomes 18 degrees. The twilight is here caused by the annual motion of the earth. In a right sphere, the sun appears to be carried, by the daily motion of the earth, in circles perpendicular to the horizon; whence it is carried directly downwards by the whole daily motion, and will arrive at 18 degrees below the horizon the soonest possible: whereas, in an oblique sphere, its path is oblique to the plane of the horizon, and therefore will be longer before it has descended 18 degrees below the horizon: and the difference of the time of twilight will increase with the degree of obliquity. As the sun sets more obliquely at some parts of the year than others, the twilight varies in its duration.

Of the Seasons. It is the annual motion of the earth round the sun, which occasions the diversity of seasons. To understand this, it must be remembered, that the axis of the earth is inclined to the plane of its orbit about 23½ degrees, and it keeps always parallel to itself; that is, it is always directed to the same point of the heavens.

The obliquity of the ecliptic is not permanent, but is perpetually diminishing, by the ecliptic approaching nearer to a parallelism with the equator, at the rate of about half a second in a year, or from 50 seconds to 55 seconds in a hundred years. The inclination at this time is rather less than 23 degrees, 28 minutes. The diminution of the obliquity of the ecliptic to the equator is owing to the action of the planets upon the earth, especially the planets Venus and Jupiter. The obliquity of the ecliptic is found by observing with great accuracy the meridian altitude of the sun's centre, on the days of the summer and winter solstice: then the difference of the two, will be the distance between the tropics; the half of which is the obliquity sought.

Let Fig. 6, Plate Astronomy, represent the earth in different parts of its elliptic orbit.

In the spring, the circle which separates the light from the dark side of the globe, called the terminator, passes through the poles as appears in the position A. The earth then, in its diurnal rotation about its axis, has every part of its surface as long in light as in shade; therefore the days are equal to the nights all over the world, the sun being at that time vertical to the equatorial parts of the earth.

As the earth proceeds in its orbit, and comes into the position B, the sun becomes vertical to those parts of the earth under the tropic, and the inhabitants of the northern hemisphere will enjoy summer, on account of the solar rays falling more perpendicularly upon them; they will also have their days longer than their nights, in proportion as they are more distant from the equator; and those within the polar circle, as will be perceived by the figure, will have constant day-light. At the same time, the inhabitants of the southern hemisphere have winter, their days being shorter than their nights, in proportion as they are farther from the equator; and the inhabitants of the polar regions will have constant night.

The earth then continues its course to the position C, when the terminator again passes through the poles, and the days and nights are equal.

After this, the earth advances to the position D, at which time the inhabitants of the northern hemisphere have winter, and their days are shorter than their nights.

The positions B and D, are the solstitial points; and A and C, the equinoctial points; they are not equidistant from each other, because the sun is not in the centre, but in the focus of the ellipsis. In summer, when the earth is at B, the sun is farther from it than in the winter, when the earth is at D; and in fact, the diameter of the sun appears longer in winter than in summer. The difference of heat is not owing to the sun's being nearer to us, or more remote, but to the degree of obliquity with which its rays strike any part of the earth.

Of the Moon. The moon is, next to the sun, the most remarkable of the celestial objects. Its form is spherical, like that of the earth, round which it revolves, and by which it is carried round the sun. Its orbit is also elliptical, having the earth in one of the foci of the ellipsis. The moon always keeps the same side towards the earth, shewing only at one time a little more of one side, and at another time a little more of the other. Hence as the moon revolves about its axis, its periodical time must be equal to that of its revolution in its orbit round the earth. This is found to be the case with the fifth satellite of Saturn as it regards its primary. And though the year is of the same absolute length, both to the earth and moon, yet the number of days in each is very different: the former having 365¼ natural days in its year, but the latter has only about 12⅞, every day and night in the moon being as long as 29½ on the earth.

The face of the moon, as seen through a telescope, appears diversified with hills and valleys. This is proved by viewing her at any other time than when she is full; for then there is no regular line bounding light and darkness; but the edge or border of the moon appears jagged; and even in the dark part near the borders of the lucid surface, there are seen some small spaces enlightened by the sun's beams.

Besides, it is moreover evident, that the spots in the moon taken for mountains and valleys, are really such from their shadows. For in all situations of the moon, the elevated parts are constantly found to cast a triangular shadow in a direction from the sun; and the cavities are always dark on the side next to the sun, and illuminated on the opposite side. Hence astronomers are enabled to find the height of the lunar mountains. Dr. Keill, in his Astronomical Lectures, has calculated the height of St. Catherine's hill to be nine miles. Since, however, the loftiest mountains upon the earth are but about three miles in height, it has been long considered as very improbable that those of a planet so much inferior in size to the earth should exceed in such vast proportion the highest of our mountains.

By the observations of Dr. Herschel, made in November, 1779, and the four following months, we learn, that the altitude of the lunar mountains has been very much exaggerated. His observations were made with great caution, by means of a Newtonian reflector, six feet eight inches long, and with a magnifying power of 222 times, determined by experiment; and the method which he made use of to ascertain the alti-

tude of those mountains which, during that time, he had an opportunity of examining, seems liable to no objection. The rock situated near Lacus Niger, was found to be about one mile in height, but none of the other mountains which he measured proved to be more than half that altitude; and Dr. Herschel concludes, that with a very few exceptions, the generality of the lunar mountains do not exceed half a mile in their perpendicular elevation. See Keill's Astron. Lect. x. Phil. Trans. Vol. LXX.

To Dr. Herschel also we are indebted for an account of several burning volcanoes, which he saw at different times in the moon. In the 77th vol. of the Phil. Trans. he says, "April 19, 10 hours, 36 minutes, sidereal time. I perceive three volcanoes in different places of the dark part of the new moon. Two of them are nearly extinct; or, otherwise, in a state of going to break out, which perhaps may be decided next lunation. The third shows an actual eruption of fire, or luminous matter." On the next night, Dr. Herschel saw the volcano burn with greater violence than on the preceding evening. He considered the eruption to resemble a small piece of burning charcoal when it is covered by a thin coat of white ashes, which frequently adhere to it, when it has been some time ignited; and it had a degree of brightness about as strong as that with which such a coal would be seen to glow in faint daylight. It is not yet determined whether there is an atmosphere belonging to the moon. See Phil. Trans. for the year 1792.

The moon is seen by means of the light which comes to it from the sun being reflected from it. Its changes or phases depend upon its situation relatively to the earth and the sun. When the moon is in opposition to the sun at A (fig. 7.) the enlightened side is turned towards the earth, as *a*, and it appears full. When the moon is in conjunction at E with the sun, its dark side is turned towards us, and it is invisible, as at *e*. As it proceeds in its orbit, as at F, a small part of the enlightened side is seen, and then we have what is called a new moon; and we continue to see more and more of the enlightened side, as the moon approaches at G and H, to the state of opposition or full moon. The waning or decreasing of the moon takes place in the same manner, but in a contrary order. The earth must perform the same office to the moon that the moon does to us; and it will appear to the inhabitants of the moon (if there be any), like a very magnificent moon, being to them about fifteen times as large as the moon to us, and it will also have the same changes or phases. Hence it is evident, that one half of the moon is never in darkness, the earth constantly affording it a strong light, during the absence of the sun; but the other half has a fortnight's light and darkness by turns.

When the moon is near the first of Aries, and moving towards the tropic of Cancer, the time of its rising will vary but little for several days together. If the moon were to move in the equator, its motion in its orbit, by which it describes a revolution, in respect of the sun, in 29 days, 12 hours, would carry it every day eastward from the sun about 12 degrees 11 minutes, whence its time of rising would vary daily about 50 minutes. But, because the moon's orbit is oblique to the equator, nearly coinciding with the ecliptic, different parts of it make different angles with the horizon, as they rise or set; those parts which rise with the smallest angles setting with the greatest, and the reverse. Now the less this angle is, the greater portion of the orbit rises in the same time. Consequently, when the moon is in those parts which rise or set with the smallest angles, it rises or sets with the least difference of time, and the reverse. But in northern latitudes, the smallest angle of the ecliptic and horizon is made when Aries rises and Libra sets, and the greatest when Libra rises and Aries sets; and therefore, when the moon rises in Aries, it rises with the least difference of time. Now the moon is in conjunction in or near Aries, when the sun is in or near Libra, that is, in the autumnal months; when, the moon rising in Aries, whilst the sun is setting in Libra, the time of its rising is observed to vary only two hours in six days in the latitude of London. This is called the harvest-moon.

This circumstance takes place every month; but as it does not happen at the time of full moon, there is no notice taken of it. When the moon's right ascension is equal to six signs, that is, when she is in or about the beginning of Libra, there is the greatest difference of the times of rising, viz. about an hour and 15 minutes. Those signs which rise with the least angle set with the greatest, and the contrary; therefore, when there is the least difference in the times of rising, there is the greatest in setting, and vice versa.

The following table shews the daily mean difference of the moon's rising and setting, on the parallel of London, for 28 days; in which time the moon finishes her period round the ecliptic, and gets nine degrees into the same sign from the beginning of which she set out.

Days.	Signs.	Degrees.	Rising Diff. H.	Rising Diff. M.	Setting Diff. H.	Setting Diff. M.
1	♋	13	1	5	0	50
2		26	1	10	0	43
3	♌	10	1	14	0	37
4		23	1	17	0	32
5	♍	6	1	16	0	28
6		19	1	15	0	24
7	♎	2	1	15	0	20
8		15	1	15	0	18
9		28	1	15	0	17
10	♏	12	1	15	0	22
11		26	1	14	0	30
12	♐	8	1	13	0	39
13		21	1	10	0	47
14	♑	4	1	4	0	56
15		17	0	46	1	5
16	♒	1	0	40	1	8
17		14	0	35	1	12
18		27	0	30	1	15
19	♓	10	0	25	1	16
20		23	0	20	1	17
21	♈	7	0	17	1	16
22		20	0	17	1	15
23	♉	3	0	20	1	15
24		16	0	24	1	15
25		29	0	30	1	14
26	♊	13	0	40	1	13
27		26	0	56	1	7
28	♋	9	1	00	1	58

The Moon's motion is subject to many irregularities, on account of the inclination of its orbit to the plane of the ecliptic, and the attraction of the Sun and the other planets.

Of the superior planets.

Mars is not so bright as Venus, nor even as Jupiter, though nearer to the sun. Its colour is a little reddish. Some spots have been observed upon its surface, from which its rotation round its axis, and the inclination of its axis to the plane of its orbit, have been determined.

The following particulars respecting Mars are given by Dr. Herschel, after long and accurate observations.

The axis of Mars is inclined to the ecliptic 59° 42.

The node of the axis is in 17° 47′ of Pisces.

The obliquity of the ecliptic on the globe of Mars in 28° 42′.

The point Aries on the Martial ecliptic answers to our 19° 28′ of Sagittarius.

The figure of Mars is that of an oblate spheroid, whose equatorial diameter is to the polar one as 1355 to 1272, or as 16 to 15 nearly.

The equatorial diameter of Mars, reduced to the mean distance of the earth from the Sun, is 9″ 8‴.

And that planet has a considerable but moderate atmosphere; so that its inhabitants, probably, enjoy a situation, in many respects, similar to ours.

Phil. Trans. Vol. lxxiv. Part 2.

Ceres Ferdinandea is a very small planet, situated next without Mars: it was discovered on the first day of the present century by Mr. Piazzi, an Italian astronomer.

Pallas is another very small planet, discovered by Dr. Olbers of Bremen, on the 28th of March, 1802. Juno is likewise a very small planet, discovered by M. Harding, as he was engaged at Lilienthal, in examining the catalogue of the stars published by M. Lalande. This planet and the two former ones, Dr. Herschel proposes to call asteroids, because they are so much smaller than any of the other planets.

Juno is the twelfth planet discovered within these few years. Dr. Herschel discovered the planet that goes by his own name, March 18, 1781. In January 1787 he perceived that this planet had two satellites, and some time after he discovered four others belonging to his planet. In the autumn of 1789 he observed two new satellites belonging to Saturn. The Ceres was discovered in 1801; the Pallas in 1802; and the Juno in 1804.

Jupiter is the brightest planet next to Venus. When viewed by a telescope, several belts are observed across its disc, parallel to its equator: these belts are variable, and have been supposed to be ranges of clouds in the atmosphere of the planet. They are sometimes of different breadths, and sometimes nearly of the same breadth. Large spots have been seen in these belts; and when one of them vanishes, the contiguous spots disappear with it. Dr. Herschel has paid attention to the rotation of these spots, and has found that the rotation of the same spot diminished; thus in February 1778 one revolved in nine hours fifty-five minutes and twenty seconds, but the same spot in April revolved in nine hours fifty-one minutes and thirty-five seconds. This he observes is agreeable to the theory of equinoctial winds, as it may be some time before the spot can acquire the velocity of the wind; and if Jupiter's spots should be observed in different

parts of its year to be accelerated and retarded, it would almost amount to a demonstration of its monsoons, and their periodical changes. The ecliptic and equator of Jupiter are nearly parallel to each other, that is, the axis of the planet is nearly perpendicular to its orbit, and on that account its inhabitants experience no sensible change of seasons. This is a wise provision, for if the axis of Jupiter were inclined any considerable number of degrees, just so many degrees round each pole would, by turns, be almost six years in darkness. Jupiter is surrounded by four moons of different sizes, which move about it in different times. These moons are sometimes eclipsed by the shadow of Jupiter falling upon them. The eclipses have been found of great use in determining the longitudes of places on the earth.

Saturn can hardly be seen by the naked eye. When examined by a telescope, it exhibits a very remarkable appearance. It is surrounded by a thin, flat, broad luminous ring, which surrounds the body of the planet, but does not touch it. This ring casts a strong shadow upon the planet; and appears to be divided into two, by a distinct line in the middle of its breadth. This ring is circular, but appears elliptical from its being viewed obliquely. Besides this ring, Saturn has seven moons of different sizes; and its body is surrounded also by belts, like those of Jupiter.

The Herschel, with its six satellites, have been entirely discovered by Dr. Herschel. It cannot be seen without a telescope, but it does not require a powerful one. The satellites cannot be seen without the most powerful telescopes.

Having given a brief account of the Sun and planets, we shall shew by what means we can ascertain their apparent and real diameters.

On the apparent and real Diameters of the Sun and Planets.—It is obvious from the principles of optics, that the determination of the real diameters of the heavenly bodies will depend conjointly on a knowledge of their apparent diameters, and their real distances from the earth. For, suppose A P B (fig. 8) a section of such body made by a plane passing through the place O of the eye, and the centre C of the body: then A O B will be the angle, which will measure the apparent diameter of the body; this being known, A O C, its half, will be known. And A O being a tangent to the surface, the angle C A O will be a right angle; whence, co-sine A O C: sine A O C: : A O: A C, the semidiameter of the body. Now A C or O C, may be found by observation; or, when the body is in opposition or conjunction with the Sun, by taking the difference or sum of its distance from the Sun, and the earth's distance from that luminary, according to the respective cases; taking care to attend to the different operations required for a superior and inferior planet. And as to the apparent diameters, it may be worth while to point out a few methods of ascertaining them.

The Sun's vertical or perpendicular diameter may be found by two observers taking, the one the height of the upper edge of the disc, the other that of the lower, at the same instant. This is most conveniently done when the Sun is at or near the meridian; because there is then no sensible change in his altitude during the space of two or three minutes. The height of each edge must be corrected, by allowing for parallax and refraction; and the apparent diameter will be equal to the difference of the corrected altitudes of the upper and lower edge. This method is very simple, and gives the apparent diameter with exactness proportional to the accuracy of the instruments made use of.

Another method of determining the Sun's apparent diameter, is to observe by a good clock the time in which the sun's disc passes over the plane of the meridian, or some other hour circle. At, or very near, one of the equinoxes, when the sun's apparent diurnal motion is in the equator, or a parallel very near it, say, as the time between the Sun's leaving the meridian and returning to it again: 360°: : the time in which he passes over the meridian: his apparent semidiameter. At any other time of the year, when the Sun is in a parallel at some distance from the equator, his diameter measures a greater number of minutes and seconds in that parallel, than it would do in a great circle, and takes up proportionally more time in passing over the meridian; we may then use this analogy, As radius: co-sine of the Sun's declination: : the time in which the Sun passes the meridian, converted into motion, at the rate of four minutes in time to 1°: the arc of the great circle which measures the Sun's apparent horizontal diameter. This method may be easily put in practice by two observers; or indeed by one, if he have an half-second pendulum placed near enough for him to hear the beats of it, whilst he observes the transit. But the diameters of the planets are best taken by the micrometer, an instrument so contrived that two parallel wires being placed in the focus of a telescope, one fixed and the other moveable, or both moveable, they may be made to approach or recede one from the other till they appear to touch exactly two opposite points in the disc of the planet, and then the index shews the apparent diameter in minutes and seconds. The apparent diameters of the planets when at about their respective mean distances from the earth, are as we have seen: Mercury, 10″; Venus, 58″; Mars, 27″; Jupiter, 39″; Saturn, 18″; Georgium Sidus, 3″ 54‴. And from these apparent diameters, and the respective distances from the earth, the diameters of the Sun and planets have been determined in English miles as here stated: Mercury, 3224; Venus, 7867; Mars, 4189; Jupiter, 89170; Saturn, 79042; the Herschel 35112; the Sun, 883246. Observations upon the planets Herschel, Saturn, Jupiter, and Mars, prove that there is a sensible difference between their equatorial and polar diameters; and it is probable that there is a like difference between the diameters of the other planets, but this has not yet been determined by observation.

Since the apparent diameters of distant bodies vary inversely as their distances, we may, having the distances from the earth at which the respective planets subtended the above angles, and knowing their mean distances from the Sun, find the mean apparent diameters of all the planets, as seen from the Sun; they have been thus given: Mercury, 20″; Venus, 30″; Earth, 17″; Mars 10″; Jupiter, 37″; Saturn, 16″; Georgium Sidus, 4″.

To measure the quantity of matter in distant bodies appears a problem of insuperable difficulty: but this has been effected to a considerable degree, by the principles of the Newtonian philosophy. Since the quantity of matter in a globe is proportional to the mean density multiplied into the cube of the diameter, and the diameters of the planets are known, the mean densities are all that are required for the solution of the problem. Now, in homogeneous, unequal, spherical bodies, the gravities on their surfaces are as their diameters, when the densities are equal; or the gravities are as the densities, when the bulks are equal: therefore, in spheres of unequal magnitude and density, the gravity is in the compound ratio of the diameters and densities; or the densities are as the gravities divided by the diameters. But the diameters are known, and the gravities at the surface are nearly found, either by means of the revolutions of the satellites, or by calculations deduced from the effects the planets are found to produce upon each other; consequently the relation of the densities becomes known. The mean density of the earth was calculated by Dr. Hutton, from observations made by Dr. Maskelyne at the mountain Schehallien; he made it to that of water as 9 to 2, and to common stone, as 9 to 5, on the supposition that the hill is only of the density of common stone. He also states the mean densities of the Sun and planets to that of water, thus: Sun, $1\frac{2}{15}$; Mercury, $9\frac{1}{6}$; Venus, $5\frac{11}{15}$; Earth, $4\frac{1}{2}$; Mars, $3\frac{2}{7}$; Jupiter, $1\frac{1}{24}$; Saturn, $0\frac{13}{32}$; and the Herschel $0\frac{99}{100}$. These densities are such as the bodies would have if they were homogeneal; and may be admitted as a fair estimate of the whole, although the density of each planet may vary considerably at different distances from the surface. From the densities, as thus estimated, and the known diameters, we may readily find the proportions of the quantities of matter; they are as under: the Sun, 333928; Mercury, 1654; Venus, ·8899; the Earth, 1; Mars, ·0875; Jupiter, 312·1; Saturn, 97·76; Georgium Sidus, 16·84.

Of the Satellites.

We have observed that Jupiter, Saturn, and the Herschel planet, are attended by satellites; of which Jupiter has four, Saturn seven, and the Herschel six. In order to arrive at certainty concerning the laws of these bodies, it is necessary to consider facts; we therefore briefly describe the chief phenomena.—1. These satellites are sometimes to the eastward, sometimes to the westward, of their respective planets, moving successively from one side to the other: each at its greatest excursion, as observed from the earth, is nearly as far distant from the one side as it was from the other, and is found on the same side again in much about the same interval of time; from which it is inferred that the orbits of the satellites are curves returning into themselves. 2. All the satellites (except those of the Herschel), in going from the western excursion to the eastern, are often hid by the planet's disc, and consequently pass behind it: sometimes one or other of them passes above or below, but never on, the planet's disc. On the contrary, in going from the eastern excursion to the western, those which passed behind, now pass over the disc; and those which passed above, now pass below, and reciprocally; which proves that they move with the primary as their centre. 3. The paths of the satellites being reduced to their respective planet's centre, sometimes appear in a right line passing

through that centre, and inclined in a certain direction to its orbit. Afterwards, they change more and more into ellipses, during one quarter of the planet's annual revolution; and all the superior conjunctions are then made above the planet's centre, and the inferior conjunctions below it: during a second quarter of the planet's revolution, these ellipses become narrower, the satellites are nearer the centre in their conjunctions, and at the end of a second quarter of the revolution, all the ellipses are again become right lines with equal inclination, but in a contrary direction. In the third quarter of the revolution, they are formed anew into ellipses, the superior conjunctions are made below the centre, and the inferior ones above; lastly, in the fourth quarter of the revolution, when the planet is returning to the same point of its orbit, these ellipses again decrease in breadth, and all return to the first state. 4. The times of the superior and inferior conjunctions of the satellites being compared, their intervals are nearly equal to their semirevolution.

Since, then, the satellites uniformly describe orbits nearly circular or elliptical, with their respective primary at their centre or focus, they are probably moved by a force of the same nature with that which moves their planets round the Sun; that is, they revolve about their primaries in consequence of a central force, and of a constant impulsive force: if so (which indeed observations render certain), they must follow Kepler's two rules namely, 1. The satellites must describe areas of their orbits proportional to the times; 2. Their mean distances from the centres of their respective primaries, must be as the cube-roots of the squares of the times of their revolutions.

The time of a synodic revolution of a satellite may be found in the following manner: Observe, when the primary planet is in opposition, the passage of a satellite over its body; and mark the time when it is half-way between the two opposite edges of the planet's disc, for then it will be nearly in conjunction with the centre of the planet, and also in conjunction with the Sun. After a long space of time, observe again when the primary planet is in opposition, and the secondary in conjunction with its centre; and divide the intervening space of time between the two observations, by the number of conjunctions of the Sun in that space, the quotient is the time of a synodic revolution. Or, the same thing may be found by means of the eclipses of the satellite: Observe when the satellite enters the shadow of its primary, called its immersion; or when it comes out of the shadow, called its emersion; and after a very long interval of time, when an eclipse happens as nearly as possible in the same situation both with respect to the node and to the place of the primary planet, again mark the time of the emersion or immersion (whichever was used in the former observation); and from the interval of these times, and the number of eclipses in that interval, the mean time of a synodic revolution will be obtained by division.

To determine the time of a periodic revolution, it must be considered, that in the return of a satellite to its mean conjunction, it describes a revolution in its orbit, together with the main angle m, described by the primary planet in that time: hence this analogy, As $360° + m$: 360 : : time of a synodic revolution : the time of a periodic revolution.

The distance of a satellite from its primary may be easily found by means of its greatest elongation, as seen from the earth, in the following manner: let S (fig. 9) represent the Sun, E the Earth, P any planet, one of its satellites at A, and the angle of elongation P E A a maximum; then the distances P E and E S are known from the theory of the planet, and the time of observation; and since the angle P E A is known in the right-angled triangle A E P, also the side P E, the side A P is readily obtained. After the same manner, when the earth and planet are in any other situations, e, p, and the satellite at a at its greatest elongation, find $e\,p$ by the theory of the earth and planet, and the given time, whence from the angle of elongation $p\,e\,a$, determine the distance $p\,a$. Make a series of such observations at all suitable opportunities, and calculate $a\,p$ or A P from each of them; for thus we may ascertain the greatest and least distance of the satellite from its primary, and half the difference of these will give the eccentricity of the orbit. These elements, if not determined accurately, may be corrected by subsequent observations.

The distances of a satellite from the centre of its primary may also be found, by measuring with a micrometer, at the time of the satellite's greatest elongation, its distance from the centre of the planet, also the semidiameter of the planet; for then the distance is known in terms of that semidiameter. Or, if the planet and satellite cannot at once be brought into the field of view of a telescope (which may sometimes happen), the distance of the satellite may be measured, at its greatest elongation, by observing the time of the passage of the planet's disc over a wire adjusted as an hour circle in the field of a telescope; and comparing it with the interval between the passage of the planet's centre, and that of the satellite. To give this method the greatest degree of accuracy, the observations should be repeated so long as the interval from the passages of the planet to that of the satellite continues increasing; for when it begins to decrease, the satellite will have passed its greatest elongation. The methods given in this article, may also be applied to the determination of the distances when in the apsides, the excentricity, and the greatest equation, by means of a long series of observations.

Or, when the periodic times of all the satellites of a planet are known, and the mean distance of one of them; the mean distances of the others may be found from the proportion between the squares of the periodic times, and the cubes of the distances. And, on the contrary, if the relative distances of all the satellites from their primary be known, and the periodic time of one of them, the periodic times of the others may be found by the same proportion.

The eclipses of the satellites are of considerable importance to astronomy and geography; it therefore becomes requisite to explain them. To this end, let S (fig. 10) be the Sun; E e the orbit of the Earth; P the place of the planet; $v\,s\,o$ the orbit of a satellite; then, it is evident, that whenever the satellite, in its orbit, passes through the shadow of the primary, its light is obscured, and it becomes eclipsed. The duration of the eclipse will depend upon the obliquity of the satellite's orbit to that of the planet, and the distance of the satellite from the node: for (fig. 11) a less proportion $m\,n$ of the inclined orbit will pass through the shadow O I m n, than if the orbit coincided with O N; and in the nodes the satellite is both in its own orbit, and that of the planet, and $n\,m$ becomes equal to O I. Now (fig. 10), when the earth is at E before the opposition of the planet, the spectator will see the immersion at i, and in some particular instances, the emersion at o also: when the earth is at e after opposition, an observer will see the emersion at o; but whether he sees the immersion, will depend upon the position of the earth with respect to the plane of the planet's orbit. When the earth is at E, the conjunction of the satellite happens later at the earth than at the Sun; but when it is at e, the conjunction occurs later at the Sun than at the earth. If the earth be at e, and the satellite at v, it cannot be seen by an observer at e, because the body of the planet intervenes; this is not an eclipse, but an occultation. In order to find the diameter of the planet's shadow at the distance of any of the satellites, let the time of an eclipse (that is, the time occupied from the immersion to the emersion) be observed when the satellite is in one of its nodes; for then the satellite passes through the centre of the shadow, and the eclipse is called central: then use this analogy, As the time of a synodic revolution of the satellite: the duration of the eclipse: : 360°: the diameter of the shadow, in degrees of the satellite's orbit. But should it so happen that both the immersion and emersion cannot be seen when the satellites are in the nodes, which is always the case with the first and second of Jupiter's satellites, then it is usual to compare the immersions some days before the opposition of the planet, with the emersions some days after; and hence, knowing how many synodic revolutions have been made in the intervening time, the time of the transit through the shadow, and consequently the corresponding measure in degrees, become known.

The eclipses of the satellites afford us a manifest proof of the velocity of light. For, if the motion of light were infinite, or if it came to us from immense distances in an instant, it is evident we should see the commencement of an eclipse of a satellite at the same moment, whatever distance we might be from it; but, on the contrary, if light move progressively, then it is equally evident, that the farther we are from a planet, the later it will be before we perceive the beginning of an eclipse of one of its satellites, because the light will occupy a longer time in travelling to us. M. Roemer was the first who deduced, from actual observations, the real velocity of light: he found (and it has since been confirmed by repeated experiments) that when the earth is exactly between Jupiter and the Sun, his satellites are seen eclipsed about $8\frac{1}{4}$ minutes sooner than they would be according to the tables; but that when the earth is at its greatest distance from Jupiter, these eclipses happen about $8\frac{1}{4}$ minutes later than the tables predict them. Hence it follows that light takes up about $16\frac{1}{2}$ minutes of time in passing over the diameter of the earth's orbit, which is, at a mean, 190 millions of miles; this is very nearly at the astonishing rate of 200,000 miles in a second. Dr. Bradley found very nearly the

ASTRONOMY.

Circles on the Sphere.

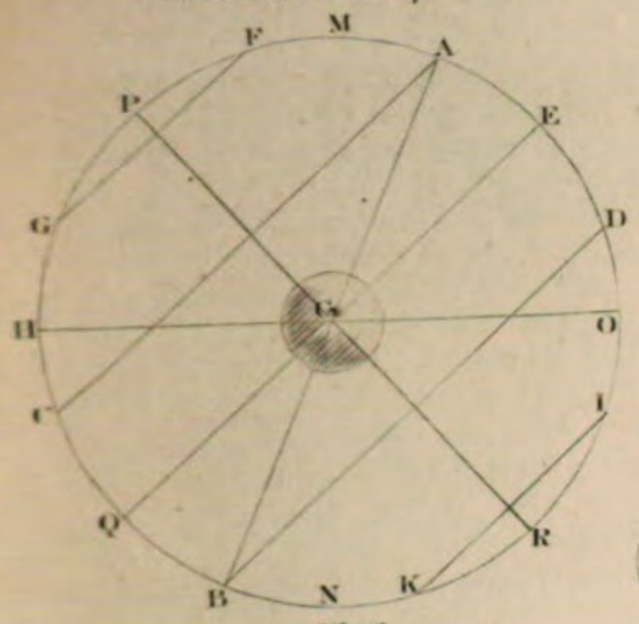


Fig 1.

The Nodes.

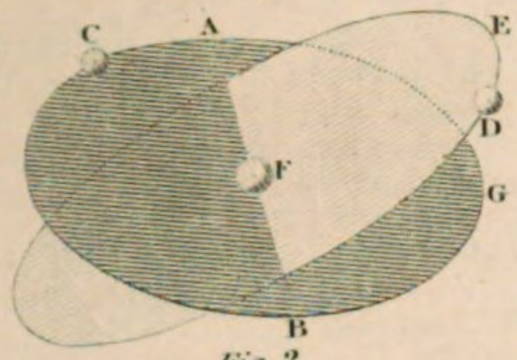


Fig 2.

Gravitation of the Planets.

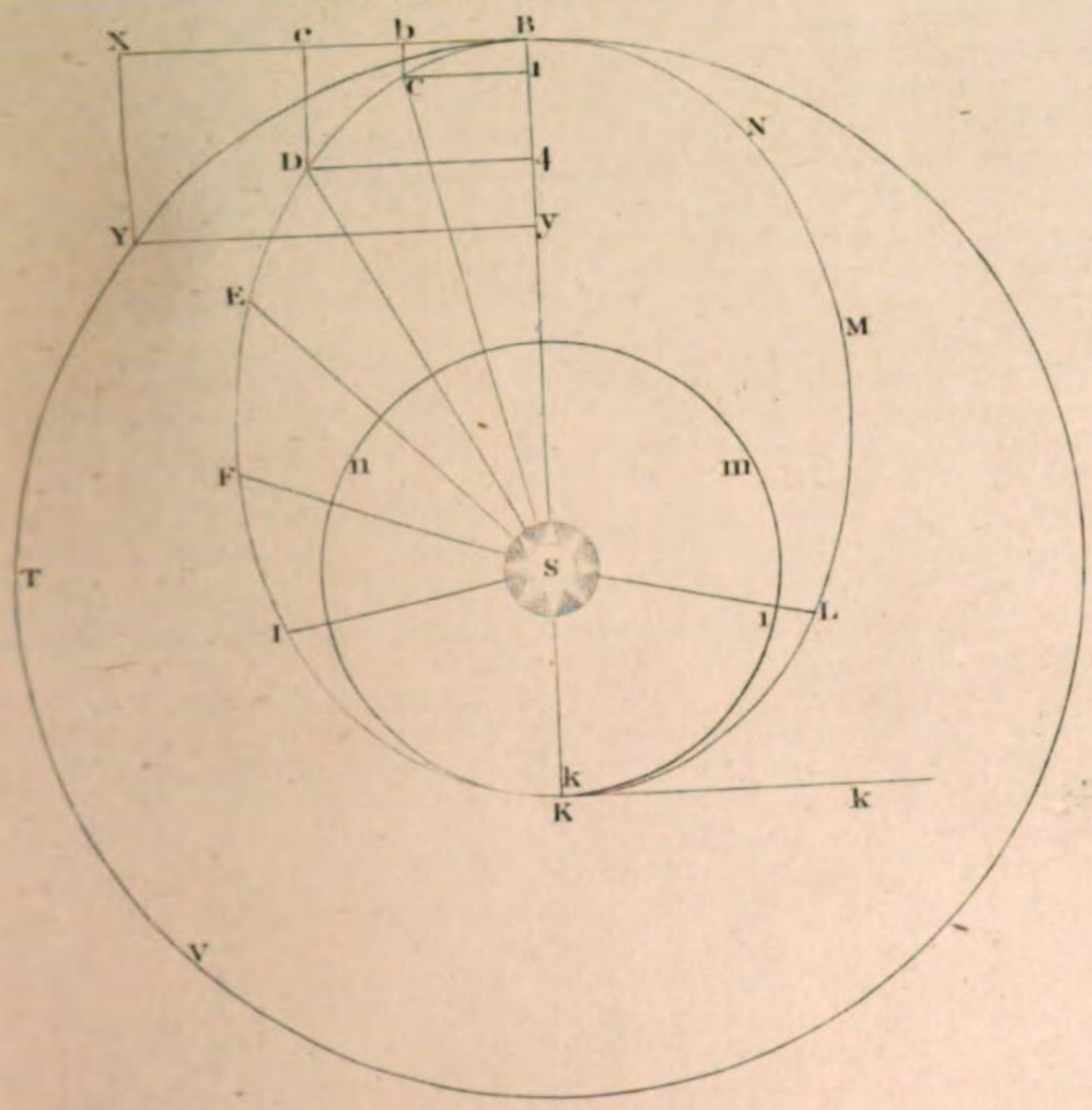


Fig. 3.

Seasons.

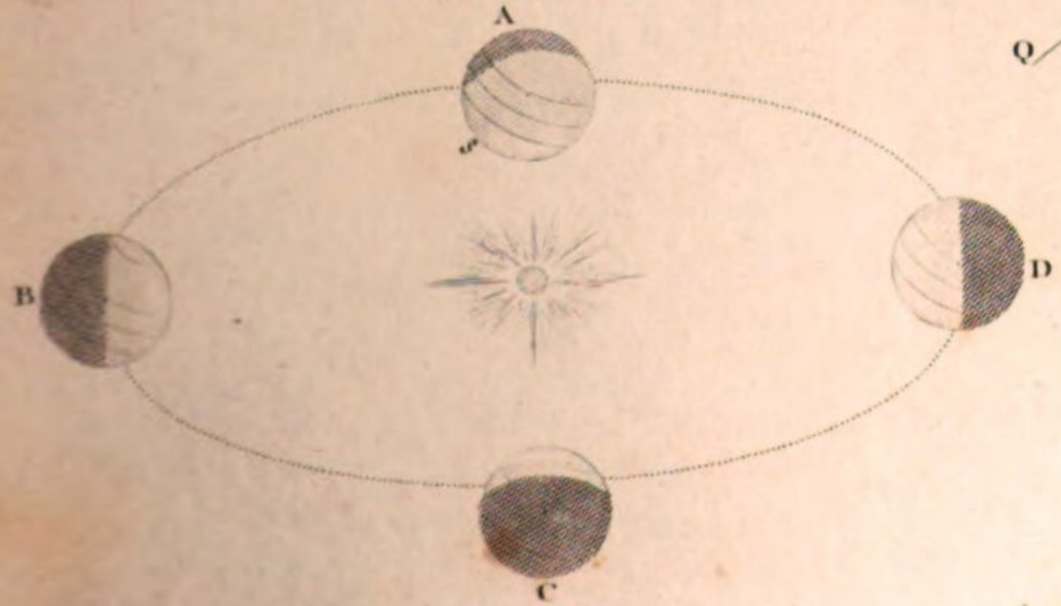


Fig. 6.

Apparent motions of the Planets.

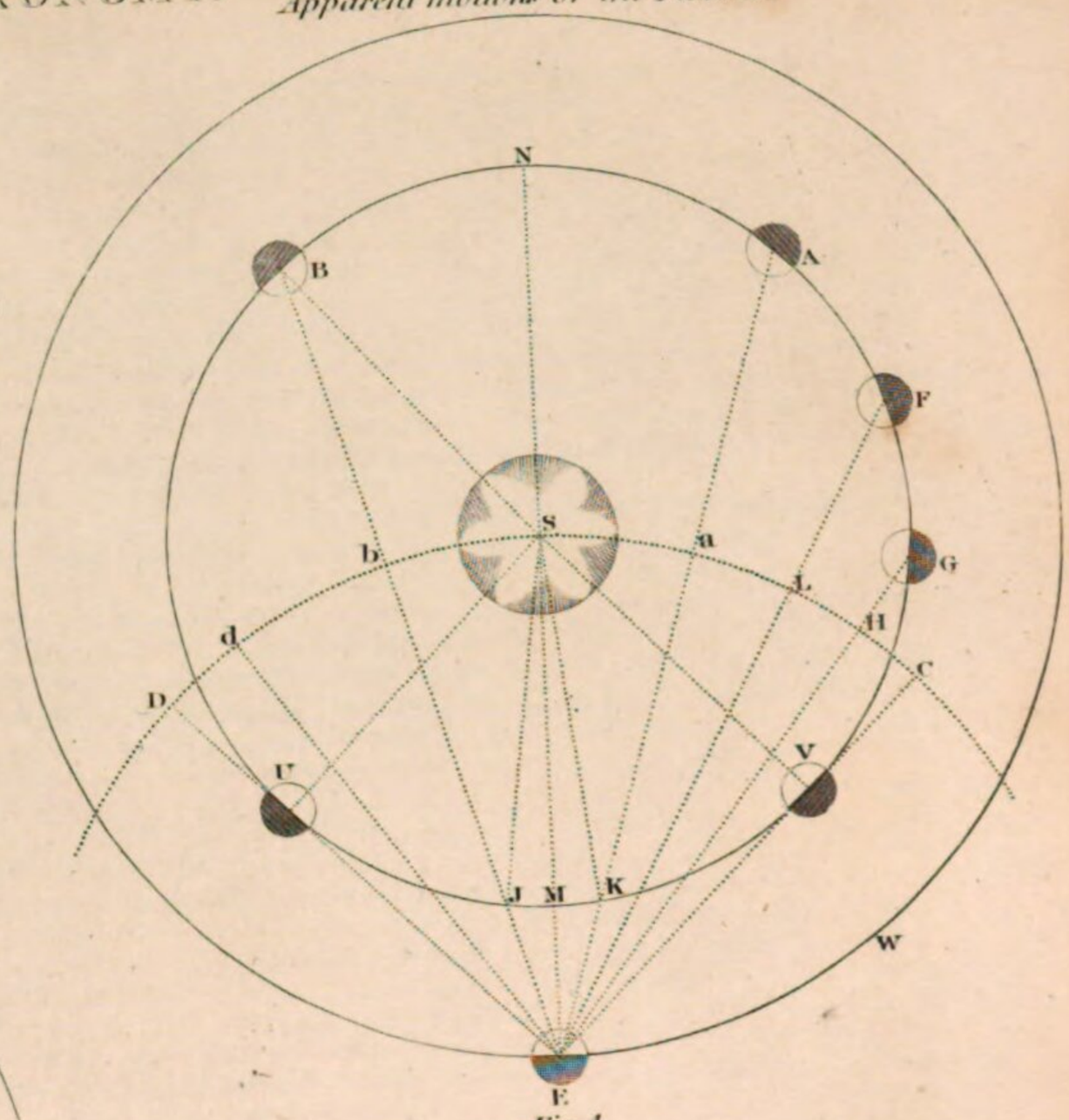


Fig 4.

Sphericity of the Earth.

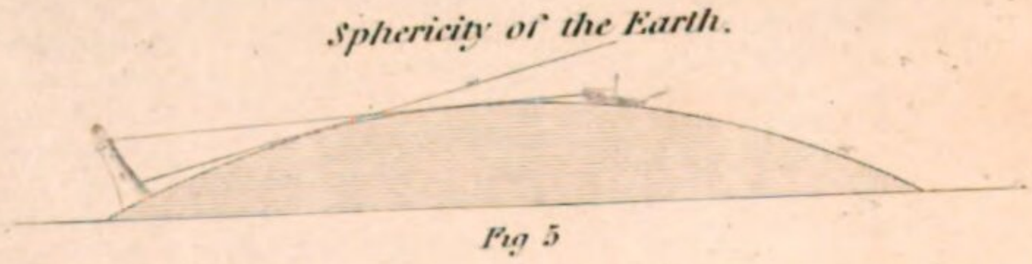


Fig 5

Phases of the Moon.

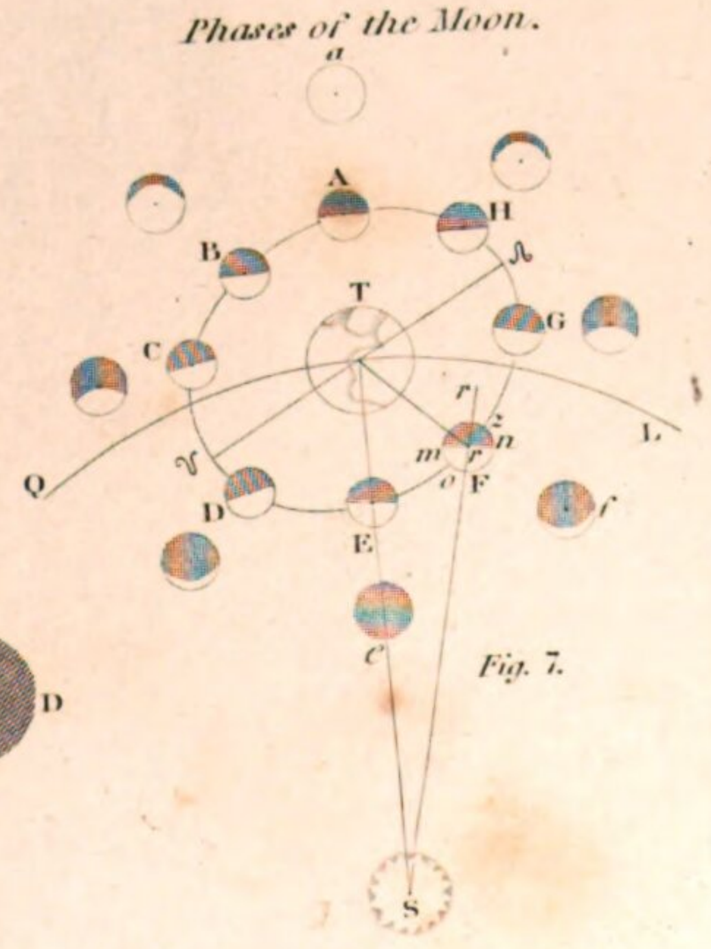
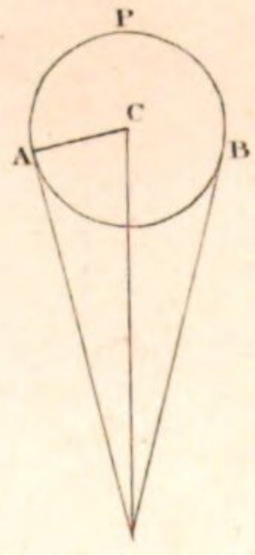


Fig. 7.

Fig. 8.



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Neele sculp 33

same velocity from observations on the fixed stars. Hence also it appears, that in determining the time of an eclipse of a satellite as seen from the earth, an allowance must be made, corresponding with the different distances of the earth and planet; this allowance is called the equation of light.

The satellites of Jupiter, Saturn, and Herschel, are subject to changes in their orbits, with respect to the situation of the apsides and nodes, the inclination of their orbits, their excentricity, &c. similar to those of the moon, and from similar causes. But in many instances they prevail to a greater degree, in consequence of the disturbing forces of the satellites upon each other; hence, therefore, a frequent revision of the tables is necessary.

The satellites of Jupiter, being situated nearer to the earth than those of any other planet, and being of very considerable importance in astronomy and navigation, have been more regularly and carefully observed than the other satellites; in consequence of which the elements of their orbits are determined with greater precision than those of the other satellites. The chief of these elements, as given by M. de Lalande, are exhibited in the following table.

SATELLITES OF JUPITER.

Elements.	I.	II.	III.	IV.
Periodic revolution	1d. 18h. 27m. 33s.	3d. 13h. 13m. 42s.	7d. 3h. 42m. 33s.	16d. 16h. 32m. 8s.
Synodic revolution	1 18 28 36	3 13 17 54	7 3 59 36	16 18 5 7
Distance in semidiam. 24	5.67	9.00	14.38	25.80
Mean dist. at mean dist. 24	1′ 51″	2′ 57″	4′ 49″	8′ 16″
Semid. shad. in time	1h. 7m. 55s.	1h. 25m. 40s.	1h. 47m. 0s.	2h. 23m.
. . . that of 24 = 1	.9941	.9967	.9857	.9913
Semider. of eclipse 90° from node, when inclin. is least	1h. 3m. 45s.	1h. 16m. 5s.	1h. 3m. 40s.	0h. 0m. 0s.
For circular { greatest inclin.	3° 18′ 38″	3° 46′ 0″	3° 25′ 57″	2° 96′ 0″
shadow { mean	3 18 38	3 16 0	3 13 58	2 36 0
{ least	3 18 38	2 46 0	3 2 0	2 36 0
For ellip. { greatest	3 4 27	3 29 42	3 11 14	2 24 51
shadow { least	3 4 27	2 34 0	2 49 0	2 24 51
Epoch of conj. 1760, for merid. Greenwich	0d. 10h. 35m. 10s.	1d. 14h. 49m. 36s. 10s.	2d. 5h. 32m. 29s. 10s.	1d. 7h. 20m. 50s. 10s.
Mean place node 1760	14° 30′ 0″	13° 45′ 2″	14° 24′ 0″	16° 39′ 4″
Annual motion node	0 0 0″	0 3 8″	0 0 0″	0 0 19″
Diurnal motion satel.	6 23 29 20	3 11 22 29	1 20 19 4	0 21 34 16
Secular motion	7 25 31 13	3 23 10 39	1 22 9 19	0 6 29 29

Of Eclipses.

The eclipses of the Sun and Moon are phenomena that command the attention even of the vulgar; who have always retained a superstitious veneration for the science of astronomy, chiefly on account of the means it affords of foretelling events of this nature. And though in reality the knowledge required in calculating an eclipse does not essentially differ from that employed in determining the time of the rising and setting of the Sun or Moon, yet there is no doubt that a more particular attention to this subject will be acceptable to the reader.

As the shadows of the Moon and Earth are the causes of eclipses, it will be necessary first to determine the figure of those shadows. Because the Sun, the Earth, and the Moon are spherical bodies, it follows that the shadows of the two latter must be either conical or cylindrical; that is to say (fig. 12), if the Sun I K be less than the Earth C D, the shadow of the latter will be part of a cone, whose section is terminated by the lines C E, D F, and whose base is indefinitely distant: or, if the Sun A B be equal to the Earth C D, the shadow will be a cylinder between the lines C G, D H, whose base is indefinitely distant. In either case the shadows of the Earth must occasionally fall upon and eclipse the superior planets, when in opposition to the Sun. But this never happens; and therefore the Sun is neither less than, nor equal to, the Earth, but greater. We know moreover, from the Sun's parallax, that it is much greater than the Earth; because the Sun's diameter seen from the Earth is about 32 minutes, whereas the Earth's diameter seen from the Sun is only about 17 seconds, a quantity that may be regarded as insensible or inconsiderable in many observations. And since the Sun exceeds the Earth in so high a proportion, it must of necessity be yet greater with regard to the Moon, because this last is less than the Earth. Let A B (fig. 13) represent the Sun greater than the Earth C D. The rays of light A C, B D, passing from the extreme edges of the Sun, and in contact with the Earth on the same side, will afterwards meet or cross in the point K. No part of the Sun's light will appear within the cone C K D; which is therefore the shadow in which an observer, being placed, would be totally deprived of the Sun. But there will be a partial shadow or penumbra between those rays A D M, B C L, that pass from the extreme edges of the Sun, and touch the opposite extremes of the Earth; that is to say, an observer between the lines C L and D M, but without the dark cone, C K D, will see only a part of the Sun, the rest being hidden by the interposition of the Earth: the quantity of the Sun thus obscured will be greater, and the penumbra darker, the nearer the observer is placed to the cone C K D. Lastly, if the observer be situated beyond the vertex of the dark shadow K, between the lines K N, K O, formed by the continuation of the extreme rays, he will behold the exterior parts of the Sun forming a lucid ring, environing the Earth on all sides.

The angle C K D, at the vertex of the Earth's shadow, is (by Euclid I. 32) equal to the difference between the diameter of the Sun seen from the Earth, or angle A C B, and the diameter of the Earth seen from the Sun, or angle C B D. Or, if the earth's apparent diameter from the Sun be rejected as inconsiderable, the angle of the shadow will be equal to the Sun's apparent diameter.

The angle C I D, at the vertex of the penumbra, is equal to the sum of the diameter of the Sun seen from the Earth, or angle A C B, and the diameter of the Earth seen from the Sun, or angle C A D: or, if the Earth's apparent diameter from the Sun be rejected as inconsiderable, the angle of the penumbra is equal to the Sun's apparent diameter. Every thing that has been here shewn respecting the shadows of the Earth, is true in like circumstances of the Moon.

To apply these observations to the facts, let A B (fig. 14) represent the Sun, C D the Earth, and I K or L the Moon in its orbit K M N; let the Moon be at I K, between the Sun and the Earth; its total shadow may then entirely deprive a part of the Earth at O of the Sun's light, and its penumbra will cause a partial eclipse of the Sun to the inhabitants between G and H. Again, suppose the Moon to be at L, and it will itself be eclipsed by the interposition of the Earth between it and the Sun. In lunar eclipses, the Earth's penumbra is not attended to, because its effects in obscuring the Moon cannot be observed with precision by a spectator placed on the Earth.

Eclipses can only happen when the Moon is near one of the nodes of its orbit. Let A B M (fig. 15) represent the Sun, viewed from the Earth; C D a portion of the ecliptic, or Sun's apparent path; and E F a part of the orbit of the Moon, which planet is represented at different times by the circles G, H, I. It is evident, that the eclipse or obscuration of the Sun entirely depends on the position of the node N, and the angle of inclination F N D. If the angle of inclination remain unaltered while the node N is very remote from the centre K of the Sun, the points K and L may be farther apart than to permit any occultation or apparent contact; and it is clear, that an enlargement of the angle F N D may produce the same effect: on the contrary, an approach or coincidence of N with K, or a diminution of the angle F N K, may cause an eclipse, the quantity of obscuration in which will be so much greater, as these circumstances are more prevalent.

The Sun's place K in the ecliptic being known from tables, together with the inclination of the Moon's orbit, the place of the node, and of the Moon itself, and likewise the apparent diameters of the luminaries respectively, it will be easy to find the velocity of the Moon in elongation, and consequently the beginning, middle, end, quantity of obscuration, and other requisites, concerning the eclipse. If the computation be made from the tabular places of the heavenly bodies, the result will give the eclipse as seen from the centre of the Earth; because, in all tables where the Earth is spoken of, that centre is meant, except otherwise mentioned. But it is required to determine the particulars of the eclipse for a given place on the Earth's surface, and this includes the consideration of parallax. The Sun's parallax being very minute may in this, and most other cases, be rejected: but the Moon's parallax is so great, that it is at least of as much consequence as any other element whatever. For, on this account, the Moon's apparent path, as seen from the surface of the Earth, is so different from that which it would have when beheld

from the centre, that the same conjunction which gives a total eclipse at one place, shall not occasion the smallest obscuration of the Sun when beheld at the same instant from another part of the Earth.

We are now to consider an eclipse of the Moon. It is evident, that the difference in the phenomena of a solar eclipse would not take place if the parallax of each luminary were the same; because, whatever mutation of place the parallax might occasion in the one, the same would be produced in the other, and they would neither approach nor recede from each other on that account. Now the section of the Earth's shadow passed through by the Moon in a lunar eclipse, being at the same distance from the Earth as the Moon itself, must be subject to the same parallax at equal altitudes; and since the individual points of immersion, emersion, or other periods of the eclipse, must in the shadow have the same altitudes as the parts of the Moon they, as it were, lie on and obscure, the effects of parallax must be the same on both. Rejecting, therefore, the consideration of parallax, the Earth's shadow A B (fig. 16) may be taken to occupy a place in the heavens diametrically opposite to the Sun, and having an equal and similar motion to the apparent motion of that luminary: its apparent diameter, seen from the Earth, will be equal to the difference between the apparent diameters of the Earth and Sun, as seen from the moon; or it will be equal to twice the horizontal parallax of the Moon, diminished by the subtraction of the Sun's apparent diameter. And if the inclination of the orbit of the Moon be found, there will be a certain distance of the node N from the centre of the shadow C, that will require the Moon near the opposition to pass through the Earth's shadow, and be consequently eclipsed. From the greater or less distance of the node N, or M, it will be determined whether the eclipse will be partial or total; and from the respective places, the quantity and direction of the relative velocity, together with the apparent magnitudes of the shadow and the Moon, all the particulars of the eclipse may be known without difficulty.

It may with great reason be demanded, how it happens that the Moon, which is affirmed to emit no light of itself, but only by reflection of the Sun, is nevertheless sufficiently luminous, even in the very middle of a total eclipse, to be distinctly seen of a dusky reddish colour. The Earth's atmosphere, or body of air that surrounds it, is the cause of this phenomenon. In fact, the shadow of the Earth itself never extends so far as the Moon's orbit; though the shadow occasioned by the dispersion or reflection of the light that falls on the atmosphere may, with a very small allowance, be taken for the shadow which the Earth would have had if the light had passed close by it without interruption. We cannot with regularity explain the refraction of light in this place. It will therefore be sufficient to observe, that in the event now under consideration the Sun's light falling obliquely on the atmosphere, is bent or turned out of its course, so as to converge sooner to a point than it would otherwise have done; the spherical atmosphere performing, in some measure, the office of a large convex lens, or burning-glass. The more obliquely the rays fall, the greater is their deviation from their original course; and those rays that pass close to the Earth are found, by observations on the setting Sun and other heavenly bodies, to suffer a refraction of about 33 minutes of measure. The laws of optics, hereafter to be explained, require that they should undergo an equal refraction in passing out through the opposite part of the atmosphere. Each exterior ray of the real shadow, will therefore pass 66 minutes within the rays that would have formed the cone CKD, fig. 13. and consequently, the angle at the vertex of the cone will be 132 minutes, or 2° 12′, greater than it would have been; that is, it will be equal to the diameter of the Sun 32, added to 2° 12′, which gives 2°. 44′. Hence the axis of the cone, or length of the shadow, is found to be no more than 42 semidiameters of the Earth; whereas the radius of the Moon's orbit, or mean distance of the Moon, is about 60 semidiameters of the Earth. In the space between the penumbra and the Earth's real shadow, it is much darker than the penumbra, though that space is illuminated by the rays of the Sun; which are variously refracted, according to the density of the air they pass through. Many rays are reflected back, and the rays that go forward are such whose nature does not admit of their being easily reflected. Hence it is that the Moon in an eclipse appears red; and a spectator on the Moon would, after losing sight of the Sun, behold the Earth environed with a narrow luminous edge of bright red light, shaded off with yellow on the outside.

Of the Tides.

The first person who clearly pointed out the cause of the tides, and shewed its agreement with the effects, was sir Isaac Newton. The Moon he presently saw was the principal agent which produces these motions of the waters; and, by applying his new principles of geometry and attraction, he soon shewed the manner in which they are effected. To follow him through all his calculations and enquiries, would carry us beyond our limits.

The ocean, it is well known, covers more than one half the globe; and this large body of water is found to be in continual motion, ebbing and flowing alternately, without the least intermission. For instance, if the tide is now at high water mark, in any port or harbour which lies open to the ocean, it will presently subside, and flow regularly back for about six hours, when it will be found at low water mark. After this, it will again gradually advance for six hours; and then return back, in the same time, to its former situation, rising and falling alternately twice a day, or in the space of about twenty-four hours. The interval between its flux and reflux is, however, not precisely six hours, but there is a little difference in each tide; so that the time of high water does not always happen at the same hour, but is about three quarters of an hour later every day, for about thirty days, when it again recurs as before. For example, if it is high water to-day at noon, it will be low water at eleven minutes after six in the evening; and, consequently, after two changes more, the time of high water the next day will be at about three quarters of an hour after noon; the day following it will be at about half an hour after one, the day after that at a quarter past two, and so on for thirty days; when it will again be found to be high water at noon, as on the day the observation was first made. And this exactly answers to the motion of the moon: she rises every day about three quarters of an hour later than upon the preceding one; and, by moving in this manner round the earth, completes her revolution in about thirty days, and then begins to rise again at the same time as before.

To make the matter still plainer; suppose, at a certain place, it is high water at three o'clock in the afternoon, upon the day of the new moon; the following day it will be high water at three quarters of an hour after three; the day after that at half an hour past four; and so on till the next new moon, when it will again be high water exactly at three o'clock, as before. And by observing the tides continually at the same place, they will always be found to follow the same rule; the time of high water, upon the day of every new moon, being exactly at the same hour; and three quarters of an hour later every succeeding day.

The nature of the tides is in such exact conformity with the motion of the Moon, that, independant of all mathematical considerations, a considerate person would certainly be induced to look to her as their cause.

Neglecting therefore, for the present, all such exceptions as affect not the truth of the theory, we shall now proceed to shew, from the Newtonian principles, that these phenomena are occasioned principally by the Moon's attraction.

The waters at Z on the side of the earth, ABCDEFGH, next the Moon M, (fig. 17) are more attracted than the central parts of the earth O by the Moon, and the central parts are more attracted by her than the waters on the opposite side of the earth at *n*; and therefore the distance between the earth's centre and the waters on its surface under and opposite to the Moon will be increased. For, let there be three bodies at H, O, and D; if they are all equally attracted by the body M, they will all move equally fast towards it, their mutual distances from each other continuing the same. If the attraction of M is unequal, then that body which is most strongly attracted will move fastest, and this will increase its distance from the other body. M will attract H more strongly than it does O, by which the distance between H and O will be increased, and a spectator on O will perceive H rising higher toward Z. In like manner, O being more strongly attracted than D, it will move farther towards M than D does; consequently the distance between O and D will be increased; and a spectator on O, not perceiving his own motion, will see D receding farther from him towards *n*; all effects and appearances being the same, whether D recedes from O; or O from D.

Suppose now there is a number of bodies, as A, B, C, D, E, F, G, H, placed round O, so as to form a flexible or fluid ring: then, as the whole is attracted towards M, the parts at H and D will have their distance from O increased; whilst the parts at B and F being nearly at the same distance from M as O is, these parts will not recede from one another; but rather by the oblique attraction of M, they will approach near to O. Hence, the fluid ring will form itself into an ellipse Z *n* L N, whose longer axis *n* O Z produced

will pass through M, and its shorter axis B O F will terminate in B and F. Let the ring be filled with fluid particles, so as to form a sphere round O; then, as the whole moves towards M, the fluid sphere being lengthened at Z and *n* will assume an oblong or oval form. If M is the Moon, O the Earth's centre, A B C D E F G H the sea covering the earth's surface, it is evident, by the above reasoning, that whilst the Earth by its gravity falls towards the Moon, the water directly below at B will swell and rise gradually towards her; also the water at D will recede from the centre, (strictly speaking, the centre recedes from D) and rise on the opposite side of the Earth; whilst the water at B and F is depressed, and falls below the former level. Hence as the Earth turns round its axis from the Moon to the Moon again in 24¾ hours, there will be two tides of flood and two of ebb in that time, as we find by experience.

That this doctrine may be still more clearly understood, let it be considered, that although the Earth's diameter bears a considerable proportion to the distance of the Earth from the Moon, yet this diameter is almost nothing when compared to the distance of the Earth from the Sun. The difference of the Sun's attraction, therefore, on the sides of the Earth under and opposite to him, will be much less than the difference of the Moon's attraction on the sides of the Earth under and opposite to her; and, for this reason, the Moon must raise the tides much higher than they can be raised by the Sun. Newton has calculated the effect of the Sun's influence, in this case, and found that it is about three times less than that of the Moon. The action of the Sun alone would, therefore, be sufficient to produce a flux and reflux of the sea; but the elevations and depressions occasioned by this means would be about three times less than those produced by the Moon.

The tides, then, are not the sole production of the Moon, but of the joint forces of the Sun and Moon together. Or, properly speaking, there are two tides, a solar one, and a lunar one, which have a joint or opposite effect, according to the situation of the bodies which produce them. When the actions of the Sun and Moon conspire together, as at the time of new and full Moon, the flux and reflux become more considerable; and these are then called the Spring Tides. But one tends to elevate the waters, whilst the other depresses them, as at the Moon's first and third quarters, and then the effect will be exactly the contrary; the flux and reflux, instead of being augmented, as before, will now be diminished; and these are called the Neap Tides.

To explain this more completely, let S represent the Sun, (fig. 18) Z H R the Earth, and F and C the Moon at her full and change. Then, because the Sun S, and the new Moon C, are nearly in the same right line with the centre of the Earth O, their actions will conspire together, and raise the water above the zenith Z, or the point immediately under them, to a greater height than if only one of these forces acted alone. But it has been shewn that when the ocean is elevated to the zenith Z, it is also elevated at the opposite point, or nadir, at the same time; and therefore, in this situation of the Sun and Moon, the tides will be augmented. And again, whilst the full Moon F raises the waters at N and Z, directly under and opposite to her, the Sun S, acting in the same right line, will also raise the waters at the same point Z and N, directly under and opposite to him; and therefore, in this situation also, the tides will be augmented; their joint effect being nearly the same at the change as at the full; and in both cases they occasion what are called the Spring Tides.

On this theory, the tides ought to be highest directly under and opposite to the Moon; that is, when the Moon is due north and south. But we find that in open seas, where the waters flow freely, the Moon is generally past the north and south meridian of the place where it is high water. The reason is obvious; for though the Moon's attraction was to cease altogether when she was past the meridian, yet the motion of ascent communicated to the water before that time would make it continue to rise for some time after; much more must it do so when the attraction is only diminished; as a little impulse given to a moving ball will cause it still to move farther than otherwise it could have done; and as experience shews that the day is hotter about three in the afternoon, than when the Sun is on the meridian, because of the increase made to the heat already imparted.

Tides answer not always to the same distance of the Moon from the meridian at the same places, but are variously affected by the action of the Sun, which brings them on sooner when the Moon is in her first and third quarters, and keeps them back later when she is in her third and fourth; because, in the former case, the tide raised by the Sun alone would be earlier than the tides raised by the Moon; and in the latter case later.

The Sun, being nearer our hemisphere in winter than in summer, is of course nearer to it in February and October than in March and September, and therefore the greatest tides happen not till some time after the autumnal equinox, and return a little before the vernal.

The sea, being put in motion, would continue to ebb and flow for several times, even though the Sun and Moon were annihilated, and their influence should cease; as if a bason of water was agitated, the water would continue to move for some time after the bason was left to stand still; or like a pendulum, which having been put in motion by the hand, continues to make several vibrations without any new impulse. When the Moon is in the equator, the tides are equally high in both parts of the lunar day, or time of the Moon's revolving from the meridian to the meridian again, which is 24 hours 50 minutes. But as the Moon declines from the equator towards either pole, the tides are alternately higher and lower at places having north or south latitude. For one of the highest elevations, which is that under the Moon, follows her towards the pole to which she is nearest, and the other declines towards the opposite pole; each elevation describing parallels as far distant from the equator, on opposite sides, as the Moon declines from it to either side; and consequently the parallels described by those elevations of the water are twice as many degrees from one another as the Moon is from the equator; increasing their distance as the Moon increases her declination, till it is at the greatest, when these parallels are, at a mean state, 47 degrees from one another; and on that day the tides are most unequal in their heights. As the Moon returns towards the equator, the parallels described by the opposite elevations approach towards each other, until the Moon comes to the equator, and then they coincide. As the Moon declines towards the opposite pole, at equal distances, each elevation describes the same parallel in the other part of the lunar day, which its opposite elevation described before. Whilst the Moon has north declination, the great tides in the northern hemisphere are when she is above the horizon; and the reverse whilst her declination is south.

In open seas the tides rise but to very small heights, in proportion to what they do in wide-mouthed rivers, opening in the direction of the stream of tide. For in channels growing narrower gradually, the water is accumulated by the opposition of the contracting bank; like a gentle wind, little felt on an open plain, but strong and brisk in a street; especially if the wider end of the street is next the plain, and in the way of the wind.

The tides are so retarded in their passage through different shoals and channels, and otherwise so variously affected by striking against capes and headlands, that to different places they happen at all distances of the Moon from the meridian, consequently at all hours of the lunar day. The tide propagated by the Moon in the German Ocean, when she is three hours past the meridian, takes twelve hours to come thence to London-bridge, where it arrives by the time that a new tide is raised in the ocean. There are no tides in lakes, because they are generally so small, that when the Moon is vertical she attracts every part of them alike; and therefore, by rendering all the waters equally light, no part of them can be raised higher than another. The Mediterranean and Baltic Seas suffer very small elevations, because the inlets by which they communicate with the ocean are so narrow, that they cannot, in so short a time, receive or discharge enough to raise or sink their surface sensibly.

Air being lighter than water, and the surface of the atmosphere being nearer to the Moon than the surface of the sea, it cannot be doubted that the Moon raises much higher tides in the air than in the sea. And therefore many have wondered why the mercury does not sink in the barometer when the Moon's action on the particles of air makes them lighter as she passes over the meridian. But we must consider, that as these particles are rendered lighter, a greater number of them is accumulated, until the deficiency of gravity is made up by the height of the column; and then there is an equilibrium, and consequently an equal pressure upon the mercury as before; so that it cannot be effected by the aërial tides. It is very probable, however, that the stars which are seen through an aërial tide of this kind will have their light more refracted than those which are seen through the common depth of the atmosphere; and this may account for the supposed refractions by the lunar atmosphere that have been sometimes observed.

Of Comets. Tycho Brahe and Cassini were the first among the modern astronomers who assigned these bodies a place in our system; but they appear to be unacquainted both with

their motion round the sun, and the true figure of their orbits. These particulars were left for the determination of Newton, who has discovered the paths they describe, and the laws to which they are subject. Their revolutions are now known to be performed in very long ellipses, whose lower focus is very near the sun; being governed throughout by the same law, of describing equal areas in equal times, which is known to regulate the motions of all the other bodies in the system. By observations of the parallax it is also found, that at their first appearance they are nearer to us than Jupiter; whence it is concluded that they are in general less than that planet; for if they were as large they would be seen at as great a distance. In their motions round the sun they are also subject to the same irregularities as the planets; but as their orbits are extremely eccentric, those variations are much more considerable. When they are near the sun their motion is very rapid, and in the more distant parts of their orbits extremely slow; so that their vicissitudes, in this respect, are as much in the extreme, as what they must undergo from heat and cold.

When a comet arrives within a certain distance of the sun, it emits a fume or vapour called its tail; which shows that they contain a portion of matter considerably more rare and volatile than any on the earth; for the tail begins to appear when they are yet in a higher, and consequently a colder region than Mars. In every situation of the comet, the tail is always directed to that part of the heavens which is nearly opposite to the sun; and it is always greater after the comet has passed its perihelium, than during its approach towards it, being greatest of all when it has just left that point.

The celebrated Dr. Halley, from the theory of Newton, has calculated tables for determining the orbits of the comets, which in several instances have been found agreeable to observation. That remarkable comet which was observed in the year 1680, is shewn to be the same with the one that appeared in the year 1106, its period being 575 years. The distance of this comet from the sun when in its perihelium, was to the distance of the earth from the sun, as 6 to 1000; its heat, therefore, at that time, was to the heat of the summer's sun with us, in the ratio of about 28000 to 1; so that, according to Newton, the surface of this comet, supposing it be composed of a matter like our earth, would have acquired a heat about 2000 times greater than that of red-hot iron; which is so intense, that vapours, exhalations, and every volatile matter, must have been immediately consumed and dissipated.

In order to describe the course of a comet, let A B C (fig. 19) be the very long orbit of a comet, in one of whose foci S is placed the Sun; the aphelium in A; the perihelium in P. The comet is not visible to us but when it approaches towards B, and during the time which it passes the arc from B to C of its orbit. But the time is considerably shorter than that which it employs to pass the other portion of its orbit C A B, for these two reasons: first, because the arc B C is much shorter than the arc C A B; and in the second place, because the comets, like the other planets, are slower in their course while they depart farther from the Sun; and on the contrary they are swifter as they approach the sun. It requires much less time to pass over the portion B C of their orbit which is visible to us, than the other portion C A B.

As the great eccentricity of the orbits of comets renders them very liable to be disturbed by the attraction of the planets and other comets, it is probably to prevent too great disturbances from these, that while all the planets revolve nearly in the same plane, the comets are disposed in very different cones, and disposed all over the heavens; that when at their greatest distance from the Sun, and moving slowest, they might be removed as far as possible out of the reach of each other's action.

The number of comets belonging to our system is unknown; but from the acounts of the antients, and the more accurate observations of the moderns, it is ascertained that more than 450 had been seen, previous to the year 1771; and when the attention of astronomers was called to this object, by the expectation of the return of the comet of 1759, no less then seven were observed in the course of as many years. Hence we may reasonably conclude, that their number is considerably beyond any estimate that can be made from the observations of which we are now in possession.

Of the fixed Stars. The fixed stars are so called, because they are observed not to change their places in the heavens as the planets do. They appear of an infinite variety of sizes, yet for convenience it is usual to class them into six or seven magnitudes: thus they are called stars of the first, second, &c. magnitude. To the naked eye they appear innumerable, but this is only a deception, caused probably by the refraction of our atmosphere. The whole number of stars visible to the naked eye is about 3186; but seldom above one-third of that number can be seen by most people.

The antients, that they might the better distinguish the stars with regard to their situation in the heavens, divided them into several constellations, that is, systems of stars, each system consisting of such as are near each other. And to distinguish these systems from one another, they gave them the names of such men or things as they fancied the space they took up in the heavens represented. To these, several new constellations have been added by modern astronomers.

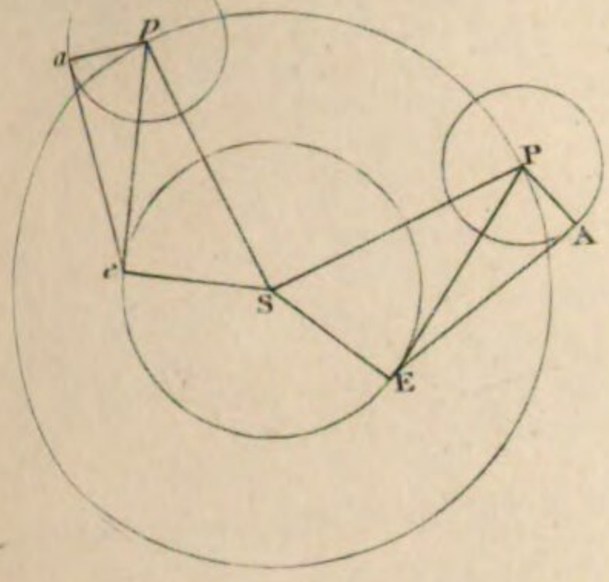
The following table contains the names of the constellations, and the number of stars observed in each by different astronomers.

The Antient Constellations.		*Ptolemy.*	*Tycho.*	*Hevelius.*	*Flamsteed.*
Ursa minor	The Little Bear	8	7	12	24
Ursa major	The Great Bear	35	29	73	87
Draco	The Dragon	31	32	40	80
Cepheus	Cepheus	13	4	51	35
Bootes, *Arctophilax*	Bootes	23	18	52	54
Corona Borealis	The Northern Crown	8	8	8	21
Hercules, *Engonasin*	Hercules kneeling	29	28	45	113
Lyra	The Harp	10	11	17	21
Cygnus, *Gallina*	The Swan	19	18	47	81
Cassiopeia	The Lady in her Chair	13	26	37	55
Perseus	Perseus	29	29	46	59
Auriga	The Waggoner	14	9	40	66
Serpentarius, *Ophiuchus*	Serpentarius	29	15	40	74
Serpens	The Serpent	18	13	22	64
Sagitta	The Arrow	5	5	5	18
Aquila, *Vultur*	The Eagle	15	12	23	71
Antinous	Antinous		3	19	
Delphinus	The Dolphin	10	10	14	18
Equulus, *Equi sectio*	The Horse's Head	4	4	6	10
Pegasus, *Equus*	The Flying Horse	20	19	38	89
Andromeda	Andromeda	23	23	47	66
Triangulum	The Triangle	4	4	12	16
Aries	The Ram	18	21	27	66
Taurus	The Bull	44	43	51	141
Gemini	The Twins	25	25	38	85
Cancer	The Crab	23	15	29	83
Leo	The Lion	35	30	49	95
Coma Berenices	Berenice's Hair		14	21	43
Virgo	The Virgin	32	33	50	110
Libra, *Chelæ*	The Scales	17	10	20	51
Scorpio	The Scorpion	24	10	20	44
Sagittarius	The Archer	31	14	22	69
Capricornus	The Goat	28	28	29	51
Aquarius	The Water-bearer	45	41	47	108
Pisces	The Fishes	38	36	39	113
Cetus	The Whale	22	21	45	97
Orion	Orion	38	42	62	78
Eridanus, *Fluvius*	Eridanus, *the River*	34	10	27	84
Lepus	The Hare	12	13	16	19
Canis major	The Great Dog	29	13	21	31
Canis minor	The Little Dog	2	2	13	14
Argo Navis	The Ship	45	3	4	64
Hydra	The Hydra	27	19	31	60
Crater	The Cup	7	3	10	31
Corvus	The Crow	7	4	0	9
Centaurus	The Centaur	37	0	0	35
Lupus	The Wolf	19	0	0	24
Ara	The Altar	7	0	0	9
Corona Australis	The Southern Crown	13	0	0	12
Piscis Australis	The Southern Fish	18	0	0	24

ASTRONOMY.

PL XIII.

Fig. 9.



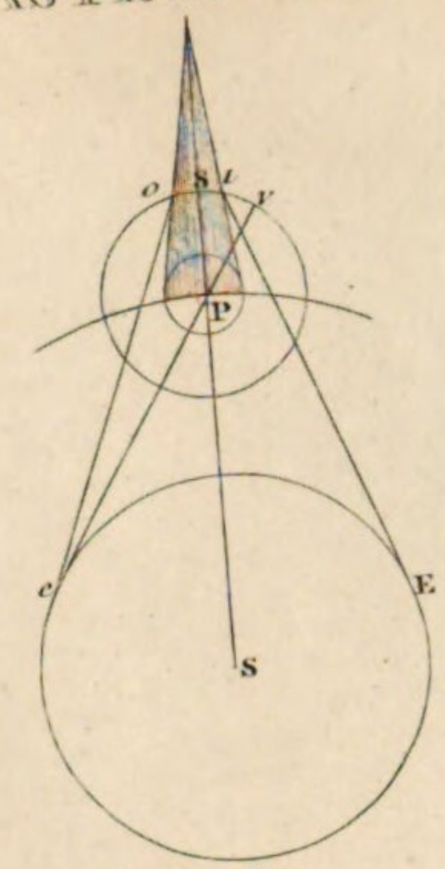
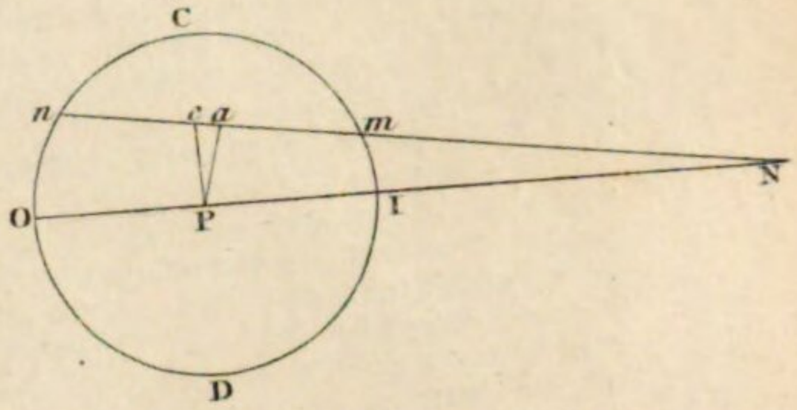


Fig. 10.

Fig. 11.



Eclipse.

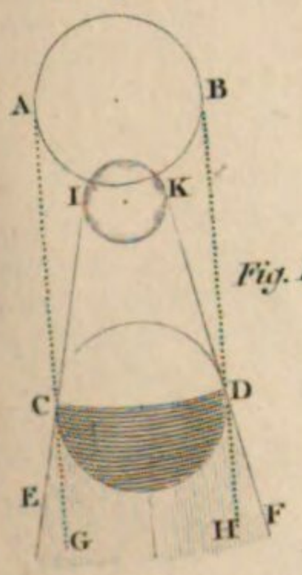


Fig. 12.

Eclipse.

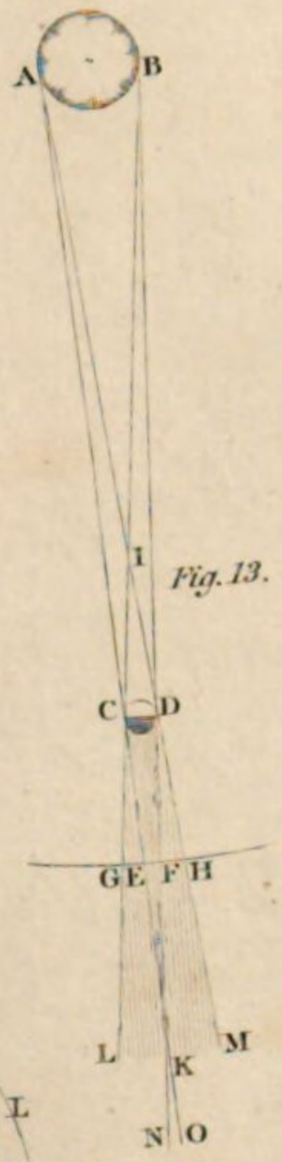


Fig. 13.

Eclipse.

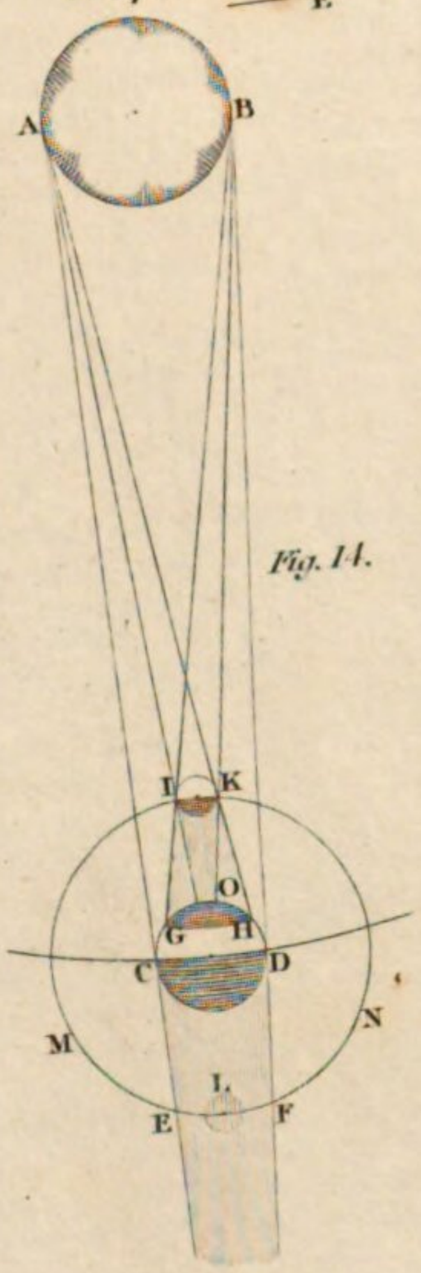


Fig. 14.

Eclipse of the Sun.

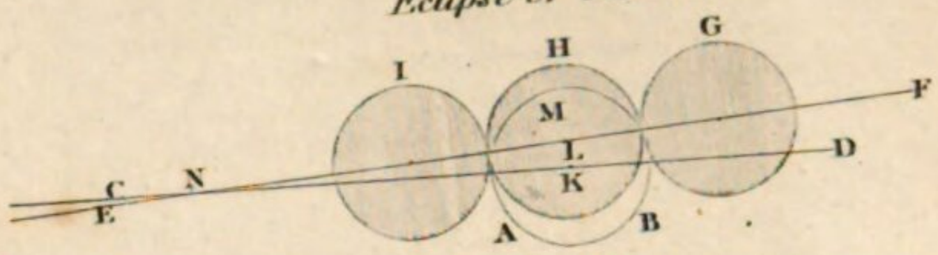


Fig. 15.

Eclipse of the Moon.

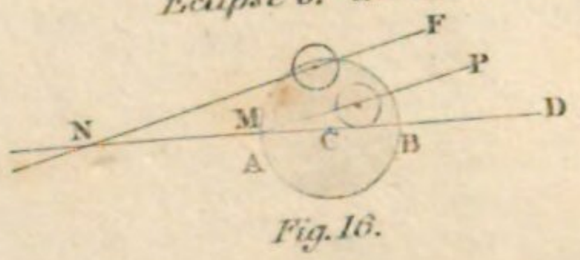


Fig. 16.

Tides.

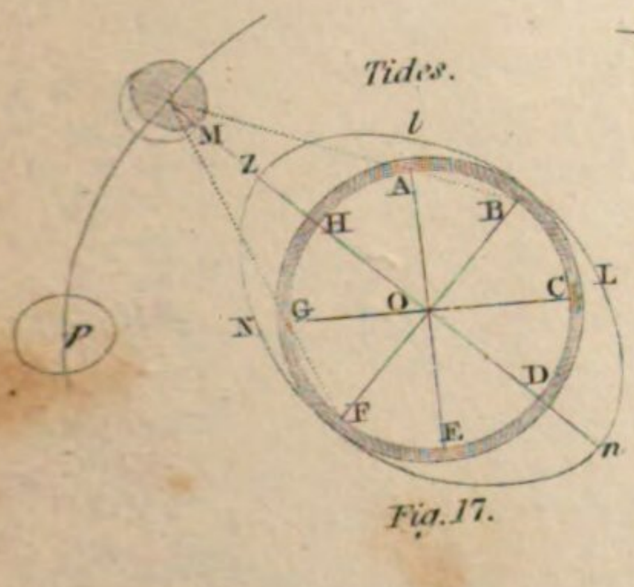


Fig. 17.

Tides.

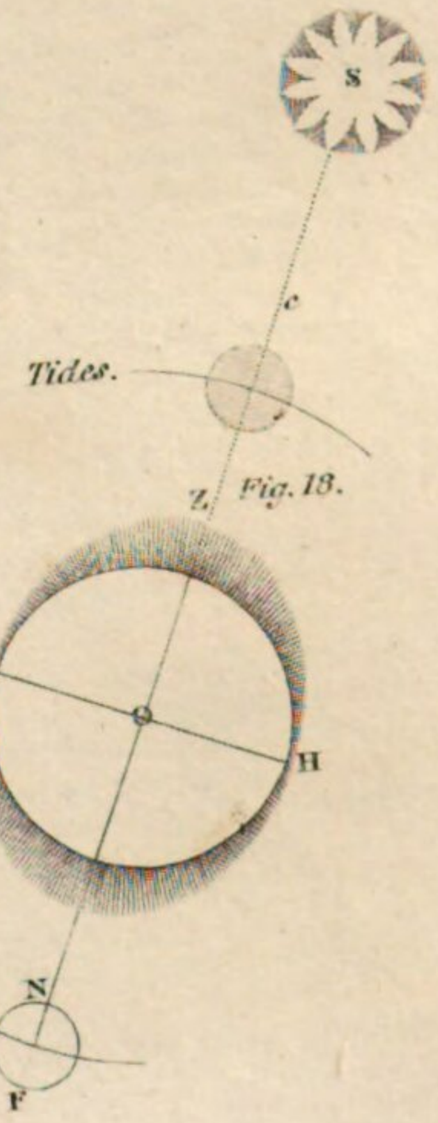


Fig. 18.

Comets.

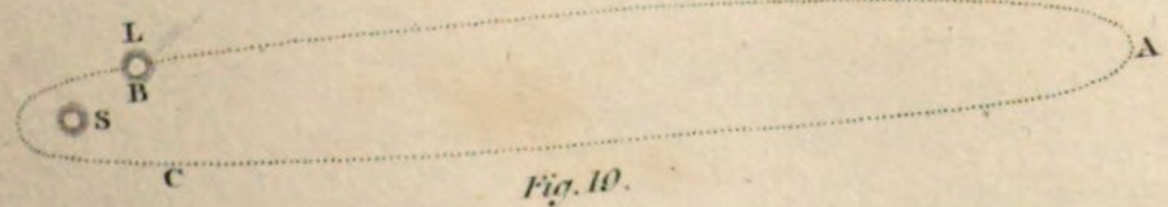


Fig. 19.

Printed, March 1, 1806, for **Richard Phillips**, *New Bridge Street, Blackfriars.*

The New Southern Constellations.

Columba Noachi -	Noah's Dove - - - - -	10
Robur Carolinum -	The Royal Oak - - - -	12
Grus - - -	The Crane - - - - -	13
Phœnix - - -	The Phenix - - - - -	13
Indus - - -	The Indian - - - - -	12
Pavo - - -	The Peacock - - - -	14
Apus, *Avis Indica* -	The Bird of Paradise - - -	11
Apis, *Musca* - -	The Bee or Fly - - - -	4
Chamæleon - -	The Cameleon - - - -	10
Triangulum Australis	The South Triangle - - -	5
Piscis volans, *Passer* -	The Flying Fish - - - -	8
Dorado, *Xiphias* -	The Sword Fish - - - -	6
Toucan - - -	The American Goose - - -	9
Hydrus - - -	The Water Snake - - - -	10

Hevelius's Constellations made out of the unformed Stars.

		Hevelius.	*Flamsteed.*
Lynx - - -	The Lynx - - - -	19	44
Leo minor - -	The Little Lion - - -		53
Asterion & Ghara -	The Greyhound - - -	23	25
Cerberus - - -	Cerberus - - - -	4	
Vulpecula & Anser -	The Fox and Goose - -	27	35
Scutum Sobieski -	Sobieski's Shield - -	7	
Lacerta - - -	The Lizard - - - -	10	16
Camelopardalus -	The Camelopard - - -	32	58
Monoceros - -	The Unicorn - - - -	19	31
Sextans - - -	The Sextant - - - -	11	41

Stars not included in any constellation are called unformed stars. Besides the names of the constellations, the antient Greeks gave particular names to some single stars, or small collections of stars: thus, the cluster of small stars in the neck of the bull was called Pleiades; five stars in the bull's face, the Hyades; a bright star in the breast of Leo, the Lion's Heart; and a large star between the knees of Bootes, Arcturus.

The constellations may be represented on two plane spheres projected on a great circle, or on the convex surface of a solid sphere, as on the celestial globe, or most perfectly on the concave surface of a hollow sphere. If the celestial globe is made use of, after rectifying it to the time of the night, the stars may be found, by conceiving a line drawn from the centre of the globe through any star in the heavens, and its representation upon the globe. Greek letters have been added by Bayer to stars in the several constellations of his catalogue (α being affixed to the largest star), by means of which any star may be easily found.

Twelve of these constellations lie upon the ecliptic, including a space about 15°, broad, called the Zodiac, within which all the planets move. The constellation Aries, about 2000 years ago, lay in the first sign of the ecliptic; but, on account of the precession of the equinoxes, it now lies in the second. In the foregoing table, Antinous was made out of the unformed stars near Aquila: and Coma Berenices, out of the unformed stars near the Lion's tail. They are both mentioned by Ptolemy, but as unformed stars. The constellations as far as the triangle, with Coma Berenices, are northern; those after Pisces are southern.

The fixed stars are placed at a distance from us so great, that it cannot be ascertained by any means yet known; hence they must shine by their own light, and not by the light which they receive from our sun, as the planets do. Though it has been said that the relative situations of the fixed stars do not vary, yet in the course of several ages, some variations have been observed among them. Some of the larger stars have not the same precise situations that antient observations attribute to them, and new stars have appeared, while some others which have been described are now no longer to be found. Some stars are likewise found to have a periodical increase and decrease. Many of the fixed stars, upon examination with the telescope, are found to consist of two.

Besides the phenomena already mentioned, there are many nebulæ, or parts of the heavens, which are brighter than the rest. The most remarkable of these is a broad irregular zone or belt, called the milky way. There are others much smaller; and some so small, that they can be seen only by telescopes. If the telescope is directed to these nebulæ, they are resolvable into clusters of stars, which appear as white clouds in instruments of less force.

Dr. Herschell has rendered it highly probable, both from observation and well-grounded conjecture, that the starry heaven is replete with these nebulæ or systems of stars, and that the milky way is that particular nebula in which our sun is placed. Reasoning analogically from the circumstances with which we are acquainted, we may deduce, that the universe consists of nebulæ or distinct systems of stars; that each nebula is composed of a prodigious number of suns, or bodies that shine by their own native splendour, and that each individual sun is destined to give light to numbers of worlds that revolve about it. See Vince's Astronomy, Gregory's Astronomy, &c.

ASTROSCOPE an instrument composed of two cones, having the constellations delineated on their surfaces, whereby the stars may be easily known.

ASTRUM, a constellation or assemblage of stars. This term is often applied to the canis major, or rather to the bright star in his mouth.

ASTYNOMI, in Grecian antiquity, magistrates in Athens, corresponding to the ædiles of the Romans; they were ten in number.

ASYLUM, a sanctuary or place of refuge, where criminals sheltered themselves from the hands of justice. It is pretended that the first asylum was built at Athens by the Heraclidæ, as a refuge for those who fled from the oppression of their fathers. Romulus when he built Rome, left a certain space as an asylum to all persons, whether freemen or slaves. The Jews had their asyla, the most remarkable of which were the six cities of refuge, the temple, and the altar of burnt offerings. This privilege began likewise to be enjoyed by the christian churches in the reign of Constantine, at which time the altar only and the inward fabric of the church were a place of refuge; but afterwards the whole precincts, nay, even the graves of the dead, crosses, schools, &c. were comprehended in that privilege. As asyla were not intended originally to patronize wickedness, but as a refuge for the innocent, the injured, and the oppressed, several crimes were excepted by law, for which the church could grant no protection; as, 1. Protection was denied to public debtors. 2. To Jews who pretended to turn Christians, in order to avoid suffering legal punishment for their crimes. 3. To heretics and apostates. 4. To slaves who fled from their masters. And 5. To robbers, murderers, conspirators, ravishers, &c.

ASYMPTOTE, in geometry, a line which continually approaches nearer to another, but though continued infinitely will never meet with it; of these there are many kinds. In strictness, however, the term asymptotes is appropriated to right lines, which approach nearer and nearer to some curve, of which they are said to be the asymptotes; but if they and their curve are indefinitely continued, they will never meet. See Conic Sections.

Concerning asymptotes and asymptotical curves, it may be remarked, 1. That although such curves as have asymptotes are of the number of those which do not include a space; yet it is not true, on the other hand, that wherever we have a curve of that nature, we have an asymptote also. 2. Of these curves that have an asymptote, some have only one, as the conchoid, cissoid, and logarithmic curve; and others two, as the hyperbola. 3. As a right line and a curve may be asymptotical to one another, so also may curves and curves; such are two parabolas, whose axes are in the same right line. 4. No right line can ever be an asymptote to a curve that is every where concave to that right line. 5. But a right line may be an asymptote to a mixed curve, that is partly concave, and partly convex, towards the same line. And 6. All curves that have one and the same common asymptote are also asymptotical to one another.

ASYNDETON, in grammar, a figure which omits the conjunction in a sentence.

ATCHE, in commerce, a small silver coin used in Turkey, and worth only one-third of the English penny.

ATCHIEVEMENT, in heraldry, denotes the arms of a person, or family; together with all the exterior ornaments of the shield, as helmet, mantle, crest, scrolls, and motto, together with such quarterings as may have been acquired by alliances, all marshalled in order. It is vulgarly called hatchment; and such are the arms which are commonly hung up in the fronts of houses, and in churches, on the death of persons.

ATHAMADULET, the prime minister

of the Persian empire, as the grand visier is of the Turkish empire.

ATHAMANTA, in botany, a genus of the pentandria digynia class and order, and in the natural method ranking under the 45th order, umbellatæ. The fruit is oblong and striated, and the petals are inflected and emarginated. Of this genus there are nine species, but none of them merit particular notice, except the athamanta cretensis, or daucus creticus, which grows wild in the Levant and the warmer parts of Europe. The flower-stalk rises about two feet high, sending out many branches. These have white flowers. The seeds have a warm biting taste, with an agreeable aromatic smell. They are said to be carminative and diuretic, but are little used in practice.

ATHANASIA, *goldilocks*, a genus of the polygamia æqualis order, and syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ discoides. The receptacle is chaffy; the pappus or down chaffy, and very short; and the calyx is imbricated. There are 20 species, all tender plants except one; and none of them possessed of beauty, or any remarkable property yet discovered.

ATHANATI, in Persian antiquity, a body of cavalry consisting of 10,000 men, always complete. They were called athanati because when one of them happened to die, another was immediately appointed to succeed him.

ATHANOR. See CHEMISTRY.

ATHELING, *adeling*, *edling*, *ethling*, or *etheling*, among our Saxon ancestors, was a title of honour properly belonging to the heir apparent, or presumptive, to the crown.

ATHENÆA, in botany, a genus of the class and order octandria monogynia; the cal. is coloured, five-parted; corolla none; bristles eight, feathered between the filaments; stigma five-parted; caps. globose, one-celled, three-valved; seeds three to five.

There is one species, a branching shrub of Guinea; the bark, leaves, and fruit, are sharp and aromatic, called caffé diable by the Creoles.

ATHENÆUM, in antiquity, a public place where the professors of the liberal arts held their assemblies, the rhetoricians declaimed, and the poets rehearsed their performances. The three most celebrated athenæa were those at Athens, at Rome, and at Lyons, the second of which was built by the emperor Adrian.

ATHERINA, in ichthyology, a genus of abdominal fishes, distinguished by having the upper jaw rather flat, six rays in the gill membrane, and a silvery stripe on each side of the body. There are five species of this genus: the most remarkable are;

1. Atherina hepsetus, with about 12 rays in the fin next the anus. It is found in the Mediterranean. It is also very common in the sea near Southampton, where it is called a smelt. The highest season is from March to the latter end of May, or beginning of June; in which month it spawns. It never deserts the place; and is constantly taken, except in hard frost. It is also found on other coasts of our island. The length is above 4¼ inches, and the tail is much forked. The fish is semi-pellucid, covered with scales; the colour silvery, tinged with yellow; beneath the side line is a row of small black spots.

2. Atherina menidea, has 24 rays in the fin next the anus. This is a very pellucid fish, with many black points interspersed; it has many teeth in the lips, but none in the tongue or jaws. It is found in the fresh waters of Carolina, and spawns in April.

ATHEROMA, in medicine, a tumour without pain or discolouring of the skin; containing, in a membranaceous bag, matter like pap, intermixed with hard and stony corpuscles, &c. It is cured by incision.

ATHLETÆ, in antiquity, men of remarkable strength and agility, disciplined to perform in the public games.

ATLANTIDES, in astronomy, the same with Pleiades. They are so called as being supposed by the poets to be the daughters of Atlas, who were translated into heaven.

ATLAS, in anatomy, the name by which some call the first vertebra of the neck; so called in allusion to Atlas.

ATLAS denotes a book of universal geography, containing maps of all the known parts of the world.

ATLAS, in commerce, a sort of silk or satin manufactured in the East Indies, in which gold and silk are so wrought together, as no workman in Europe can imitate. In China they weave long slips of gilt paper into their silks. The same slips of paper are twisted about silk threads so artificially, as to look finer than gold thread, though of no great value.

ATMOSPHERE, a term used to signify the whole of the fluid mass, consisting of air, aqueous and other vapours, electric fluids, &c. which surrounds the earth to a considerable height; and partaking of all its motions, both annual and diurnal.

The composition of that part of our atmosphere properly called air, was till within a few years but very little known. Formerly it was supposed to be a simple, homogeneous, and elementary fluid; but the experiments of Dr. Priestley and others have discovered, that the atmospheric air is in reality a compound, and may be artificially produced by the union of two other kinds of air, viz. oxygen, or pure air, and nitrogen or azotic gas. By accurate experiments, the air that we usually breathe is composed of only one-fourth part of oxygen air, or perhaps less; the other three parts, or more, consisting of azotic gas or nitrogen.

ATMOSPHERE, *uses of*. The uses of the atmosphere are so many and great, that it seems indeed absolutely necessary, not only to the comfort and convenience of men, but even to the existence of all animal and vegetable life, and to the very constitution of all kinds of matter whatever, and without which they would not be what they are; for by it we live, breathe, and have our being; and by insinuating itself into all the vacuities of bodies, it becomes the great spring of most of the mutations here below; as generation, corruption, dissolution, &c. and without which none of these operations could be carried on.

By the mechanical force of the atmosphere too, as well as its chemical virtues, many necessary purposes are answered. We employ it as a moving power, in the motion of ships, to turn mills, and for other such uses. And it is one of the great discoveries of the modern philosophers, that the several motions attributed by the antients to a *fuga vacui*, are really owing to the pressure of the atmosphere. Galileo, having observed that there was a certain standard altitude, beyond which no water could be elevated by pumping, took an occasion then to call in question the doctrine of the schools, which ascribed the ascent of water in pumps, to the abhorrence of a vacuum, and instead of it he happily substituted the hypothesis of the weight and pressure of the air. It was with him indeed little better than an hypothesis; since it had not then those confirmations from experiment, afterwards found out by his pupil Torricelli, and other succeeding philosophers, particularly Mr. Boyle.

ATMOSPHERE, *salubrity of*. On the tops of mountains the air is generally more salubrious than in pits or very deep places. Besides the difference arising from the mere difference of altitude, the salubrity of the atmosphere is greatly affected by many other circumstances. The air, when confined or stagnant, is commonly more impure than when agitated and shifted: thus, all close places are unhealthy; and even the air in a bed-chamber is less salubrious in a morning, after it has been slept in, than in the evening. Dr. White, in vol. 68 Philos. Trans. gives an account of experiments on this quality of the air; and remarks one instance when the air was particularly impure, viz. Sept. 13, 1777; when the barometer stood at 30° 30, the thermometer at 69°; the air being then dry and sultry, and no rain having fallen for more than two weeks. A slight shock of an earthquake was perceived that day. In vol. 70 of the same Transactions, Dr. Ingenhousz gives an account of some experiments on this head, made in various places and situations: he finds, "that the air at sea, and close to it, is in general purer, and fitter for animal life, than the air on the land;" but the doctor did not find much difference between the air of the towns and of the country, nor between one town and another. The abbé Fontana made nearly the same conclusions, from accurate experiments, asserting, "that the difference between the air of one country and that of another, at different times, is much less than what is commonly believed; and yet that this difference in the purity of the air at different times, is much greater than the difference between the air of the different places observed by him." Finally, M. Fontana concludes, that "nature is not so partial as we commonly believe. She has not only given us an air almost equally good every where at every time, but has allowed us a certain latitude, or a power of living and being in health, in qualities of air which differ to a certain degree. By this it is not meant to deny the existence of certain kinds of noxious air in some particular places; but to own that in general the air is good every where, and that the small differences are not to be feared so much as some people would make us believe. Nor is it meant to speak here of those vapours and other bodies which are accidentally joined to the common air in particular places, but do not change its nature and intrinsical property. This state of the air cannot be known by the test of nitrous air; and those vapours are to be considered in the same manner as we should consider so many particles of arsenic swimming in the atmosphere. In this case it is the arsenic, and not the degenerated air, that would kill the ani-

mals who ventured to breathe it." See CHEMISTRY.

ATMOSPHERE, *figure of.* As the atmosphere envelopes all parts of the surface of our globe, if they both continued at rest, and were not endowed with a diurnal motion about their common axis, then the atmosphere would be exactly globular, according to the laws of gravity; for all the parts of the surface of a fluid in a state of rest must be equally removed from its centre. But as the earth and the ambient parts of the atmosphere revolve uniformly together about their axis, the different parts of both have a centrifugal force; the tendency of which is more considerable, and that of the centripetal less, as the parts are more remote from the axis; and hence the figure of the atmosphere must become an oblate spheroid, since the parts that correspond to the equator are farther removed from the axis than the parts which correspond to the poles. Besides, the figure of the atmosphere must, on another account, represent a flattened spheriod; namely, because the sun strikes more directly the air which encompasses the equator, and is comprehended between the two tropics, than that which pertains to the polar regions; for from this it follows, that the mass of air, or part of the atmosphere, adjoining to the poles, being less heated, cannot expand so much, nor reach so high. And yet, notwithstanding, as the same force which contributes to elevate the air diminishes its gravity and pressure on the surface of the earth, higher columns of it about the equatorial parts, all other circumstances being the same, may not be heavier than those about the poles.

In the transactions of the Royal Irish Academy for 1788, Mr. Kirwin has an ingenious dissertation on the figure, height, weight, &c. of the atmosphere. He observes, that in the natural state of the atmosphere, that is, when the barometer would every where, at the level of the sea, stand at 30 inches, the weight of the atmosphere, at the surface of the sea, must be equal all over the globe; and in order to produce this equality, as the weight proceeds from its density and height, it must be lowest where the density is greatest, and highest where the density is least; that is, highest at the equator and lowest at the poles, with several intermediate gradations.

ATMOSPHERE, *weight or pressure of.* It is evident that the mass of the atmosphere, in common with all other matter, must be endowed with weight and pressure; and this principle was asserted by almost all philosophers, both antient and modern. But it was only by means of the experiments made with pumps and the barometrical tube, by Galileo and Torricelli, that we came to the proof, not only that the atmosphere is endued with a pressure, but also what the measure and quantity of that pressure is. Thus it is found that the pressure of the atmosphere sustains a column of quicksilver in the tube of the barometer, of about 30 inches in height; it therefore follows, that the whole pressure of the atmosphere is equal to the weight of a column of quicksilver of an equal base, and 30 inches height; and because a cubical inch of quicksilver is found to weigh nearly half a pound avoirdupoise, therefore the whole 30 inches, or the weight of the atmosphere on every square inch of surface, is equal to 15 pounds. Again, it has been found that the pressure of the atmosphere balances, in the case of pumps, &c. a column of water of about 34½ feet high; and the cubical foot of water weighing just 1000 ounces, or 62½ pounds, 34½ times 62½, or 2158lb., will be the weight of the column of water, or of the atmosphere, on a base of a square foot; and consequently the 144th part of this, or 15lb., is the weight of the atmosphere on a square inch, the same as before. Hence Mr. Cotes computed, that the pressure of this ambient fluid on the whole surface of the earth, is equivalent to that of a globe of lead of 60 miles in diameter. And hence also it appears, that the pressure upon the human body must be very considerable; for as every square inch of surface sustains a presure of 15 pounds, every square foot will sustain 144 times as much, or 2160 pounds; then if the whole surface of a man's body is supposed to contain 15 square feet, which is pretty near the truth, he must sustain 15 times 2160, or 32400 pounds, that is, nearly 14½ tons weight, for his ordinary load. By this enormous pressure we should undoubtedly be crushed in a moment, if all parts of our bodies were not filled either with air or some other elastic fluid, the spring of which is just sufficient to counterbalance the weight of the atmosphere. But whatever this fluid may be, it is certain that it is just able to counteract the weight of the atmosphere, and no more; for if any considerable pressure is superadded to that of the air, as by going into deep water, it is always severely felt, let it be ever so equable, at least when the change is made suddenly; and if, on the other hand, the pressure of the atmosphere is taken off from any part of the human body, as the hand for instance, when put over an open receiver, whence the air is afterward extracted, the weight of the external atmosphere then prevails, and we imagine the hand strongly sucked down into the glass.

The difference in the weight of the air which our bodies sustain at one time more than another, is also very considerable, from the natural changes in the state of the atmosphere. This change takes place chiefly in countries at some distance from the equator; and as the barometer varies at times from 28 to 31 inches, or about one-tenth of the whole quantity, it follows that this difference amounts to about a ton and a half on the whole body of a man, which he therefore sustains at one time more than at another. On the increase of this natural weight, the weather is commonly fine, and we feel ourselves what we call braced and more alert and active; but on the contrary, when the weight of the air diminishes, the weather is bad, and people feel a listlessness and inactivity about them. And hence it is no wonder that persons suffer very much in their health, from such changes in the atmosphere, especially when they take place very suddenly, for it is to this circumstance chiefly that a sensation of uneasiness and indisposition is to be attributed: thus, when the variations of the barometer and atmosphere are sudden and great, we feel the alteration and effect on our bodies and spirits very much; but when the change takes place by very slow degrees, and by a long continuance, we are scarcely sensible of it; owing, undoubtedly, to the power with which the body is naturally endowed, of accommodating itself to this change in the state of the air, as well as to the change of many other circumstances of life; the body requiring a certain interval of time to effect the alteration in its state, proper to that of the air, &c. Thus, in going up to the tops of mountains, where the pressure of the atmosphere is diminished two or three times more than on the plain below, little or no inconvenience is felt from the rarity of the air, if it is not mixed with other noxious vapours, &c. because in the ascent the body has had sufficient time to accommodate itself gradually to the slow variation in the state of the atmosphere; but when a person ascends with a balloon very rapidly to a great height in the atmosphere, he feels a difficulty in breathing and an uneasiness of body; and the same is soon felt by an animal when inclosed in a receiver, and the air suddenly drawn or pumped out of it. So also, on the condensation of the air, we feel little or no alteration in ourselves, except when the change happens suddenly; as in very rapid changes in the weather, and in descending to great depths in a diving bell.

It is not easy to assign the true reason for the variations that happen in the gravity of the atmosphere in the same place. One cause of it however, either immediate or otherwise, it seems, is the heat of the sun; for where this is uniform, the changes are small and regular: thus between the tropics it seems the change depends on the heat of the sun, as the barometer constantly sinks about half an inch every day, and rises again to its former station in the night time; but in the temperate zones the barometer ranges from 28 to near 31 inches, shewing by its various altitudes the changes that are about to take place in the weather. If we could know, therefore, the causes by which the weather is influenced, we should also know those by which the gravity of the atmosphere is affected. These may perhaps be reduced to immediate ones, viz. an emission of latent heat from the vapour contained in the atmosphere, or of electric fluid from the same, or from the earth; as it is observed that both produce the same effect with the solar heat in the tropical climates, viz. to rarefy the air, by mixing with it, or setting loose a lighter fluid, which did not before act in such large proportion in any particular place.

ATMOSPHERE, *height and density of.* Various attempts have been made to ascertain the height to which the atmosphere is extended all round the earth. These commenced soon after it was discovered, by means of the Torricellanian tube, that air is endued with weight and pressure. And had not the air an elastic power, but was it every where of the same density, from the surface of the earth to the extreme limit of the atmosphere, like water, which is equally dense at all depths, it would be a very easy matter to determine its height from its density, and the column of mercury which it would counterbalance in the barometer tube; for it having been observed that the weight of the atmosphere is equivalent to a column of 30 inches, or 2½ feet of quicksilver, and the density of the former to that of the latter as 1 to 11040; therefore the height of the uniform atmosphere would be 11040 times 2½ feet, that is, 27600 feet, or little more than five miles and a quarter. But the air, by its

elastic quality, expands and contracts, and it being found by repeated experiments in most countries of Europe, that the spaces it occupies, when compressed by different weights, are reciprocally proportional to those weights themselves; or that the more the air is pressed, so much the less space it occupies; it follows that the air in the upper regions of the atmosphere must grow continually more and more rare, as it ascends higher; and indeed that, according to that law, it must necessarily be extended to an indefinite height. Now, if we suppose the height of the whole divided into innumerable equal parts, the quantity of each part will be as its density: and the weight of the whole incumbent atmosphere being also as its density; it follows, that the weight of the incumbent air is every where as the quantity contained in the subjacent part; which causes a difference between the weights of each two contiguous parts of air. But by a theorem in arithmetic, when a magnitude is continually diminished by the like part of itself, and the remainders the same, these will be a series of continued quantities decreasing in geometrical progression; therefore if, according to the supposition, the altitude of the air, by the addition of new parts into which it is divided, continually increases in arithmetical progression, its density will be diminished, or, which is the same thing, its gravity decreased, in continued geometrical proportion. And hence, again, it appears that, according to the hypothesis of the density being always proportional to the compressing force, the height of the atmosphere must necessarily be extended indefinitely. And farther, as an arithmetical series adapted to a geometrical one, is analogous to the logarithms of the geometrical one; it follows therefore that the altitudes are proportional to the logarithms of the densities, or weights, of air; and that any height taken from the earth's surface, which is the difference of two altitudes to the top of the atmosphere, is proportional to the difference of the logarithms of the two densities there, or to the logarithm of the ratio of those densities, or their corresponding compressing forces, as measured by the two heights of the barometer there. This law was first observed and demonstrated by Dr. Halley, from the nature of the hyberbola; and afterwards by Dr. Gregory, by means of the logarithmic curve. See Philos. Trans. N° 181, or Abridg. vol. 2. p. 13, and Greg. Astron. lib. v. prop. 3.

It is now easy, from the foregoing property, and two or three experiments, or barometrical observations, made at known altitudes, to deduce a general rule to determine the absolute height answering to any density, or the density answering to any given altitude above the earth. And accordingly calculations were made upon this plan by many philosophers, particularly by the French; but it having been found that the barometrical observations did not correspond with the altitudes as measured in a geometrical manner, it was suspected that the upper parts of the atmospherical regions were not subject to the same laws with the lower ones, in regard to the density and elasticity. It has, however, been discovered, that the law above given holds very well for all such altitudes as are within our reach, or as far as to the tops of the highest mountains on the earth, when a correction is made for the difference of the heat or temperature of the air only; as was fully evinced by M. De Luc, in a long series of observations, in which he determined the altitudes of hills both by the barometer and by geometrical measurement, from which he deduced a practical rule to allow for the difference of temperature. See his Treatise on the Modifications of the Atmosphere. Similar rules have also been deduced from accurate experiments, by sir George Shuckburgh and general Roy, both concurring to shew that such a rule for the altitudes and densities, holds true for all heights that are accessible to us, when the elasticity of the air is corrected on account of its density; and the result of their experiments shewed, that the difference of the logarithms of the heights of the mercury in the barometer, at two stations, when multiplied by 10000, is equal to the altitude in English fathoms, of the one place above the other; that is, when the temperature of the air is about 31 or 32 degrees of Fahrenheit's thermometer, and a certain quantity, more or less, according as the actual temperature is different from that degree.

But it may here be shewn, that the same rule may be deduced independent of such a train of experiments as those above, merely by the density of the air at the surface of the earth alone. Thus, let D denote the density of the air at one place, and d the density at the other; both measured by the column of mercury in the barometrical tube: then the difference of altitude between the two places will be proportional to the log. of D — the log. of d, or to the log. of $\frac{D}{d}$. But as this formula expresses only the relation between different altitudes, and not the absolute quantity of them, assume some indeterminate, but constant quantity b, which multiplying the expression log. $\frac{D}{d}$, may be equal to the real difference of altitude a; that is, $a = b \times$ log. of $\frac{D}{d}$. Then, to determine the value of the general quantity b, let us take a case in which we know the altitude a, which corresponds to a known density d; as for instance, taking $a = 1$ foot, or 1 inch, or some such small altitude: then, because the density D may be measured by the pressure of the whole atmosphere, or the uniform column of 27600 feet, when the temperature is 55°; therefore 27600 feet will denote the density D at the lower place, and 27599 the less density d at 1 foot above it; consequently $1 = b \times$ log. of $\frac{27600}{27599}$, which, by the nature of logarithms, is nearly $= b \times \frac{.43429448}{27600}$, or $\frac{1}{63551}$ nearly; and hence we find $b = 63551$ feet; which gives us this formula for any altitude a in general, viz. $a = 63551 \times$ log of $\frac{D}{d}$, or $a = 63551 \times$ log. of $\frac{M}{m}$ feet, or $10592 \times$ log. of $\frac{M}{m}$ fathoms; where M denotes the column of mercury in the tube at the lower place, and m that at the upper. This formula is adapted to the mean temperature of the air 55°: but it has been found, by the experiments of sir Geo. Shuckburgh and general Roy, that for every degree of the thermometer, different from 55°, the altitude a will vary by its 435th part; hence, if we would change the factor b from 10592 to 10000, because the difference 592 is the 18th part of the whole factor 10592, and because 18 is the 24th part of 435; therefore the change of temperature, answering to the change of the factor b, is 24°; which reduces the 55° to 31°. So that, $a = 10000 \times$ log. of $\frac{M}{m}$ fathoms, is the easiest expression for the altitude, and answers to the temperature of 31°, or very nearly the freezing point: and for every degree above that, the result must be increased by so many times its 435th part, and diminished when below it.

From this theorem it follows, that, at the height of 3½ miles, the density of the atmosphere is nearly twice rarer than it is at the surface of the earth; at the height of 7 miles, 4 times rarer; and so on, according to the following table:

Height in miles.	Number of times rarer.
3½	2
7	4
14	16
21	64
28	256
35	1024
42	4096
49	16384
56	65536
63	262144
70	1048576

And, by pursuing the calculations in this table, it might be easily shewn, that a cubic inch of the air we breathe would be so much rarefied at the height of 500 miles, that it would fill a sphere equal in diameter to the orbit of Saturn.

ATOM, in philosophy, a particle of matter, so minute as to admit of no division.

ATONIA, or ATONY, in medicine, a word that signifies want of firmness, or strength, in the muscular fibre. This condition takes place in most forms of chronic diseases, and in the convalescent period of acute diseases.

ATONICS, in grammar, words not accented.

ATRA BILIS, the black bile, one of the humours of the antient physicians; which the moderns call melancholy. See MEDICINE.

ATRACTYLIS, in botany, a genus of the syngenesia polygamia class of plants. The corolla is radiated; and each of the little corollæ of the radius has 2 teeth. There are 8 species.

1. Atractylis cancellata, or small cnicus, is an annual plant, rising about eight or nine inches high, with a slender stem; at the top of the branches are sent out two or three slender stalks, each terminated by a head of flowers, like those of the thistle, and of a purplish colour.

2. Atractylis gummifera, or prickly gum-bearing cnicus, known among physicians by the name of carline thistle, is a perennial plant. It has many florets inclosed in a prickly empalement. Those on the border are white; but such as compose the disk, are of a yellowish colour. It flowers in July, but never perfects seeds in Britain. Its roots were formerly used as a warm diaphoretic and alexipharmic; but the present practice has entirely rejected them.

3. Atractylis humilis, or purple prickly cnicus, rises about a foot high, with purple flowers. All these plants are natives of the warm parts of Europe; as Spain, Sicily, and the Archipelago islands.

ATRAGENE, in botany: a genus of the polyandria order, and polygamia class of plants. The calyx has four leaves; the petals are twelve; and the seeds are caudated. There are five species, all natives of the East.

ATRAPHAXES, in botany, a genus of the digynia order and hexandria class of plants; and in the natural method ranking under the 12th order, holoracæ. The calyx has two leaves; the petals are two, and sinuated; and there is but one seed. There are two species, both natives of warm countries.

ATRESIA, the state of persons who want some natural aperture.

ATRETI, persons in whom the anus, vagina, urethra, &c. are imperforate, whether naturally or occasioned by disease.

ATRIPLEX, ORACH, or ARRACH: a genus of the monœcia order, and polygamia class; and, in the natural method, ranking under the twelfth order, holoracæ. The calyx of the hermaphrodite flower is five-parted; there is no corolla; the stamina are five, and the stylus is bifid; the seed is one, and depressed. There are 14 species, of which the following are the most remarkable.

1. Atriplex halimus, the broad-leaved orach, was formerly cultivated in gardens as a shrub, by some formed into hedges, and constantly sheared to keep them thick; but this is a purpose to which it is by no means adapted, as the shoots grow so numerous, that it is impossible to keep the hedge in any tolerable order; and, what is worse, in severe winters, the plants are often destroyed.

2. Atriplex hortensis, the garden orach, was formerly cultivated in gardens, and used as a substitute for spinach; to which it is still preferred by some, though in general it is disliked by the English. There are three or four varieties of this plant, whose only difference is their colour; one is a deep green, another a dark purple, and a third has green leaves and purple borders. They are all annual, and must be propagated by seeds.

3. Atriplex petulacoides, the shrubby sea orach, grows wild by the sea-side, in many places of Britain. It may have a place in gardens among other low shrubs, where it will make a pretty diversity. This species requires little culture. It thrives in a poor gravelly soil, and may be propagated from cuttings.

ATROPA, DEADLY NIGHT-SHADE: a genus of the monogynia order, and pentandria class of plants; and in the natural method, ranking under the 25th order, luridæ. The corolla is campanulated; the stamina are distant; the berry is globular, and consists of two cells. There are eight species; of which the following are the most remarkable.

1. Atropa belladonna grows wild in many parts of Britain. It has a perennial root, which sends out strong herbaceous stalks of a purplish colour. These rise to the height of four or five feet, garnished with entire oblong leaves, which towards autumn change to a purple. The flowers are large, and come out singly between the leaves, upon long foot stalks; bell-shaped, and of a dusky colour on the outside, but purplish within. After the flower is past, the germen turns to a round berry, a little flatted at the top, about the size of a cherry. It is first green; but when ripe, turns to a shining black, sits close upon the empalement, and contains a purple juice of a nauseous sweet taste, and full of small kidney-shaped seeds. This species, being remarkable for its poisonous qualities, is very seldom admitted into gardens. Mr. Ray gives an account of the symptoms that follow the taking of it inwardly, by what happened to a mendicant friar, upon his drinking a glass of mallow wine, in which the herb was infused. In a short time, he became delirious, and soon after was seized with a grinning laughter; then with several irregular motions, and at last, with a real madness, and such a stupidity as those have who are sottishly drunk; but after all, he was cured by a draught of vinegar. Buchanan also gives an account of the destruction of the Danes under Sueno, when they invaded Scotland, by mixing a quantity of the belladonna berries with the drink which the Scots were, according to a treaty of truce, to supply them with. This so intoxicated the Danes, that the Scots fell upon them in their sleep, and killed the greatest part of them, so that there were scarcely men enough left to carry off their king. There have also been many instances in Britain, of children being killed by eating the berries of the belladonna. When an accident of this kind is discovered in time, a glass of warm vinegar will prevent the bad effects.

2. Atropa frutescens, is a native of Spain, and rises with a shrubby stem to the height of six or eight feet. The flowers come out between the leaves, on short foot-stalks, shaped like those of the former, but much less; of a dirty yellowish colour, with a few brown stripes; but these are never succeeded by berries in Britain.

3. Atropa herbacea, is a native of Campeachy, and has an herbaceous stalk, rising about two feet. The flowers come out from between the leaves, on short foot-stalks; they are white, and shaped like those of the common sort, but smaller. It flowers in July and August, but seldom ripens its fruit in Britain.

4. Atropa mandragora, the mandrake, has been distinguished into the male and female. The male mandrake has a very large, long, and thick root: it is largest at the top or head, and thence gradually grows smaller. Sometimes it is single and undivided to the bottom; but more frequently, it is divided into two or more parts. When only parted into two, it is pretended that it resembles the body and thighs of a man. From this root arise a number of very long leaves, broadest in the middle, and obtusely pointed at the end; they are a foot or more in length, and about five inches in breadth; of a dusky and disagreeable green colour, and of a very fetid smell. The female mandrake perfectly resembles the other in its growth; but the leaves are longer and narrower, and of a darker colour, as are also the seeds and roots. It grows naturally in Spain, Portugal, Italy, and the Levant. These three last species are propagated by seeds, and placed in stoves. This plant has been absurdly recommended as a cure for barrenness. Its fresh root is a violent purge, the dose being from ten to twenty grains in substance, and from half a dram to a dram in infusion. It is also narcotic. It has been found of service in hysteric complaints, but must be used with great caution.

ATROPHY, in medicine, a disease, wherein the body or some of its parts do not receive the necessary nutriment, but waste and decay incessantly. This is a disorder proceeding from the whole habit of the body, and not from any distemper of the intestines: it is attended with no remarkable fever, and is natural in old age, which is called atrophia senilis. See MEDICINE.

ATTACHMENT, in law, the taking or by virtue of a writ apprehending of a person, or precept.

It is distinguished from an arrest in this respect; that whereas an arrest lies only on the body of a man, an attachment is often on the goods only, and sometimes on the body and goods; there is this farther difference, that an arrest proceeds out of an inferior court by precept only, and an attachment out of a higher court, either by precept or writ.

An attachment by writ differs from distress, insomuch that attachment does not extend to lands, as a distress does; and a distress does not touch the body, as an attachment does.

In the common acceptation, an attachment is the apprehension of a man's body, to bring him to answer the action of the plaintiff.

ATTACHMENT *out of the chancery*, is obtained upon an affidavit made, that the defendant was served with a subpœna, and made no appearance; or it issues upon not performing some order or decree. Upon the return of this attachment by the sheriff, quod non est inventus in balliva sua, another attachment, with a proclamation, issues; and if he appears not thereupon, a commission of rebellion.

ATTACHMENT *of the forest*, is one of the three courts held in the forest. The lowest court is called the court of attachment, or wood-mote court; the mean, swan-mote; and the highest, the justice in eyre's seat.

This attachment is by three means; by goods and chattels, by body, pledges, and mainprize, or the body only. This court is held every forty days throughout the year, whence it is called forty-days court.

ATTACHMENT *of privilege*, is by virtue of a man's privilege to call another to that court whereto he himself belongs, and in respect whereof he is privileged to answer some action.

Foreign ATTACHMENT, is an attachment of money or goods, found within a liberty or city, to satisfy some creditor within such liberty or city.

By the custom of London, and several other places, a man can attach money or goods in the hands of a stranger, to satisfy himself.

ATTACK, in the military art, is an effort made to force a post, break a body of troops, &c.

ATTACK *of a siege*, is a furious assault made by the besiegers with trenches, covers, mines, &c. in order to make themselves masters of a fortress, by storming one of its sides. If there are two or three attacks made at the same time, there should be a communication betwixt them.

ATTACKS, *false*, are never carried on with

that vigour and briskness that the other is; the design of them being to favour the true attack, by amusing the enemy, obliging the garrison to a greater duty in dividing their forces, that the true attack may be more successful.

ATTACK *in flank*, is to attack both sides of the bastion.

ATTAINDER, in law, is when a man has committed felony or treason, and sentence is passed upon him for the same. The children of a person attainted of treason, are, thereby, rendered incapable of being heirs to him, or to any other ancestor; and if he was noble before, his posterity are degraded, and made base: nor can this corruption of blood be salved, but by an act of parliament, unless the sentence is reversed by a writ of error.

ATTAINDER, *bill of*, a bill brought into parliament for attainting, condemning, and executing, a person for high-treason. A most unconstitutional proceeding.

ATTAINT, in law, attincta, a writ which lies against a jury that have given a false verdict in any court of record, in a real or personal action, where the debt or damages amount to above 40 shillings.

If the verdict is found false, the judgment by common law was, that the jurors' meadows should be ploughed up, their houses broken down, their woods grubbed up, all their lands and tenements forfeited, &c. but by statute the severity of the common law is mitigated, where a petty jury is attainted, and there is a pecuniary penalty appointed.

But if the verdict be affirmed, such plaintiff shall be imprisoned and fined.

ATTELABUS, a genus of coleopterous insects (or beetle-kind), distinguished by having the head inclined, and pointed behind; antennæ moniliform, and thickest near the end. The larva of the attalabi attack the leaves, flowers, the fruits, and even the stalks and roots of different plants: but most of the species, of which there are 34, penetrate into the plant, and subsist entirely on the spongy parts within. Preparatory to the pupa state, some species spin a silky web, and others form a little ball of a very solid kind, in which they remain during a second state. The perfect insects inhabit the same plants as the larva, but are deemed less injurious to them. For the character, see Plate. The most remarkable species are:

1. Attelabus apiarius, is bluish, with red elytra, and three black belts. It is a native of Germany.

2. Attelabus avellana, is black; with the breast, feet, and elytra, red.

3. Attelabus betula has springy, legs, and the whole body is of a dark red. It frequents the leaves of the birch.

4. Attelabus buprestoides, is of a dark colour, with a globular breast, and nervous elytra. It is a native of Europe.

5. Attelabus ceramboides is of a blackish red colour, and the elytra is furrowed. It frequents the spongy boletus, a species of mushroom.

6. Attelabus coryli, is black, with red elytra, or crustaceous wings.

7. Attelabus curculionoides, is black, with red elytra and breast. These two last species and the Avellana frequent the leaves of the hazel and filbert nut-trees.

8. Attelabus formicarius, is black, with a red elytra, and a double white belt towards the base. It is a native of Europe.

9. Attelabus melanurus, is black, with testaceous elytra, black at the apex. It is a native of Sweden.

10. Attelabus mollis is hairy and yellowish, with pale elytra, and three belts. It is a native of Europe.

11. Attelabus Pennsylvanicus is black, with red elytra, a black belt round the middle, and another towards the apex of the elytra. It is a native of Philadelphia.

12. Attelabus sipylus, is green, with a hairy breast, and a double yellow belt upon the elytra.

13. Attelabus Surinamensis, has a double indentation (or two teeth) in the top of the elytra. It is a native of Surinam.

ATTENTION, in regard of hearing, is the stretching the membrana tympani, to make it more susceptible of sounds, or adjusting the tension of that membrane to the proper key or tone of the sound.

According to lord Bacon, "sounds are meliorated by the intension of the sense, where the common sense is collected most to the particular sense of hearing, and the sight suspended. Therefore sounds are sweeter and more powerful in the night than in the day, and I suppose they are sweeter to blind men than to others; and it is manifest, that between sleeping and waking, when all the senses are blind and suspended, music is far sweeter than when one is fully waken."

ATTENUANTS, in pharmacy, medicines which resolve the viscosity of the humours in the human body; promoting their circulation, as well as the discharge of all noxious and excrementitious matter.

When these medicines act upon fluids lodged in the capillary vessels, they get the appellation of aperitives, or aperients; as they do that of expectorants, when they promote a discharge of the viscid humours in the lungs.

ATTIC, in architecture, a sort of building wherein the roof or covering is not to be seen; thus named, because the buildings at Athens were generally of this form.

ATTIC ORDER, a small order raised upon a large one, by way of crowning, or to finish the building: or it is, according to some, a kind of rich pedestal, sometimes used for the conveniency of having a wardrobe, or the like; and instead of columns, has only pilasters of a particular form, and sometimes no pilasters at all.

The name attic is also given to a whole story into which this order enters; this little order being always found over another greater one.

ATTIC *base*, a peculiar kind of base used by the antient architects in the Ionic order; and by Palladio, and some others, in the Doric. This is the most beautiful of all bases. See ARCHITECTURE.

ATTIRE, in hunting, signifies the head and horns of a deer.

ATTITUDE, in painting, &c. the posture or disposition of a figure, expressive of a designed action or end.

ATTOLENS, in anatomy, an appellation given to several muscles, otherwise called levators and elevators. See ANATOMY.

ATTORNATO FACIENDO, &c. a writ commanding a sheriff or steward to admit an attorney to appear for a person who owes suit to the county court, court baron, &c.

ATTORNEY, at law, one who is retained to prosecute, or defend, a law-suit.

Attorneys, being properly those who sue out writs or process, or commence, carry on, and defend actions, in any of the courts of common law, are distinguished from solicitors, as the latter do the same business in the courts of equity; and none are admitted, either as an attorney or solicitor, unless they have served a clerkship of five years, been enrolled, and taken the oath in that case provided; and the judges of their respective courts are required to examine their several capacities.

By 34 Geo. III. c. 14. a stamp duty of 100*l.* is charged upon all articles of clerkship to an attorney or solicitor. Also, every attorney, solicitor, notary, proctor, or agent, within the bills ofmortality, shall annuallytake out a certificate, charged with a stamp duty of 5*l.* and of 3*l.* in any part of the kingdom.

Attorneys may be punished for ill practices; and if an attorney, or his clerks, of which he must have but two at one time articled, do any thing against the express rules of the court, he or they may be committed.

Neither a plaintiff nor defendant may change his attorney without rule of court, whilst the suit is depending: and attorneys are not generally obliged to deliver up the writings in their hands, till their fees are satisfied: likewise, an action does not lie against an attorney, for what he advises in the way of his profession; yet if an attorney plead any plea, or appear, without warrant from his client, action of the case lies against him.

Attorneys have the privilege to sue and be sued in the courts of Westminster, where they practise; and they shall not be chosen into offices against their will, except the militia.

ATTORNEY, of the duchy of Lancaster is the second officer in that court.

ATTORNEY-GENERAL, is a great officer under the king, created by letters patent, whose office it is to exhibit informations, and prosecute for the crown in criminal causes; and to file bills in the exchequer, for any thing concerning the king in inheritance or profits. To him come warrants for making of grants, pardons, &c. his salary from the crown is 1000*l.* per annum.

ATTOURNMENT, or ATTORNMENT, in law, a transfer from one lord to another, of the homage and service a tenant makes; or that acknowledgment of duty to a new lord.

ATTRACTION, a general term to denote the principle by which all bodies mutually tend towards each other, without regarding the cause that produces the effect.

It has been found by experience, that all matter, of whatever kind, is subject to certain general laws, and the principal of these are attraction and repulsion. Five different kinds of attraction have been enumerated by modern philosophers. 1. The attraction of cohesion; 2. Of combination, or, as it is called by chemists, elective attraction; 3. Gravity; 4. The magnetic attraction; and, 5. The attraction of electricity. Whether the same principle acts in all these cases, or whether each of these effects depends upon a dis-

tinct cause, human sagacity has not been able to discover.

1. The attraction of cohesion may be observed in almost all the common operations of nature, and is exemplified by variety of easy experiments. Two leaden balls, having each a smooth surface, if strongly compressed together, will cohere almost as strongly as if united by fusion; and even two plates of glass, if the surfaces are even and dry, will require some force to separate them. By the same law of nature the particles of even fluid bodies, in which the attraction is necessarily weaker than in solid substances, indicate a disposition to unite.

The drops of dew that appear in the morning on the leaves of plants assume a globular form, from the mutual attraction between the particles of water. Small portions of quicksilver, when brought near to each other, will run together, and assume the same globular appearance. Also, by the same law, a vessel may be filled with water, mercury, or any other fluid, above the brim, and the fluid will be observed to rise in a convex form.

To this principle we may very properly refer what is termed capillary attraction. Thus,if a fluid is contained in a vessel not full to the brim, it will always be attracted to the edges of the vessel, and will assume a concave form. Thus, also, if two plates of glass, at a small distance from each other, are immersed perpendicularly in water, the fluid will rise above its level between the two plates, and the height to which it rises will bear a certain proportion to the distance of the plates, A capillary tube is a tube with an exceeding small bore, and by the same law which raises the water between the plates of glass, a fluid will rise to a considerable height in one of these tubes. Both these experiments will answer equally well in the vacuum of an air-pump, which proves that the effect is not owing to the pressure of the air. In the same manner also, and by the same law, fluids will ascend in the cavity of a sponge, in the interstices of linen cloth, or any porous body.

2. The attraction of combination, or chemical or elective attraction, is in many respects analogous to the attraction of cohesion. Like the latter, it seems to depend on the minute particles of bodies being brought nearly into contact with each other; and indeed so nearly alike are the effects of these two species of attraction, that if they are different in principle, it is difficult to say which is the most essential to the cohesion and solidity of bodies. Chemical attraction may probably be no other than the attraction of cohesion acting in a free and unresisting medium, since its only distinguishing characteristic is the disposition which bodies in solution indicate to unite with certain substances in preference to others. To make this clear by an experiment: If silver is added to a quantity of aqua fortis, the cohesion of the particles of silver will be destroyed, and they will unite forcibly with those of the aqua fortis. The fluid will however, remain perfectly clear; the particles being so extremely minute, that the rays of light will suffer no interruption in passing through them. If however to this solution of silver a quantity of mercury or quicksilver is added, the aqua fortis will be attracted by the mercury, and the silver will be precipitated, or thrown to the bottom of the vessel in which the fluid is contained; if, again copper is added, it will assume the place of the quicksilver; and if to this solution of copper a bright piece of iron is introduced, the acid will immediately quit the copper, and seize upon the iron, a quantity of which being dissolved in the fluid, and the copper will be deposited in its place on the surface of the bar of iron. The iron may afterwards be displaced by the addition of an alkali. This species of attraction is called combination; because the particles of two bodies by those means become so intimately united or combined, that they cannot be separated but by the addition of a third body, which has a greater attraction for one of the component bodies than they have for one another, and it is called elective attraction and affinity, from the superior tendency in substances to unite with certain bodies in preference to others. In all cases of elective attraction it is necessary, that at least one of the bodies should be in a fluid state.

3. The attraction of gravitation materially differs from the two preceding species of attraction, since it requires neither the particles of the bodies, nor the bodies themselves, to be brought into immediate contact, but acts at considerable distances, and in this respect it is analogous to the attraction of magnetism and electricity.

The most obvious effect of gravitation is the general tendency of bodies to the surface, or perhaps to the centre, of the earth. It appears to be one of the great laws of gravitation, that the attraction of bodies is in proportion to the quantity of matter they contain. The earth, therefore, being such an immense aggregate of matter, is supposed to destroy the effect of this attraction between smaller bodies, by forcibly compelling them to itself. The attraction of mountains, however, upon the balls of pendulums, has been found, by repeated observations, to be very considerable.

The efficient cause of this species of attraction is as much a secret as all the other great principles of nature. But first, it appears, that the gravitating force being proportioned always to the quantity of matter, all bodies gravitate from equal distances with equal velocity, except prevented or impeded by some resisting medium. Thus, though a guinea and a feather will not fall to the ground with equal velocity in the open air, because of the resistance of that fluid, yet if the air by any means is removed, as in the vacuum of an air-pump, they appear to fall at the very same instant of time: for though the guinea contains considerably more of solid matter than the feather, and consequently requires a more considerable force to put it in motion, yet it appears that the attractive power being proportioned to the quantity of matter, its velocity is equal to that of a body which requires less force to put it in motion.

Secondly, The attractive force of bodies is reciprocally as the square of the distances. Thus, if a body is of the weight of one hundred pounds at the distance of ten diameters of the earth, at half that distance it would have four times that weight, or the force of gravity would be exerted upon it in a quadruple ratio, and so in proportion as it approaches the body of the earth.

4. The attraction of magnetism only differs from that of gravity in its operations being limited to particular substances. The magnet is an ore of iron, and its property of attracting certain portions of that metal at moderate distances is well known. Like the attraction of gravitation, that of magnetism bears a proportion to the distance, and probably to the quantity of magnetic matter in the attracting bodies. But the properties of the magnet are so curious and important in nature, that they well deserve a distinct consideration.

5. The attraction of electricity is also analogous to that of gravity in the property of acting upon bodies at a certain distance; but it differs from it in its operation being confined to a particular state of those bodies, that is, when excited by friction.

ATTRACTION of mountains. See MOUNTAINS.

AVADOUTAS, a sect of Indian bramins, distinguished for their austerity and abstinence.

AVAIL of marriage, in Scotch law, denotes a custom, by which the superior was entitled to a certain sum from his vassal, upon his attaining the age of puberty.

AVALANCHES, a name given in Switzerland and Savoy, to those prodigious masses of snow, which are precipitated with a noise like thunder from the mountains, destroying every thing in their course. They have sometimes overwhelmed whole villages. The best preservative against their effects being the forests with which the Alps abound, there is scarcely a village situated at the foot of a mountain, that is not sheltered by trees, which the people preserve with uncommon reverence. Thus what constitutes one of the principal beauties of the country, affords security also to the inhabitants.

AVANIA, in Turkish customs, a fine for crimes and on deaths, paid to the governor of the place. In cities and towns where several nations live together under a Turkish governor, he takes this profitable method of punishing all crimes among the Christians or Jews, unless it be the murder of a Turk.

AVAST, in the sea language, a term requiring to stop, to hold, or to stay.

AVANTURINE, in natural history, a yellowish stone full of sparkles, resembling gold, very common in France. An artificial imitation of it is made by mixing sparkles of copper with glass whilst it is in fusion, which is used by enamellers, and to sprinkle, as sand, upon writing.

AUBANE, in the old customs of France, a right vested in the sovereign of being heir to a foreigner that died within his dominions. By this right the French sovereign claimed the inheritance of all foreigners that died within his dominions, notwithstanding any testament the deceased could make.

AUBIN, in horsemanship, a broken kind of gait between an amble and a gallop, accounted a defect.

AUBLETIA, in botany, a genus of the class and order polyandria monogynia. The essential character is; cal. five-leaved; cor. five-petalled; caps. many-celled, echinate, with many seeds in each cell. There are

three species, all trees, and natives of South America.

AUCTION, sales by auction are subject to many legal regulations: the auctioneer is obliged to take out a licence; and is subject to various penalties if he is negligent of certain acts of parliament, made principally since the 19th of the present reign.

AUCUBA, in botany, a genus of the monoecia tetandria class and order. The essential character is: male cal. 4-toothed; cor. 4-petalled; berry 1-seeded: fem. nect. none; nut one-celled.

There is but one species of this beautiful tree, the specific name of which is Japonica, to note its native place. Notwithstanding this, it is found to be very hardy; and being easily propagated by cuttings, it is now become very common in our gardens, though it does not seem with us as yet to attain a growth beyond that of a shrub. The leaves are beautifully spotted with white or yellow, and among other shrubs it makes a fine appearance.

AUDIENDO ET TERMINANDO, a commission directed to certain persons when any riotous assembly, insurrection, &c. is committed in any place, for appeasing it, and punishing the offenders.

AUDIENTES, an order of catechumens in the primitive Christian church, consisting of such as were but newly instructed in the mysteries of the Christian religion, and not yet admitted to baptism.

AUDITA QUERELA, a writ that lies where any person has any thing to plead, but has not a day in court for pleading it; or where judgment is given for debt, and the defendant's body in execution; then if he has a release, or other sufficient cause to be discharged therefrom, but wants a day in court to plead the same, this writ may be granted by the lord-chancellor, upon view of the exception suggested to the judges of either bench.

AUDITOR *of the receipts*, is an officer of the exchequer who files the tellers' bills, makes an entry of them, and gives the lord treasurer a certificate of the money received the week before. He also makes debentures to every teller, before they receive any money, and takes their accounts. He keeps the black book of receipts, and the treasurer's key of the treasury, and sees every teller's money locked up in the new treasury.

AUDITORY *nerves*, in anatomy, a pair of nerves arising from the medulla oblongata, with two trunks, the one of which is called the portio dura, hard portion, the other portio mollis, or soft portion. See ANATOMY.

AVELLANE, in heraldry, a cross, the quarters of which somewhat resemble a filbert-nut.

AVENA, OATS, a genus of the digynia order, belonging to the triandria class of plants, and in the natural method ranking under the 4th order, gramina. The calyx has a double valve, and the awn on the back is contorted. There are 25 species, of which the first six following are natives of England.

1. Avena flatior, tall oat grass.
2. Avena fatua, the bearded oat grass.
3. Avena flavescens, the yellow oat grass.
4. Avena nuda, the naked oat.
5. Avena pratensis, the meadow oat grass.
6. Avena pubescens, the rough oat grass.
7. Avena sativa, the common oats cultivated in our fields. It is remarkable that the original native place of this plant is almost totally unknown. Anson says that he observed it growing wild or spontaneously in the island of Juan Fernandez; but a vague observation from a single author is not to be depended on. Oats are an article of the materia medica. Gruels made from them have a kind of soft mucilaginous quality, by which they obtund acrimonious humours, and prove useful in inflammatory diseases, coughs, hoarseness, and exulcerations of the fauces.

AVENAGE, in law, a certain quantity of oats paid by a tenant to a landlord instead of rent, or some other duties.

AVERAGE, in commerce, is divided into three kinds. 1. The simple or particular average, which consists in the extraordinary expences incurred for the ship alone, or for the merchandizes alone. Such is the loss of anchors, masts, and rigging, occasioned by the common accidents at sea, the damages which happen to merchandize by storm, prize, shipwreck, wet, or rotting; all which must be borne and paid by the thing which suffered the damage. 2. The large and common average, being those expences incurred, and damages sustained, for the common good and security both of the merchandizes and vessels, consequently to be borne by the ship and cargo, and to be regulated upon the whole. Of this number are the goods or money given for the ransom of the ship and cargo, things thrown overboard for the safety of the ship, the expences of unlading for entering into a river or harbour, and the provisions and hire of the sailors when the ship is put under an embargo. 3. The small averages, which are the expences for towing and piloting the ship out of or into harbours, creeks, or rivers, one-third of which must be charged to the ship, and two-thirds to the cargo.

AVERAGE, in agriculture, a term used by farmers, in many parts of England, for the stubble, or remainder of straw and grass left in corn-fields after the harvest is carried in. In some counties it is called gratten.

AVERIA, in a general sense, signifies any cattle, but it is used in law for oxen or horses of the plough.

AVERIA, in commerce, a branch of Spanish revenue that denotes a tax paid on account of convoys to guard the ships sailing to and from America, which was first imposed when sir Francis Drake made his expedition to the South Sea.

AVERMENT, an offer of the defendant to make good an exemption pleaded in abatement, or bar of the plaintiff's action.

AVERMENT, *general*, is the conclusion of every plea to the writ, or in bar of replications, or other pleadings, containing matter affirmative.

AVERMENT, *particular*, is when the life of a tenant for life, or tenant in tail, is averred.

AVERRHOA, in botany, a genus of the decandria order, belonging to the pentagynia class of plants, and in the natural method ranking under the 14th order, gruinales. The calyx has five leaves; the petals are five, opening at top; and the apple or fruit is pentagonous, and divided into five cells. There are two species:

The averrhoa carambola, called in Bengal the camrue or camrunga, is a tree which grows to the height of 14 feet, and is remarkable for possessing a power somewhat similar to those species of mimosa which are termed sensitive plants; its leaves, on being touched, moving very perceptibly. In the mimosa the moving faculty extends to the branches; but from the hardness of the wood this cannot be expected in the carambola. The leaves are alternately pinnated with an odd one; and their most common position in the day-time is horizontal. On being touched, they move themselves downward, frequently in so great a degree that the two opposite almost touch one another by their under sides, and the young ones sometimes either come into contact, or even pass each other. The whole of the leaves of one pinna move by striking the branch with the nail of the finger or other hard substance, or each leaf can be moved singly by making an impression that shall not extend beyond that leaf. Notwithstanding this apparent sensibility of the leaf, however, large incisions may be made in it with a pair of sharp scissars, without occasioning the smallest motion; nay, it may even be cut almost entirely off, and the remaining part still continue unmoved, when by touching the wounded leaf with the finger or point of the scissars, motion will take place as if no injury had been offered. The reason is, that although the leaf is the ostensible part which moves, the petiolus is the seat both of sense and action. After sunset the leaves go to sleep, first moving down so as to touch one another by their under sides: they therefore perform more extensive motion at night of themselves than they can be made to do in the day-time by external impressions. With a convex lens the rays of the sun may be collected on a leaf, so as to burn a hole in it, without occasioning any motion; but upon trying the experiment on the petiolus, the motion is as quick as if from strong percussion, although the rays be not so much concentrated as to cause pain when applied in the same degree on the back of the hand. The leaves move very fast from the electrical shock, even although very gentle. The fruit of this tree is said to be delicious.

AVERRUNCI, in the antient heathen theology, an order of deities among the Romans, whose peculiar office it was to avert danger and exile.

AVERSIONE *venire*, in civil law, seems to denote the selling or letting things in the lump, without fixing any particular prices for each piece.

AUGIT, *silex augites*, in mineralogy. The colour of this mineral is a deep olive or pear green: it sometimes occurs in rounded fragments, but more usually crystallized. See MINERALOGY.

AUGMENTATION was the name of a court erected 27 Hen. VIII., so called from the augmentation of the revenues of the crown, by the suppression of religious houses; and the office still remains, wherein there are many curious records, though the court has been dissolved long since.

AUGMENTATION, in heraldry, are additional charges to a court armour, frequently given as particular marks of honour.

AUGUR, an officer among the Romans appointed to foretel future events. There was a college or community of them consisting originally of three members, with respect to the three tribes, Luceres, Rham-

nenses, and Tatienses: afterwards the number was increased to nine, four of whom were patricians, and five plebians. They bore an augural staff or wand, as the ensign of their authority, and their dignity was so much respected that they were never deposed, nor any substituted in their place, though they should be convicted of the most enormous crimes.

AUGURY, in antiquity, the art of foretelling future events, is distinguished into five sorts. 1. Augury from the heavens. 2. From birds. 3. From chickens. 4. From quadrupeds. 5. From portentous events. When an augury was taken, the augur divided the heavens into four parts, and having sacrificed to the gods, he observed with great attention from what part the sign from heaven appeared. If, for instance, there happened a clap of thunder from the left, it was taken as a good omen. If a flock of birds came about a man, it was a favourable presage, but the flight of vultures was unlucky. If when corn was flung before the sacred chickens, they crowded about it, and ate it greedily, it was looked upon as a favourable omen; but if they refused to eat and drink, it was an unlucky sign.

Augury, in its more general signification, comprizes all the different kinds of divination, which Varro distinguishes into four species, according to the four elements, viz. pyromancy, or augury by fire; aeromancy, or augury by air; hydromancy, or augury by water; and geomancy, or augury by the earth.

AUGUSTALES, in Roman antiquity, an epithet given to the flamens or priests appointed to sacrifice to Augustus, after his deification, and also to the ludi or games celebrated in honour of the same prince on the fourth of the ides of October.

AUGUSTALIA, a festival instituted by the Romans in honour of Augustus Cæsar, on his return to Rome after having settled peace in Sicily, Greece, Syria, Asia, and Parthia; on which occasion they likewise built an altar to him, inscribed *Fortunæ reduci*.

AUGUSTALIS PRÆFECTUS, a title peculiar to a Roman magistrate who governed Egypt, with a power much like that of a proconsul in other provinces.

AUGUSTINS, a religious order in the church of Rome, who follow the rule of St. Augustin, prescribed them by Pope Alexander IV. Among other things, this rule enjoins to have all things in common; to receive nothing without the leave of the superior; and several other precepts relating to charity, modesty, and chastity. There are likewise nuns of this order.

The Augustins are clothed in black, and at Paris were known under the name of the religious of St. Genevieve, that abbey being the chief of the order.

AVICIENNA, in botany, a genus of plants of the tetandria monogynia class of Linnæus; the flower of which consists of a single petal, divided into four ovato-acuminated segments; the fruit is a coriaceous capsule of one cell, containing a single seed of an elliptic figure. There are three species, natives of the West Indies. The A. tomentose is a tree about 15 feet high, agreeing in many respects with the mangrove.

AVIS, bird, *aves*, among naturalists, the second class of animals, a race of creatures sufficiently distinguished from others in having the body covered with feathers, two feet, and two wings formed for flight. Birds have the mandible protracted and naked; and are destitute of external ears, lips, teeth, scrotum, womb, urinary vessel, or bladder, epiglottis, corpus callosum, or its fornix, and diaphragm. In the Linnæan system, birds are divided into six orders, viz. accipitres, or falcon kind, picæ, or pies, anseres, or geese and duck kind, grallæ, cranes or waders, gallinæ, the poultry kind, and passeres, sparrows or small birds.

Avis is also the name of an order of knighthood in Portugal, instituted by Sancho the first king, in imitation of the order of Alcantara, whose great cross they wear.

AVISANDUM, in Scots law, literally signifies advising, or under consideration. A process is said to be under avisandum, when the whole proofs, with the arguments on both sides, are under the consideration of the judge, before he has given an interlocutor or decision upon the cause.

AVISO, (*adviso*, Ital.) a term chiefly used in matters of commerce, to denote an advertisement, an advice, or a piece of intelligence.

AULIC, an epithet given to certain officers of the Germanic empire, who compose a court, which decides, without appeal, in all processes entered in it.

The aulic council is composed of a president, who is a catholic; of a vice-chancellor, presented by the archbishop of Mentz; and of eighteen counsellors, nine of whom are protestants, and nine catholics. They are considered as a bench of lawyers, and always follow the emperor's court; for which reason they are called justitium imperatoris, the emperor's justice, and aulic council. The aulic court ceases at the death of the emperor; whereas the imperial chamber of Spire is perpetual, representing not only the deceased emperor, but the whole Germanic body, which is reputed never to die.

Aulic, in the Sorbonne and foreign universities, is an act which a young divine maintains upon being admitted a doctor in divinity.

It begins by an harangue of the chancellor, addressed to the young doctor; after which he receives the cap, and presides at the aulic, or disputation.

AUME, a Dutch measure for Rhenish wine, containing forty English gallons.

AUMONE, in law, signifies a tenure where lands are given in alms to some church or religious house.

AUNCEL-WEIGHT, an antient kind of balance, now out of use, being prohibited by several statutes, on account of the many deceits practised by it. It consisted of scales hanging on hooks, fastened at each end of a beam, which a man lifted up on his hand. In many parts of England auncel-weight signifies meat sold by the hand, without scales.

AUNE, a long measure used in France to measure cloth, stuffs, ribbons, &c.

At Rouen it is equal to one English ell, at Calais to 1.52, at Lyons to 1.016, and at Paris to 0.95.

AVOCATORIA, a mandate of the emperor of Germany, addressed to some prince in order to stop his unlawful proceedings in any cause appealed to him.

AVOIDANCE in the canon law, is when a benefice becomes void of an incumbent: which happens either in fact, as by the death of the parson; or in law, as by cession, deprivation, resignation, &c. In the first of these cases, the patron must take notice of the avoidance, at his peril; but in avoidance by law, the ordinary is obliged to give notice to the patron, in order to prevent a lapse.

AVOIRDUPOIS *weight*, a kind of weight used in England, of which the pound weighs 16 ounces. The proportion of a pound avoirdupois to a pound troy, is as 17 to 14; or the avoirdupois pound contains 7000 grains, and the troy pound 5760.

All the larger and coarser commodities are weighed by avoirdupois weight; as groceries, cheese, wool, lead, hops, &c.

AVOWRY, in law, is where a person distrained sues out a replevin; for then the distrainer must avow and justify his plea, which is called his avowry. The avowry must contain sufficient matter for judgment to have return, but so much certainty is not required as in a declaration; and if made for rent, though it appears that part of that rent is not due, yet the avowry is good for the rest.

AURANTIUM, the orange-tree. See Citrus.

AURANTII *cortex*. See Pharmacy.

AUREA *Alexandrina*, in pharmacy, a kind of opiate, or antidote against the cholic and apoplexy, composed of a great number of ingredients, which was in great fame among the antient writers. It is called aurea from the gold (aurum) which is an ingredient in its composition; and Alexandrina, as having been invented by a physician named Alexander.

AURELIA. See Chrysalis.

AUREOLA, in its original signification, signifies a jewel which is proposed as a reward of victory in some public dispute. Hence the Roman schoolmen applied it to denote the reward bestowed on martyrs, virgins, and doctors, on account of their works of supererogation; and painters use it to signify the crown of glory, with which they adorn the heads of saints, confessors, &c.

AUREUS, a Roman gold coin, equal in value to twenty-five denarii.

According to Ainsworth, the aureus of the higher empire weighed near five pennyweights, and in the lower empire little more than half that weight.

AURICHALCUM. See Orichalcum.

AURICLE, in anatomy, that part of the ear which is prominent from the head, called by many authors auris externa. See the article Ear. Also the appendages of the heart at its base, which are distinguished by the names of the right and left.

AURICULA. See Primula.

AURIFLAMMA, in the French history, a standard belonging to the abbey of St. Dennis, suspended over the tomb of that saint, which the religious, on occasion of any war in defence of their lands or rights, took down with great ceremony, and gave it to their protector or advocate, to be borne at the head of their forces. Hence the word is sometimes used to denote the chief flag or standard of an army.

AURIGA, the waggoner, in astronomy, a constellation of the northern hemisphere, consisting of twenty-seven stars according to

Tycho, forty according to Hevelius, and sixty-six in the Britannic catalogue.

This is one of the forty-eight asterisms mentioned by all antient astronomers; and represented by the figure of an old man in a kind of sitting posture, with a goat and her kids in his left hand, and a bridle in his right. Besides the hœdi, this constellation includes another star, called capella; which is the bright one near the shoulder, and supposed to be the mother of the hœdi, and the nurse of Jupiter. The hœdi, or the two stars in the arm of Auriga, were regarded by the ancients as affording presages of the weather; and these were so much dreaded on account of the storms and tempests that succeeded their rising, that they are said to have shut up the navigation at this season.

AURIUM *abscissio*, in antiquity, cutting off ears, was a punishment inflicted by the Saxon law on those who robbed churches, and afterwards on every thief, and at length on other criminals.

AURORA BOREALIS, *northern light*, or *streamers*, a kind of meteor appearing in the northern part of the heavens, mostly in the winter season, and in frosty weather. It is usually of a reddish colour, inclining to yellow; and sends out frequent coruscations of pale light, which seem to rise from the horizon in a pyramidal undulating form, and shooting with great velocity up to the zenith. It appears often in form of an arch, which is partly bright and partly dark, but generally transparent: and the matter of it is not found to have any effect on the rays of light, which pass freely through it. Dr. Hamilton observes that he could plainly discern the smallest speck in the Pleiades through the density of those clouds which formed part of the aurora borealis in 1763, without the least diminution of its splendour, or increase of twinkling. Philos. Essays, p. 106.

Sometimes it produces an iris. Hence M. Godin judges that most of the extraordinary meteors and phenomena in the skies, related as prodigies by historians, as battles, and the like, may probably enough be reduced to the class of auroræ boreales. Hist. Acad. R. Scien. for 1762, p. 405.

This kind of meteor never appears near the equator; but, it seems, is as frequent towards the south pole as towards the north, having been observed there by voyagers. See Philos. Trans. No. 461, and vol. 54; also Forster's Account of his Voyage round the World with Capt. Cook, in which he describes their appearance as observed for several nights together, in sharp frosty weather; which was much the same as those seen in the north, excepting that they were of a lighter colour.

It seems that meteors of this kind have appeared at some times more frequently than at others. They were so rare in England, or else so little regarded, that none are recorded in our annals since that remarkable one of November 14, 1574, till the surprising aurora borealis of March 6, 1716, which appeared for three nights successively, but by far more strongly on the first; except that five small ones were observed in the years 1707 and 1708. Hence it would seem that the air or earth, or both, are not at all times disposed to produce this phenomenon.

The extent of these appearances is also amazingly great. That in March 1716 was visible from the west of Ireland to the confines of Russia and the east of Poland, extending at least near 30 degrees of longitude, and from about the 50th degree in latitude over almost all the north of Europe; and in all places, at the same time, it exhibited the like wondrous appearances.

Father Boscovich has determined the height of an aurora borealis, which was observed by the marquis of Polini the 16th of December, 1737, and found it was 825 miles high; and Mr. Bergman, from a mean of 30 computations, makes the average height of the aurora borealis amount to 70 Swedish, or 469 English, miles. But Euler supposes the height to be several thousands of miles; and Mairan also assigns to them a very elevated region.

In Sweden and Lapland the auroræ boreales are not only singularly beautiful, but afford travellers, by their almost constant effulgence, a very fine and brilliant light during the whole night. In Hudson's-bay, the light of the aurora borealis is said to be equal to that of a full moon: and in the north-eastern parts of Siberia, we are told, these northern lights are observed to begin with single bright pillars, rising in the north, and almost at the same time in the north-east, which, gradually increasing, comprehend a large space of the heavens, rush about from place to place with incredible velocity, and finally almost cover the whole sky up to the zenith, and produce an appearance in the heavens of a vast expanded tent, glittering with gold rubies and sapphire. A more interesting spectacle cannot be conceived; but whoever sees such a northern light for the first time could not behold it without terror. For however fine the illumination may be, it is attended, as it is said, with a hissing noise through the air, as if the largest fire-works were playing off. To describe what they then hear, the natives make use of the expression *spolochi chodjat*, that is, the raging host is passing. The hunters who pursue the foxes are frequently overtaken with these lights; and their dogs are then so much terrified, that they will not move, but lie obstinately on the ground till the noise is passed. See Phil. Trans. vol. lxxiv.

Many attempts have been made to determine the cause of this phenomenon. Dr. Halley imagines that the watery vapours or effluvia, exceedingly rarefied by subterraneous fire, and tinged with sulphureous streams, which many naturalists have supposed to be the cause of earthquakes, may also be the cause of this appearance; or that it is produced by a kind of subtile matter freely pervading the pores of the earth, and which, entering into it nearer the southern pole, passes out again with some force into the æther, at the same distance from the northern. This subtile matter, by becoming more dense, or having its velocity increased, may perhaps be capable of producing a small degree of light, after the manner of effluvia from electric bodies, which, by a strong and quick friction, emit light in the dark; to which sort of light this seems to have a great affinity. Philos. Trans. No. 347. See also Mr. Cotes's description of this phenomenon, and his method of explaining it by streams emitted from the heterogeneous and fermenting vapours of the atmosphere, in Smith's Optics, p. 69; or Philos. Trans. abr. vol. 6, part 2.

Ever since the identity of lightning and the electric matter has been determined, however, philosophers have been naturally led to seek for the explication of aerial meteors in the principles of electricity; and there is now no doubt that most of them, and especially the aurora borealis, are electrical phenomena. Besides the more obvious and known appearances which constitute a resemblance between this meteor and the electric matter by which lightning is produced, it has been observed, that the aurora occasions a very sensible fluctuation in the magnetic needle; and that when it has extended lower than usual in the atmosphere, the flashes have been attended with various sounds of rumbling and hissing, especially in Russia and the other more northern parts of Europe, as noticed by Sig. Beccaria and M. Messier. Mr. Canton, soon after he had obtained electricity from the clouds, offered a conjecture that the aurora is occasioned by the dashing of electric fire positive towards negative clouds at a great distance, through the upper part of the atmosphere, where the resistance is least: and he supposes that the aurora which happens at the time when the magnetic needle is disturbed by the heat of the earth, is the electricity of the heated air above it: and this appears chiefly in the northern regions, as the alteration in the heat of the air in those parts is the greatest. Nor is this hypothesis wholly improbable, when it is considered that electricity is the cause of thunder and lightning; that it has been extracted from the air at the time of the aurora borealis; that the inhabitants of the northern countries observe it remarkably strong when a sudden thaw succeeds very cold severe weather; and that the tourmalin is known to emit and absorb the electric fluid only by the increase or diminution of its heat. Positive and negative electricity in the air, with a proper quantity of moisture to serve as a conductor, will account for this and other meteors sometimes seen in a serene sky. Mr. Canton afterwards contrived to exhibit this meteor by means of the Torricellian vacuum, in a glass tube about three feet long, and sealed hermetically. When one end of the tube is held in the hand, and the other applied to the conductor, the whole tube will be illuminated from end to end, and will continue luminous without interruption for a considerable time after it has been removed from the conductor. If, after this, it is drawn through the hand either way, the light will be remarkably intense through the whole length of the tube. And though a great part of the electricity is discharged by this operation, it will still flash at intervals, when held only at one extremity, and kept quite still; but if, at the same time, it is grasped by the other hand in a different place, strong flashes of light will dart from one end to the other; and these will continue 24 hours or more, without a fresh excitation. Sig. Beccaria conjectures that there is a constant and regular circulation of the electric fluid from north to south; and he thinks that the aurora borealis may be this electric matter performing its circulation in such a state of the atmosphere as renders it visible, or approaching nearer than usual to the earth: though probably this is not the mode of its operation, as the meteor is observed in the southern hemisphere with the same appearances as in the northern. Dr. Franklin supposes that the electric fire discharged into the polar regions, from many

leagues of vaporised air raised from the ocean between the tropics, accounts for the aurora borealis; and that it appears first where it is first in motion, namely, in the most northern part; and the appearance proceeds southward, though the fire really moves northward. Franklin's Exper. and Obs. 1769, p. 49. Philos. Trans. vol. lviii. p. 358, 784; *Ib.* vol. li. p. 403; Lettere dell' Ellettricismo, p. 269; or Priestley's Hist. of Electricity.

Mr. Dalton, who has paid considerable attention to meteorology, gives the following account of the appearances of the aurora borealis:—They come under four different descriptions. 1. A horizontal light, like the break of day. 2. Fine slender luminous beams, well defined, and of dense light, which often continue nearly a minute at rest. 3. Flashes pointing upwards, or in the direction of the beams which they succeed. These are only momentary, and have no lateral motion. They appear broad and diffuse, and of a weaker light than the beams; they grow gradually fainter till they disappear, and continue for hours flashing at intervals. 4. Arcs nearly in the form of a rainbow: these when complete go quite across the heavens, from one point of the horizon to the opposite point. These appearances generally succeed each other in the following order: 1, the faint rainbow-like arcs; 2, the beams; and, 3, the flashes. The northern horizontal light appears to consist of an abundance of flashes or beams blended together by the situation of the observer. The beams of the aurora appear at all places to be arcs of great circles of the sphere, with the eye in the centre; and these arcs, if prolonged upwards, would all meet in a point. The rainbow-like arcs cross the magnetic meridian at right angles. When two or more appear at once, they are concentric, and tend to the east and west: also the broad arc of the horizontal light tends to the magnetic east and west, and is bisected by the magnetic meridian; and when the aurora extends over any part of the hemisphere, the line separating the illuminated part of the hemisphere from the clear part is half the circumference of a great circle crossing the magnetic meridian at right angles, and terminating in the east and west. That point in the heavens to which the beams of the aurora appear to converge, at any place, is the same as that to which the south pole of the dipping needle points at that place. The beams appear to rise above each other in succession; so that of any two beams, that which has the higher base has also the higher summit. Every beam appears broadest at or near the base, and to grow narrower as it ascends; so that the continuation of the bounding lines would meet in the common centre to which the beam tends. The height of the rainbow-like arcs of the aurora borealis is estimated by Mr. Dalton to be 150 miles above the earth's surface.

AURUM, gold. Gold seems to have been known from the very beginning of the world. Its properties and its scarcity have rendered it more valuable than any other metal.

It is of an orange red or reddish yellow colour, and has no perceptible taste or smell. Its lustre is considerable, yielding only to that of platinum, steel, silver, and mercury. Its specific gravity 19.3. No other substance is equal to it in ductility and malleability. It may be beaten out into leaves so thin that one grain of gold will cover 56¾ square inches. These leaves are only 1-282000th of an inch thick, but the gold leaf with which silver wire is covered has only 1-12th of that thickness. An ounce of gold, upon silver wire, is capable of being extended more than 1300 miles in length. Its tenacity is considerable, though in this respect it yields to iron, copper, platinum, and silver. From the experiments of Sickingen it appears that a gold wire 0.078 inch in diameter is capable of supporting a weight of 150.07 lbs. avoirdupois, without breaking. It melts at 32° of Wedgewood's pyrometer. When melted, it assumes a bright bluish green colour. It expands in the act of fusion, and consequently contracts while becoming solid more than most metals; a circumstance which renders it less proper for casting into moulds. It requires a very violent heat to volatilize it; it is, therefore, to use a chemical term, exceedingly *fixed*. Boyle and Kunkel kept it for some months in a glass-house furnace, and yet it underwent no change; nor did it lose any perceptible weight, after being exposed for some hours to the utmost heat of Mr. Parker's lens. Homberg, however, observed, that when a very small portion of gold is kept in fusion, part of it is volatilized. This observation was confirmed by Macquer; who observed the metal rising in fumes to the height of five or six inches, and attaching itself to a plate of silver, which it gilded very accurately; and Mr. Lavoisier observed the very same thing when a piece of silver was held over gold melted by fire blown by oxygen gas, which produces a much greater heat than common air. After fusion, it is capable of assuming a crystalline form.

Gold is not in the least altered by being kept exposed to the air; it does not even lose its lustre; neither has water the smallest action upon it. It is capable, however, of combining with oxygen, and even of undergoing combustion in particular circumstances. The resulting compound is an oxide of gold. There are two oxides of gold; the protoxides is of a purple or violet, the peroxide of a yellow colour.

Gold must be raised to a very high temperature before it is capable of abstracting oxygen from common air. It may be kept red hot almost any length of time without any such change. Homberg, however, observed, that when placed in the focus of Tschirnhausen's burning glass, its surface became covered with a purple-coloured oxide; and the truth of his observations were put beyond doubt by the subsequent experiments of Macquer with a still more powerful burning glass. It was remarked also in 1773 by Camus, that when the electric explosion is transmitted through gold leaf placed between two plates of glass, or when a strong charge is made to fall on a gilded surface—in both cases the metal is oxidized, and assumes a purple colour. The reality of the oxidizement of gold by electricity was disputed by some philosophers, but it has been put beyond the reach of doubt by the experiments of Van Marum. When that celebrated philosopher made electric sparks from the powerful Teylerian machine pass through a gold wire suspended in the air, it took fire, burnt with a green-coloured flame, and was completely dissipated in fume, which when collected proved to be a purple-coloured oxide of gold. This combustion, according to Van Marum, succeeded not only in common air, but also when the wire was suspended in hydrogen gas and other gases which are not capable of supporting combustion. These singular observations would require to be verified by other experiments before any conclusion can be drawn from them. The combustion of gold is now easily effected by exposing gold-leaf to the action of the galvanic pile. It has been made to burn with great brilliancy by exposing a gold wire to the action of a stream of oxygen and hydrogen gas mixed together and burning. In all cases of the combustion of gold, it has been ascertained, that the protoxide or purple-coloured oxide only is formed. The peroxide, or yellow-coloured oxide, may be procured in the following manner: Equal parts of nitric and muriatic acids are mixed together, and poured upon gold; an effervescence takes place, the gold is gradually dissolved, and the liquid assumes a yellow colour. It is easy to see in what manner this solution is produced. No metal is soluble in acids till it has been reduced to the state of an oxide. There is a strong affinity between the oxide of gold and muriatic acid. The nitric acid furnishes oxygen to the gold, and the muriatic dissolves the oxide as it forms. When nitric acid is deprived of the greater part of its oxygen, it assumes a gaseous form, and is then called nitrous gas, or more properly nitric oxide gas. It is the emission of this gas which causes the effervescence. The oxide of gold may be precipitated from the nitro-muriatic acid, by pouring in a little potash dissolved in water, or, which is much better, a little lime; both of which have a stronger affinity for muriatic acid than the oxide has.

The oxides of gold may be decomposed in close vessels by the application of heat. The gold remains fixed, and the oxygen assumes the gaseous form. They may be decomposed, too, by all the substances which have a stronger affinity for oxygen than gold has.

Hitherto gold has not been found capable of combining with sulphur, carbon, or hydrogen. M. Pelletier combined it with phosphorus, by melting together in a crucible half an ounce of gold and an ounce of phosphoric glass, surrounded with charcoal. The phosphuret of gold thus produced was brittle, whiter than gold, and had a crystallized appearance. It was composed of 23 parts of gold and one of phosphorus. He formed the same compound by dropping small pieces of phosphorus into gold in fusion. Phosphorus, then, is the only one of the simple combustibles with which gold at present is supposed capable of combining.

Neither does gold combine, as far as is known, with either of the simple incombustible bodies. But gold combines readily with the greater number of the metals, and forms a variety of alloys.

The affinities of gold and its oxides are placed by Bergman in the following order:

Gold.	*Oxide of Gold.*
Mercury,	Muriatic acid,
Copper,	Nitric,
Silver,	Sulphuric,
Lead,	Arsenic,
Bismuth,	Fluoric,
Tin,	Tartaric,

Gold.	*Oxide of gold.*
Antimony,	Phosphoric,
Iron,	Prussic,
Platinum,	
Zinc,	
Nickel,	
Arsenic,	
Cobalt,	
Manganese.	

AURUM *fulminans*. See CHEMISTRY.

AURUM *potabile*, potable gold, a liquid preparation of this metal, formerly much used in medicine.

AUSCULTARE, in ancient customs. A person was formerly appointed to instruct the monks to read and sing before they were allowed to perform in public. This was called *auscultare*, to *hear* or *listen*.

AUSPICIUM. See AUGURY.

AUSTRALIS *Piscis*, a constellation of the southern hemisphere, not visible in our latitude. The stars in Ptolemy's catalogue are 18, and in the Britannic 24. The star Fomahaut, of the first magnitude, is in the mouth of the fish.

AUTER *droit*, in law, is when persons sue or are sued in another's right, as executors, guardians, &c.

AUTER *fois acquit*, in law, a plea made by a criminal that he has been already acquitted of the same crime with which he is charged. For no man shall be arraigned more than once for the same offence.

AUTHENTIC, in the civil law, a name given to the novels of Justinian, in which *authenticating* is a term used for punishing an adultress by public whipping and imprisonment for two years; then, if her husband refuses to take her back, she is shaven, veiled, and shut up for life.

AUTHORITY, in law, a power given by word or writing to a second person to transact something, and may be by writ, warrant, commission, letter of attorney, &c. and sometimes by law. An authority given to another to do what a person himself cannot do is void; and it must be for doing a thing that is lawful, otherwise it will be no good authority.

AUTO *da fe*. See ACT OF FAITH.

AUTOMATON, a seemingly self-moving machine; or one so constructed, by means of weights, levers, pulleys, springs, &c. as to move for a considerable time as if it was endued with animal life: and according to this description, clocks, watches, and all machines of that kind, are automata.

It is said that Archytas of Tarentum, 400 years before Christ, made a wooden pigeon that could fly; that Archimedes also made such automatons; that Regiomontanus made a wooden eagle that flew forth from the city, met the emperor, saluted him, and returned; also that he made an iron fly, which flew out of his hand at a feast, and returned again after flying about the room; that Dr. Hook made the model of a flying chariot, capable of supporting itself in the air. Many other surprising automatons we have been eye-witnesses of in the present age: thus, we have seen figures that could write, and perform many other actions in imitation of animals. M. Vaucanson made a figure that played on the flute: the same gentleman also made a duck which was capable of eating, drinking, and imitating exactly the voice of a natural one; and, what is still more surprising, the food it swallowed was evacuated in a digested state, or considerably altered on the principles of solution; also the wings, viscera, and bones, were formed so as strongly to resemble those of a living duck; and the actions of eating and drinking shewed the strongest resemblance, even to the muddling the water with its bill. M. Le Droz, of La Chaux de Fonds, in the province of Neufchatel, has also executed some very curious pieces of mechanism: one was a clock, presented to the king of Spain, which had, among other curiosities, a sheep that imitated the bleating of a natural one, and a dog watching a basket of fruit, that barked and snarled when any one offered to take it away; besides a variety of human figures, exhibiting motions truly surprising.

Another automaton of Droz's was the figure of a man, about the natural size, which held in the hand a metal style, and by touching a spring that released the internal clockwork from its stop, the figure began to draw on a card; and having finished its drawings on the first card, the figure rested, and then proceeded to draw different subjects on five or six other cards. The first card exhibited elegant portraits of the king and queen facing each other; and the figure was observed to lift its pencil with the greatest precision, in the transition from one point to another, without making the least slur.

AUTOUR, in natural history, a sort of bark which resembles cinnamon, but is paler and thicker; it is the colour of a broken nutmeg, and full of spangles. It comes from the Levant, and is an ingredient in the carmine dye.

AUTUMNAL *signs*, in astronomy, are the signs Libra, Scorpio, and Sagittarius, through which the Sun passes during the autumn.

AUXILIARY *verbs*, in grammar, are such as help to form or conjugate others; that is, are prefixed to them, to form or denote the moods or tenses thereof: as *to have* and *to be*.

In the English language the auxiliary verb *am* supplies the want of passive verbs.

AUXILIUM *ad filium militem faciendum, vel filiam maritandam*, a precept or writ directed to the sheriff of every county where the king or other lords had any tenants, to levy of them reasonable aid towards the knighting his eldest son, or the marriage of his eldest daughter.

AWARD, in law, the judgment of an arbitrator for terminating a difference.

AWK, see ALCA.

AXILLA, in anatomy, the arm-pit, or the cavity under the upper part of the arm.

AXILLA, in botany, the space comprehended betwixt the stems of plants and their leaves.

AXIOM, in philosophy, is such a plain, self-evident, and received notion, that it cannot be made more plain and evident by demonstration, because it is itself better known than any thing that can be brought to prove it: as, that nothing can act where it is not; that a thing cannot be and not be at the same time; that the whole is greater than a part thereof; and that from nothing nothing can arise.

AXIS, in geometry, the straight line in a plane figure, about which it revolves, to produce or generate a solid: thus, if a semicircle be moved round its diameter at rest, it will generate a sphere, the axis of which is that diameter.

AXIS, in astronomy. 1. Axis of the world, an imaginary right line conceived to pass through the centre of the earth from one pole to the other, about which the sphere of the world, in the Ptolemaic system, revolves in its diurnal rotation. 2. The axis of a planet is that line drawn through the centre about which the planet revolves. The Sun, together with all planets, except Mercury and Saturn, are known by observation to move about their respective axes. The axis of the Earth, during its revolution round the Sun, remains always parallel to itself; and is inclined to the plane of the ecliptic, making with it an angle of 66½ degrees. 3. The axes of the equator, horizon, ecliptic, zodiac, &c. are right lines drawn through the centres of those circles perpendicular to their planes. See ASTRONOMY.

AXIS, in conic sections, a right line dividing the section into two equal parts, and cutting all its ordinates at right angles. See CONIC SECTIONS.

The axis of the parabola is of an indeterminate length. The axis of the ellipsis is determinate. In the ellipsis and hyperbola, there are two axes and no more; and in the parabola only one.

AXIS, in mechanics. The axis of a balance is that line about which it moves, or rather turns. Axis of oscillation is a right line parallel to the horizon, passing through the centre, about which a pendulum vibrates. See MECHANICS.

AXIS *in peritrochio*, one of the five mechanical powers, consisting of a peritrochium or wheel, and moveable together with it about its axis. The power is applied at the circumference of the wheel, and the weight is raised by a rope that is gathered up on the axis while the machine turns round. The power may be conceived as applied at the extremity of the arm of a lever, equal to the radius of the wheel; and the weight as applied at the extremity of a lever, equal to the radius of the axis; only those arms do not meet at one centre of motion, as in the lever, but in place of this centre, we have an axis of motion, viz. the axis of the whole machine. See MECHANICS.

The use of this machine is to raise weights to a greater height than the lever can do, because the wheel is capable of being turned several times round, which the lever is not; and also to communicate motion from one part of a machine to another. Accordingly, there are few compound machines without it.

AXIS, in optics, is that ray among all others that are sent to the eye, which falls perpendicularly upon it, and which consequently passes through the centre of the eye. Common or mean axis is a right line drawn from the point of concourse of the two optic nerves through the middle of the right line, which joins the extremity of the same optic nerves. Axis of a glass or lens, is a right line joining the middle points of the two opposite surfaces of the glass.

Axis of incidence, in dioptrics, is a right line perpendicular in the point of incidence to the refracting superficies, drawn in the same medium that the ray of incidence comes from.

Axis of refraction is a right line drawn

through the refracting medium, from the point of refraction, perpendicular to the refracting superficies.

Axis, in architecture. Spiral axis is the axis of a twisted column drawn spirally in order to trace the circumvolutions without. Axis of the Ionic capital, is a line passing perpendicularly through the middle of the eye of the volute.

Axis of a vessel, is an imaginary right line passing through the middle of it perpendicularly to its base, and equally distant from its sides.

Axis of a magnet, is a line passing through the middle of a magnet lengthwise in such a manner as that, however the magnet is divided, provided the division is made according to a plane in which such line is found, the magnet will be cut or separated into two loadstones; and the extremes of such lines are called the poles of the magnet.

Axis, in anatomy, the second vertebra of the neck, so called from the head's turning on it like an axis.

Axis, in zoology, an animal of the deer kind. See Cervus.

AXYRIS, in botany, a genus of the triandria order, belonging to the monœcia class of plants, and in the natural method ranking under the twelfth order, holoraceæ. The calyx of the male is tripartite; it has no corolla. The calyx of the female consists of two leaves; it has two styli and one seed. There are three species, all annual, and natives of Siberia.

AYE-AYE, in zoology, a singular quadruped discovered in Madagascar. Its name is an exclamation of the inhabitants, which M. Sonnerat applied to this animal. Both male and female are slothful and gentle animals; and, like owls, they are scarcely able to discern objects in the day-time. They live chiefly under ground, feeding on worms and insects which they find in the earth or in crevices in the trunks of trees, whence they extract them by means of their long and slender toe. Sonnini forms a new genus of this animal, the generic character of which is the long toes, the thumb of the hinder pair being turned backward.

AYENIA, in botany, a genus of the pentandria order, belonging to the gynandria class of plants, and in the natural method ranking under the 37th order, columniferæ. The calyx has two leaves; the petals are in the form of a star, with long ungues; and the capsule has five cells. There are four species, all natives of the West Indies.

AZAB, in the Turkish armies, a distinct body of soldiery, who are great rivals of the Janizaries.

AZALEA, an American upright honeysuckle, a genus of the monogynia order, and pentandria class of plants; and in the natural method ranking under the 18th order, bicornes. The corolla is bell-shaped; the stamina are inserted into the receptacle, and the capsule has 5 cells. There are 7 species, of which the most remarkable are the following:

1. Azalea nudiflora, or red American upright honeysuckle, grows taller than the viscosa, and in its native country will sometimes arrive at the height of 12 feet, but in Britain never rises to above half that height. It has several stems with oblong smooth leaves. The flower-stalks arise from the division of the branches, which are long and naked, supporting a cluster of red flowers: these are divided at the top into 5 equal segments, which spread open.

2. Azalea viscosa, with a white flower, is a low shrub, arising with several stems to the height of two or three feet. The leaves come out in clusters without any order at the end of the shoots, and their edges are set with very short teeth, which are rough. The flowers come out in clusters between the leaves, have much the appearance of honeysuckle, and are as well scented.

3. Azalea Pontica, a native of Pontus, has large and beautiful yellow flowers, very fragrant.

Of the nudiflora there are also some beautiful varieties, particularly the scarlet and the orange. In short, there has not been a greater accession to our gardens than these truly elegant shrubs. They will only thrive in bog-earth, and are chiefly propagated by layers, as the finer roots seldom ripen seeds in England. They must be removed with a clump of earth, as disturbing the fibres destroys them.

AZIMUTH, in astronomy, an arch of the horizon, intercepted between the meridian of the place and the azimuth, or vertical circle passing through the centre of the object, which is equal to the angle of the zenith formed by the meridian and vertical circle; or it is found by this proportion; As the radius, to the tangent of the latitude of the place, so is the tangent of the sun's or star's altitude, for instance, to the co-sine of the azimuth from the south, at the time of the equinox. To find the azimuth by the globe, see the article Globe.

Azimuth, *magnetical*, an arch of the horizon intercepted between the azimuth, or vertical circle passing through the centre of any heavenly body, and the magnetical meridian. This is found by observing the object with an azimuth compass.

Azimuth *compass*, an instrument adapted to find, in a more accurate manner than by the common sea-compass, the sun's or star's magnetical amplitude, or azimuth.

Azimuth *dial*, one whose style or gnomon is at right angles to the plane of the horizon.

Azimuth *circles*, called azimuths, or vertical circles, are great circles of the sphere, intersecting each other in the zenith and nadir, and cutting the horizon at right angles in all the points thereof. The horizon being divided into 360°, they usually conceive 360 azimuths. These azimuths are represented by the rhumbs on common sea-charts, and on the globe they are represented by the quadrant of altitude when screwed in the zenith. On these azimuths is reckoned the height of the stars, and of the sun, when not in the meridian.

AZOGA ships, Spanish ships, commonly called the quicksilver ships, from their carrying quicksilver to the Spanish West Indies, in order to extract the silver out of the mines of Mexico and Peru. These ships, strictly speaking, are not to carry any goods unless for the king of Spain's account; but by procuring special licences, they are enabled to take in a full cargo for merchants, as well as the sovereign.

AZOOPHAGUS, a term used by authors to express such animals and insects as never eat the flesh of any creature that has had life.

AZOTE, or *nitrogen*, in chemistry, a substance hitherto considered as elementary, existing abundantly in nature, forming full three-fourths of the atmosphere. It is a peculiar and almost characteristic ingredient of animal matter, the basis of nitric acid, and one of the constituents of volatile alkali. Pure azote is known only in the form of gas; it is then synonimous with the phlogisticated air of Scheele and Priestley, the atmospherical mephitis of Lavoisier, and the nitrogen gas of Chaptal.

Azote may be procured by the following processes. If a quantity of iron filings and sulphur, mixed together, and moistened with water, is put into a glass vessel full of air, it will absorb all the oxygen in the course of a few days; but a considerable residuum of air will still remain incapable of any farther diminution. This residuum has obtained the appellation of azotic gas. There are other methods of obtaining it more speedily. If phosphorus, for instance, is substituted for the iron filings and sulphur, the absorption is completed in less than 24 hours. The following method, first pointed out by Berthollet, furnishes very pure azotic gas, if the proper precautions are attended to. Very much diluted aqua fortis, or nitrous acid, as it is called in chemistry, is poured upon a piece of muscular flesh, and a heat of about 100° applied. A considerable quantity of azotic gas is emitted, which may be received in proper vessels.

The air of the atmosphere contains about 0.78 parts (in bulk) of azotic gas; almost all the rest of it is oxygen gas. Mr. Lavoisier was the first philosopher who published this analysis, and who made azotic gas known as a component part of air. His experiments were published in 1774, or perhaps rather 1775. Scheele undoubtedly was acquainted as early with the composition of air; but his Treatise on Fire, in which that analysis is contained, was not published till 1777.

Mr. Kirwan examined the specific gravity of azotic gas obtained by Scheele's process; it was 0.00120; it is therefore somewhat lighter than atmospheric air; it is to atmospheric air as 985 to 1000. According to the experiments of Lavoisier, its specific gravity is only 0.00115, or it is to common air as 942.6 to 1000.

This gas is invisible and elastic, like common air; and like it too, capable of indefinite condensation and dilation. It is exceedingly noxious to animals; if obliged to respire it, they drop down dead almost instantly. No combustible will burn in it. Hence the reason why a candle is extinguished in atmospherical air as soon as the oxygen near it is consumed.

Azotic gas is capable of combining with oxygen. Take a glass tube, the diameter of which is about the sixth part of an inch; shut one of its ends with a cork, through the middle of which passes a small wire with a ball of metal at each end. Fill the tube with mercury, and then plunge its open end into a bason of that fluid. Throw up into the tube as much of a mixture, composed of 13 parts of azotic and 87 parts of oxygen gas, as will fill three inches. Through this gas make, by means of the wire in the cork, a number of electric explosions pass. The volume of gas gradually diminishes, and in its place there is found a quantity of nitric acid. This

acid, therefore, is composed of azote and oxygen: and these two substances are capable of combining; or, which is the same thing, azotic gas is capable of combustion in the temperature produced by electricity, which we know to be high. The combination of azotic gas with oxygen, and the nature of the product, were discovered by Mr. Cavendish, and communicated to the Royal Society on the 2d of June 1785.

When sulphur is melted in azotic gas, part of it is dissolved, and sulphurated azotic gas formed. This gas has a fetid odour. Its properties are still unknown.

Phosphorus plunged into azotic gas is dissolved in a small proportion. Its bulk is encreased about 1-40th, and phosphureted azotic gas is the result. When this gas is mixed with oxygen gas, it becomes luminous, in consequence of the combustion of the dissolved phosphorus. The combustion is most rapid when bubbles of phosphureted azotic gas are let up into a jar full of oxygen gas. When phosphureted oxygen gas and phosphureted azotic gas are mixed together, no light is produced, even at the temperature of 82°.

Azotic gas dissolves also a little carbon; for azotic gas obtained from animal substances, by Berthollet's process, when confined long in jars, deposits on the sides of them a black matter, which has the properties of charcoal.

When mixed with hydrogen gas, it undergoes no change. It may, however, be combined with hydrogen, and the compound formed is known by the name of ammonia or volatile alkali.

The affinities of azote are still unknown. It has never yet been decompounded; and must therefore, in the present state of our knowledge, be considered as a simple substance. See AIR, page 31.

AZURE, in heraldry, the blue colour in the arms of any person below the rank of a baron. In the escutcheon of a nobleman, it is called saphire; and in that of a sovereign prince, Jupiter. In engraving, this colour is expressed by lines or strokes drawn horizontally.

AZYGOS, in anatomy, a vein rising within the thorax on the right side, having no fellow on the left; whence it is called azygos, or vena sine pari.

AZYMITES, in church-history, Christians who administer the eucharist with unleavened bread.

AZYMOUS, something unfermented; as bread, &c. made without leaven. This term has occasioned frequent disputes, and, at length, a rupture between the Latin and the Greek churches; the former of which maintain, that the bread in the mass ought to be azymous, unleavened, in imitation of the paschal bread of the Jews, and of our Saviour, who instituted the sacrament on the day of the passover. The latter as strenuously maintain the contrary from tradition, and the common usage of the church.

B.

B, the second letter of the alphabet, is used as an abbreviation: in music, B stands for the tone above A: B also stands for bass, and B. C. for basso continuo, or thorough bass. As a numeral, B was used by the Greeks and Hebrews, to denote 2: but among the Romans, for 300, and with a dash over it (thus $\overline{B}$) for 3000. The same people likewise used B. for Brutus, B. F. for bonum factum. B, in the old chemical alphabet, signifies Mercury: B. A. stands for bachelor of arts; B. L. for bachelor of laws; and B. D. for bachelor of divinity.

BABOON, in zoology. See SIMIA.

BABYLONICA, *texta*, a rich sort of weavings, or hangings, so denominated from the city of Babylon, where the practice of interweaving divers colours in their hangings was first invented.

BACA, in botany. See BERRY.

BACCHÆ, in antiquity, priestesses of the god Bacchus. They were likewise called mænades, on account of the frantic ceremonies used in their feasts; as also thyades, which signifies impetuous, or furious.

BACCHANALIA, feasts celebrated in honour of Bacchus by the antient Greeks and Romans; of which the two most remarkable were called the greater and lesser. The latter were held in the open fields about autumn; but the greater, called dionysia, were celebrated in the city in spring time.

BACCHARIS, in botany, *ploughman's spikenard*, a genus of the polygamia superflua order, belonging to the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ discoides. The characters are; it has a naked receptacle, and hairy pappus; with a cylindrical imbricated calyx, and feminine florets mixed with the hermaphrodite ones. There are 9 species, all natives of warm climates; of which the two following chiefly merit notice.

1. Baccharis halimifolia, or Virginia groundsel-tree, a native of Virginia and other parts of North America. It grows about 7 or 8 feet high, with a crooked shrubby stem; and flowers in October. The flowers are white, and not very beautiful; but the leaves continuing green, has occasioned this shrub to be admitted into many curious gardens. It may be propagated by cuttings; and will live very well in the open air, though severe frost will sometimes destroy it.

2. Baccharis ivæfolia, or African tree-groundsel, a native of the Cape of Good Hope, as well as of Peru and other warm parts of America. It grows to the height of 5 or 6 feet; and though there is little beauty in the flower, has been long admitted into the gardens of the curious. It is pretty hardy, and will live abroad in moderate winters in England; but is usually kept in green-houses, and placed abroad only in summer. It may be propagated either by cuttings or by seeds, which ripen well in this country.

BACCHIUS, in antient poetry, a kind of foot composed of a short syllable and two long ones.

BACILLARIA, in natural history, a genus of vermes infusoriæ, of which only a single species is described. The body consists of straw-like cylinders, placed parallel to each other, and frequently changes its direction and arrangement.

BACK, in brewing, a large flat kind of tub or vessel, in which the wort is put for cooling. The ingredients of beer pass through three kinds of vessels; they are mashed in one, worked in another, and cooled in a third. See BREWING.

BACK *the sails*, is to put them in a situation that will occasion the ship to retreat or move astern.

BACK, in the manege. To back a horse, or mount a horse *à dos* in French, is to mount him bare-backed, or without a saddle.

BACK-GAMMON, an ingenious game played with dice and tables, to be learned only by observation and practice. However, the following rules concerning it cannot fail to be acceptable to our readers. In the first place, the men, which are 30 in number, being equally divided between the two gamesters, are placed thus, viz. two on the ace point, five on the side of your left-hand table, three on the cinque, and five on the ace point of your right-hand table, which are answered on the like points by your adversary's men: or they may be disposed thus, viz. two on the ace point, five on the double sice or sice-cinque point, three on the cinque point in your own tables, and five on the sice point at home; which are to be answered by your adversary. The men being thus disposed, be sure to make good your trey and ace points; hit boldly, and come away as fast as you can. When you come to bearing, have a care of making when you need not; and doublets now will stand you most in stead. If both bear together, he that is first off, without doublets, wins one; if both bear, and one goes off with doublets, he wins two. If your table be clear before your adversary's men are come in, that is a back-gammon, which is three; but if you thus go off with doublets, it is four.

The great dexterity of this game is to be forward, if possible, upon safe terms; and so to point the men, that it shall not be possible for the adversary to pass, though you have entered your men, till you give him liberty, after having got two to one of the advantage of the game.

BACK-STAFF, in the sea language, an instrument to take the sun's altitude. It consists of two concentric arches, the greater of which is divided into 30 degrees, and every degree into 5 minutes, by means of diagonal lines; and the lesser into 60 degrees. There are likewise 3 vanes belonging to it: that upon the arch of 30 degrees, being called the sight vane; that upon the arch of 60 degrees, the shade vane; and the other, in the centre of the arches, the horizon vane.

To find the sun's altitude by this instrument, fix the shade vane on the 60 degrees arch, at about 15 or 20 degrees less than the complement of the altitude; and turning your back towards the sun, move the sight vane up and down till the sun's image fall on the horizon vane, and at the same

instant you see the horizon through the slit in the horizon vane; then will the degrees cut by the shade vane on the arch, being added to those cut by the sight vane on the other arch, be the sun's zenith distance at that time, which being substracted from 90 degrees, will give his altitude.

BACOPA, in botany, a genus of the pentandria monogynia class and order: the essential character is, calyx with a short tube, spreading at top; stam. inserted into the tube of the corolla, stigma headed, caps. one-celled.

There is but one species, an aquatic plant of Cayenne, celebrated by the inhabitants for its efficacy in curing burns.

BACTRIS, in botany, a genus of the class and order monoecia hexandria. In the male flowers the calyx is 3-parted; corolla 1-petalled, 3-cleft; stam. 6; fem. cal. 1-leaved, 3-toothed, cor. the same, stigma 3-cleft, drupe coriaceous. This genus is classed among the palms: there are two species, the majus and minus, both natives of Carthagena, where the fruit is eaten.

BACULARES, a sect of anapabtists, so called as holding it unlawful to bear a sword, or any other weapon besides a staff.

BACULE, in fortification, a kind of portcullis, or gate, made like a pitfall with a counterpoise, and supported by two great stakes. It is usually made before the corps-de-garde, not far from the gate of a place.

BADGER, in zoology. See URSUS.

BADGER, in old law-books, one that was licensed to buy corn in one place, and carry it to another to sell, without incurring the punishment of an ingrosser. They are to be annually licensed by the justices.

BADIAGA, a water-plant resembling a sponge, and said to be good for removing the livid marks from blows.

BADIANE, or BADIAN, the seed of a tree which grows in China, and smells like anise-seed. The Chinese, and the Dutch in imitation of them, sometimes use the badiane to give their tea an aromatic taste.

BADIGEON, a mixture of plaister and free-stone, used by statuaries to fill up little holes.

BÆCKEA, in botany, a genus of the octandria order and monogynia class of plants. The calyx is a permanent perianthium, consisting of a single funnel-shaped leaf, cut into 5 segments at the brim; the corolla consists of 5 roundish petals inserted into the calyx; the pericarpium is a globose capsule, made up of 4 valves, and containing 4 cells, in which are a few roundish angular seeds. There is one species, a native of China.

BÆOBOTRYS, a genus of the pentandria monogynia class and order. The essential character is; cor. tubular; border 5-cleft; cal. double, outer 2-leaved, inner 1-leaved, bell-shaped; berry globose, 1-celled, growing to calyx, many-seeded. There is but one species, a native of Zanna in the South Seas.

BÆTYLIA, anointed stones, worshipped by the Phenicians, and by other barbarous nations.

BAFFETAS, or BASTAS, a cloth made of coarse white cotton thread, which comes from the East Indies. Those of Surat are the best.

BAG, among farriers, is when, in order to retrieve a horse's lost appetite, they put an ounce of asafœtida, and as much powder of savin, into a bag, to be tied to the bit, keeping him bridled for two hours, several times a-day: as soon as the bag is taken off, he will fall to eating. The same bag will serve a long time.

BAGNOLIANS, BAGNOLENSES, in church history, a sect of heretics, who in reality were manichees, though they somewhat disguised their errors. They rejected the Old Testament, and part of the New; held the world to be eternal, and affirmed that God did not create the soul when he infused it into the body.

BAGPIPE, a musical instrument of the wind kind, chiefly used in country places, especially in the north; it consists of two principal parts; the first a leathern bag, which blows up like a foot-ball, by means of a port-vent, or little tube, fitted to it, and stopped by a valve; the other part consists of three pipes or flutes, the first called the great pipe, or drone, and the second the little one; which pass the wind out only at the bottom: the third has a reed, and is played on by compressing the bag under the arm, when full, and opening and stopping the holes, which are eight, with the fingers. The little pipe is ordinarily a foot long; that played on, thirteen inches; and the port-vent six.

BAGUETTE, in architecture, a small round moulding, less than an astragal, and so called from the resemblance it bears to a ring.

BAHAR, or BARRE, in commerce, weights used in several places in the East Indies.

There are two of these weights, the one the great bahar, with which they weigh pepper, cloves, nutmegs, ginger, &c. and contains about 5cwt. and 24 pounds 9 ounces, avoirdupois weight. With the little bahar they weigh quicksilver, vermilion, ivory, silk, &c. It contains about 437 pounds 9 ounces.

BAIL, in law, the setting at liberty one arrested, or imprisoned, upon an action either civil or criminal, upon sureties taken for his appearance at a day and place assigned. In civil cases the bail is either common or special. Common bail is a matter of course, being nothing but a mere form upon appearance, after personal service of the writ, and notice to appear upon the defendant. If he appear thereto, his attorney puts in imaginary sureties for his future attendance, as John Doe and Richard Roe. But if the plaintiff will make affidavit that the cause of action amounts to 10*l.* or upwards, in order to arrest the defendant, and make him put in substantial sureties for his appearance, called special bail; it is then required that the true cause of action be expressed in the body of the writ, or process. 3 Black. 287.

Special bail, are two or more persons, who, after the arrest, undertake generally, or enter into bond to the sheriff in a certain sum, to insure the defendant's appearance at the return of the writ; this obligation is called the bail-bond.

Bail in criminal cases. Upon offering sufficient surety, bail may be taken either in court, or in some particular cases, by the sheriff, coroner, or other magistrate, but most usually by justices of the peace, in the following cases: Persons of good fame charged with a bare suspicion of manslaughter, or other inferior homicide. Persons charged with petit larceny, or any felony not before specified. Accessaries to felony, not being of evil fame, nor under strong presumption of guilt. But bail cannot be taken upon an accusation of treason, nor of murder, nor in the case of manslaughter if the person is clearly the slayer; nor such as being committed for felony have broken prison, nor persons outlawed, nor such as have abjured the realm, nor approvers, nor persons taken with the maner, or in the fact of felony, nor persons charged with house-burning, nor persons taken by writ of excommunicato capiendo.

BAILE, or BALE, in the sea-language. The seamen call throwing the water by hand out of the ship or boat's hold, bailing. They also call those hoops that bear up the tilt of a boat, its bails.

BAILMENT, in law, is a delivery of things, whether writings, goods, &c. to another, sometimes to be delivered back to the bailer; that is, to him who so delivered them; sometimes to the use of the bailee; that is, of him to whom they are delivered; and sometimes also to be delivered to a third person; this delivery is called a bailment. 2 Black. 451.

The following rules are laid down as actions in the law of bailments: A bailee, who derives no benefit from his undertaking, is responsible only for gross negligence. A bailer, who alone receives benefit from the bailment, is responsible for slight neglect. When the bailment is beneficial to both parties, the bailee must answer for ordinary neglect. A special agreement of the bailee to answer for more or less, is in general valid. All bailers are answerable for actual fraud, even though the contrary be stipulated. No bailee shall be charged for a loss by inevitable accident, or irresistible force, except by special agreement. Robbery by force is considered as irresistible; but a loss by private stealth, is presumptive evidence of ordinary neglect. Gross neglect is a violation of good faith. No action lies to compel performance by a naked contract. The negligence of a servant acting by his master's orders, expressed or implied, is the negligence of the master.

BAILIFF, a keeper, or protector. Hence the sheriff is considered as bailiff to the crown: and the county of which he has the care, and in which he is to execute the king's writ, is called his bailiwick; so also his officers who execute writs, warrants, &c. are called bailiffs.

BAILIFF, *water*, an officer appointed in all port-towns, for the searching of ships, gathering the toll for anchorage, &c. and arresting persons for debts, &c. on the water.

BAILIFF is still applied to the chief magistrate of several corporate towns. The government of some of the king's castles is also committed to persons called bailiffs, as the bailiff of Dover castle.

In France, bailiffs have some considerable prerogatives; they are reputed heads of their respective districts, or administer justice by their lieutenants, at least within the precincts of the several parliaments or provinces of France. In their name justice is administered, contracts and other deeds passed, and to them is committed the command of the militia.

In Scotland, bailiff is the name of a judge, as well as the appellation of alderman.

BAILIFFS *of courts baron*, summon those courts, and execute the process thereof; they present all pound-breaches, cattle strayed, &c. &c.

BAILIWICK, signifies sometimes that liberty which is exempted from the sheriff of

the county, over which the lord of the liberty appoints a bailiff, such as the bailiff of Westminster.

BAILS, *clerk of the*, is an officer belonging to the court of king's-bench: he files the bail-pieces taken in that court, and attends for that purpose.

BAIOCAO, a copper coin, current at Rome, and throughout the whole state of the church, ten of which make a julio, and an hundred a Roman crown.

BAIRAM, in the Mahometan customs, a yearly festival of the Turks, which they keep after the fast of ramazan.

The Mahometans have two bairams, the great and the little. The little bairam continues for three days, and is seventy days after the first, which follows immediately after the ramazan. During the bairam the people leave their work for three days, make presents to one another, and spend the time with great manifestations of joy. If the day after ramazan should prove so cloudy as to prevent the sight of the new moon, the bairam is put off to the next day, when it is kept, even if the moon should still be obscured. When they celebrate this feast, after numerous ceremonies, or rather strange mimicries, in their mosque, it is concluded with a solemn prayer against the infidels, to extirpate christian princes, or to arm them against one another, that they may have an opportunity to extend the limits of their law.

BAITING is applied to the act of smaller or weaker beasts attacking and harassing greater and stronger ones. Bulls and bears are baited by mastiffs, or bull-dogs. The practice of bull-baiting, and other sports of the same kind, which cannot be too strongly reprobated, may be traced to an early period of our history. In the twelfth century, it was a common practice on every holiday. In the reign of Henry VIII. many herds of bears were maintained for the purpose of baiting. Queen Mary had a great exhibition of bear-baiting immediately after mass, with which to entertain her sister Elizabeth, then a prisoner in Hatfield house; and the same princess, soon after her accession to the throne, entertained the foreign ambassadors with the baiting of bulls and bears. The custom of bull-baiting was most ingeniously defended by Mr. Windham in the house of commons in the session of 1803, when a bill was brought in to stop that inhuman practice. Whales are baited by a kind of fish called oriæ, or killers, ten or twelve of which will attack a young whale at once, and not leave him till he is killed. Phil. Trans. No. 287.

BAJULUS, an antient officer in the court of the Greek emperors.

BAKER, a person whose occupation or business is to prepare bread, or to reduce meals of any kind, whether simple or compound, into bread, biscuits, &c.

It is not known when this very useful business first became a particular profession. Bakers were a distinct body of people in Rome nearly two hundred years before the Christian æra, and it is supposed that they came from Greece. To these were added a number of freemen, who were incorporated into a *college*, from which neither they nor their children were allowed to withdraw. They held their effects in common without enjoying any power of parting with them. Each bakehouse had a *patron*, who had the superintendency of it; and one of the patrons had the management of the others, and the care of the college. So respectable were the bakers at Rome, that occasionally one of the body was admitted among the senators.

Even by our own statutes the bakers are declared not to be handicrafts; and in London they are under the particular jurisdiction of the lord-mayor and aldermen, who fix the price of bread, and have the power of fining those who do not conform to their rules.

Bread is made of flour mixed and kneaded with yeast, water, and a little salt. It is known in London under two names, the *white* or *wheaten*, and the *household*: these differ only in degrees of purity: and the loaves must be marked with a W or H, or the baker is liable to suffer a penalty.

The process of bread-making is thus described:—To a peck of meal are added a handful of salt, a pint of yeast, and three quarts of water, cold in summer, hot in winter, and temperate between the two. The whole being kneaded, will rise in about an hour; it is then moulded into loaves, and put into the oven to bake. The oven takes more than an hour to heat properly, and bread about three hours to bake.

The price of bread is regulated according to the price of wheat; and bakers are directed in this by the magistrates, whose rules they are bound to follow. By these the peck-loaf of each sort of bread must weigh seventeen pounds six ounces avoirdupois weight, and smaller loaves in the same proportion. Every sack of flour is to weigh two hundred and a half; and from this there ought to be made, at an average, twenty such peck-loaves, or eighty common quartern-loaves.

If the bread was short in its weight only one ounce in thirty-six, the baker formerly was liable to be put in the pillory; and for the same offence he may now be fined, at the will of the magistrate, in any sum not less than one shilling, nor more than five shillings for every ounce wanting; such bread being complained of and weighed in the presence of the magistrate within twenty-four hours after it is baked, because bread loses in weight by keeping.

It is said that scarcely any nation lives without bread, or something as a substitute for it. The Laplanders have no corn, but they make bread of their dried fishes, and of the inner rind of the pine, which seems to be used not so much on account of the nourishment to be obtained from it, as for the sake of having a dry food. In Norway they make bread that will keep thirty or forty years, and the inhabitants esteem the old and stale bread in preference to that which is newly made. For their great feasts particular care is taken to have the oldest bread; so that at the christening of a child, for instance, they have usually bread which has been baked perhaps at the birth of the father, or even grandfather. It is made from barley and oats, and baked between two hollow stones.

The process of biscuit-baking, as practised at the victualing-office at Deptford, is curious and interesting. The dough, which consists of flour and water only, is worked by a large machine. It is then handed over to a second workman, who slices it with a large knife for the bakers, of whom there are five. The first, or the *moulder*, forms the biscuits two at a time; the second, or *marker*, stamps and throws them to the *splitter*, who separates the two pieces, and puts them under the hand of the *chucker*, the man that supplies the oven, whose work of throwing the bread on the peel must be so exact, that he cannot look off for a moment. The fifth, or the *depositer*, receives the biscuits on the peel, and arranges them in the oven. All the men work with the greatest exactness, and are, in truth, like parts of the same machine. The business is to deposit in the oven seventy biscuits in a minute; and this is accomplished with the regularity of a clock, the clacking of the peel operating like the motion of the pendulum. There are twelve ovens at Deptford, and each will furnish daily bread for 2040 men.

The bakers of London make a distinct company, the nineteenth in order.

BALÆNA, the whale, in zoology, a genus of the mammalia class, belonging to the order of ceti. The characters of this genus are these: the balæna, in place of teeth, has a horny plate on the upper jaw, and a double fistula or pipe for throwing out water. There are four species: viz.

1. Balenæa bo-ops, the pike-headed whale, has a double pipe in its snout, three fins, and a hard horny ridge on its back. The belly is full of longitudinal folds or rugæ. It frequents the northern ocean. The length of one taken on the coast of Scotland, as remarked by sir Robert Sibbald, was forty-six feet, and its greatest circumference twenty. This species takes its name from the shape of its nose, which is narrower and sharper pointed than that of other whales.

2. Balæna musculus has a double pipe in its front, and three fins; the under jaw is much wider than the upper one. It frequents the Scotch coasts, and feeds upon herrings.

3. Balæna mysticetus, the common or great Greenland whale, which has no fin on the back. This is the largest of all animals; it is even at present sometimes found in the northern seas ninety feet in length; but formerly they were taken of a much greater size, when the captures were less frequent, and the fish had time to grow. Such is their bulk within the arctic circle: but in the torrid zone, where they are less molested, whales are still seen one hundred and sixty feet long. The head is very much disproportioned to the size of the body, being one-third of the size of the fish: the under lip is much broader than the upper. The tongue is composed of a very soft spongy fat, capable of yielding five or six barrels of oil. The gullet is very small for so vast a fish, not exceeding four inches in width. In the middle of the head are two orifices, through which it spouts water to a vast height, and with a great noise, especially when disturbed or wounded; the eyes are placed towards the back of the head, being the most convenient situation for enabling them to see both before and behind; as also to see over them, where their food is principally found. They are guarded by eye-lids and eye-lashes, as in quadrupeds; and the animals seem to be very sharp-sighted. Nor is their sense of hearing in less perfection; for they are warned at a great distance of any danger preparing against them. It is true, indeed, that the external organ of hearing is not perceptible, for this might only embarrass them in their natural element; but as soon as the thin scarf-skin

after-mentioned is removed, a black spot is discovered behind the eye, and under that is the auditory canal, that leads to a regular apparatus for hearing. In short, the animal hears the smallest sounds at very great distances, and at all times, except when it is spouting water; which is the time that the fishers approach to strike it. What is called whalebone, adheres to the upper jaw, and is formed of thin parallel laminæ, some of the longest four yards in length; of these there are commonly 350 on each side, but in very old fish more. They are surrounded with long strong hair, not only that they may not hurt the tongue, but as strainers to prevent the return of their food when they discharge the water out of their mouth. The real bones of the whale are hard, porous, and full of marrow. Two very strong bones sustain the upper lip, lying against each other in the shape of a half-moon. The tail is broad and semilunar; and when the fish lies on one side, its blow is tremendous. The tail alone it makes use of, to advance itself forward in the water; and it is surprising with what force and celerity its enormous bulk cuts through the ocean. The fins are only made use of for turning in the water, and giving a direction to the velocity impressed by the tail. The female also makes use of them, when pursued, to bear off her young, clapping them on her back, and supporting them by the fins on each side from falling. The whale varies in colour; the back of some being red, the belly generally white. Others are black, some mottled, and others quite white. Their colours in the water are extremely beautiful, and their skin is very smooth and slippery. The outward or scarf-skin of the whale is no thicker than parchment; but this removed, the real skin appears, of about an inch thick, and covering the fat or blubber that lies beneath: this is from eight to twelve inches in thickness; and is, when the fish is in health, of a beautiful yellow. The muscles lie beneath; and these, like the flesh of quadrupeds, are very red and tough. The teats in the female are placed in the lower part of the belly. They breed only once in two years. Their fidelity to each other exceeds whatever we are told even of the constancy of birds. Some fishers, as Anderson informs us, having struck one of two whales, a male and a female, that were in company together, the wounded fish made a long and terrible resistance; it struck down a boat with three men in it, with a single blow of its tail, by which all went to the bottom. The other still attended its companion, and lent it every assistance; till, at last, the fish that was struck, sunk under the number of its wounds; while its faithful associate, disdaining to survive the loss, with great bellowing, stretched itself upon the dead fish, and shared its fate. The whale goes with young nine or ten months, and is then fatter than usual, particularly when near the time of bringing forth. It is said that the embryo, when first perceptible, is about seventeen inches long, and white; but the cub, when excluded, is black, and about ten feet long. She generally produces one young one, and never above two. When she suckles her young, she throws herself on one side of the surface of the sea, and the young one attaches itself to the teat. Nothing can exceed the tenderness of the female for her offspring. Even when wounded, she still clasps her young one; and when she plunges to avoid danger, takes it to the bottom; but rises sooner than usual, to give it breath again. The young ones continue at the breast for a year; during which time, they are called by the sailors, *short-heads*. They are then extremely fat, and yield above fifty barrels of blubber. The mother at the same time is equally lean and emaciated. At the age of two years they are called *staunts*, as they do not thrive much immediately after quitting the breast: they then yield scarcely above twenty or twenty-four barrels of blubber: from that time forward they are called *skull-fish*, and their age is wholly unknown. The food of the great whale is a small sea insect well known under the name of the Medusa or sea-blubber.

4. Balæna physalus, or fin fish, (see Plate, Natural History, fig. 44.) is distinguished from the common whale by a fin on the back, placed very low and near the tail. The length is equal to that of the common kind, but much more slender. It is furnished with whalebone in the upper jaw, mixed with hairs, but short and knotty, and of little value. The blubber also in the body of this kind is very inconsiderable. These circumstances, added to its extreme fierceness and agility, which render the capture very dangerous, cause the fishers to neglect it. The natives of Greenland, however, hold it in great esteem, as it affords a quantity of flesh which to their palate is very agreeable. The lips are brown, and like a twisted rope: the spout hole is seemingly split in the top of its head, through which it blows water with much more violence, and to a greater height, than the common whale. The fishers are not very fond of seeing it, for on its appearance the others retire out of those seas. It feeds on herrings and small fish. Inoffensive as the whale is, it is not without enemies. There is a small animal, of the shell-fish kind, called the whale-louse, that sticks to its body, as we see shells sticking to the foul bottom of a ship. This insinuates itself chiefly under the fins; and whatever efforts the great animal makes, it still keeps its hold, and lives upon the fat, which it is provided with instruments to arrive at.

The sword-fish, however, is the whale's most terrible enemy. "At the sight of this little animal," says Anderson, "the whale seems agitated in an extraordinary manner, leaping from the water as if with affright: wherever it appears, the whale perceives it at a distance, and flies from it in the opposite direction. I have been myself," continues he, "a spectator of their terrible encounter. The whale has no instrument of defence except the tail; with that it endeavours to strike the enemy; and a single blow taking place would effectually destroy its adversary: but the sword-fish is as active as the other is strong, and easily avoids the stroke; then bounding into the air, it falls upon its enemy, and endeavours not to pierce with its pointed beak, but to cut with its toothed edges. The sea all about is soon dyed with blood, proceeding from the wounds of the whale; while the enormous animal vainly endeavours to reach its invader, and strikes with its tail against the surface of the water, making a report at each blow louder than the noise of a cannon."

There is still another powerful enemy to this fish, which is called the orien or killer. A number of these are said to surround the whale in the same manner as dogs get round a bull. Some attack it with their teeth behind; others attempt it before: until, at last, the great animal is torn down, and its tongue is said to be the only part they devour when they have made it their prey.

But of all the enemies of these enormous fishes man is the greatest; he alone destroys more in a year than the rest in an age, and actually has thinned their numbers in that part of the world where they are chiefly sought. At the first discovery of Greenland, whales not being used to be disturbed frequently, came into the very bays, and were accordingly killed almost close to the shore; so that the blubber being cut off, was immediately boiled into oil on the spot. The ships, in those times, took in nothing but the pure oil and the whalebone, and all the business was executed in the country; by which means a ship could bring home the product of many more whales than she can according to the present method of conducting this trade. The fishery also was then so plentiful, that they were obliged sometimes to send other ships to fetch off the oil they had made, the quantity being more than the fishing ships could bring away. But time and change of circumstances have shifted the situation of this trade. The ships coming in such numbers from Holland, Denmark, Hamburgh, and other northern countries, all intruders upon the English, who were the first discoverers of Greenland, the whales were disturbed; and gradually, as other fish often do, forsaking the place, were not to be killed so near the shore as before; but are now found, and have been so ever since, in the openings and space among the ice, where they have deep water, and where they go sometimes a great many leagues from the shore.

The whale fishery begins in May, and continues all June and July; but whether the ships have good or bad success, they must come away, and get clear of the ice, by the end of August; so that in the month of September at farthest they may be expected home; but a ship that meets with a fortunate and early fishery in May, may return in June or July.

The manner of taking whales at present is as follows. Every ship is provided with six boats, to each of which belong six men for rowing the boat, and an harpooner, whose business is to strike the whale with his harpoon. Two of these boats are kept constantly on the watch at some distance from the ship, fastened to pieces of ice, and are relieved by others every four hours. As soon as a whale is perceived, both the boats set out in pursuit of it, and if either of them can come up before the whale finally descends, which is known by his throwing up his tail, the harpooner discharges his harpoon at him. There is no difficulty in choosing the place where the whale is to be struck, as some have asserted; for these creatures only come up to the surface in order to spout up the water, or *blow*, as the fishermen term it, and therefore always keep the soft and vulnerable part of their bodies above water. A late improvement was made in the method of discharging the harpoon, namely, by shooting it out of a kind of swivel or musquetoon: but it does not appear that since this improvement was made the whale-fishing ships have had better success than

before. As soon as the whale is struck, the men set up one of their oars in the middle of the boat as a signal to those in the ship. On perceiving this, the watchman alarms all the rest with the cry of *fall! fall!* upon which all the other boats are immediately sent out to the assistance of the first.

The whale finding himself wounded, runs off with prodigious violence. Sometimes he descends perpendicularly; at others, goes off horizontally, at a small depth below the surface. The rope which is fastened to the harpoon is about two hundred fathoms long, and properly coiled up, that it may freely be given out as there is a demand for it. At first the velocity with which this line runs over the side of the boat is so great, that it is wetted to prevent its taking fire: but in a short time the strength of the whale begins to fail, and the fishermen, instead of letting out more rope, strive as much as possible to pull back what is given out already, though they always find themselves necessitated to yield at last to the efforts of the animal, to prevent his sinking their boat. If he runs out the two hundred fathoms of line contained in one boat, that belonging to another is immediately fastened to the end of the first, and so on; and there have been instances, where all the rope belonging to the six boats has been necessary, though half that quantity is seldom required. The whale cannot stay long below the water, but again comes up to blow: and being now much fatigued and wounded, stays longer above water than usual. This gives another boat time to come up with him, and he is again struck with another harpoon. He again descends, but with less force than before; and when he comes up again, is generally incapable of descending, but suffers himself to be wounded and killed with long lances, which the men are provided with for the purpose. He is known to be near death when he spouts up the water deeply tinged with blood.

The whale being dead, is lashed along-side the ship. They then lay it on one side, and put two ropes, one at the head, and the other in the place of the tail, which, together with the fins, is struck off as soon as he is taken, to keep these extremities above water. On the off-side of the whale are two boats, to receive the pieces of fat, utensils, and men, that might otherwise fall into the water on that side. These precautions having been taken, three or four men with irons at their feet, to prevent slipping, get on the whale, and begin to cut out pieces of about three feet thick and eight long, which are hauled up at the capstan or windlass. When the fat is all got off, they cut off the whiskers of the upper jaw with an axe. Before they cut, they are all lashed to keep them firm: which also facilitates the cutting, and prevents them from falling into the sea. When on board, five or six of them are bundled together, and properly stowed; and after all is got off, the carcase is turned adrift, and devoured by the bears, who are very fond of it. In proportion as the large pieces of fat are cut off, the rest of the crew are employed in slicing them smaller, and also in picking out all the lean. When this is prepared, they stow it under the deck, where it lies till the fat of all the whales is on board; then cutting it still smaller, they put it up in casks in the hold, cramming them very full and close. Nothing now remains but to sail homewards, where the fat is boiled, and melted down into train oil.

BALANCE, or *ballance*, in mechanics, one of the simple powers which serve to find out the equality or difference of weight in heavy bodies. See MECHANICS.

The modern balance consists of a lever, suspended exactly by the middle, and scales affixed to each extremity: the principle on which each is founded is the same, and may be easily conceived.

BALANCE, *hydrostatical*. See the article HYDROSTATICS.

BALANCE *of trade*, in commerce, the equality between the value of the commodities bought of foreigners, and the value of the native productions transported into other nations.

It is reckoned that that nation has the advantage in the balance of trade, which exports more of native commodities, and imports less of the foreign; so that the nation grows so much richer in bullion as the balance of that trade amounts to, which must be made up of bullion or money.

Among various others, the most received methods of arriving at the knowledge whether a nation gains or loses by foreign trade, or any branch thereof, are the following:

1°. A strict survey must be taken of what proportion the value of the commodities exported bears to those imported. If the exports exceed the imports, it is concluded that that nation is so far in a gaining way, by the overplus imported in bullion. But this method is uncertain, from the difficulty of obtaining a true account, either of the exports or imports; as custom-house books are no rule in this case, on account of the running of goods, especially many fine commodities of small bulk, but great value; besides the various accidents which affect the value of the stock, either sent out or brought in, as losses at sea, &c.

2°. The second method, no less defective than the other, is by observing the course of exchange, which if generally above the intrinsic value, or par of the coins of foreign countries, we not only lose by such exchange, but the same is a proof that we lose by the general course of our trade.

3°. The third method is made from the increase or the diminution of our trade and shipping in general; for if these diminish, the nation loses, and *vice versa*: this seems equally imperfect with the following.

4°. A fourth way is, by observing the increase and diminution of our coin and bullion.

BALANCE of a clock or watch. See the article CLOCKWORK.

BALANCE-*fish*. See ZYGÆNA.

BALANI *marini*, certain multivalve shells, usually growing in clusters on the shells of the larger sort of sea shell-fish. See LEPAS.

BALCONY, in architecture, a projection in the front of a house, or other building, supported by pillars or consoles, and encompassed with a balustrade: or it is a kind of open gallery for people to stand in, to behold any public show, or for taking the air in.

BALCONY, in a ship, is a gallery either covered or open, made abaft, either for ornament or convenience of the captain's cabin.

BALDACHIN, or BALDAQUIN, in architecture, a building in form of a canopy, supported by pillars, and frequently used as a covering to insulated altars. Some also use the term baldachin for the shell over a door.

BALE, in commerce, is said of merchandises packed up in cloth, and corded round very tight, in order to keep them from breaking, or preserve them from the weather.

A bale of cotton-yarn is from three to four hundred weight; of raw silk, it is from one to four hundred; of lockram or dowlass either three, three and a half, or four pieces.

BALE-*goods*, among the English merchants, are all such as are imported or exported in bales; but the French give that name to certain hardwares, and other sort of merchandise, which come to Paris, and are commonly made by bad workmen, of indifferent materials.

BALISTES, in ichthyology, a genus of fishes belonging to the order of amphibia nantes. The characters are these; the head is flat; there are eight teeth in each side, and the two anterior ones are longest; in the place of gills, the balistes has an aperture immediately above the pectoral fins; the body is flat, the scales are joined together by the skin, and the belly is keeled. There are 24 species of this genus: the most remarkable are,

1. Balistes aculeatus, which has a triradiated back fin; and the spines of the tail lean upon each other. It is a native of India.

2. Balistes hispidus has the head-fin uniradiated; and there is a round black spot in the tail fin. The body is rough, and bristly towards the tail. The spine or horn is situated between the eyes; the snout is subulated; and instead of a belly-fin, it has a jagged sharp spine. This species is a native of Carolina.

3. Balistes monoceros, whose head-fin consists of but one ray, and the tail-rays are carinated. It is called the *unicorn fish* by Catesby, who informs us that the intestines of this fish are full of small shells and coralline substances, which by the strength and hardness of its jaw it is enabled to grind very small. These fish, he adds, are not eaten, being accounted poisonous. They most frequent those seas, amongst the Bahama islands, where the corals are in greatest plenty.

4. Balistes papillosus has a biradiated back-fin, and a papillous body.

5. Balistes ringens has a triradiated back-fin; there are three folds in each side of the head, and the tail-fin is forked. It is found at Ascension Island.

6. Balistes tomentosus, whose head-fin is biradiated, and the body of it towards the hind part is hairy. It is a native of America.

7. Balistes verrucosus has a triradiated back-fin, and the tail is full of little warts. In the place of a belly-fin, this species has a large, thick, warty ray. It has 25 small reversed sharp spines at the side of the tail, disposed in four rows. It is a native of India.

8. Balistes vetula, or old wife, has a triradiated back-fin; the belly-fin is longitudinal, and somewhat carinated; and the tail is fin-forked. It is found at Ascension Island. See Plate, Nat. Hist. fig. 45.

Nearly all the fishes of this genus, which by Linnæus is divided into nineteen species,

but by later writers into twenty-four, are remarkable for their splendid colours.

BALIVO *amovendo*, in law, was a writ for removing a bailiff from his office, for want of having sufficient land in his bailiwick to answer the king and his people, according to the statute of Westminster, 2 reg. Orig. 78.

BALLS *of fire*, in meteorology, are meteors seen passing over countries, and estimated to be at considerable heights in the atmosphere.

BALL, in the military art, comprehends all sorts of bullets for fire-arms, from the cannon to the pistol.

Cannon-balls are of iron; musquet-balls, pistol-balls, &c. are of lead. The experiment has been tried of iron balls for pistols and fusees, but they are justly rejected, not only on account of their lightness, which prevents them from flying strait, but because they are apt to furrow the barrel of the pistol.

Cannon-balls are distinguished by their calibres thus:

A 42	pound ball, the diameter of which is	6,684 inches
32		6,105
24		5,547
18		5,040
12		4,403
9		4,000
6		3,498
3		2,775
2		2,423
1		1,923

BALLS, *fire*, } of which there are various
BALLS, *light*, } sorts, used for various purposes. Their composition is mealed powder two, saltpetre one and a half, sulphur one, rosin one, turpentine two and a half. Sometimes they are made of an iron shell, sometimes of a stone, filled and covered with various coats of the above composition, till it conglomerates to a proper size; the last coat being of grained powder. But the best sort is to take thick brown paper, and make a shell the size of the mortar, and fill it with a composition of an equal quantity of sulphur, pitch, rosin, and mealed powder; which being well mixed, and put in warm, will give a clear fire, and burn a considerable time.

When they are intended to set fire to magazines, buildings, &c. the composition must be mealed powder ten, saltpetre two, sulphur four, and rosin one; or rather mealed powder forty-eight, saltpetre thirty-two, sulphur sixteen, rosin four, steel or iron filings two, fir-tree saw-dust boiled in saltpetre ley two, birch-wood charcoal one, well rammed into a shell for that purpose, having various holes filled with small barrels, loaded with musket-balls; and, lastly, the whole immerged in melted pitch, rosin, and turpentine oil.

BALLS, *smoke*, are prepared as above, with this difference, that they contain five to one of pitch, rosin, and saw-dust. This composition is put into shells made for that purpose, having four holes to let out the smoke. Smoke-balls are thrown out of mortars, and continue to smoke from twenty-five to thirty minutes.

BALLS, *stink*, are prepared by a composition of mealed powder, rosin, saltpetre, pitch, sulphur, rasped horses' and asses' hoofs burnt in the fire, assafœtida, seraphim-gum or ferula, and bug or stinking herbs, made up into balls, as mentioned of *light-balls*, agreeably to the size of the mortar out of which you intend to throw them.

BALLS, *poisoned*. We are not sure that they have ever been used in Europe; but the Indians and Africans have always been very ingenious at poisoning several sorts of warlike stores and instruments. Their composition is mealed powder 4, pitch 6, rosin 3, sulphur 5, assafœtida 8, poisonous substances, chiefly euphorbia, 12, made into balls as above directed. At the commencement of the French revolution, poisoned balls were exhibited to the people, as pretended to have have been fired by the Austrians, particularly at the siege of Lisle. They contained glass, small pieces of iron, &c. and were said to be concocted together by means of a greasy composition which was impregnated with poisonous matter. In 1792 they were deposited in the archives of Paris.

BALLS, *red-hot*, are fired out of mortars, howitzers, or cannon. Use which you will, the ball must be made red-hot, which is done upon a large coal fire in a square hole made in the ground, six feet every way, and four or five feet deep. Some make the fire under an iron grate, on which the shell or ball is laid; but the best way is to put the ball into the middle of a clear burning fire, and when red-hot, all the fiery particles must be swept off. Whatever machine you use to throw the red-hot ball out of, it must be elevated according to the distance you intend it shall range, and the charge of powder must be put into a flannel cartridge, and a good wadding upon that; then a piece of wood of the exact diameter of the piece, and about three and a half inches thick, to prevent the ball from setting fire to the powder; then place the ball on the edge of the mortar, &c. with an instrument for that purpose, and let it roll of itself against the wood, and instantly fire it off. Should there be a ditch or parallel before such a battery, with soldiers, the wood must not be used, as the blast of powder will break it to pieces, and its own elasticity prevent it from flying far; it would in that case either kill or wound your own people: for this deficiency the wadding must be double.

BALLS, *chain*, are two balls linked together by a chain of eight or ten inches long, and some have been made with a chain of three or four feet long; they are used to destroy the palisadoes, wooden bridges, &c. of a fortification; they are also very destructive to the rigging of a ship.

BALL *and socket* is an instrument made of brass, with a perpetual screw, so as to move horizontally, vertically, and obliquely; and is generally used for the managing of surveying instruments, and astronomical instruments.

BALL, *puff*, the English name of the lycoperdon. See LYCOPERDON.

BALLAD generally means a kind of song, adapted to the capacity of the lower class of people. It has not, however, been always confined to low and inferior compositions. In an old English version of the Bible, Solomon's Song is designated as the *ballad of ballads*. Some have supposed that the knowledge of the ballads in common use is necessary to a minister of state to learn the temper and disposition of the people; and lord Cecil, prime minister to queen Elizabeth, is said to have made an ample collection of ballads for this purpose. See Dr. Percy's Collection of old English and Scotish Ballads, and a Dissertation prefixed to Dr. Aikin's Collection of Songs.

BALLAST, a quantity of stones, gravel, or sand, laid in a ship's hold, to make her sink to a certain depth into the water, and sail upright, rendering her of a prodigious weight. The ballast is sometimes one-quarter, one-third, or one-half, of the ship's burden, according to the difference of the bulk. Flat vessels require the most ballast.

The following table will exhibit in one view the quantity of ballast allowed to ships of different sizes:

Ballast allowed to the following ships:

Guns.	Tonnage.	Iron Tons.	Shingle Tons.
110	2290	180	370
100	2090	180	370
98	2110	160	350
90	1870	160	350
80	1620	140	300
74	1700	80	270
64	1370	70	260
50	1100	65	170
44	900	65	160
38	930	70	170
36	870	65	160
32	700	65	140
28	600	60	100
24	500	50	80
22	450	50	70
20	400	50	60
Sloop	300	50	40
Brig	160	30	15
Cutter	—	20	Seldom
Sloop	—	15	any.

The iron ballast is first stored fore and aft, from bulk-head to bulk-head; then the shingle ballast is spread and levelled over the iron.

Ships are said to be in ballast when they have no other loading. Masters of vessels are obliged to declare the quantity of ballast they bear, and to unload it at certain places. They are prohibited unloading their ballast in havens, roads, &c. inattention to which has ruined many excellent ports.

BALLET, a kind of dramatic poem, representing some fabulous action or subject divided into several acts, in which several persons appear, and recite things under the name of some deity, or other illustrious character. The term is now particularly used for a stage dance.

BALLET is likewise the name given, in France, to a whimsical kind of opera, in which dancing is a principal part of the performance. In most of these ballets the several acts seem so many different subjects, connected only by some general relation foreign to the action, which the spectator could not discover, if it was not made known in the prologue.

BALLIAGE, a small duty paid to the city of London by aliens and others for certain commodities exported by them, which they claim by their charter.

BALLISTA, in antiquity, a military machine used by the antients in besieging cities, to throw large stones, darts, and javelins.

It resembled our cross-bows, though much larger, and superior in force.

From this engine, stones of a size not less than mill-stones were thrown with so great violence, as to dash whole houses in pieces at a blow. It is described thus: a round iron cylinder was fastened between two planks, from which reached a hollow square beam, placed crosswise, and fastened with cords, to which were added screws; at one end of this stood the engineer, who put a wooden shaft with a big head into the cavity of the beam: this done, two men bent the engine by drawing some wheels: when the top of the head was drawn to the utmost end of the cords, the shaft was driven out of the ballista, &c.

BALLOON, or *ballon*, in a general sense, signifies any spherical hollow body, of whatever matter it is composed, or for whatever purposes it is designed.

Thus, with chemists, balloon denotes a round short-necked vessel, used to receive what is distilled by means of fire; in architecture, a round globe on the top of a pillar; and among engineers, a kind of bomb made of pasteboard, and played off in fire-works, either in the air or in the water, in imitation of a real bomb.

Balloon, in the French paper trade, is a term for a quantity of paper, containing twenty-four reams. It is also the name of a sort of brigantine used in the kingdom of Siam.

Balloon, *air*. See Air-balloon.

BALLOTA, white horehound, a genus of the gymnospermia order and didynamia class of plants; and in the natural method ranking under the 42d order, verticillatæ. The calyx has five teeth, with ten striæ; and the upper lip of the corolla is crenated. It is a common weed growing on the sides of banks in most parts of England, so is seldom admitted into gardens. The flowers grow in whorls, upon branching peduncles, and lean on one side of the stalk; they are commonly of a dull red colour, but sometimes white. It was formerly used in hysteric cases, but is now fallen into disuse. The Swedes reckon it almost an universal remedy in the diseases of their cattle. Horses, cows, sheep, and goats, refuse to eat it. There are five species.

BALLS, or *ballets*, in heraldry, a frequent bearing in coats of arms, usually denominated according to their colours, bezants, plates, hurts, &c.

BALLUSTRADE, a series or row of balusters, joined by a rail; serving as well for a rest to the elbows, as for a fence or enclosure to balconies, altars, staircases, &c.

BALNEUM, a term used by chemists to signify a vessel filled with some matter, as sand, water, &c. in which another is placed that requires a more gentle heat than the naked fire. Thus balneum arenosum, called also balneum siccum, or sand-heat, is when the cucurbit is placed in sand, in ashes, or filings of iron. Balneum mariæ, or maris, is when the vessel, containing the ingredients to be distilled, &c. is put into a vessel of water, which is made to boil; so that no greater heat than that of boiling water can be communicated to the substance to be treated. And balneum vaporis, or vaporarium, is when two vessels are disposed in such a manner, that the vapour raised from the water contained in the lower, heats the matter contained in the upper. See Chemistry.

BALSAM, or *native balsam*, an oily resinous, liquid substance, flowing either spontaneously, or by means of incision, from certain plants of sovereign virtue in the cure of several disorders. There are many kinds of balsams, but the most remarkable are benzoin, storax, styrax, balsam of Peru, balsam of Tolu. They owe their most important properties to the resinous ingredient.

1. *Benzoin*. This substance is obtained from the styrax benzoin, a tree which grows in Sumatra, &c. It flows from incisions made in the trunk. Benzoin comes to Europe in large masses of a light brown colour with yellow specks. It is very brittle, and breaks vitreous. When rubbed it emits a fragrant odour, and when heated sufficiently lets the benzoic acid escape. It is soluble in alcohol, but insoluble in water. It is used chiefly to perfume apartments, and extract from it benzoic acid. It has not been examined by any modern chemist. Its specific gravity is 1.092. It is considered as a compound of resin and benzoic acid.

2. *Storax*. This substance is obtained by incision from the styrax officinale, a tree which grows abundantly in the islands of the Levant, and in Italy and France. The storax is sometimes in large masses, sometimes in small tears; it is brittle, and has a brown colour. It has an aromatic taste and fragrant smell. It is soluble in alcohol, and yields benzoic acid by the usual processes. It is composed apparently of benzoic acid and resin.

3. *Styrax*. This is a semifluid juice, used in medicine on the continent, though scarcely in Britain. Its natural history is but imperfectly known; but it is said to exude from a tree called by the natives *rosamallos*, which is cultivated in Arabia. Bouillon Lagrange has published an account of its properties. Its colour is greenish, and its taste aromatic, and its smell agreeable. It is easily volatilized by heat. When treated with water, its benzoic acid is dissolved, while the other constituent remains. It is totally soluble in alcohol, except the impurities. When exposed to air it becomes harder, and absorbs oxygen. Hence we may consider it as a combination of benzoic acid and an imperfect resin.

4. *Balsam of Peru*. This substance is obtained from the myroxylon peruiferum, which grows in the warm parts of South America. The tree is full of resin, and the balsam is obtained by boiling the twigs in water. It has the consistency of honey, a brown colour, an agreeable smell, and a hot acrid taste. Like the last it consists of benzoic acid and volatile oil, not completely converted into resin. Water dissolves part of the acid, alcohol the whole balsam. It is easily volatilized by heat.

5. *Balsam of Tolu*. This substance is obtained from the toluifera balsamum, a tree which grows in South America. The balsam flows from incisions made in the bark. It comes to Europe in small gourd shells. It is of a reddish brown colour, and considerable consistence; and when exposed to the air, it becomes solid and brittle. Its smell is fragrant. The composition of this substance has not been ascertained. It is only from analogy that it has been put among the balsams. Mr. Hatchett's experiments on it are very curious and important. He has ascertained that the balsams in general are soluble in alkalies. When Tolu is dissolved in the smallest possible quantity of lixivium of potash, it completely loses its own odour, and assumes a most fragrant smell, somewhat resembling that of the clove pink. "This smell," Mr. Hatchett observes, "is not fugitive, for it is still retained by a solution which was prepared in June, and has remained in an open glass during four months." Mr. Hatchett found that it dissolved in nitric acid with nearly the same phenomena as the resins; but it assumed the odour of bitter almonds, which leads him to suspect the formation of prussic acid.

Such are the balsamic substances at present known. *Tar*, which has been sometimes placed among them, is obtained by a rude distillisation of the fir. Hence it contains a variety of ingredients, oil, resin, pyrolignous acid, water. When concentrated by heat it loses these volatile parts, and is converted into *pitch;* a substance which possesses the properties of resin.

BALSAMICS, in pharmacy, softening, restoring, healing, and cleansing medicines, of gentle attenuating principles, very friendly to nature. See Pharmacy.

BALTIMORA, in botany, a genus of the polygamia necessaria order and syngenesia class of plants. The receptaculum is chaffy; there is no pappus; the calyx is cylindrical and polyphyllous; and the ray of the corolla is quinqueflorous. There is but one species, viz. baltimora recta, a native of Maryland.

BAMBOE, or *bambou*. See Arundo.

BAMBUSA, in botany. See Arundo.

BAN, in commerce, a sort of smooth, fine muslin, which the English import from the East Indies. The piece is almost a yard broad, and runs about twenty yards and a half.

BANANA, in botany. See Musa.

BAND, in architecture, a general name for any flat, low member, or moulding, that is broad, but not very deep.

Band *of pensioners*, are a company of 120 gentlemen, who receive a yearly allowance of 100*l.* for attending on his majesty on solemn occasions.

Band is also the denomination of a military order in Spain, instituted by Alphonsus XI. king of Castile, for the younger sons of the nobility, who, before their admission, must serve ten years, at least, either in the army, or at court: and are bound to take up arms for the catholic faith against the infidels.

BANDAGE, in surgery, a fillet, roller, or swathe, used in dressing and binding up wounds, restraining dangerous hæmorrhages, and in joining fractured or dislocated bones. See Surgery.

BANDAL, or *bandle*, the name of a measure in the south of Ireland, which is something more than half a yard; but the coarse narrow linen is sold in the markets, on which account it is called *bandle-cloth*.

BANDALEER, or *bandeleer*, in military affairs, a large leathern belt, thrown over the right shoulder, and hanging under the left arm; worn by the antient musqueteers, both for the sustaining of their fire-arms, and for the carriage of their musquet-charges.

BANDE, or *inbend*, in heraldry, ex-

presses the position of a lion, when he is placed diagonally in the shield.

BANDERET, a general, or one of the commanders in chief of the forces.

BANDEROLE, in heraldry, is a stream affixed by small lines or strings immediately under the crook, on the staff of a crosier, and folding over the staff.

BANDEROLL, a little flag, in form of a guidon, extended more in length than breadth, used to be hung out on the masts of vessels, &c. It is a name also for camp colours.

BANGUE, a species of opiate, in great use throughout the east for drowning cares, and inspiring joy.

BANIANS, a religious sect in the empire of the mogul, who believe a metempsychosis, and will therefore eat no living creature, nor even kill noxious animals; but endeavour to release them when in the hands of others: whence the vulgar phrase *banian*-day for a fast.

BANISHMENT, a kind of punishment, by which the guilty person is obliged to leave the realm.

There are two kinds of banishment; one voluntary and upon oath, the other upon compulsion, for some crime or offence; the former, properly called abjuration, is now ceased; the latter is chiefly enjoined by judgment of parliament, or other courts of justice.

By Magna Charta, none shall be outlawed, or banished his country, but by lawful judgment of his peers, according to the law of the land, 9 Hen. III. 29.

BANK, in commerce, a common repository, where many persons agree to keep their money, to be always ready at their call or direction: or certain societies or communities, who take the charge of other people's money, either to improve it, or to keep it secure.

There are banks of various kinds, and different in the nature of their constitutions and establishments: some are instituted wholly on the public account, and put under the direction of the magistrates, as the famous bank of Amsterdam, where the money deposited shall be always kept for the use of the proprietors, and shall never be let out for profit or advantage.

Payments made by assignments upon this bank are valued from three to six per cent. above the payment of the money in specie, arising from an opinion that the proprietors entertain of the equity of its administration; for judging themselves secure that their money lies always ready at hand, they seldom draw out large sums, but make their mutual payments by transferring the sums from one man's account to another.

A second sort of bank is such as consists of a company of moneyed men, who being duly established, and incorporated by the laws of their country, agree to deposit a certain considerable fund, or joint stock, to be employed for the use of the society; as lending money upon good security, buying and selling bullion, gold, and silver, discounting bills of exchange, &c. Such is the bank of England, which was established in the year 1694, with a capital of 1,200,000*l.* This they lent to government, for which eight per cent. interest was paid, and 4000*l.* per annum for charges of management. The corporation was entitled "The governor and company of the bank of England;" and their charter directed that there be a governor and twenty-four directors; it also lays down rules respecting the qualifications of voters and of directors, with other regulations. In 1697 the bank was allowed to enlarge its capital to 2,201,171*l.* 10*s.* for the purpose of supporting public credit, bank notes having been at twenty per cent. discount, owing to the want of punctuality in the payments of government. This capital was allowed to increase from time to time, till at Michaelmas 1746, when the whole debt due to the bank from the public was 11,686,800*l.* and its divided capital has been raised to 10,780,000*l.*

From an early period after the establishment of the bank, it had been the practice of the company to assist government with money in anticipation of the land and malt taxes, and by making temporary advances on exchequer bills and other securities. In the year 1781, the sums thus lent to government amounted to upwards of eight millions, in addition to the permanent debt of 11,686,800*l.* The company now sought a renewal of their charter, and offered to advance two millions on exchequer bills: this being agreed to, a call was made of eight per cent. on their capital, which was now increased from 10,780,000*l.* to 11,642,400*l.* the sum on which they divide at present.

The bank of England acts not only as an ordinary bank, but as a great engine of state. It receives and pays the greater part of the annuities which are due to the creditors of the public; it circulates exchequer bills; and it advances to government, as we have already seen, the annual amount of the land and malt taxes, which are frequently not paid up for some years. It discounts bills of merchants; and upon different occasions it has supported the credit of the principal houses, not only of England, but of Hamburgh and Holland.

The company is properly a trading company; and that which is peculiarly distinguished by the appellation of bank stock is a trading stock, the dividend of which, on a capital of 11,642,400*l.* paid half yearly, and now seven per cent., besides occasional bonuses, accrues from the annual income of the company; and this arises from the interest received for the money advanced by the proprietors to the public, or the permanent debt; from interest on annual temporary advances; from the profits of their dealings in bullion, and of their discounts; from the interest of stock held by the company; and from the sums allowed by government for the management of the annuities paid at the offices of the bank.

Such is also the bank of the United States of America.

There are indeed public banks established in most of the trading cities of Europe, as in Venice, Paris, Hamburgh, &c. The bank of Venice is the most antient. It is established by a solemn edict of the commonwealth, which enacts, that all payments for wholesale merchandise, and letters of exchange, shall be in bank notes; that all debtors shall be obliged to carry their money to the bank, and all creditors receive their money from the bank; so that payments are performed by a simple transfer from the one person to the other. In matters of retail, effective payments are sometimes made, which do not diminish, but rather augment the stock, in consequence of the liberty of withdrawing their money at pleasure, &c.

A third sort is the banks of private men, or partnerships, who deal in the same way as the former, upon their own single stock or credit; and such are the Lombard-street, or other bankers, as they are called.

BANK, an elevation of the ground, or bottom of the sea, so as sometimes to surmount the surface of the water, or at least to leave it so shallow, as not to allow a vessel to remain afloat over it. Bank, in this sense, is much the same with flat, shoal, &c. There are banks of sand, and others of stone, called shelves and rocks. Sometimes the vapours at sea lead mariners to imagine that they see certain objects at a distance, these they call fog-banks. The BANK denotes that of Newfoundland, celebrated for its cod fishery: it is more than two hundred miles long. Banks at sea are usually distinguished by a buoy, the colour of which is varied. Sand-banks are denoted by light-coloured buoys, and rocks by black ones.

BANK, in vessels moved with oars, is the bench on which the rowers are seated.

BANK denotes an elevation of earth, &c. to stop the waters, and prevent inundations.

BANKAFALET, a game at cards, which being cut into as many heaps as there are players, every man lays as much money on his own card as he pleases; and the dealer wins or looses as many as his card is superior or inferior to those of the other gamesters. The best card is the ace of diamonds; the next to it the ace of hearts; then the ace of clubs; and, lastly, the ace of spades: and so of the rest of these suits in order, according to their degree. The cheat lies in securing an ace, or any other sure winning card; which are somehow marked, that the sharper may know them.

BANKER, in bricklaying, a piece of timber, six or eight feet long, and eight or nine inches square, on which they cut the bricks.

BANKRUPT, a trader whom misfortune or extravagance has induced to commit an act of bankruptcy. The benefit of the bankrupt laws is allowed to none but *actual traders*, or such as buy and sell, and gain a livelihood by so doing.

Requisites to constitute a trading: the merchandising, or buying and selling, must be of that kind, whereby the party gains a credit upon the profits of an uncertain capital stock. Manufacturers, or persons purchasing goods or raw materials to sell again under other forms, or ameliorated by labour, as bakers, brewers, butchers, shoemakers, smiths, tanners, taylors, &c. are also within the statutes.

The following description of persons are not within the statutes of bankruptcy, viz. proprietors or persons having an interest in land, if buying and selling to whatever extent, for the purposes of disposing merely of the produce and profits of such land; graziers and drovers; owners of coal-mines working and selling the coals; owners or farmers of alum-rocks; farmers who make cheeses for sale, or those who sell cyder made from apples of their own orchard. In all such cases, and others of a similar nature, where the several materials are purchased, and even a

some kind of manufacture exercised; yet as this is the necessary and customary mode of receiving the benefit arising from the land, such persons are not held to be traders within the statutes; nor are persons buying and selling bank stock or government securities. Buying or selling only will neither *singly* constitute trading; neither will a single act of buying *and* selling; or drawing or redrawing bills of exchange merely for the purpose of raising money for *private* occasions, and not with a view to gain a profit upon the exchange. Being a part-owner in a ship, barge, or waggon, does *not constitute* a trader; nor holding a share or interest in a joint-stock with others who trade, unless he share in the profit and loss upon the disposition of the capital. The merchandise must also be general, and not in a qualified manner only, as victuallers or innkeepers, schoolmasters, commissioners of the navy who victual the fleet by private contract, the king's butler, steward, or other officers; officers of excise or customs, sutlers of the armies, butlers, stewards of inns of court, clergymen, &c. as acting in such capacities *merely*, are not liable to be made bankrupts; the buying and selling in such cases not being general, but in the exercise of particular employments. Neither, upon the same principle, are receivers of the king's taxes, or persons discounting exchequer bills. If the parties above enumerated, however, are themselves within the bankrupt laws in any other respect, they will be liable to their operation, although they should evidently not profit by trading, or such trading should be illegal; although the trading should not be wholly carried on in England, buying only in England and selling beyond sea. Any person, native, denizen, or alien, residing in any part of the British dominions, or in foreign countries, though never a resident trader in England, yet if he is a trader, and coming to England commits an act of bankruptcy, he will be subject to the bankrupt laws.

No one can be a bankrupt on account of any debt which he is not compellable by law to discharge, as infants or married women. And if a single woman is a trader, and committing any act of bankruptcy, afterwards marry, a commission issued against her after such marriage cannot be supported. But according to the custom of London, where a married woman is *sole trader*, she is held liable to a commission of bankruptcy like a *feme sole*.

Acts of bankruptcy. Departing the realm. This must be done with intent to defraud or delay creditors: when it appears that there was no such intention, it will not be a departure within the meaning of the statutes. 7 T. R. 509.

Departing from the dwelling-house. Such departure must also be with intent to defraud *and delay* creditors; for the departure with an *intent* to delay, has been held insufficient, without *an actual* delay of some creditors. St. 803.

Beginning to keep the house; the being denied to a creditor who calls for money; but an *order* to be denied is not enough, without *an actual denial*, and that also to a creditor who has a debt demandable at the time. 5 T. R. 575.

Voluntary arrest, not only for a fictitious debt, but even for a just one, if done with the intent to delay creditors, is an act of bankruptcy.

Suffering an outlawry, with intent to defraud the creditors; but this will not make a man a bankrupt, if reversed before issuing a commission, or for default of proclamation after it, unless such *outlawry* was originally fraudulent.

Escaping from prison. Being arrested for a just debt of 100*l.* or upwards, and escaping against the consent of the sheriff.

Fraudulent procurement of goods to be attached or sequestered. A fraudulent execution, though void against creditors, is not within the meaning of the words *attachment*, or *sequestration*, used in the statute; because they relate only to proceedings used in London, Bristol, and other places.

Making any fraudulent conveyance. Any conveyance of property, whether total or partial, made with a view to defeat the claims of creditors, is a fraud, and if it be by deed, is held to be an act of bankruptcy.

A conveyance by a trader of all his effects and stock in trade by deed, to the exclusion of any one or more of his creditors, has been ever held to be an act of bankruptcy.

A mortgage (amongst other things) of all the stock in trade of a tradesman, was held to be an act of bankruptcy, as being an assignment of all the stock in trade, without which he could carry on no business.

A conveyance by a trader of part of his effects to a particular creditor carries no evidence whatever of fraud, unless made in contemplation of bankruptcy.

Being arrested for debt; lying in prison two months or more, upon that or any other arrest, or detention in prison for debt, will make the party a bankrupt, from the time of the first arrest; but where the bail is fairly put in, and the party at a future day surrenders in discharge of his bail, the two months are computed from the time of the surrender.

Of proceedings under a commission. The lord chancellor is empowered to issue a commission of bankrupt, and is bound to grant it as matter of right. By 5 Geo. II. c. 30. no commission can issue, unless upon the petition of a single creditor, to whom the bankrupt owes a debt which shall amount to 100*l.* the debt of two or more, *being partners*, shall amount to 150*l.* and of three or more to 200*l.*

If the debt against the bankrupt amounts to the sum required, it is not material, though the creditor should have acquired it for less.

If a creditor to the *full amount*, before an act of bankruptcy committed, receive after notice of the bankruptcy a part of his debt, such payment being illegal, cannot be retained, and the original debt remains in force, and will support a commission.

The debt must be a legal and not an equitable one, and if the legal demand be not in its nature assignable, the assignee cannot be the petitioning creditor, as the assignee of a bond.

If the creditor, for a debt at law, has the body of his debtor in execution, he cannot at the same time sue out a commission upon it; that being, in point of law, a satisfaction for the debt.

Of opening the commission. When the commissioners have received proof of the petitioning creditor's debt, the trading, and act of bankruptcy, they declare and adjudge the party a bankrupt. They are authorized to issue a warrant under their hands and seals, for the seizure of all the bankrupt's effects, books, or writings, and for that purpose to enter the house, or any other place belonging to the bankrupt.

Such debts only can be proved under a commission, as were either debts certainly payable, and which existed at the time of the bankruptcy, or which although originally contingent, yet, from the contingency happening before the bankruptcy, were become absolute. In every case the amount of the debt must be precisely ascertained.

Time and method of proving. Creditors were formerly precluded from proving after four months; but the court now, except in cases of gross negligence, allows them to come in at any time, whilst any thing remains to be disposed of. The usual proof required, is the oath of the creditor himself; either in person, or by affidavit if he live remote from the place of meeting, or reside in foreign parts. 5 Geo. II.

Corporations, or *companies*, are generally admitted to prove by a treasurer, clerk, or other officer duly authorized.

Of the assignees. Immediately after declaration of the bankruptcy, the commissioners are to appoint a time and place for the creditors to meet and choose assignees, and are directed to assign the bankrupt's estate and effects to such persons as shall be chosen by the major part in value.

The powers and duties of assignees are principally those of collecting the bankrupt's property, reducing the whole into ready money, and making distribution as early as possible. One assignee is not answerable for the neglect of another. Assignees, if they act improperly, are not only liable at law to the creditors for a breach of trust, but may be removed on account of misbehaviour, &c. by petitioning the lord chancellor. Upon the removal of an assignee, he is directed to join with the remaining one, in assignment to the latter and new assignee.

Provisions for wife, children, &c. By the statute of Eliz. the commissioners may assign any lands, &c. that the bankrupt shall have purchased jointly with his wife, and the assignment shall be effectual, against the bankrupt, his wife, or children; but this shall not extend to conveyances made before the bankruptcy *bona fide*, and not to the use of the bankrupt himself only, or his heirs, and where the parties to the conveyance are not privy to the fraudulent purposes to deceive the creditors.

Examination of the bankrupt. By the 5th Geo. II. the commissioners are empowered to examine the bankrupt, and all others, as well by parole, as by interrogations in writing. The said statute requires the bankrupt to discover all his estate and effects, and how, and to whom, and in what manner, on what consideration, and at what time, he has disposed of it; and all books, papers, and writings, relative thereto, of which he was possessed or interested, or whereby he or his family may expect any profit, advantage, &c. and on such examination he shall deliver up to the commissioners all his effects, (except the necessary wearing apparel of himself, his wife, and

children), and all books, papers, and writings, relating thereto.

With respect to his privilege from arrest. By the above act, the bankrupt shall be free from all arrest in coming to surrender, and from his actual surrender to the commissioners for and during the forty-two days, or the further time allowed to finish his examination, provided he was not in custody at the time of his surrender.

Books and papers. By 5 Geo. II. c. 30. the bankrupt is entitled, before the expiration of the forty-two days, or enlarged time, to inspect his books and papers, in the presence of the assignees, or some person appointed by them, and make such extracts as he shall deem necessary.

Power of commissioners in case of contumacy. The statutes empower the commissioners to enforce their authority by commitment of the party, in the following cases: persons refusing to attend on the commissioners' summons; refusing to be examined, or to be sworn, or to sign and subscribe their examination, or not fully answering to the satisfaction of the commissioners.

Of the certificate. By the 5 Geo. II. a bankrupt surrendering, making a full discovery, and in all things conforming to the directions of the act, may with the consent of his creditors obtain a certificate. If the commissioners certify his conformity, and the same be allowed by the lord chancellor, his person, and whatever property he may afterwards acquire, will be discharged and exonerated from all debts owing by him at the time he became a bankrupt. But no bankrupt is entitled to the benefit of the act, unless *four parts in five,* both in number and value of his creditors, who shall be creditors for not less than 20*l.* respectively, and who shall have duly proved their debts under the commission, or some other person duly authorized by them, shall sign the certificate.

Of the dividends. The assignees are allowed four months from the date of the commission to make a dividend; and should apply to the commissioners to appoint a meeting for that purpose, or they may be summoned by them to shew cause why they have not done so.

Allowance to the bankrupt. Every bankrupt surrendering, and in all things conforming to the directions of the act, shall be allowed five per cent. out of the nett produce of his estate, provided, after such allowance, it be sufficient to pay his creditors ten shillings in the pound, and that the said five per cent. shall not in the whole exceed 200*l.* Should his estate in like manner pay 12*s.* 6*d.* in the pound, he shall be allowed seven and a half per cent. so as not to exceed 250*l.* and if his estate pay 15*s.* in the pound, he shall be allowed ten per cent. so as not to exceed 300*l.* But the bankrupt is not entitled to such allowance, till after a second dividend, nor can he be entitled to it till he has received his certificate.

Of the surplus. The commissioners are, on request of a bankrupt, to give a true and particular account of the application and disposal of his estate, and to pay the overplus, if any, to the bankrupt.

Of superseding commissions. Commissions may be superseded for the want of a sufficient debt of the petitioning creditor, or because he was an infant, or for want of sufficient evidence of the trading or act of bankruptcy, or in cases of fraud, or by agreement or consent of the creditors.

Joint commissions. Partners are liable to a joint commission, or individually, against each; but a joint and separate commission cannot in point of law be concurrent. A joint commission must include all partners; if there be three partners, and one of them an infant, there can neither be a commission against the three, nor against the other two.

Felony of bankrupts. If any person, who shall be duly declared a bankrupt, refuse, within forty-two days after notice left at his place of abode, and in the London Gazette, to surrender himself to the commissioners, and to fully disclose and discover all his estate and effects, real and personal, and all transferences thereof, and also all books, papers, and writings, relating thereto; and deliver up to the said commissioners, all such estate and effects, books, papers, &c. as are in his power (except his necessary wearing apparel, &c.); or in case he shall conceal, or embezzle, any part of his estate, real or personal, to the value of 20*l.*, or any books of accounts, papers, or writings, relating thereto, with *intent to defraud his creditors,* being lawfully convicted thereof, by judgment or information, he shall be adjudged guilty of felony, without benefit of clergy, and his goods divided amongst his creditors. 5 Geo. II. c. 30.

BANKSIA, in botany, a genus of the monogynia order, belonging to the tetandria class of plants. The amentum is scaly, the corolla consists of four petals; the antheræ are in the cavity of the folds, and sessile; the capsule is bivalvular; and the seed is solitary and bipartite. There are eight species, all greenhouse plants, and natives of New Holland.

BANN, or BAN, in the feudal law, a solemn proclamation or publication of any thing. Hence the custom of asking, or bans, before marriage.

BANN, in military affairs, a proclamation made in the army by beat of drum, sound of trumpet, &c. requiring the strict observance of discipline, either for the declaring a new officer, or punishing an offender. At present such kind of proclamations are given out in the written orders of the day.

BANN *of the empire,* an imperial proscription, being a judicial punishment, wherewith such as are accessary in disturbing the public peace are judged unworthy of the immunities and protection of the empire, and are outlawed or banished, &c.

BANNER. We find a multiplicity of opinions concerning the etymology of this word; some deriving it from the Latin bandum, a band or flag; others, from the word bann, to summon the vassals to appear in arms; others, again, from the German ban, a field or tenement, because landed men alone were allowed a banner; and, finally, there are some who think it is a corruption of panniere, from pannus, cloth, because banners were originally made of cloth.

BANNER, the ordnance-flag fixed on the fore-part of the drum-major's kettle-drum carriage of the royal artillery.

BANNER, in the horse equipage, for the kettle-drums and trumpets, must be of the colour of the facing of the regiment. The badge of the regiment, or its rank, to be in the centre of the banner of the kettle-drums, as on the second standard. The king's cypher and crown to be on the banner of the trumpets, with the rank of the regiment in figures underneath. The depth of the kettle-drum banners to be three feet six inches; the length four feet eight inches, excluding the fringe. Those of trumpets to be twelve inches in depth, and eighteen inches in length.

BANNERET, an ancient order of knights, or feudal lords, who possessing several large fees, led their vassals to battle under their own flag, when summoned thereto by the king. This order never was conferred but upon some heroic action performed in the field. Anciently there being but two kind of knights, great and little, the first were called bannerets, the second bachelors; the first composed the upper, the second the middle nobility. Till lately we have had none of this order created in England since the time of king Charles the First; the late sir William Erskine, however, on his return from the continent in 1764, was made a knight banneret, in Hyde-park, by his present majesty, in consequence of his distinguished conduct at the battle of Emsdorff. But he was not acknowledged as such in this country, although he was invested with the order between the two standards of the fifteenth regiment of light dragoons, because the ceremony did not take place where the engagement happened. Captain Trollope, of the royal navy, is the last-created knight banneret. Knights banneret take precedence next to knights of the bath.

The form of the banneret's creation was this: on a day of battle, the candidate presented his flag to the king, or general, who cutting off the train or skirt thereof, and making it a square, returned it again; the proper banner of bannerets, who from hence are sometimes called knights of the square flag.

BANNEROLS, in heraldry, are small flags used at funerals.

BANNISTERIA, in botany: a genus of the trigynia order, and decandria class of plants; and in the natural method ranking under the 23d order, trihilatæ. The calyx is quinquepartite, with nectareous pores on the outside of the base; the petals are roundish and ungulated; the seeds are three, with membranaceous wings. There are 24 species, all natives of warm countries, but possessing no remarkable properties.

BANNIMUS, the form of expulsion of any member from the university of Oxford, by affixing the sentence up in some public place, as a denunciation of it.

BANQUET, in the manege, that small part of the branch of a bridle that is under the eye.

BANQUET-LINE, an imaginary line drawn, in making a bitt, along the banquet, and prolonged up or down, to adjust the designed force or weakness of the branch, in order to make it stiff or easy.

BANQUET, or Banquette, in fortification, a little foot bank, or elevation of earth, forming a path, which runs along the inside of a parapet, upon which the musqueteers get up, in order to discover the counterscarp, or to fire on the enemy in the moat, or in the covert-way.

BANTAM-WORK, a kind of painted or carved work, resembling that of Japan, only more gaudy.

There are two sorts of Bantam as well as Japan work: as in the latter, some are flat, and others embossed; so in Bantam work some are flat, and others cut in, or carved into the wood. The Japan artists work in gold and other metals, and the Bantam generally in colours, with a small sprinkling of gold.

BAPTES, a name give by the ancients to a fossil substance used in medicine: it was soft and of an agreeable smell, and probably one of the bitumens.

BAR, in courts of justice, an inclosure made with a strong partition of timber, where the counsel are placed to plead causes. Hence our lawyers, who are called to the bar, or licensed to plead, are termed barristers, an appellation equivalent to licentiate in other countries.

Bar, in law, a plea of a defendant, which is said to be sufficient to destroy the plaintiff's action. It is divided into bar special, bar to common intendment, bar temporary, and bar perpetual. Bar special, falls out upon some special circumstances of the case in question, as where an executor being sued for his testator's debt, pleads that he had no goods in his hands at the day on which the writ was sued out. Bar to common intendment is a general bar, which commonly disables the plaintiff's declaration. Bar temporary is such as is good for the present, but may afterwards fail; and bar perpetual is that which overthrows the plaintiff's action for ever. In personal actions, once barred and ever so, is the general rule; but it is intended, where a bar is to the right of the cause, not where a wrong action is brought.

Bar, in heraldry, an ordinary in form of the fess, but much less. It differs from the fess only in its narrowness, and in this, that the bar may be placed in any part of the field, whereas the fess is confined to a single place.

Bar, in the manege, the highest part of that place of a horse's mouth situated between the grinders and tushes.

Bar, a stroke drawn perpendicularly across the lines of a piece of music, including between each two a certain quantity or measure of time, which is various as the time of the music is either triple or common. In common time, between each two bars is included the measure of four crotchets; in triple, three. The principal use of bars is to regulate the beating of time in a concert.

Bar, in hydrography, denotes a bank of sand, or other matter, whereby the mouth of a river is in a manner choked up.

BARALIPTON, among logicians, a term denoting the first indirect mode of the first figure of syllogism. A syllogism in baralipton, is when the two first propositions are general, and the third particular, the middle term being the subject in the first proposition, and the predicate in the second. Thus:

Every evil ought to be feared:
Every violent passion is an evil;
Therefore something that ought to be feared is a violent passion.

BARALLOTS, a sect of Manicheans at Bologna in Italy, who had all things in common, even their wives and children.

BARANGI, officers among the Greeks of the lower empire. Cujas calls them in Latin protectores, and others give them the name of securigeri. It was their business to keep the keys of the city-gates where the emperor resided.

BARATHRUM, in antiquity, a deep dark pit at Athens, into which condemned persons were cast headlong. It had sharp spikes at the top, that no man might escape out, and others at the bottom to pierce and torment such as were cast in.

The term is also applied to certain baleful caverns, inaccessible on account of their fetid or poisonous fumes.

BARBACAN, or Barbican, a watch-tower, for the purpose of descrying an enemy at a great distance: it also implies an outer defence, or sort of ancient fortification to a city or castle, used especially as a fence to the city or walls; also an aperture made in the walls of a fortress to fire through upon the enemy. It is sometimes used to denote a fort at the entrance of a bridge, or the outlet of a city, having a double wall with towers.

BARBADOES-TAR. See Bitumen.

BARBICAN, in architecture, a canal, or opening left in the wall, for water to come in and go out, when buildings are erected in places liable to be overflowed, or to drain off the water from a terras, or the like.

BARBARA, among logicians, the first mode of the first figure of syllogisms.

A syllogism in barbara, is one of which all the propositions are universal, and affirmative; the middle term being the subject of the first proposition, and attribute in the second. For example,

Bar. Every wicked man is miserable:
Ba. All tyrants are wicked men;
Ra. Therefore all tyrants are miserable.

BARBATED *leaf*, one terminated by a bunch of strong hairs.

BARBE, in commerce, a Barbary horse, greatly esteemed for its beauty, strength, and swiftness.

Barbe, in the military art: to fire in barbe means to fire the cannon over the parapet instead of firing through the embrasures; in which case the parapet must not be above three feet and a half high.

Barbe, or *Barde*, is an old word, denoting the armour of the horses of the antient knights and soldiers.

BARBED and Crested, in heraldry, an appellation given to the combs and gills of a cock, when particularised for being of a different tincture from the body.

A barbed cross is a cross, the extremities of which are like the barbed irons used for striking of fish.

BARBELICOTÆ, in church-history, a sect of gnostics, who affirmed that an immortal eon had commerce with a virgin called Barbelath, to whom he granted successively the gift of prophecy, incorruptibility, and eternal life.

BARBER, one who makes a trade of shaving, or trimming, the beards of other men, for money. Besides curling the hair, and shaving, the ancient barbers trimmed the nails. Formerly some musical instrument was part of a barber's stock in trade; and it was customary for persons above the common rank to resort to his shop, either for surgical operations, or for shaving, &c. The music was for the amusement of the waiting customers, and answered the same purpose as a newspaper in modern times. Barbers were uniformly bleeders; and the *pole* now used as a sign, was a representation of the staff which was put into the hand of a person undergoing the operation of phlebotomy. The white band which surrounds it is designed to represent the fillet that binds up the arm. The surgeon-barbers were incorporated by Henry the VIIIth, and separated from the surgeons by an act of Anne.

BARBET, in *ornithology*, the name of a *genus* of birds in Latham's Synopsis, corresponding with the bucco of Linnæus. Barbets are described as a dull stupid race of birds, inhabiting the tropical climates. They probably take their name from the strong bristles which surround the bill. They are in general larger than a lark, and vary in plumage, being black, green, reddish, pied, &c. See Bucco.

BARBING, is sometimes used for shearing: by an ancient statute, cloth was not to be sold, till barbed, rowed, and shorn.

BARBLES, or Barbs, in farriery, the knots of superfluous flesh that grow up in the channels of a horse's mouth, that is, in the intervals that separate the bars, and lie under the tongue.

BARCALON, an appellation given to the prime minister of the king of Siam.

BARCONE, a short and broad vessel used in the Mediterranean for the carriage of corn, salt, and other provisions, from one place to another.

BARDESANISTS, christians of the second century, who maintained that the devil was a self-existent independent being; that Jesus Christ was not born of a woman, but brought his body with him from heaven; and denied the resurrection of the body.

BAREGE-*waters*, are celebrated for their mineral virtues: they are situated at Barege on the French side of the Pyrenées, and differ in the degree of temperature from 120 degrees, to 73 degrees. By analysis they are found to contain sulphurated hydrogen and soda, some common salt, and a bitumen. See Mineral Waters.

BAR-FEE, a fee of twenty-pence, which every prisoner acquitted of felony pays to the gaoler.

BARGAIN and Sale. See Contract.

BARGE-COURSE, with bricklayers, a term used for that part of the tiling which projects over without the principal rafters, in all sorts of buildings, where there is either a gable or kirkin-head.

BARGHMOTE, a court which takes cognizance of causes and disputes between miners. By custom of the mines, no person is to sue a miner for ore, debt, &c. but in this court, on penalty of forfeiting the debt, and paying the charge at law.

BARILLA, a kind of Spanish alkaline salt used in the glass trade. It is procured by burning to ashes several plants of the kali kind. It is brought over in brown speckled masses, without smell and strongly alkaline. See Soda.

BARK, in the anatomy of plants, the exterior part of trees, corresponding to the skin of an animal. See Physiology of Plants.

Bark, in navigation, a little vessel with two or three triangular sails; but, according to Guillet, it is a vessel with three masts, viz. a main-mast, fore-mast, and mizen-mast.

Bark, or Jesuit's Bark. See Cinchona.

BARK-BED, in *gardening*, that sort of hot-bed, which is wholly or principally constituted of tanner's bark, commonly employed in a hot-house, because it retains its heat longer and emits less steam than a hot-bed of horse-dung.

BARK-BOUND, a disease in trees thought to be capable of being cured by making a slit or opening through the bark.

BARK-LONGUE, or Barca Longa, a small low sharp-built but very long vessel, without a deck. It goes with sails and oars, and is very common in Spain.

BARLERIA, a genus of the angiospermia order, and didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The calyx is quadripartite; two of the stamina are much less than the rest; the capsule is quadrangular, bilocular, bivalved, elastic, and without claws; and the seeds are two. There are eleven species; all natives of the warm parts of America, and therefore require to be kept in a stove, and treated like other tender exotics. They possess no great beauty nor any remarkable property; but are kept for the sake of variety.

BARLEY. See HORDEUM.

BARLEY-CORN, the least of our long-measures, being the third of an inch.

BARLEY, *pearl*, and *French* BARLEY, are barley freed from the husk, and rounded by a mill; the distinction between the two being that the *pearl* barley is reduced to the size of small shot, all but the heart being ground away.

BARM. See YEAST.

BARNABITES, a religious order, founded in the sixteenth century, by three Italian gentlemen, who had been advised by a famous preacher of those days to read carefully the epistles of St. Paul. Hence they were called clerks of St. Paul, and Barnabites, because they performed their first exercise in a church of St. Barnabas at Milan. Their habit is black, and their office is to instruct, catechise, and serve in mission.

BARNACLE, or BERNICLE, in ornithology. See ANAS.

BARNACLES, in farriery, an instrument composed of two branches joined at one end with a hinge, to put upon horses' noses when they will not stand quietly to be shod, blooded, or dressed.

BARNADESIA, in botany; a genus of the polygamia æqualis order, and syngenesia class of plants; the characters of which are: the corolla is radiated; the calyx is naked, imbricated, and pungent; the pappus of the rays feathery, of the disk bristly and retrofracted. There is but one species, viz.

Barnadesia Spinosa, a native of South America.

BAROCO, in logic, a term given to the fourth mode of the second figure of syllogisms. A syllogism in baroco has the first proposition universal and affirmative, but the second and third particular and negative, and the middle term is the predicate in the two first propositions. For example:

Every virtue is attended with discretion:
Some kinds of zeal are not attended with discretion;
Therefore some kinds of zeal are not virtues.

BAROMETER, a machine for measuring the weight of the atmosphere. The barometer is founded on an experiment of Torricelli, who considering that a column of water of about thirty-three feet was equal in weight to a column of air of the same base, concluded that a column of mercury, no longer than about twenty-nine inches and a half, would be so too, such a column of mercury being as heavy as thirty-three feet of water. Accordingly he tried the experiment, and the apparatus he made use of is now the common barometer or weather-glass.

The tubes of which barometers are made ought to be at least one fourth of an inch bore; but one third or even one half of an inch is better. The tube should be new, and perfectly clean within. In order to this, it should be hermetically sealed at both ends, at the glass-house, when made; one of the ends may be cut off with a file, when you use it. The mercury ought to be perfectly pure, and should be purged from air by boiling it in a tube.

To fill the tube with mercury, warm it, and pour some mercury into it by a small paper funnel, so as to reach within an inch of the top; you will see that as the tube fills, there are bubbles of air in several parts. When the tube is full, apply your finger hard against the open end, and invert it; by which means the air that was on the top, now rising through all the quicksilver, gathers every bubble in its way. Turn the tube up again, and the bubble of air re-ascends; and, if there are many small bubbles left, carries them away. If, however, any remain, the operation must be repeated. The tube is now to be filled to the top, and stopping the open end with the finger, must be inverted into a bason of mercury. When the end of the tube is perfectly plunged under the surface of the mercury, the finger must be taken away, and the mercury in the tube will subside, remaining suspended at the height of 29 or 30 inches, according to the pressure of the atmosphere at the time. The space at the top of the tube is a perfect vacuum.

The following is a still better way of filling the tube: Pour the purest mercury into the tube (which must be very dry and well cleaned), to within two inches of the top, and then hold it with the sealed end lowest, in an inclined position, over a chafing-dish of burning charcoal, placed near the edge of a table, in order that all parts of the tube may be exposed successively to the action of the fire, by moving it obliquely over the chafing-dish. The sealed end is to be first gradually presented to the fire. As soon as the mercury becomes hot, the internal surface of the tube will be studded with an infinite number of air-bubbles, giving the mercury a kind of grey colour: these increase in size by running into one another, and ascend towards the higher parts of the tube, where, meeting with a cooler part of the fluid, they are condensed, and nearly disappear. In consequence, however, of successive emigrations towards the upper parts of the tube, which are successively heated, they finally acquire a bulk, which enables them in their united form entirely to escape. When the first part of the tube is sufficiently boiled, move it onward, by little and little, through its whole length. When the mercury boils, its parts strike against each other, and against the sides of the tube, with such violence, that a person unacquainted with the operation, naturally apprehends the destruction of his tube. By this process the mercury is entirely deprived of the air which adhered to it.

The tube is now fixed with its bason to a wooden frame prepared for it, having a scale of inches at the upper end, which is accurately measured from the surface of the mercury in the cistern. (Plate IX. Miscel. fig. 6.) Fig. 7 shews the scale or vernier at the top, drawn larger.

This is the common construction of the barometer, and is still found to be the best. However, as the space through which the upper part of the mercury in the tube has to rise and fall does not exceed three inches, from 28 inches to 31 above the mercury in the bason, several contrivances have been used to increase the scale, and thereby shew more sensibly small changes; the chief of which are the following:

The diagonal barometer. A B C (fig. 8) is a tube sealed at C, immersed in mercury at A; this tube is perpendicular from A to B, where the scale of variation begins; thence it is bent into B C. This part B C proceeds to the highest limit in the scale of variation, viz. I C; and consequently, while the mercury rises from I to C in the common barometer, it will move in this from B to C; and so the scale will be by this means enlarged in the proportion of B C to I C.

This form however, being subject to a great degree of friction, on account of the obliquity in the part B C, which inclination makes the quicksilver frequently divide into several parts, it requires the trouble of filling tubes anew too often.

The horizontal, or rectangular barometer, consists of a tube A C D F (fig. 9), sealed on the upper end A, and bent to a right angle at D. The mercury stands in both legs from E to C. Here it is evident, that in moving three inches from A to C, it will move through so many times three inches in the small leg D F, as the bore of D F is less than the bore of A C, whence the motion of the mercury at E must be extremely sensible. This form is liable to the same exceptions as remarked in that of fig. 8; and, besides a great degree of friction, and the frequent breaking off of the mercury in the leg E, the part D F being a very small bore, the free motion of the mercury must be impeded by the attraction of cohesion.

The wheel barometer. A (fig. 10), represents the quicksilver in a glass tube, having a large round head or ball, and turned up at bottom B; upon the surface of the mercury in the recurved leg, there is then placed a short glass tube loaded with mercury, with a string going over a pulley, and is balanced by another weight hanging freely in the air: As the surface at A is very large, and that at B very small, the motion of the quicksilver and consequently of the ball, will at the bottom be very considerable; but as the weight moves up and down, it turns the pulley, and that a hand or index; and by the divisions of a large graduated circle, the minutest variations of the air are plainly shewn, if the instrument is accurately made, and the friction of the several parts inconsiderable.

There is also a barometer, contrived so as not to be affected by the motion of a ship, called the marine barometer.

Also a portable barometer, for moving from place to place without injury; and for measuring the heights of mountains, by observing the difference of the altitude of the mercury at the bottom and top of the mountain.

A thermometer should always be attached to the barometer, as a necessary appendage; and by the side of it a scale of correction, to shew how much to add or subtract from the height of the mercury in the barometer for the degree of temperature; for it is evident that the mercury in the tube will be affected by heat and cold in the same manner as the thermometer, and on that account it will not shew the true weight of the atmosphere. This correction is, therefore, very necessary.

Ever since it was observed that a change of weather generally accompanied or followed a variation in the height of the barometer, it has been used as a prognostic of the weather. A great variety of observations have been made by different people, relative to the effect which certain changes of weather have upon this instrument; and thence they have derived a system of rules, to enable any one to know what change will happen in the weather, by knowing the alteration that has taken place in the height of the mercury.

Before we proceed to mention the rules, which are the result of the long observation and experience of philosophers, it is necessary to observe, that they are by no means so certain, and so much to be depended upon, as many people suppose. So numerous are the causes that affect the state of the atmosphere, with which we are but little acquainted, that no single instrument can point out with precision the alterations likely to happen. Besides the barometer, there are several other instruments used for meteorological purposes, such as the thermometer, hydrometer, wind-gage, rain-gage, electrometer, &c. with which we shall become acquainted in their turn. To be best enabled to prognosticate the change of weather, accurate observations ought to be made with all these instruments, aided by considerable experience and the knowledge of natural philosophy and chemistry; and even then, it requires more science than we are possessed of, to predict with certainty the alterations of the weather. See METEOROLOGY.

As the barometer, however, is the most useful of these, and as it undoubtedly affords us considerable assistance, we shall lay down such directions as are most approved of for this purpose.

1. The rising of the mercury presages, in general, fair weather; and its falling, foul weather; as rain, snow, high winds, and storms. 2. In very hot weather, the falling of the mercury foretells thunder. 3. In winter, the rising presages frost; and in frosty weather, if the mercury falls three or four divisions, there will certainly follow a thaw. But in a continued frost, if the mercury rises, it will certainly snow. 4. When foul weather happens soon after the falling of the mercury, expect but little of it; and, on the contrary, expect but little fair weather, when it proves fair shortly after the mercury has risen. 5. In foul weather, when the mercury rises much and high, and continues so for two or three days before the foul weather is quite over, then expect a continuance of fair weather to follow. 6. In fair weather, when the mercury falls much and low, and thus continues for two or three days before the rain comes, then expect a great deal of wet, and probably high winds. 7. The unsettled motion of the mercury denotes uncertain and changeable weather. 8. You are not so strictly to observe the words engraved on the plates (though in general it will agree with them), as the mercury's rising and falling; for if it stands at much rain, and then rise up to changeable, it presages fair weather; though not to continue so long as if the mercury had risen higher; and, on the contrary, if the mercury stood at fair, and falls to changeable, it presages foul weather; though not so much of it as if it had sunk lower.

From these observations it appears, that it is not so much the height of the mercury in the tube that indicates the weather, as the motion of it up and down; wherefore, in order to form a right judgment of what weather is to be expected, we ought to know whether the mercury is actually rising or falling; to which end, the following rules are of use:

1. If the surface of the mercury is convex, standing higher in the middle of the tube than at the sides, it is generally a sign that the mercury is then rising. 2. If the surface is concave, it is then sinking. And, 3. if it is level, the mercury is stationary, or rather, if it is a little convex; for mercury, being put into a glass tube, especially a small one, will naturally have its surface a little convex, because the particles of mercury attract one another more forcibly than they are attracted by glass. If the glass is small, shake the tube; and then if air is grown heavier, the mercury will rise about half the tenth of an inch higher than it stood before; if it is grown lighter, it will sink as much. This proceeds from the mercury's sticking to the sides of the tube, which prevents the free motion of it until it is disengaged by the shock; and therefore, when an observation is to be made by such a tube, it ought always to be shaken first; for sometimes the mercury will not vary of its own accord, until the weather it ought to have indicated is present.

Here we must observe, that the above-mentioned phenomena are peculiar to places lying a considerable distance from the equator; for in the torrid zone, the mercury in the barometer seldom either rises or falls much. In Jamaica, it is observed by sir William Beeston, that the mercury in the morning constantly stood at one degree below changeable, and at noon sunk to one degree above rain; so that the whole scale of variation there was only three-tenths of an inch. At St. Helena, too, where Dr. Halley made his observations, he found the mercury to remain almost stationary, whatever weather happened. Of these phenomena, their causes, and why the barometer indicates an approaching change of weather, the doctor gives us the following account:

1. In calm weather, when the air is inclined to rain, the mercury is commonly low. 2. In serene, good, and settled weather, the mercury is generally high. 3. Upon very violent winds, though they are not accompanied with rain, the mercury sinks lowest of all, with relation to the point of the compass the wind blows upon. 4. The greatest heights of the mercury are found upon easterly or north-easterly winds. 5. In calm frosty weather, the mercury generally stands high. 6. After very great storms of wind, when the mercury has been very low, it generally rises again very fast. 7. The more northerly places have greater alterations of the barometer than the more southerly. 8. Within the tropics, and near them, according to the accounts we have had from others, and the observations made at St. Helena, the changes of the weather made very little or no variation in the height of the mercury.

Hence it is thought that the principal cause of the rise and fall of the mercury is from the variable winds which are found in the temperate zone, and whose great inconstancy in England is notorious.

A second cause is, the uncertain exhalation and precipitation of the vapours lodging in the air, whereby it is at one time much more crowded than at another, and consequently heavier; but this latter depends in a great measure upon the former. Now, from these principles we may explain the several phenomena of the barometer, taking them in the same order as they are laid down. Thus,

1. The mercury being low, indicates rain; because the air being light, the vapours are no longer supported by it, being become specifically heavier than the medium in which they floated; so that they descend towards the earth, and, in their fall, meeting with other aqueous particles, they incorporate together, and form little drops of rain: but the mercury's being at one time lower than another, is the effect of two contrary winds blowing from the place where the barometer stands; whereby the air of that place is carried both ways from it, and consequently the incumbent cylinder of air is diminished, and accordingly the mercury sinks: as, for instance, if in the German Ocean it should blow a gale of westerly wind, and at the same time an easterly wind in the Irish Sea; or if in France, it should blow a northerly wind, and in Scotland a southerly; it must be granted, that that part of the atmosphere impendent over England would be exhausted and attenuated, and the mercury would subside, and the vapours which before floated in these parts of the air of equal gravity with themselves, would sink to the earth.

2. The greater height of the barometer is occasioned by two contrary winds blowing towards the place of observation, by which the air of other places is brought thither and accumulated; so that the incumbent cylinder of air being increased both in height and weight, the mercury pressed by it must needs stand high, as long as the winds continue so to blow; and then the air being specifically heavier, the vapours are kept suspended, so that they have no inclination to precipitate, and fall down in drops; which is the reason of the serene good weather which attends the greater heights of the mercury.

3. The mercury sinks the lowest of all by the very rapid motion of the air in storms of wind. For the tract or region of the earth's surface, in which the winds rage, not extending all round the globe, that stagnant air which is left behind, as likewise that on the sides, cannot come in so fast as to supply the

Abacus, or Counting Board.

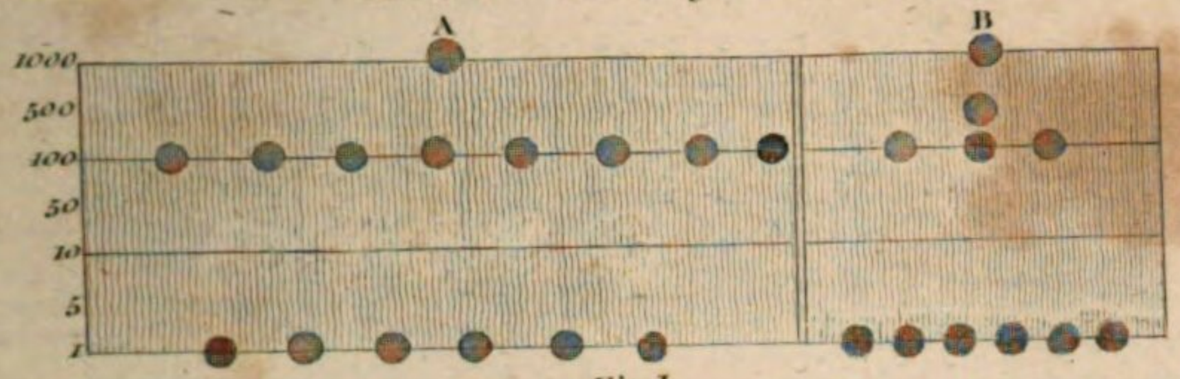


Fig. 1.

Aberration of Light.

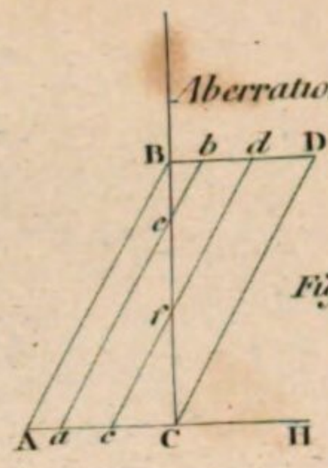
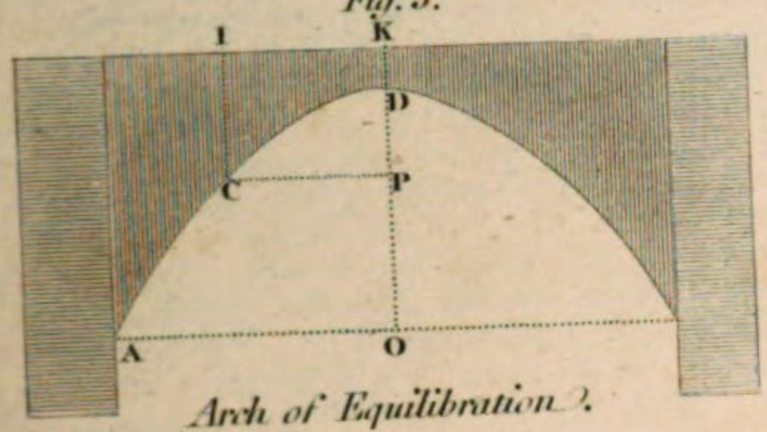


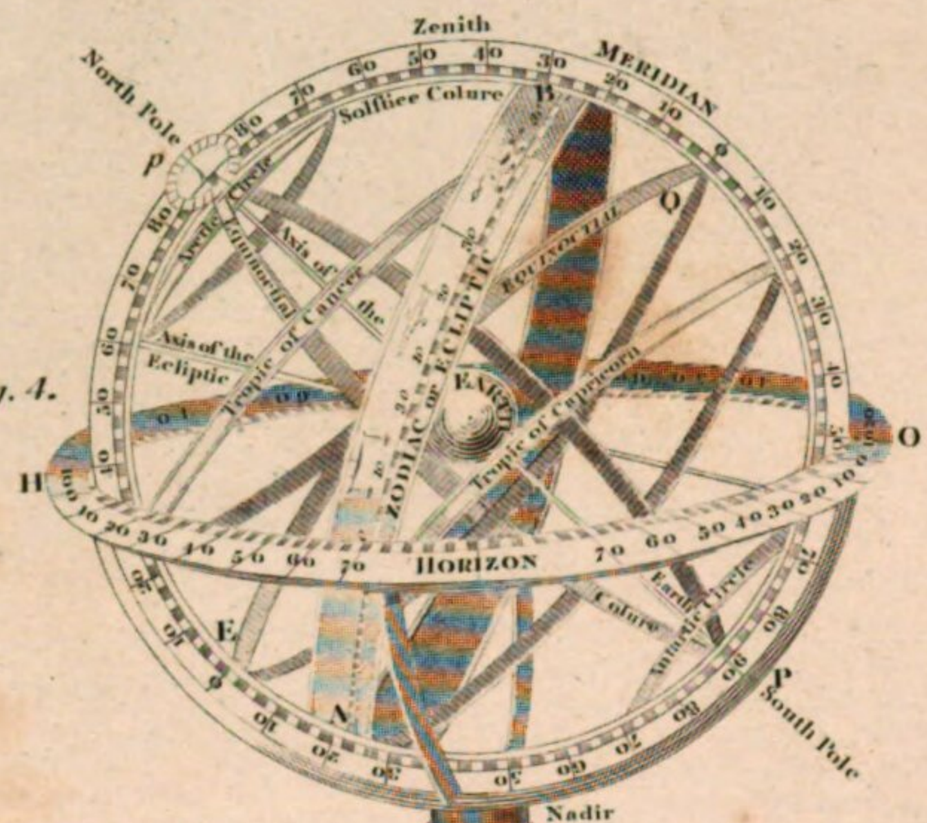
Fig. 2.

Fig. 3.



Arch of Equilibration.

Fig. 4.



Armillary Sphere.

Astrolabe.

Fig. 5.

Fig. 6. *Barometer.*

Cardioid.

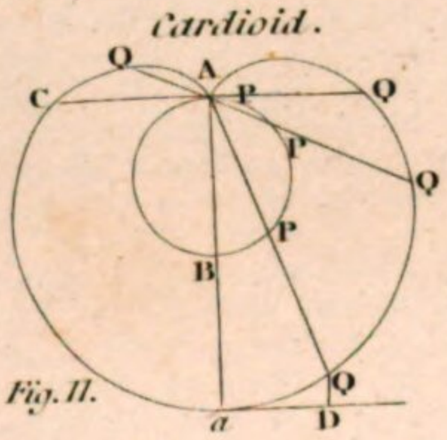
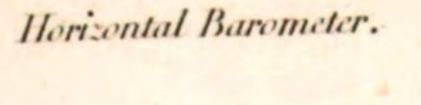


Fig. 11.

Diagonal Barometer.

Fig. 8.

Fig. 9.



Horizontal Barometer.

Vernier.

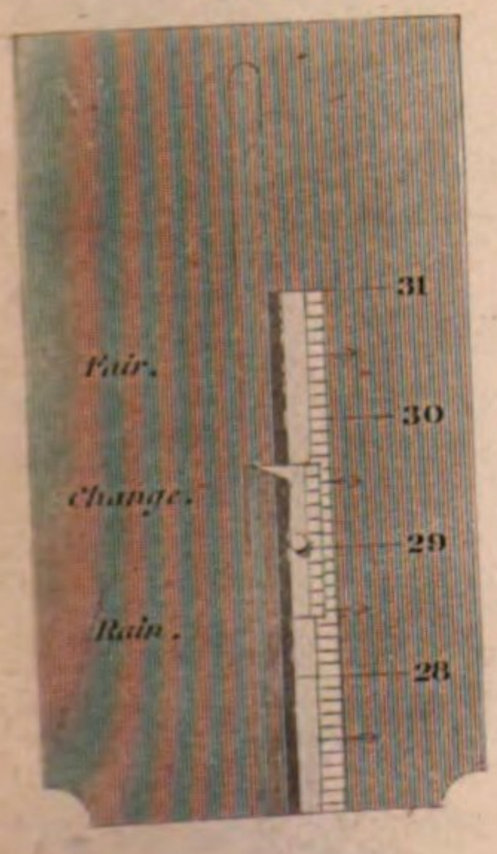


Fig. 7.

Catacaustic Curve.

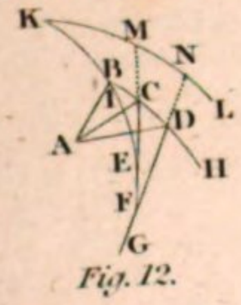


Fig. 12.

Catenaria.

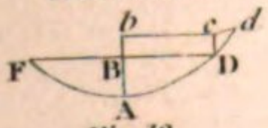


Fig. 13.

Wheel Barometer.

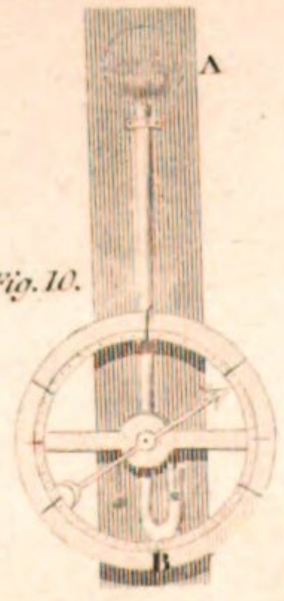


Fig. 10.

Printed March 1, 1806, for Richard Phillips, *New Bridge Street, Blackfriars.*

Neele, sculp. 352, Strand.

vacuity made by so swift a current; so that the air must necessarily be attenuated when and where the winds continue to blow, and that more or less, according to their violence: add to which, that the horizontal motion of the air being so quick, may in all probability take off some part of the perpendicular pressure; and the great agitation of its particles is the reason why the vapours are dissipated, and do not condense into drops, so as to form rain, otherwise the natural consequence of the air's rarefaction.

4. The mercury stands highest upon the easterly and north-easterly wind; because, in the great Atlantic Ocean, on this side the thirty-fifth degree of north latitude, the winds are almost always westerly or south-westerly; so that, whenever here the wind comes up at east and north-east, it is sure to be checked by a contrary gale as soon as it reaches the ocean; wherefore, according to the second remark, the air must needs be heaped over this island, and consequently the mercury must stand high as often as these winds blow. This holds true in this country; but is not a general rule for others, where the winds are under different circumstances: and we have sometimes had the mercury here so low as 29 inches, upon an easterly wind, but then it blew exceedingly hard; and thus is accounted for, what was observed in the third remark.

5. In calm frosty weather, the mercury generally stands high, because it seldom freezes but when the winds come out of the northern and north-eastern quarters, or at least, unless those winds blow at no great distance off; for the northern parts of Germany, Denmark, Sweden, Norway, and all that tract whence north-eastern winds come, are subject to almost continual frost through the winter, and thereby the lower air is very much condensed, and in that state is brought hitherward by those winds; and, being accumulated by the opposition of the westerly wind blowing in the ocean, the mercury must needs be forced to a more than ordinary height; and, as a concurring cause, the shrinking of the lower parts of the air into lesser room, by cold, must cause a descent of the upper parts of the atmosphere, to reduce the cavity made by this contraction to an equilibrium.

6. After great storms, when the mercury has been very low, it generally rises again very fast. It has been observed to rise one inch and a half in less than six hours, after a long-continued storm of south-west wind. The reason is, that the air being very much rarefied by the great evacuation which such continued storms make of that fluid, the neighbouring air runs in the more swiftly to bring it into an equilibrium.

Lastly. The variations are greater in the more northerly places.

BARON, a degree of nobility next below a viscount, and above a baronet. It is probable that formerly all those were barons who had lordships with courts-baron, and soon after the Conquest all such sat in the house of peers; but being very numerous, it grew an order and custom, that none should sit but such as the king thought fit to call up by writ, which ran pro hac vice tantum. This state of nobility being very precarious, they at length obtained of the king letters patent, and these were called barons by patent, or creation; the only way now in use of making barons, unless when the son of a lord, in his ancestor's life-time, is summoned by writ.

Barons *of the cinque-ports* are members of the house of commons, elected by the five ports, two for each port.

Those who have been mayors of Corfe-castle in Dorsetshire are also denominated barons; as were formerly the principal citizens of London.

Baron and Feme, in our law, a term used for the husband and wife; and they are deemed but one person, so that a wife cannot be witness for or against her husband, nor he for or against his wife, except in cases of high treason.

Baron and Feme, in heraldry, is when the coats of arms of a man and his wife are borne per pale in the same escutcheon, the man's being always on the dexter side, and the woman's on the sinister.

BARONET, a modern degree of honour, which is hereditary, and has the precedence of all knights, except those of the garter, bannerets, and privy-counsellors.

Baronets *of Ireland*, an hereditary dignity instituted in 1619. There are also baronets of Nova Scotia, an order instituted by Charles I. in 1625.

BARONY, the honour and territory which gives title to a baron, whether he is a layman or a bishop.

Barony, in Ireland, the name of the divisions of the counties, answering to English hundreds.

BARRA, in commerce, a long measure used in Portugal and some parts of Spain, to measure woollen cloths, linen cloths and serges.

BARRATOR, in law, a common mover or maintainer of suits and quarrels, either in courts or elsewhere in the country. A man cannot be adjudged a barrator for bringing any number of suits in his own right, though they are vexatious. Barrators are punished by fine and imprisonment. 4 Blacks. 134.

BARRATRY, in a ship-master, is his cheating the owners. If goods delivered on shipboard are embezzled, all the mariners ought to contribute to the satisfaction of the party that lost his goods, by the maritime law; and the cause is to be tried in the admiralty.

BARREL, a measure of liquids. The English barrel, wine-measure, contains the eighth part of a tun, the fourth part of a pipe, and one-half of an hogshead; that is to say, it contains thirty-one gallons and a half: a barrel, beer-measure, contains thirty-six gallons. The barrel of beer, vinegar, or liquor preparing for vinegar, ought to contain thirty-four gallons, according to the standard of the ale quart.

Barrel also denotes a certain weight of several merchandizes, which differs according to the several commodities: a barrel of Essex butter weighs one hundred and six pounds, and of Suffolk butter, two hundred and fifty-six pounds. The barrel of herrings ought to contain thirty-two gallons wine-measure, which amount to about twenty-eight gallons old standard, containing about a thousand herrings. The barrel of salmon must contain forty-two gallons. The barrel of eels the same. The barrel of soap must weigh two hundred and fifty-six pounds.

Barrel, in anatomy, a pretty large cavity behind the tympanum of the ear, about four or five lines deep, and five or six wide.

Barrels, *thundering*, in the military art, are filled with bombs, grenades, and other fire-works, to be rolled down a breach.

BARRERIA, in botany, a genus of the syngenesia monogamia class and order. The essential character is, calyx five-toothed, very small; corolla five-parted; style short; stigma trifid. There is but one species, a tree of Guiana, which rises to the height of 40 or 50 feet.

BARRICADE, a warlike defence, consisting of barrels and similar vessels filled with earth, stones, &c. or trees cut down, against an enemy's shot, or assault; but generally pales which are crossed with battoons as long as a half-pike, bound about with iron at the feet.

Barricade, in the marine, a strong wooden rail supported by pillars, and extending as a fence across the foremost part of the quarter-deck. In ships of war, the intervals between the pillars are filled with cork, old cable, &c. About a foot above the rail, there extends a double rope netting; and between the two parts of the netting are stuffed hammocks, seamen's bedding, &c. to intercept small shot fired by swivel guns and muskets in time of battle.

BARRIER, in fortification, a kind of fence made at a passage, retrenchment, &c. composed of great stakes, about four or five feet high, placed at the distance of eight or ten feet from one another, with transums, or overthwart rafters, to stop either horse or foot that would enter or rush in with violence.

BARRINGTONIA, in botany, a genus of the polyandria order, and monadelphia class of plants, the characters of which are: female, the calyx diphyllous above, with a drupa which it crowns; and the seed is a quadrilocular nut. There is but one species known, viz.

Barringtonia speciosa, a native of China and Otaheite.

BARRISTER, in common law, a person qualified and empowered to plead and defend the cause of clients in the courts of justice. They are of two sorts: the outward or outer barristers, who, by their long study in, and knowledge of, the law, which must be for a term of five years at least, are called to public practice, and always plead without the bar. The inner-barristers are those who, because they are either attorney, solicitor, serjeant, or counsel to the king, are allowed out of respect, the privilege of pleading within the bar. But at the rolls, and some other inferior courts, all barristers are admitted within the bar.

BARROW, in the salt-works, wicker cases almost in the shape of a sugar-loaf, in which the salt is put to drain.

Barrows, a name usually given to those hillocks or mounds of earth which were antiently raised over the bodies of deceased heroes, and persons of distinguished character. These are considered by some antiquarians as the most antient sepulchral monuments in the world.

BARRULET, in heraldry, the fourth part of the bar, or the one-half of the closset: an usual bearing in coat-armour.

BARRULY, in heraldry, is when the field is divided bar-ways, that is, across from side to side, into several parts.

BARRY, in heraldry, is when an escutcheon is divided bar-ways, that is, across from

side to side, into an even number of partitions, consisting of two or more tinctures, interchangeably disposed.

BARRY-*bendy* is when an escutcheon is divided evenly, bar and bend-ways, by lines drawn transverse and diagonal, interchangeably varying the tinctures of which it consists.

BARRY-*pily* is when a coat is divided by several lines drawn obliquely from side to side, where they form acute angles.

BARTERING, in commerce, the exchanging of one commodity for another, or the trucking wares for wares, among merchants. Such was the original and natural mode of commerce, there being no buying till money was invented, though, in exchanging, both parties are buyers and sellers. The only difficulty in this way of dealing lies in the due proportioning the commodities to be exchanged, so as that neither party sustain any loss.

The value of the goods bartered are always equal to the product of the quantities bartered into their respective rates. Therefore multiply the given quantity and rate of one commodity, and this product divided by the rate of the other commodity, will give the quantity, or divided by the quantity will give the rate.

BARTON is used in the west of England for the demesne lands of a manor: also for the manor-house; and in some parts for outhouses, &c.

BARTSIA, *painted cup*, a genus of the angiospermia order, and didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is bilbous, emargined, and coloured; the corolla less coloured than the calyx, with its upper lip longer than the under one. There are five species, of which the principal are,

1. Bartsia alpina, the mountain eye-bright cow-wheat. It is a native of Britain, and is found near rivulets in hilly countries. Sheep and goats eat it.

2. Bartsia viscosa, marshy, or yellow marsh eye-bright, is about 10 or 12 inches high, with an erect stalk, downy and unbranched: the leaves are sessile, spear-shaped, and a little viscous; the flowers are yellow, and the plant dries black. It is found in marshy places in Cornwall.

BARULES, in church history, certain Christians who held that the Son of God had only a phantom of a body; that souls were created before the world, and that they lived all at one time.

BARYTES, in mineralogy and chemistry, an earth that was discovered by Scheele in 1774, and the first account of its properties was published by him in his Dissertation on Manganese.

The experiments of Scheele were confirmed by Bergman, who gave the earth the name of terra ponderosa. Morveau gave it the name of barote, and Kirwan of barytes; which last was approved of by Bergman, and is now universally adopted. Different processes for obtaining barytes were published by Scheele, Bergman, Wiegleb, and Afswelius; but little addition was made to the properties ascertained by the original discoverer, till Dr. Hope published his experiments in 1793. In 1797, our knowledge of its nature was still farther extended by the experiments of Pelletier, Fourcroy, and Vauquelin.

1. Barytes may be obtained from ponderous spar, or sulphat of barytes as it is now called, by the following process, for which we are indebted to Vauquelin. Reduce the mineral to a fine powder; mix it with the eighth part of its weight of charcoal powder, and keep it for some hours red-hot in a crucible, and it will be converted into sulphuret of barytes. Dissolve the sulphuret in water, and pour nitric acid into the solution, and the sulphur will be precipitated. The solution, which consists of nitric acid combined with barytes, is to be filtred and evaporated slowly till it crystallizes. Put the crystals into a crucible, and expose it to a strong heat; the nitric acid is driven off, and the barytes remains in a state of purity.

Another method attended with less expence was pointed out long ago by Dr. Hope, and has been since proposed by several foreign chemists without taking any notice of the original discoverer. The method is this: Decompose the sulphat of barytes, by heating it strongly along with charcoal powder. The product is to be treated with water to dissolve every thing that is soluble: and the liquid, being filtred, is to be mixed with a solution of carbonat of soda. A white powder falls. Wash this powder; make it up into balls with charcoal, and heat it strongly in a crucible. When these balls are treated with boiling water, a portion of barytes is dissolved, which crystallizes as the water cools.

Barytes obtained by the first method is a greyish-white porous body, which may be very easily reduced to powder. It has a harsh and more caustic taste than lime; and when taken into the stomach proves a most violent poison. It has no perceptible smell. It tinges vegetable blues green, and decomposes animal bodies like the fixed alkalies, though not with such energy.

Its specific gravity, according to Fourcroy, is 4; but according to Hassenfratz, only 2.374. But there is reason to conclude, from the method employed by this philosopher, that the specific gravities which he assigns are all too low.

When heated it becomes harder, and acquires internally a bluish-green shade. When exposed to the blow-pipe on a piece of charcoal, it fuses, bubbles up, and runs into globules, which quickly penetrate the charcoal. This is probably in consequence of containing water, for Lavoisier found barytes not affected by the strongest heat which he could produce.

When exposed to the air, it immediately attracts moisture; in consequence of which it swells, heat is evolved, and the barytes falls to a white powder, just as happens to quicklime when water is sprinkled on it. After the barytes is thus slacked, it gradually attracts carbonic acid, and loses its acrid properties, its weight being increased. It cannot therefore be kept pure except in close vessels.

When a little water is poured upon barytes it is slacked like quick lime, but more rapidly, and with the evolution of more heat. The mass becomes white, and swells considerably. If the quantity of water is sufficient to dilute it completely, the barytes crystallizes in cooling, and assumes the appearance of a stone composed of needle-form crystals; but when exposed to the air it gradually attracts carbonic acid and falls to powder.

Water is capable of dissolving 0.05 parts of its weight of barytes. This solution, which is known by the name of barytes water, is limpid and colourless, has an acrid taste, and converts vegetable blues first to a green and then destroys them. When exposed to the air, its surface is soon covered with a stony crust, consisting of the barytes combined with carbonic acid.

Boiling water dissolves more than half its weight of barytes. As the solution cools, the barytes is deposited in crystals; the shape of which varies according to the rapidity with which they have been formed. When most regular, they are flat hexagonal prisms. These crystals are transparent and colourless, and appear to be composed of about 53 parts of water and 47 of barytes. When exposed to the heat of boiling water, they undergo the watery fusion; that is to say, the water which they contain becomes sufficient to keep the barytes in solution. A stronger heat makes the water fly off. When exposed to the air, they attract carbonic acid, and crumble into dust. They are soluble in 17½ parts of water at the temperature of 60°; but boiling water dissolves any quantity whatever: the reason of which is evident; at that temperature their own water of crystallization is sufficient to keep them in solution.

Barytes undergoes no change from light; neither is it capable, as far as is known, of combining with oxygen.

None of the simple combustibles combine with it except sulphur and phosphorus.

Sulphuret of barytes may be formed by mixing its two ingredients together, and heating them in a crucible. The mixture melts at a red heat, and when cold forms a mass of a reddish-yellow colour, without any smell, which is sulphuret of barytes. This sulphuret decomposes water with great rapidity: sulphureted hydrogen is formed, which, combining with the sulphuret, converts it into a hydrogenated sulphuret. This change takes place whenever the sulphuret is moistened with water, or even exposed to the atmosphere. When boiling water is poured upon sulphuret of barytes, a great quantity of sulphureted hydrogen is formed almost instantaneously, which combines with the water and occasions the solution of the sulphuret. When the solution cools, a great number of brilliant white crystals are deposited.

Phosphuret of barytes may be formed by putting a mixture of phosphorus and barytes into a glass tube close at one end, and heating the mixture by putting the tube upon burning coals. The combination takes place very rapidly. This phosphuret is of a dark-brown colour, very brilliant and very fusible. When moistened, it exhales the odour of phosphureted hydrogen gas. When thrown into water, it is gradually decomposed, phosphureted hydrogen gas is emitted, which takes fire when it comes to the surface of the water, and the phosphorus is gradually converted into phosphoric acid.

Barytes is not acted on by azote; but it combines readily with muriatic acid, and forms a compound called muriat of barytes.

Barytes has no action on metals; but it is capable of combining with several of the metallic oxydes, and forming with them compounds which have not hitherto been much examined. For instance, if poured into a solution of silver or lead in nitric acid, it precipitates the first brown, and the second

white; but if an excess of barytes water is added, the precipitates are redissolved.

Barytes does not combine with the alkalies. Its component parts are unknown; but it resembles the alkalies in so many of its properties, that it is thought the composition of both is analogous.

BASALTES, in natural history, a kind of stone of a very fine texture, of a deep glossy black, resembling that of polished steel, and mixed with no other colour, nor any extraneous matter of any kind. The most remarkable quality of this stone is its figure, being never found in strata, but standing up in the form of regular angular columns, composed of a number of joints, one placed on and nicely fitted to another, as if formed by the hands of a skilful workman. It is remarkably hard and heavy, will not strike fire with steel, and is a fine touchstone.

The basaltes was originally found in columns in Ethiopia, in fragments in the river Tmolus, and some other places; we now have it frequently, both in columns and small pieces, in Spain, Russia, Poland, near Dresden, and in Silesia; but the noblest store in the world seems to be that called the giant's causeway in Ireland, where it rises far up in the country, runs into the sea, crosses its bottom, and rises again on the opposite land.

The constituent parts of this mineral are:

Silex -	44
Alumina -	16
Oxyd of iron	16
Lime -	9
Water -	5
Soda - -	4
Muriatic acid	1
	95.

Besides the use of basalt in building and paving, it is now employed as an ingredient in the manufacture of glass bottles: and when calcined and pulverized it makes excellent mortar, which has the property of hardening under water.

A dispute is still carried on in the philosophical world concerning the origin of basaltes; some considering it as a crystallization in water, others regarding it as a species of lava.

BASARUCO, in commerce, a small base coin in the East Indies, being made only of very bad tin.

BASE, in geometry, the lowest side of the perimeter of a figure: thus, the base of a triangle may be said of any of its sides, but more properly of the lowest, or that which is parallel to the horizon. In rectangled triangles, the base is properly that side opposite to the right angle.

BASE *of a solid figure*, the lowest side, or that on which it stands; and if the solid has two opposite parallel plane sides, and one of them is the base, then the other is called the base also.

BASE *of a conic section*, a right line in the hyperbola and parabola, arising from the common intersection of the secant plane, and the base of the cone.

BASE, in architecture, is used for any body which bears another, but particularly for the lower part of a column and pedestal.

The base of a column is that part between the shaft and the pedestal, if there be any pedestal, or if there be none, between the shaft and the plinth, or zocle. The base is different in the different orders. See Plates Architecture.

BASE, in fortification, the exterior side of the polygon, or that imaginary line which is drawn from the flanked angle of a bastion to the angle opposite to it.

BASE, in gunnery, the least sort of ordnance, the diameter of whose bore is $1\frac{1}{4}$ inch, weight 200 pounds, length 4 feet, load 5 pound, shot $1\frac{1}{2}$ pound weight, and diameter $1\frac{5}{8}$ inch.

BASE *line*, in perspective, the common section of a picture, and the geometrical plane.

BASE, or BASIS. By this term modern chemists express either species or families of saline matters, which differ with regard to the acid, but agree as to the alkali, earth, or metallic oxyd, which they contain. Thus, salts with the base of potash include all those which are formed by the combination of the several acids with potash. Salts with an alkaline base comprehend those, the bases of which are potash, soda, or ammonia, as distinguished from those with earthy or metallic bases.

The term base is used to denote species; as when we say sulphuric acid is composed of oxygen united with a base of sulphur: the vegetable acids consist of oxygen and compound base of hydrogen and carbon. The term is also used more indefinitely; as phosphate of lime is the base of animal bone, azote is the base of muscular fibre; that is, the characteristic or principal part.

BASE, in law. Base estate, such as base tenants have in their hands. Base tenure, the holding by villenage or other customary services, as distinguished from the higher tenures in capite, or by military service. Base fee, is to hold in fee at the will of the lord, as distinguished from soccage tenure. Base court, any court not of record.

BASELLA, *climbing nightshade*, from Malabar, a genus of the pentandria class of plants and trigynia order, and in the natural method ranking under the 12th order, holoraceæ. The calyx is wanting; the corolla is seven-cleft, with the two opposite divisions broader, and at last berried; there is one seed. There are four species, but the two following suffice to give an idea of the plant:

1. Basella alba, with oval, waved, flaccid leaves, and small flowers and fruit. These plants will climb to a considerable height, and send forth a great number of branches; so they should be trained up to a trellis, or fastened to the back of the stove, otherwise they will twist themselves about whatever plants stand near them.

2. Basella rubra, with red leaves and simple footstalks, has thick, strong, succulent stalks and leaves, which are of a deep purple colour. This plant will climb to the height of 10 or 12 feet, provided it is kept in a stove. The flowers have no great beauty, but it is cultivated on account of the odd appearance of its stalks and leaves, and the flowers of a whitish green colour tipped with purple. The berries are said to be used for staining calicoes in India. Mr. Miller assures us, that he has seen a very beautiful colour drawn from them, but which did not continue long when used in painting. He is of opinion, however, that a method of fixing the colour might be invented, in which case the plant would be very useful. This, the Scotch Encyclopedists apprehend, might be accomplished by means of solution of tin in aqua regia, which has a surprising effect both in brightening and giving durability to other vegetable colours. Both species are propagated from seeds, which should be sown in a moderate hotbed in spring, and treated afterwards as stove plants.

BASEMENT, the lower part or story of a building, when it is in the form of a pedestal, with a base or plinth, die, and cortice or plat-band.

BASHAW, a Turkish governor of a province, city, or other district.

Bashaws include beglerbegs; and sometimes sangiacbegs; though a distinction is sometimes made, and the name bashaw is appropriated to the middle sort, or such as have two ensigns or horse-tails carried before them. Those who have the honour of three tails, are called beglerbegs; and those who have only one, sangiacbegs.

BASIL, in botany. See OCYMUM.

BASIL, among joiners, the sloping edge of a chisel, or of the iron of a plane, to work on soft wood: they usually make the basil twelve degrees, and for hard wood eighteen; it being remarked, that the more acute the basil is, the better the instrument cuts; and the more obtuse, the stronger and fitter it is for service.

BASIL, *order of St.*, the most antient of all the religious orders, was very famous in the East. It passed into the West about the year 1057, and was held in great esteem, especially in Italy. By their rules, the Italian monks of that order fast every Friday in the year: they eat meat but three times a week, and then but once a day: they work all together at certain hours of the day: their habit is nearly like that of the Benedictines, and they wear a small beard like the fathers of the mission.

BASILIC, in antient architecture, a term used for a large hall, or public place, with isles, porticos, galleries, tribunals, &c. where princes sat and administered justice in person.

BASILICA, in anatomy, the interior branch of the axillary vein, running the whole length of the arm.

BASILICON, in pharmacy, an epithet for a great many compositions to be found in the antient medicinal writers: but it more particularly denotes an officinal ointment, composed of wax, resin, pitch, and oil of olives, from hence called tetrapharmacum.

BASILICS, a body of the Roman laws, translated into Greek. The basilics comprehend the institutes, digests, code, novels, and some edicts, of Justinian and other emperors.

BASILICUS, in astronomy, cor leonis, a fixed star of the first magnitude in the constellation Leo.

BASILIDIANS, in church history, a branch of gnostics who maintained that Christ's body was only a phantom, and that Simon the Cyrenean suffered in his stead.

BASILISK, in military affairs, a large piece of ordnance, being a forty-eight pounder, and weighing about seven thousand two hundred pounds.

BASKETS *of earth*, in the military art, called by the French corbeilles, are small baskets used in sieges, on the parapet of a

trench, being filled with earth. They are about a foot and a half high, about a foot and a half diameter at the top, and eight or ten inches at bottom; so that being set together, there is a sort of embrasure left at their bottoms, through which the soldiers fire without exposing themselves.

BASKETS are made of rushes, splinters, or willows, which last, according to their manner of growth, are called osiers and sallows. They thrive best in moist places; and the proprietors of such marsh lands generally let what they call the willow-beds to persons who cut them at certain seasons, and prepare them for basket-makers. To form an osier-bed, the land should be divided into plots, six, eight, or ten feet broad, by narrow ditches; and if there is a power of keeping water in these cuts at pleasure, by means of a sluice, it is highly advantageous in many seasons. Osiers planted in small spots, and along hedges, will supply a farmer with hurdle-stuff, as well as with a profusion of all sorts of baskets. The common osier is cut at three years, but that with yellow bark is permitted to remain a year longer.

When the osiers are cut down, those that are intended for white work, such as baskets used in washing, are to be stripped of their bark or rinds while green. This is done by means of a sharp instrument fixed into a firm block: the osiers are passed over this, and stripped of their covering with great velocity. They are then dried, and put in bundles for sale. Before they are worked up, they must be soaked in water, which gives them flexibility. The basket-maker usually sits on the ground to his business, unless when the baskets are too large for him to reach their upper parts in that position.

Hampers and other coarse work are made of osiers without any previous preparation except soaking. It requires no great capital either of money or ingenuity to exercise the business of a basket-maker. Some expert workmen make a variety of articles of wicker manufacture, as work-baskets of different descriptions, table-mats, small baskets used for fruit at desserts, &c.

The antient Britons were noted for their ingenuity in making baskets, which they exported in large quantities. They were of very elegant workmanship, and bore a high price. Martial takes notice of them:

"A basket I, by painted Britons wrought,
And now to Rome's imperial city brought."

BASKET, as a measure, denotes an uncertain quantity; as, a basket of medlars is two bushels, of asafœtida from 20 to 30 lb. weight.

BASON, in mechanics, a term used by glass-grinders for a dish of copper, iron, &c. in which they grind convex glasses, as concave ones are formed on spheres; and by hatters for a round iron mould, in which they form the matter of their hats; and also for a leaden one for the brims of hats, having an aperture in the middle, of a diameter sufficient for the largest block to go through.

BASON, *sale by the*, at Amsterdam, is a public sale made by authority, over which presides an officer appointed by the magistrates. It is so called because, before the lots are delivered to the highest bidder, they commonly strike on a copper bason, to give notice that the lot is going to be adjudged.

BASS, in music, that part of a concert which is most heard, which consists of the gravest and deepest sounds, and which is played on the largest pipes or strings of a common instrument, as of an organ, lute, &c. or on instruments larger than ordinary for that purpose, as bass-viols, bassoons, bass-hautboys, &c. The bass is the principal part of a musical composition, and the foundation of harmony; for which reason it is a maxim among musicians that when the bass is good the harmony is seldom bad.

BASS *thorough*, is the harmony made by the bass-viols, or theorbos, continuing to play both while the voices sing, and the other instruments perform their parts, and also filling up the intervals when any of the other parts stop. It is played by cyphers marked over the notes on the organ, spinet, harpsichord, &c. and frequently simply and without cyphers, on the bass-viol, and bassoon.

BASS, *counter*, is a second or double bass, where there are several in the same concert.

BASSET, a game at cards, said to have been invented by a noble Venetian, for which he was banished. The persons concerned in it are a dealer, or banker; his assistant, who supervises the losing cards; and the punter, or any one who plays against the banker.

BASSIA, in botany, a genus of the dodecandria class of plants, and monogynia order, the characters of which are: the calyx is quadriphyllous; the corolla octofid, with the tube inflated; the stamina are 16; and the drupe is quinquespermous. There are three species, natives of Malabar and the South Seas.

BASSOON, a musical instrument of the wind sort, blown with a reed, furnished with eleven holes, and used as a bass in a concert of hautboys, flutes, &c.

BASSORIA, a genus of the pentandria monogynia class and order. The essential character is: calyx five-cleft, spreading, with a short tube; berry ovate, knobbed, and many seeds. There is but one species, an herbaceous plant of Guiana, of little note.

BASSO-RELIEVO, or BASS-RELIEF, a piece of sculpture, where the figures or images do not project or stand out far above the plane on which they are formed. Whatever figures or representations are thus cut, stamped, or otherwise wrought, so that not the entire body, but only part of it is raised above the plane, are said to be done in relief, or relievo; and when the work is low, flat, and but a little raised, it is called low relief: when a piece of sculpture, a coin, or a medal, has its figure raised so as to be well distinguished, it is called bold, and we say its relief is strong.

The origin of basso-relievo is thought to have been described in the story of the Maid of Corinth, related by Pliny; who says that Dibutades, the Sicyonian potter, her father, invented a method of taking likenesses in the following manner: His daughter being in love with a young man who was going on foreign service, she circumscribed the shadow of his face with lines upon the wall by lamp-light; her father took the impression in clay, and baked it among his vases.

BASS-VIOL, a musical instrument of the same form with that of a violin, but much larger. It is struck with a bow as that is, has the same number of strings, and has eight stops, which are subdivided into semi-stops: its sound is grave, and has a much nobler effect in a concert than that of the violin.

BASTARD, one who is born of any woman not married, so that his father is not known by order of the law. A bastard, by our English laws, is one that is not only begotten, but born, out of lawful matrimony. As all children born before matrimony are bastards, so are all children born so long after the death of the husband, that by the usual course of gestation they could not be begotten by him.

If a man marry a woman grossly big with child by another, and even within three days afterwards she is delivered, the issue is no bastard. 1 Danv. Abr. 729.

If a child is born within a day after marriage between parties of full age, if there be no apparent impossibility that the husband should be the father of it, the child is no bastard, but supposed to be the child of the husband. 1 Rol. Abr.

If a bastard die without issue, though the land cannot descend to any heir on the part of the father, yet to the heir on the part of the mother (being no bastard) it may; because he is of the blood of the mother, but he has no father. 2 Roll. Abr. If a bastard die intestate, leaving neither widow nor issue, the king is intitled to the personality. 2 Black. 505.

The incapacity of a bastard consists principally in this, that he cannot be heir to any one, neither can he have heirs but of his own body; for being nullius filius, he is therefore of kin to no one, nor has he any ancestor from whom any inheritable blood can be derived. 3 Salk. 66.

A bastard may be made legitimate, and capable of inheriting, by the transcendent power of an act of parliament. 1 Black. 459.

If any single woman be delivered of a bastard-child which shall be chargeable or likely to become chargeable; or shall declare herself to be with child, and that such child is likely to be born a bastard, and to be chargeable; and shall in either of such cases, in an examination to be taken in writing, on oath, before one justice of the peace of the county, &c. where such parish or place shall lie, charge any person with having gotten her with child, it shall be lawful for such justice, upon application made to him by the overseers of the poor of such parish, or one of them, or by any substantial householder of any extra-parochial place, to issue out his warrant for the immediate apprehending such person so charged as aforesaid, and for bringing him before such justice, or before any other justices of the peace of such county, city, or town corporate; and the justice, before whom such person shall be brought, shall commit him to the common gaol or house of correction, unless he shall give security to indemnify such parish or place; or shall enter into a recognizance, with sufficient security, upon condition to appear at the next general quarter session, or general session of the peace. 6 Geo. II. c. 31.

Though a bastard child is prima facie settled where born, yet this rule admits of several exceptions: as where a bastard is born under an order of removal, and before the mother can be sent to her place of settlement; or if a woman be delivered on the road in transitu, while the officers are conducting her, by virtue of an order of re-

moval; or if the child be born in the house of correction, or in the house of industry, of any hundred or district, or in a lying-in hospital, it shall follow the mother's settlement. 1 Sess. Cr. 33. 94. 2 Salk. 474. 13 Geo. III. c. 29. 20 Geo. III. c. 36.

BASTARD *eigne*, is a son born before marriage, whose parents afterwards intermarry, and by the civil law he is mulier, or lawful issue, but not by the common law. *2 Inst.* 99.

BASTARDY, arms of, in heraldry, should be crossed with a bar, fillet, or traverse from left to right. Bastards were formerly not allowed to carry the arms of their father, and therefore they invented arms for themselves, and this is still done by the natural sons of a king.

BASTION, in the modern fortification, a huge mass of earth, faced usually with sods, sometimes with brick, and rarely with stone, standing out from a rampart, whereof it is a principal part, and is what, in the antient fortification, is called a bulwark, *propugnaculum*.

A bastion consists of two faces and two flanks; the faces include the angle of the bastion, and their union makes the outmost or the salient angle, called also the angle of the bastion; and the union of the two faces to the two flanks makes the side-angles, called also the shoulders or epaules; and the union of the two other ends of the flanks to the two curtains makes the angles of the flanks.

In regard to the bastion, the great rule is, that every part of it be seen and defended from some other part: whence mere angles are not sufficient, but flanks and faces are necessary. For the proportion of the faces, they a.e not to be less than 24 Rhineland perches, nor more than 30. The flanks of a bastion, in case they stand at the same angle under the line of defence, are so much the better the longer they are; whence they must stand at right angles to the line of defence: and the disposition of the flanks makes the principal part of fortification, as it is that on which the defence chiefly depends, and which has introduced the various forms of fortifying. The angle of the bastion must be more than 60 degrees, otherwise it will be too small to give room for guns, and will either render the line of defence too long, or the flanks too short; so that it must be either a right angle or some intermediate one between that and 60 degrees; for it is disputed whether or not it should exceed a right angle. See FORTIFICATION.

BASTON, or BATOON, in heraldry, a kind of bend, having only one third of the usual breadth.

BAT, see VESPERTILIO.

BAT, BATE, or BATZ, a small copper coin, mixed with a little silver, current in several cities in Germany: it is worth four crutzers. It is also a coin of Switzerland, current at five livres or one hundred sols French money.

BATCHELOR, in the livery companies of London, are those not yet admitted to the livery.

BATCHELORS, in the university, are persons who have taken the first degree in the liberal arts and sciences. Before a person can be admitted to this degree at Oxford, it is necessary that he study there four years; three years more may entitle him to the degree of master of arts; and in seven years more he may commence batchelor of divinity. At Cambridge the degrees are usually taken as at Oxford, excepting in law and physic, in either of which the batchelor's degree may be taken in six years. In France the degree of batchelor of divinity is attained in five years' study, that is, in two years of philosophy and three of divinity.

BAT-FOWLING, a method of catching birds in the night, by lighting some straw or torches near the place where they are at roost; for upon beating them up they fly to the flame, where being amazed, they are easily caught in nets, or beaten down with bushes fixed to the end of poles, &c.

BATH, warm, cold, vapour, &c. see MEDICINE and MINERAL WATERS.

BATH, in Hebrew antiquity, a measure of capacity, containing the tenth part of an omer, or seven gallons and four pints, as a measure for things liquid: or three pecks and three pints, as a measure for things dry.

BATH. See BALNEUM, and CHEMISTRY.

BATH, *knights of*, a military order in England, supposed to have been instituted by Richard the Second, who limited their number to four: his successor, however, Henry IV. increased them to forty-six. Their motto was *tres in uno*, signifying the three theological virtues.

This order derived this denomination from a custom of bathing before they received the golden spur. It is seldom or never conferred but at the coronation of kings or the inauguration of a prince of Wales or duke of York. They wear a red ribband beltwise.

The order of the bath, after remaining many years extinct, was revived under George the First, by a solemn creation of a great number of knights.

BATIS, in botany, a genus of the tetandria order and dicœcia class of plants, the characters of which are: of the male the amentum is four-ways imbricated, and both the calyx and corolla are wanting: of the female the amentum is ovate, the involucrum diphyllous; calyx and corolla wanting; the stigma is bilobate and sessile; the berries condunate and four-seeded. There is but one species, viz. batis mantina, a native of Jamaica.

BATMAN, in commerce, a kind of weight used at Smyrna, containing six okes of four hundred drams each, which amount to sixteen pounds, six ounces, and fifteen drams, of English weight.

BATTALION, or BATALLION, an undetermined body of infantry in regard to number, generally from 600 to 1000 men. The companies of grenadiers and light infantrymen having been detached from their several corps and formed into separate battalions, the guards at present consist of nine battalions. The different companies are likewise considerably augmented; so that it is impossible to affix any specific standard to their complement of men. The royal regiment of artillery consists of four battalions. Sometimes regiments consist each of one battalion; but if more numerous, are divided into several battalions, according to their strength; so that every one may come within the numbers mentioned. A battalion in one of our marching regiments consists of 1000 and sometimes of 1200 men, officers and non-commissioned included. When there are companies of several regiments in a garrison to form a battalion, those of the eldest regiment post themselves on the right, those of the second on the left, and so on until the youngest fall into the centre. The officers take their posts before their companies, from the right and left, according to seniority. Each battalion is divided into four divisions, and each division into two subdivisions, which are again divided into sections. The companies of grenadiers being unequal in all battalions, their post must be regulated by the commanding officer.

BATTEN, a name that workmen give to a scantling of wooden stuff, from two to four inches broad, and about one inch thick, the length undetermined.

BATTER, a cannonade of heavy ordnance, from the first or second parallel of entrenchment, against any fortress or works.

BATTER in breach, implies a heavy cannonade of many pieces directed to one part of the revetement from the third parallel.

BATTERING, in military affairs, implies the firing with heavy artillery on some fortification or strong post possessed by an enemy, in order to demolish the works.

BATTERING-*pieces* are large pieces of cannon used in battering a fortified town or post.

It is judged by all nations that no less than 24 or 18 pounders are proper for that use. Formerly much larger calibres were used; but, as they were so long and heavy, and very troublesome to transport and manage, they were for a long time rejected, till adopted among the French, who, during the late war, have brought 36 and 42 pounders into the field.

BATTERING-*train*, a train of artillery used solely for besieging strong places, inclusive of howitzers: all heavy 24, 18, and 12 pounders, come under this denomination; as likewise the 13, 10, and 8-inch mortars and howitzers.

BATTERY, in military affairs, implies any place where cannon or mortars are mounted, either to attack the forces of the enemy, or to batter a fortification: hence batteries have various names, agreeable to the purposes they are designed for.

BATTERY, *gun*, is a defence made of earth faced with green sods or fascines, and sometimes made of gabions filled with earth: it consists of a breast-work, parapet, or epaulement, of 18 or 20 feet thick at top, and of 22 or 24 at the foundation; of a ditch 12 feet broad at the bottom, and 18 at the top, and 7 feet deep. They must be 7½ feet high. The embrasures are 2 feet wide within, and 9 without, sloping a little downward, to depress the metal on occasion. The distance from the centre of one embrasure to that of the other is 18 feet; that is, the guns are placed at 18 feet distance from each other; consequently the merlins (or that part of solid earth between the embrasures) are 16 feet within and 7 without. The genouilliers (or parts of the parapet which cover the carriage of the gun) are generally made 2½ feet high from the platform to the opening of the embrasures; though this height ought to be regulated according to the semi-diameter of the wheels of the carriage or the nature of the gun. The platforms are a kind of wooden floors, made to prevent the cannon from sinking into the ground, and to render the working of the guns more easy; and are, strictly speaking, a part of the battery. They

are composed of five sleepers or joists of wood, laid lengthways, the whole length of the intended platform; and to keep them firm in their places, stakes must be driven into the ground on each side: these sleepers are then covered with sound thick planks, laid parallel to the parapet; and at the lower end of the platform, next to the parapet, a piece of timber six inches square, called a hurter, is placed, to prevent the wheels from damaging the parapet. Platforms are generally made 18 feet long, 15 feet broad behind, and 9 before, with a slope of about 9 or 10 inches, to prevent the guns from recoiling too much, and for bringing them more easily forward when loaded. The dimensions of the platforms, sleepers, planks, hurters, and nails, ought to be regulated according to the nature of the pieces that are to be mounted.

The powder-magazines to serve the batteries ought to be at a convenient distance from them, as also from each other; the large one at least 55 feet in the rear of the battery, and the small ones about 25. Sometimes the large magazines are made either to the right or left of the battery, in order to deceive the enemy; they are generally built five feet under ground; the sides and roof must be well secured with boards, and covered with earth, clay, or something of a similar substance, to prevent the powder from being fired: they are guarded by centinels. The balls are piled in readiness beside the merlins, between the embrasures.

The officers of the artillery ought always to construct their own batteries and platforms, and not the engineers, as is practised in England; for certainly none can be so good judges of those things as the artillery officers, whose daily practice it is; consequently they are the most proper to direct the situation and to superintend the making of batteries on all occasions.

Battery, *mortar*. These kind of batteries differ from gun-batteries, only in having no embrasures. They consist in a parapet of 18 or 20 feet thick, 7½ high in front, and 6 in the rear; of a berm 2½ or 3 feet broad, according to the quality of the earth; of a ditch 24 feet broad at the top, and 20 at the bottom. The beds must be 9 feet long, 6 broad, 8 from each other, and 5 feet from the part: they are not to be sloping like the gun-platforms, but exactly horizontal. The insides of these batteries are sometimes sunk two or three feet into the ground, by which they are much sooner made than those of cannon. The powder-magazines and piles of shells are placed as is mentioned in Gun-battery.

Battery, *ricochet*, so called by its inventor M. Vauban, and first used at the siege of Aeth, in 1697. It is a method of firing with a very small quantity of powder, and a little elevation, so as just to fire over the parapet; and then the shot will roll along the opposite rampart, dismounting the cannon, and driving or destroying the troops. In a siege they are generally placed at about 300 feet before the first parallel, perpendicular to the faces produced, which they are to enfilade. Ricochet practice is not confined to cannon alone; small mortars and howitzers may effectually be used for the same purpose. They are of singular use in action to enfilade the enemy's ranks; for when the men perceive the shells rolling about with their fuses burning, expecting them to burst every moment, the bravest among them will not have courage to wait their approach and face the havock of their explosion.

Batteries, *horizontal*, are such as have only a parapet and ditch; the platform being only the surface of the horizon made level.

Batteries, *breach* or *sunk*, are such as are sunk upon the glacis with a design to make an accessible breach in the faces or salient angles of the bastion and ravelin.

Batteries, *cross*, are such as play athwart each other against the same object, forming an angle at the point of contact; whence greater destruction follows, because what one shot shakes, the other beats down.

Batteries, *oblique*, or *batteries en echarpe*, are those which play on any work obliquely, making an obtuse angle with the line of range, after striking the object.

Batteries, *enfilading*, are those that sweep or scour the whole length of a straight line, or the face or flank of any work.

Batteries, *redan*, are such as flank each other at the salient and rentrant angles of a fortification.

Batteries, *direct*, are those situated opposite to the place intended to be battered, so that the balls strike the works nearly at right angles.

Batteries, *reverse*, are those which play on the rear of the troops appointed to defend the place.

Batteries, *glancing*, are such whose shot strike the object at an angle of about 20°, after which the ball glances from the object, and recoils to some adjacent parts.

Batteries, *joint*, } when several
Batteries, *camarade*, } guns fire on the same object at the same time. When ten guns are fired at once, their effect will be much greater than when fired separately.

Batteries, *sunk*, are those whose platforms are sunk beneath the level of the field, the ground serving for the parapet, and in it the embrasures are made. This often happens in mortar, but seldom in gun, batteries. Battery sometimes signifies the guns themselves placed in a battery.

Batteries, *fascine*, } are batteries made
Batteries, *gabion*, } of those machines where sods are scarce and the earth very loose or sandy.

Battery-*planks* are those planks or boards used in making platforms.

Battery-*boxes* are square chests or boxes filled with earth or dung, used in making batteries, where gabions and earth are not to be had: they must not be too large, but of a size that is governable.

Battery-*nails* are wooden pins made of the toughest wood, with which the planks that cover the platforms are fastened. Iron nails might strike fire against the iron-work of the wheels, in recoiling, &c. and be dangerous.

Battery, in law, the striking, beating, or offering any violence to another person, for which damages may be recovered. But if the plaintiff made the first assault the defendant shall be quit, and the plaintiff amerced to the king for his false suit. Battery is frequently confounded with assault, though, in law, they are different offences; for in the trespass for assault and battery, one may be found guilty of assault, yet acquitted of the battery: there may therefore be assault without battery, but battery always implies an assault. See Assault.

Battle, in the military art, has ever been the last resource of good generals. A situation where chance and accident often baffle and overcome the most prudential and most able arrangements, and where superiority of numbers by no means ensures success, is such as is never entered into without a clear necessity for so doing. The fighting a battle only because the enemy is near, or from having no other formed plan of offence, is a direful way of making war. Darius lost his crown and life by it; king Harold of England did the same; and Francis I. at Pavia lost the battle and his liberty. King John of France fought the battle of Poictiers, though ruin attended his enemy if he had not fought.

The true situation for giving battle is when an army's situation cannot be worse, if defeated, than if it does not fight at all; and when the advantage may be great, and the loss little. Such was the duke of Cumberland's at Hastenbeck, in 1757, and prince Ferdinand's at Vellinghausen, in 1761. The reasons and situations for giving battle are so numerous, that to treat of them all would fill a large volume; we shall therefore content ourselves with the following:—There may be exigencies of state that require its army to attack the enemy at all events. Such were the causes of the battle of Blenheim in 1704, of Zorndorff in 1758, of Cunnersdorff in 1759, and of Rosbach in 1757. To raise a siege, to defend or cover a country. An army is also obliged to engage when shut up in a post. An army may give battle to effect its junction with another army, &c.

The preparations for battle admit of infinite variety. By a knowledge of the detail of battles, the precept will accompany the example. The main general preparations are, to profit by any advantage of ground; that the tactical form of the army be in some measure adapted to it; and that such form be, if possible, a form tactically better than the enemy's; and, in forming the army, to have a most careful attention to multiply resources, so that the fate of the army may not hang on one or two efforts; to give any particular part of the army, whose quality is superior to such part of the enemy's army, a position that ensures action; and, finally, to have a rear by nature or if possible by art, capable of checking the enemy in case of defeat.

The dispositions of battles admit likewise of an infinite variety of cases; for even the difference of ground which happens at almost every step, gives occasion to change the disposition or plan; and a general's experience will teach him to profit by this, and take the advantage the ground offers him. It is an instant, a *coup-d'œil*, which decides this; for it is to be feared the enemy may deprive you of those advantages, or turn them to his own profit; and for that reason this admits of no precise rule, the whole depending on the time and the occasion.

With regard to battles, there are three things to be considered: what precedes, what accompanies, and what follows the action. As to what precedes the action, you should unite all your force, examine the advantage of the ground, the wind, and the sun (things not to be neglected), and choose if possible a field of battle proportioned to the number of your troops.

You must post the different kinds of troops advantageously for each: they must be so disposed as to be able to return often to the charge; for he who can charge often with fresh troops, is commonly victorious. Your wings must be covered so as not to be surrounded; and you must observe that your troops can assist each other without any confusion, the intervals being proportioned to the battalions and squadrons.

Great care must be taken about the regulation of the artillery, which should be disposed so as to be able to act in every place to the greatest advantage; for nothing is more certain than that, if the artillery is well commanded, properly distributed, and manfully served, it will greatly contribute to gaining the battle, being looked upon as the general instrument of the army, and the most essential part of military force. The artillery must be well supplied with ammunition, and each soldier have a sufficient number of cartridges. The baggage, provisions, and treasure of the army, should, on the day of battle, be sent to a place of safety.

In battle, where the attacks are, there is also the principal defence. If an army attacks, it forms at pleasure; it makes its points at will: if it defends, it will be sometimes difficult to penetrate into the designs of the enemy, but when once found, succour succeeds to the discovery. Ground and numbers must ever lead in the arrangement of battles; impression and resource will ever bid fairest for winning them.

BATTLE-*array*, } the method and order
BATTLE, *line of*, } of arranging the troops in order or line of battle; the form of drawing up the army for an engagement. This method generally consists of three lines, viz. the front line, the rear line, and the reserve.

The second line should be about 300 paces behind the first, and the reserve at about 5 or 600 paces behind the second. The artillery is likewise divided along the front of the first line. The front line should be stronger than the rear line, that its shock may be more violent; and that, by having a greater front, it may more easily close on the enemy's flanks. If the first line has the advantage, it should continue to act, and attack the enemy's second line, terrified by the defeat of their first. The artillery must always accompany the line of battle in the order it was at first distributed, if the ground permit it; and the rest of the army should follow the motions of the first line, when it continues to march on after its first success.

BATTLE-*ax*, an offensive weapon, formerly much used by the Danes, and other northern infantry. It was a kind of halbert, and did great execution when wielded by a strong arm.

BATTLE, *naval*, the same with a sea-fight or engagement between two fleets of men of war. Before a naval battle, every squadron usually subdivides itself into three equal divisions, with a reserve of certain ships out of every squadron to bring up their rear. Every one of these, observing a due birth and distance, are in the battle to second one another; and the better to avoid confusion and falling foul of eah other, to charge, discharge, and fall off by threes or fives, more or less, as the fleet is greater or smaller. The ships of reserve are instructed either to succour and relieve those that are any way in danger, or to supply and put themselves in the place of those that shall be made unserviceable.

As for a fleet consisting but of few ships, when obliged to fight in an open sea, it should be brought up to battle in only one front, with the chief admiral in the middle of them, and on each side of him the strongest and best-provided ships of the fleet.

The English mode of fighting at sea has latterly been, to bear down on the enemy in a single column or line, to break the line of the enemy ship by ship, raking them by a broadside as they pass. By thus breaking the enemy's line at a particular part, an opportunity is afforded, wind and other circumstances favouring, of cutting off any given number of their force, and reducing them to an equality. Such was the famous manœuvre of sir John Jervis off Cape St. Vincent, by which he gained a victory over a very superior force. In the ever-memorable battle of Trafalgar, lord Nelson bore down upon the combined fleets in two columns, which brought them to action sooner and to greater advantage than could otherwise have been effected. The disposition of the enemy on the same occasion was most masterly; for by ranging a part of their fleet behind the others in the intervals between ship and ship, they rendered it so much the more difficult and hazardous to break their line.

BATTLEMENTS, in architecture, are indentures or notches in the top of a wall or other building, in the form of embrasures, for the sake of looking or firing through them.

BATZ, a copper coin mixed with some silver, and current at different rates, according to the alloy, in Nuremberg, Basil, Fribourg, Lucerne, and other cities of Germany and Switzerland.

BAUHINIA, mountain ebony, a genus of the monogynia order and decandria class of plants, and in the natural method ranking under the 33d order, lomentaceæ. The calyx is quinquefid and deciduous; the petals are oblong, expanded, and clawed, the superior one more distant, all inserted on the calyx; the capsule is a legumen. There are 13 species, all trees and shrubs, which are propagated by seeds; and must be sown in hot-beds, and afterwards kept in a bark stove. The most remarkable are,

1. Bauhinia aculeata, with a prickly stalk, very common in Jamaica and other American sugar islands, where it rises to 16 or 18 feet, with a crooked stem, and divides into many irregular branches armed with strong short spines, compound winged leaves, each having two or three pair of lobes ending with an odd one, which are oblique, blunt, and indented at the top. The stalks are terminated by several long spikes of yellow flowers, succeeded by bordered pods about three inches long, containing two or three swelling seeds. It is called in America the savin tree, from its strong odour somewhat resembling the common savin.

2. Bauhinia acuminata, with oval leaves, is a native of both the Indies, and rises with several pretty strong, upright, smooth stems, sending out many slender branches. The flowers come out at the extremities of the branches, three or four in a loose bunch; some of the petals are red or striped with white, but others are plain upon the same branch; the stamina and style are white, and stand out beyond the petals. The wood of this tree is very hard, and veined with black; whence its name of mountain ebony.

3. Bauhinia divaricata, with oval leaves, whose lobes spread different ways. This grows naturally in great plenty on the north side of the island of Jamaica. It seldom rises more than five or six feet, but divides into several branches. The flowers grow in loose panicles at the end of the branches, have a white colour, and a very agreeable scent. They appear the greatest part of summer, which makes it one of the greatest beauties of the hot-house.

4. Bauhinia tomentosa, with heart-shaped leaves, is a native of Campeachy, and rises to 12 or 14 feet, with a smooth stem dividing into many branches, having two smooth-pointed lobes. Every branch is terminated by a long spike of yellow flowers, so that when these trees are in flower they make a fine appearance.

5. Bauhinia variegata, with heart-shaped leaves, and lobes joining together, is a native of both the Indies. It rises with a strong stem upwards of 20 feet, dividing into many strong branches. The flowers are large, and grow in loose panicles at the extremity of the branches. They are of a purplish red colour marked with white, and have a yellow bottom. The flowers have a very agreeable scent, and are succeeded by compressed pods about six inches long, and three quarters of an inch broad, containing three or four compressed seeds in each.

BAWN, or BAN, to construct and secure with branches of trees an area enclosed with thick ditches of earth, square or circular, impaled with wooden stakes or branches of trees, and surrounded with a deep trench. Numerous remains of such fortresses are found in Britain, Germany, and other countries in the north of Europe.

BAY, among farmers, a term used to signify the magnitude of a barn; as if a barn consists of a floor and two heads, where they lay corn, they call it a barn of two bays. These bays are from 14 to 20 feet long.

BAYONET, in the military art, a short broad dagger, fitted for the bore of a firelock, to be fixed there after the soldier has fired.

BAYS, in commerce, a sort of open woollen stuff, having a long nap, sometimes frized, and sometimes not. This stuff is without wale, and is wrought in a loom with two treddles, like flannel. It is chiefly manufactured at Colchester, and Bocking in Essex, where there is a hall called the Dutch bay-hall, or raw-hall. The exportation of bays was formerly much more considerable than at present. However, the English bays are still sent in great quantities to Spain and Portugal, and even to Italy.

BAZAR, BAZARI, or BAZAARD, a place designed for trade among the eastern nations, particularly the Persians, some of which are open at top, like the market-places of Europe; others are covered with high vaulted ceilings, and adorned with domes to give light.

At Constantinople the old and new bazar are large square buildings, covered with domes, and sustained by arches and pilasters; the former chiefly for arms, harnesses, and the like; the latter for goldsmiths, jewellers, furriers, and all sorts of manufactures.

BAZAT, or BAZA, in commerce, a long,

fine, spun cotton, which comes from Jerusalem, whence it is also called Jerusalem cotton.

BAZENDGES, the name of a vegetable substance used by the Turks, and other eastern nations in the scarlet dying. They mix it for this purpose with cochineal and tartar, in the proportion of two parts of bazendges to one of cochineal.

BDELLIUM, a gum resin somewhat resembling myrrh in appearance, brought from the Levant. It is met with in single drops, of a very irregular size, some of which are as large as a hazel nut. Its colour is dusky, and its taste bitter.

There is much uncertainty concerning both the plant from which it proceeds, and the place of its production. The smell of this gum is fragrant, and its taste bitter and pungent. It readily burns, giving out smoke and a crackling noise. It is partly soluble in alcohol, and partly in water, or completely in diluted spirit. It was formerly used as a stimulating remedy, chiefly for external application, and is still retained in the Paris dispensatories.

BEACON, a public signal, to give warning against rocks, shelves, invasions, &c. It is made sometimes by putting pitch-barrels upon a long pole, and fixing them up on an eminence, so that they may be seen at a distance; for the barrels being fired, the flame in the night time, and the smoke in the day, give notice, and in a few hours may alarm the whole kingdom, upon an approaching invasion, &c.

BEACONAGE, a tax or farm paid for the use and maintenance of a beacon. The Trinity-house is empowered to levy this tax, by act of parliament.

BEAD. The common black glass of which beads are made for necklaces, &c. is coloured with manganese only.

BEAD, in architecture, a round moulding, commonly made upon the edge of a piece of stuff, in the Corinthian and Roman orders, cut or carved in short embossments, like beads in necklaces. Sometimes a plain bead is set on the edge of each fascia of an architrave, and sometimes likewise an astragal is thus cut. A bead is often placed on the lining-board of a door-case, and on the upper edges of skirting boards.

BEAD-*proof*, among distillers and venders of liquors, a fallacious mode of determining the strength of spirits, from the continuance of the bubbles, or beads, raised by shaking a small quantity of them in a phial.

BEAD-*roll*, among papists, a list of such persons for the rest of whose souls they are obliged to repeat a certain number of prayers, which they count by means of their beads.

BEAGLE. See CANIS.

BEAK, the bill or nib of a bird. See BILL.

BEAK, in architecture, the small fillet left on the head of a larmier, which forms a canal, and makes a kind of pendant.

BEAK, or BEAK-HEAD, of a ship, that part without a ship, before the forecastle, which is fastened to the stern, and is supported by the main knee.

BEAKED, in heraldry, a term used to express the beak or bill of a bird. When the beak and legs of a fowl are of a different tincture from the body, we say beaked and membered of such a tincture.

BEAM, in architecture, the largest piece of wood in a building, which lies across the walls, and serves to support the principal rafters of the roof, and into which the feet of these rafters are framed. No building has less than two of these beams, viz. one at each end. Into these the girders of the garret roof are also framed; and if the building is of timber, the teazle tenons of the posts are framed into them. The proportions of beams in or near London are fixed, by statute, as follows: a beam 15 foot long must be seven inches on one side its square, and five on the other; if it is 16 feet long, one side must be eight inches, the other six; and so proportionably to their lengths. In the country, where wood is more plenty, they usually make their beams stronger.

BEAMS of a ship are the great main cross-timbers which hold the sides of the ship from falling together, and which also support the decks and orlops. The main beam is next the main mast, and from it they are reckoned by first, second, third beam, &c. The greatest beam of all is called the mid-ship beam. See SHIP.

BEAM-*compass*, an instrument consisting of a square wooden or brass beam, having sliding sockets, that carry steel or pencil points; they are used for describing large circles, where the common compasses are useless.

BEAM, in heraldry, the term used to express the main horn of a hart or buck.

BEAM-*filling*, in building, the filling up of the vacant space between the raison and roof, with stones or bricks laid between the rafters on the raison, and plaistered on with loam, where the garrets are not pargeted, or plaistered, as in country places.

BEAM *of an anchor*, the longest part of it, called also the shank.

BEAM also denotes the lath, or iron, of a pair of scales; sometimes the whole apparatus for weighing of goods is so called: thus we say, it weighs so much at the king's beam.

BEAM *of a plough*, that in which all the parts of the plough-tail are fixed. It is commonly made of ash, and is eight feet long; but in the four-coultered plough it is ten feet long.

BEAM, or ROLLER, among weavers, a long and thick wooden cylinder, placed lengthwise on the back part of the loom of those who work with a shuttle. That cylinder on which the stuff is rolled as it is weaved, is also called the beam, or roller, and is placed on the fore part of the loom.

BEAN. See VICIA, and PHASEOLIS.

BEAR. See URSUS.

BEAR, in astronomy, a name given to two constellations, called the greater and lesser bear, or ursa major and minor.

BEAR, a species of barley cultivated in Scotland and Ireland, and the northern parts of England. It is not esteemed so good for malting as the common barley.

BEAR, in heraldry. He that has a coat of arms is said to bear in it the several charges or ordinaries that are in his escutcheon.

BEAR'S *breech*. See ACANTHUS.

BEARER, in architecture, a post, or brick wall, trimmed up between the two ends of a piece of timber, to shorten its bearing, or to prevent its bearing with the whole weight at the ends only.

BEARING, in navigation and geography, the situation of one place from another, with regard to the points of the compass; or the angle which a line drawn through the two places makes with the meridians of each. The bearings of places on the ground are usually determined from the magnetic needle, in the managing of which consists the principal part of surveying; since the bearing or distance of a second point from a first being found, the place of that second is determined; or the bearings of a third point from two others, whose distance is known, being found, the place of the third is determined instrumentally; but to calculate trigonometrically, there must be more data.

BEARING, in the sea language. When a ship sails towards the shore, before the wind, she is said to bear in with the land or harbour. To let the ship sail more before the wind, is to bear up. To put her right before the wind, is to bear round. A ship that keeps off from the land is said to bear off. When a ship that was to windward comes under another ship's stern, and so gives her the wind, she is said to bear under her lee, &c. There is another sense of this word, in reference to the burden of a ship; for they say a ship bears, when having too slender or lean a quarter, she will sink too deep into the water with an over-light freight, and thereby can carry but a small quantity of goods.

BEARING *of a piece of timber*, among carpenters, the space either between the two fixed extremes thereof, when it has no other support, which they call bearing at length, or between one extreme and a post, brick wall, &c. trimmed up between the ends to shorten its bearings.

BEAST, *la bête*, among gamesters, a game at cards, played in this manner: The best cards are the king, queen, &c. whereof they make three heaps, the king, the play, and triolet. Three, four, or five, may play; and to every one are dealt five cards. However, before the play begins, every one stakes to the three heaps. He that wins most tricks, takes up the heap called the play; he that has the king, takes up the heap so called; and he that has three of any sort, that is, three fours, three fives, three sixes, &c. takes up the triolet heap.

BEAT of drum, in the military art, is to give notice by beat of drum, of a sudden danger; or, that scattered soldiers may repair to their arms and quarters, is to beat an alarm, or to arms; also to signify, by different manners of sounding a drum, that the soldiers are to fall on the enemy; to retreat before, in, or after, an attack; to move, or march, from one place to another; to treat upon terms, or confer with the enemy; to permit the soldiers to come out of their quarters at break of day; to order to repair to their colours, &c. is to beat a charge, a retreat, a march, &c.

BEAVER, in zoology. See CASTOR.

BECAH, or BEKAH, in Hebrew antiquity, a Jewish coin, equal to thirteen and eleven sixteenths pence of our money.

BED. All beds that are for sale must be filled with one sort of stuffing only, on the pain of forfeiture; as the mixing of feathers, down, scalded feathers, dry pulled feathers, any ways together, is conceived to be injurious to a man's body to lie on. Also bed-quilts, mattresses, and cushions, stuffed with horse-hair, fen-down, goat's-hair, and neat's-hair, which are dressed in lime, and in which the heat of a man's body will exhale, and cause them to yield a noxious smell, are prohibited by statute.

Bed *of justice*, in the French customs, a throne upon which the king used to be seated when he went to the parliament. The king never held a bed of justice unless for affairs that concerned the state, and then all the officers of parliament were clothed in scarlet robes.

Bed *of the carriage of a great gun*, a thick plank that lies under the piece, being in fact the body of the carriage.

Bed, in masonry, a course or range of stones; and the joint of the bed is the mortar between two stones placed over each other.

BEDCHAMBER, *lords of*, in the British customs, 14 lords who attend in their turns, each a week, during which time they lie in the king's bed-chamber, and wait on him when he dines in private. Their salary is 1000*l.* per annum. The first of these is called groom of the stole. There are also twelve grooms of the bed-chamber.

BEDA, a sacred book of the religion and laws of the brahmins of Hindostan, called also veda.

BEDOUINS, in the Arabian customs, tribes of Arabs, who live in tents, and are dispersed all over Arabia, Egypt, and the north of Africa.

BEE, in zoology. See Apis.

BEECH-galls, hard protuberances found on the leaves of the beech, wherein are lodged the maggots of a certain fly. These galls are of an oblong figure and somewhat flatted. They resemble the stone of a plum in shape, and are very hard. In each gall there is single cavity inhabited by a white worm, which in time passes through the nymph state into that of the fly, to which it owes its origin.

Beech-*mast*, the fruit of the beech-tree, said to be good for fattening hogs, deer, &c. and to have supplied men instead of bread. The island of Chios sustained a siege by means of mast.

Beech-*oil*, an oil drawn by expression from the mast of the beech-tree, after it has been shelled and pounded. This oil is very common in some parts of France, and used instead of butter; but most of those who take a great deal of it, complain of pains and a heaviness of the stomach.

BEELE, a kind of pick-ax, used by the miners for separating the ores from the rocks in which they lie: this instrument is called a tubber by the miners of Cornwall.

BEER, a common and well-known liquor, made with malt and hops, and used in those parts of Europe where vines will not grow, and where cyder is scarce. See Brewing, &c.

BEET, in botany. See Beta.

BEETLE, in entomology, a common English name for all insects that are furnished with shelly wing-cases; those which have them divided by a straight suture are properly beetles, and belong to the coleoptera order. The scarabæi are beetles in the strictest sense of the word.

BEGGAR. See Vagrant.

BEGHARDI, a certain sect of Christians which arose in Germany, and in the Low-countries, about the end of the thirteenth century. They made profession of a monastical life, without observing celibacy; and maintained, if they are not scandalized by the monks, that man could become as perfect in this life as he shall be in heaven; that every intellectual nature is of itself happy, without the succour of grace; and that he who is in this state of perfection ought to perform no good works, nor worship the host.

BEGLERBEG, a governor of one of the principal governments in the Turkish empire. There are two sorts of beglerbegs; the one have a certain revenue assigned upon the cities, boroughs, and villages of their government, which they raise by power of the commission granted to them by the sultan; the others have a certain rent paid by the treasurer of the grand signior. They are become almost independent, and have under their jurisdiction several sangiacs, or particular governments, and begs, agas, and other officers who obey them.

BEGONIA, in botany, a genus of plants of the monoecia polyandria class and order; the characters of which are: the flowers are of two kinds; the one is the male flower, with no cal. but many petals, some broader, and others narrower; the other, which produces the embryo fruit, is of the rosaceous sort, and is composed of several petals, arranged in a circular form, and placed on a foliated cup, which finally becomes a trigonal alated caps. and containing small seeds. There are 13 species, chiefly stove plants.

BEGUINS, congregations of devout young women, who maintain themselves by the work of their hands, leading a middle kind of life between the secular and religious. These societies consist of several houses placed together in one inclosure, with one or more churches, according to the number of beguins. There is in every house a prioress, without whose leave they cannot stir out. Their vow is conceived in these terms: 'I promise to be obedient and chaste, as long as I continue in this beguinage.' They observe a three years noviciate, before they take the habit; and the rector of the parish is their superior, but can do nothing without the advice of eight beguins. They were formerly established in several parts of Flanders.

BEHEADING, a capital punishment among the Romans: it was performed at first with an ax, but afterwards with a sword, as was formerly the case in Holland and France. In France, however, during the last 15 years the guillotine has been used for the purpose of dispatching criminals; and in the course of that space of time a multitude of the most loyal, virtuous, and most honourable men in Europe, for actions the most praiseworthy, have been cruelly murdered by that instrument.

BEHEN, in the materia medica, the name of two roots, the one white the other red, both accounted cordials and restorative.

BEJARIA, a genus of the dodecandria monogynia class and order: the essential character is; calyx seven-cleft; petals seven; stam. fourteen; berry seven-celled, many-seeded.

There are two species, one a tree and the other a shrub, of New Granada. The tree has purple flowers, and the shrub flesh-coloured, something allied to the rhododendrons.

BEIZA, or Beizath, in Hebrew antiquity, a word signifying an egg, was a certain measure in use among the Jews. The beiza was likewise a gold coin, weighing forty drachms, among the Persians.

BELAY, in the sea-language, is to make fast the ropes in their proper places.

BELEMNITES, in natural history, are fossils, composed of several thin coats or crusts, encircling one another, and all of a striated texture; they have usually a hollow in the middle, of a conical shape; sometimes empty, and sometimes filled up with spar, pyrites, or a marine shell of the straight concamerated kind. They have usually a chink running down the whole length of the body, and sometimes two or three; but the additional ones usually begin at the apex of the stone, and run up but a little way. Their figure is sometimes conic, sometimes cylindric: some are of all the intermediate figures between conic and cylindric, and some almost orbicular. They are of various sizes, from a quarter of an inch to eight inches in length, and though always of the same structure, are of various colours, and they have a peculiar smell when scraped. They are found in all sorts of strata, sometimes in clay, sometimes among gravel, often immersed in beds of stone, often in loose flints, and are sometimes found covered with a sparry crust of a different texture with the body of the mass. The finest specimens have been procured from chalk-pits of Oxfordshire.

BELL, a well-known machine, ranked by musicians among the musical instruments of percussion. The music of bells is altogether melody; but the pleasure arising from it consists in the variety of interchanges, and the various successions and general predominance of the consonances in the sounds produced. The metal of which a bell is made, is a composition of tin and copper, or pewter and copper; the proportion one to the other is almost 20 pounds of pewter, or 23 pounds of tin, to 100 weight of copper. Bell-metal is prohibited to be imported, as are hawk-bells, &c.

The constituent parts of a bell are the body or barrel, the clapper on the inside, and the ear or cannon on which it hangs to a large beam of wood. The sound of a bell consists in a vibratory motion of its parts, much like that of a musical chord. The stroke of the clapper must necessarily change the figure of the bell, and of a round make it oval; but the metal having a great degree of elasticity, that part will return back again which the stroke drove farthest off from the centre, and that even some small matter nearer the centre than before; so that the two parts which before were extremes of the longest diameter, do then become those of the shortest; and thus the external surface of the bell undergoes alternate changes of figure, and by that means gives that tremulous motion to the air, in which the sound consists. To understand this more completely, let us conceive that a bell is composed of a series of circular zones, decreasing in diameter all the way to its top, each of which may be considered as a flat ring, composed of as many concentric circles as its thickness will admit of. If this ring is struck at the point *a*, (Plate Miscel. fig. 11.) the part so struck tends towards *g*, and at the same time the parts *b* and *d* tend towards *i* and *m*, and this action in these parts necessarily causes the point *c* to approach towards *e*; by their elastic power, however, these parts presently regain the position in which they were before the bell was struck; but as they return with an accelerated force, they generally go beyond the point where they ought to rest. The part *a*, therefore, after having returned from *g* to *a*, tends towards *f*, the part *c* towards *h*,

and the parts *b* and *d* towards *k* and *l*; whence it happens that the bell, at first of a circular form, really becomes alternately oval in two different directions; it follows then, that in those parts where the curvature is the greatest, their exterior points depart from each other.

BELLA-DONNA. See AMARYLLIS and ATROPA.

BELLES-LETTRES, a word absurdly introduced from the French, and noted here only to reprobate the contemptible practice of debasing the simple majesty of our native language, by wretched gallicisms. The French writers themselves have no determinate idea affixed to this phrase; some applying it to polite literature only, and some extending it to the whole scope of human learning, even to mathematics.

BELLIS, in botany, the daisy, a genus of the syngenesia class, and polygamia superflua order of plants; and in the natural method ranking under the 49th order, compositæ discoidæ. The receptacle is naked and conic; there is no pappus; the calyx is hemispherical, with equal scales; and the seeds are ovated. There are two species, and many varieties.

1. Bellis annua, with leaves on the lower part of the stalk, is a low annual plant growing naturally on the Alps and the hilly parts of Italy. It seldom rises more than three inches high, and has an upright stalk, with leaves on the lower part; but the upper part is naked, supporting a single flower, like that of the common daisy, but smaller.

2. Bellis perennis, the common daisy, with a naked stalk, and one flower, grows naturally in pasture lands in most parts of Europe. It is often a troublesome weed in the grass of gardens, so is never cultivated. Its leaves have a subtile subacid taste; and are recommended as vulneraries, and in asthmas and hectic fevers, as well as in such disorders as are occasioned by drinking cold liquors when the body has been much heated.

The Bellis hortensis, or garden daisy, is only a variety of this species. It has a large double flower. The varieties cultivated in gardens are; 1. the red and white garden daisy: 2. the double variegated garden daisy: 3. the childing, or hen and chicken garden daisy: and 4. the cock's-comb daisy, with red and white flowers.

BELLIUM, a genus of the syngenesia, polygamia superflua class and order. The essential character is; cal. with equal leaflets; seeds conic, with chaffy eight-leafed crown, and auned down; recept. naked. There are two species, natives of Italy and the Levant, in many respects resembling the daisy in habit and appearance.

BELLON, a distemper common in countries where they smelt lead ore. It is attended with languor, intolerable pains, and sensation of gripings in the belly, and generally costiveness. Beasts, poultry, &c. as well as men, are subject to this disorder. Hence a certain space round the smelting-houses is called bellon-ground, because it is dangerous for an animal to feed upon it.

BELLONIA, in botany, a genus of the monogynia order, and pentandria class of plants. The characters are; the flower is wheel-shaped; the germen is situated under the receptacle of the flower, which afterward becomes a turbinated seed-vessel, ending in a point, having one cell filled with small round seeds. Of this genus there are two species known, viz.

1. Bellonia aspera, or shrubby bellonia, has a rough balm leaf. It is very common in the warm islands of America.

2. Bellonia spinosa, a native of Hispaniola.

BELLOWS, a machine so contrived, as to agitate the air with great briskness, expiring and inspiring the air by turns, and that only from enlarging and contracting its capacity. This machine is of various constructions, but in general is composed of two flat boards, sometimes of an oval, sometimes of a triangular figure: two or more hoops, bent according to the figure of the boards, are placed between them; a piece of leather, broad in the middle, and narrow at both ends, is nailed on the edges of the boards, which it thus unites together, as also on the hoops which separate the boards, that the leather may the easier open and fold again; a tube of iron, brass, or copper, is fastened to the undermost board; and there is a valve within that covers the holes in the under board, to keep in the air. In foundries, and other great works, where a constant and vast heat is required, the bellows are made double, so that there is a constant blast proceeding by the upward and downward motion of the handle.

The action of bellows, however wrought, whether by water, steam, or men, depends on this; that the air which enters them, and which they contain when raised, is again compressed into a narrower space when they are closed, and it flows out of the pipe with a velocity proportional to the force by which it is compressed. The blast also will last in the proportion which the quantity of air drawn in through the valve bears to the pipe. The bellows of smiths and founders are worked by means of a rocker, with a string or chain fastened to it, and pulled by the workman. One of the boards is fixed, and by drawing down the handle of the rocker, the moveable board rises, and by means of a weight on the top of the upper board, sinks again. The bellows of an organ are wrought by a man called the blower; but in small organs, by the foot of the player.

BELLY, the abdomen. See ANATOMY.

BELTS, in astronomy, two zones, or girdles, surrounding the body of the planet Jupiter, more lucid than the rest, and of unequal breadth. See ASTRONOMY.

BELTS, in geography, certain streights between the German ocean and the Baltic. The belts belong to the king of Denmark, who exacts a toll from all ships which pass through them, excepting those of Sweden, which are exempted.

BENCAPED, among sailors. A ship is said to be bencaped when the water does not flow high enough to bring her off the ground, out of the dock, or over the bar.

BENCH, *free*, signifies that estate in copyhold lands, which the wife, being espoused a virgin, has after the decease of her husband, for her dower, according to the custom of the manor. As to this free-bench, several manors have their own customs; and in the manors of East and West Enbourne, in the county of Berks, and other parts of England, there is a custom, that when a copyhold tenant dies, the widow shall have her free-bench in all the deceased husband's lands, whilst she lives single and chaste; but if she commits incontinency, she shall forfeit her estate: nevertheless, upon her coming into the court of the manor, riding on a black ram, and having his tail in her hand, and at the same time repeating a form of words prescribed, the steward is obliged, by the custom of the manor, to re-admit her to her free bench.

BEND, in heraldry, one of the nine honourable ordinaries, containing a third part of the field when charged, and a fifth when plain. It is sometimes, like other ordinaries, indented, ingrailed, &c. and is either dexter or sinister.

BENDING, in the sea language, the tying two ropes or cables together: thus they say, bend the cable; that is, make it fast to the ring of the anchor: bend the sail, make it fast to the yard.

BENDS, in a ship, the same with what is called wails, or wales; the outmost timbers of a ship's side, on which men set their feet in climbing up. They are reckoned from the water, and are called the first, second, or third bend. They are the chief strength of a ship's sides, and have the beams, knees, and foot-hooks, bolted to them.

BENEDICTINES, in church-history, an order of monks, who profess to follow the rules of St. Benedict. The benedictines being those only that are properly called monks, wear a loose black gown, with large wide sleeves, and a capuche, or cowl, on their heads, ending in a point behind. In the canon law they are styled black friars, from the colour of their habit.

The rules of St. Benedict, as observed by the English monks before the dissolution of the monasteries, were as follows: they were obliged to perform their devotions seven times in 24 hours, the whole circle of which devotions had respect to the passion and death of Christ: they were obliged always to go two and two together: every day in Lent they were obliged to fast till six in the evening, and abated of their usual time of sleeping and eating; but they were not allowed to practise any voluntary austerity without leave of their superior; they never conversed in their refectory at meals, but were obliged to attend to the reading of the scriptures: they all slept in the same dormitory, but not two in a bed; they lay in their clothes. For small faults they were shut out from meals; for greater, they were debarred religious commerce, and excluded from the chapel; and as to incorrigible offenders, they were excluded from the monasteries. Every monk had two coats, two cowls, a table-book, a knife, a needle, and a handkerchief: and the furniture of their bed was a mat, a blanket, a rug, and a pillow.

BENEFICE, a church endowed with a revenue, for the performance of divine service; or the revenue itself assigned to an ecclesiastical person, by way of stipend, for the service he is to do that church.

All church preferments, except bishopries, are called benefices; and all benefices are, by the canonists, sometimes styled dignities; but we now ordinarily distinguish between benefice and dignity; applying dignity to bishopries, deaneries, archdeaconries, and prebends; and benefice to parsonages, vicarages, and donatives.

The canonists distinguish three manners of vacating a benefice, viz. de jure, de facto, and

by the sentence of a judge. A benefice is vacated de jure, when the person enjoying it is guilty of certain crimes expressed in those laws, as heresy, simony, &c. A benefice is vacated de facto as well as de jure, by the natural death or the resignation of the incumbent; which resignation may be either express, or tacit, as when he engages in a state, &c. inconsistent with it, as, among the Romanists, by marrying, entering into a religious order, or the like. A benefice becomes vacant by the sentence of a judge, by way of punishment for certain crimes, as concubinage, perjury, &c.

In the church of England there are 1071 benefices under 10*l.* per annum; 1467 from 10 to 20; 1126 from 20 to 30; 1049 from 30 to 40; 884 from 40 to 50; and there are 5597 livings under 50*l.* per annum. It must be 500 years before every living can be raised to 60*l.* a-year by queen Anne's bounty, and 339 years before any of them can exceed 50*l.* a-year. On the whole, there are above 11,000 church preferments in England, exclusive of bishoprics, deaneries, canonries, prebends, priest-vicars, lay-vicars, secondaries, &c. belonging to cathedrals, or choristers, or even curates to well beneficed clergymen. Benefices began about A. D. 500.

BENISH *days*, among the Egyptians, a term of three days of the week, which are days of less ceremony in religion than the other four.

BENZOIN, a dry and solid resin, brought to us in masses of various sizes from the East Indies, particularly from the kingdom of Siam, and the islands of Java and Sumatra. It is very brittle, and breaks vitreous. When rubbed, it emits a fragrant odour, and when heated sufficiently, lets the benzoic acid escape. It is soluble in alkohol, but insoluble in water. It is used chiefly to perfume apartments, and benzoic acid is extracted from it. It has not been examined by any modern chemist. Its specific gravity is 1.092. It is considered as a compound of resin and benzoic acid. See STYRAX, and for benzoic acid see CHEMISTRY.

BERAMS, a coarse cloth, all made with cotton-thread, which comes from the East Indies, and particularly from Surat.

BERBERIS, the barbery, or pipperidge bush. A genus of the monogynia order, and hexandria class of plants: the characters of which are; the calyx consists of six leaves; the petals are six, with two glands at the ungues; it has no stylus; and the berry contains two seeds. The species are four:

1. Berberis cretica, with a single flower in each footstalk, is at present very rare in Britain; the plants being tender whilst young, and most of them killed by severe frost. This never rises more than three or four feet high in England; but sends out many stalks from the root, which are strongly armed with spines at every joint: the leaves are produced without order, and are shaped like those of the narrow-leaved box-tree; the flowers come out from between the leaves, each having a slender footstalk; but they are not succeeded by fruit in Britain.

2. Berberis illicifolia, with leaves like the holm oak.

3. Berberis Sibirica, a very small shrub, scarcely a span in height.

4. Berberis vulgaris, the common barberry, which grows naturally in hedges in many parts of England; but is also cultivated in gardens, on account of its fruit, which is pickled. It rises to the height of eight or ten feet, with many stalks, which have a white bark, yellow on the inside. The flowers come out from the wings of the leaves in small ramose bunches like those of the currant-bush, and are of a yellow colour: these are succeeded by oval fruit, which are at first green, but when ripe turn to a fine red colour. The flowers appear in May, and the fruit ripens in September. There are two or three varieties of this shrub, which by some have been taken for distinct species; one is the barberry without stone; another, the barberry with white fruit; and a third is called by Tournefort taller eastern barberry, with a black sweet fruit. Of these Mr. Miller observes, that the first certainly depends on the age of the plant, because the suckers taken from those bushes commonly produce fruit with stones. The second, he says, seldom bears any fruit; the leaves are of a lighter green colour, and the bark of the stalks are whiter, than those of the common kind. The third appears to be the same with the common sort, excepting the colour and flavour of its fruit, which can never indicate a specific difference. The berries, which are so acid that birds will not feed upon them, are moderately astringent; and have been given with success in bilious fluxes, and diseases proceeding from heat, acrimony, and thinness of the juices. The leaves also are gratefully acid. The flowers are offensive to the smell when near, but at a distance their odour is extremely fine. An infusion of the bark in white wine is purgative. The roots boiled in ley, dye wool yellow. In Poland they dye leather of a most beautiful yellow with the bark of the root. The inner bark of the stems dyes linen of a fine yellow with the assistance of alum. This shrub should never be permitted to grow in corn-lands; for the ears of wheat that grow near it never fill, and its influence in this respect has been known to extend across a field of 300 or 400 yards. Cows, sheep, and goats, eat it: horses and swine refuse it.

BERCHEROT, or BERKCOITS, a weight used at Archangel, and in all the Russian dominions: it weighs about 364 pounds English avoirdupois weight.

BERDASH, a name formerly used in England for a certain kind of neck-dress; and hence a person who made or sold such neck-cloths, was called berdasher, from which is derived our word haberdasher.

BERENGARIANS, a religious sect of the 11th century, which adhered to the opinion of Berengarius, who, even in those days, strenuously asserted, that the bread and wine in the Lord's supper is not really and essentially, but only figuratively, changed into the body and blood of Christ.

BERGAMOT, the name of a fragrant essence extracted from a species of citron. As this oil exists pure in the peel, being simply deposited in small cells, the extraction is easy, either by expression or distillation. The former is the best, as the oil is not liable to be altered by heat; but more is produced by distillation than by expression: by this mode two ounces of the oil have been obtained from two pounds of the peel.

It is also the denomination of a coarse tapestry, manufactured with flocks of silk, wool, cotton, hemp, ox, cow, or goat's hair, and supposed to be invented by the people of Bergamo.

BERGESA, a genus of the class and order decandria monogynia. The essential character is, calyx five-parted; petals five; berry subglobular, one-celled, with five seeds.

There is one species, a leafy tree, with the bark of the alder; a native of the East Indies.

BERGIA, a genus of the class and order decandria pentagynia. The essential character is, calyx five-parted; petals five; capsule one, globular, with swellings, five-celled, five-valved, valves resembling petals; seeds many.

There are two species, the B. capensis and glomerata, both natives of the Cape.

BERGHMOT, an assembly, or court, held upon a hill, in Derbyshire, for deciding controversies among the miners.

BERIBERI, a kind of palsy, common in the East Indies. The word, in the language of the country, signifies a sheep; and was given by the natives to this distemper, because the patients, on throwing out their knees, and lifting up their legs, seem to imitate sheep in their walk.

BERME, in fortification, a space of ground left at the foot of the rampart, on the side next the country, designed to receive the ruins of the rampart, and prevent the filling up of the fosse. It is sometimes palisadoed, for the more security; and in Holland it is generally planted with a quickset hedge. It is also called liziere, relais, foreland, retraite, pas de souris, &c.

BERNARDINES, an order of monks, founded by Robert abbot of Moleme, and reformed by St. Bernard. They wear a white robe with a black scapulary; and when they officiate, they are clothed with a large gown, which is all white, and with great sleeves, and a hood of the same colour. They differ but very little from the Cistercians.

BERRY, a round fruit, for the most part soft, and covered with a thin skin, containing seeds in a pulpy substance; but if it is harder, or covered with a thicker skin, it is called pomum, apple.

BERTIESA, a genus of the pentandria monogynia class and order. The essential character is, calyx turbinate, five-toothed; corolla, tube short, with a villose mouth; berry globose, inferior, two-celled, many-seeded.

There is but one species, the B. Guianensis, which the specific name announces to be a native of Guiana. The flower is white.

BERYL, in natural history, called by our lapidaries aqua marina, is a pellucid gem of a bluish green colour, found in the East Indies and about the gold mines of Peru, and especially in Siberia and Tartary, where its crystals are sometimes a foot long.

The beryl, like most other gems, is met with both in the pebble and columnar form, but in the latter most frequently. In the pebble form it usually appears of a roundish but flatted figure, and commonly full of small flat faces, irregularly disposed. In the columnar or crystalline form it always consists of hexangular columns, terminated by hexangular pyramids. It never receives any admixture of colour into it, nor loses the blue and green, but has its genuine tinge in the degrees from a very deep and dusky to

the palest imaginable of the hues of sea-water.

The beryl has many points of resemblance with the emerald, and in particular the crystals of both are divisible parallel to the sides and extremities of a regular hexahedral prism. The beryl is externally shining, with a vitreous lustre. It is generally transparent, but sometimes only semi-transparent. The specific gravity varies from 2.65 to 2.75. A specimen, analysed by Vauquelin, contained

69 silica
13 alumina
16 glucina
1 oxide of iron
0.5 lime

99.5

It was by the analysis of this stone that Vauquelin discovered the earth which he called glucina. The beryl, when cut and polished, has a considerable lustre: it is ranked among gems; but its value is trifling, compared with the ruby, sapphire, topaz, &c.

BERYL-CRYSTAL, in natural history, a species of what Dr. Hill calls ellipomacrostyla, or imperfect crystals, is of an extremely pure, clear, and equal texture, and scarcely ever subject to the slightest films or blemishes. It is ever constant to the peculiarity of its figure, which is that of a long and slender column, remarkably tapering towards the top, and very irregularly hexangular. It is of a very fine transparency, and naturally of a pale brown; and carries such evident marks of distinction from all other brown crystals, that our lapidaries call it, by way of eminence, the beryl-crystal, or simply the beryl.

BESANT, or *bezant*, a coin of pure gold, of an uncertain value, struck at Byzantium, in the time of the Christian emperors: hence the gold offered by the king at the altar, is called besant, or bisant.

Few coins ever had a more general currency than these besants; having been current from the beginning to the end of the eastern empire, in all its provinces, and also in those countries that had been provinces of the western empire: and among others in Britain. With us they were received in payments. They are frequently referred to by the historians of the crusades, but are rarely mentioned by ours; and are not to be found in Domesday-book, nor in the acts of Henry I. or Stephen, nor in the last will of king Henry II.

BESANTS, in heraldry, round pieces of gold, without any stamp, frequently borne in coats of arms.

BESISTAN, a name given to those places at Constantinople, &c. where the merchants have their shops, and expose their goods to sale. A particular besistan belongs to each class of merchants.

BESLERIA, a genus of the angiospermia order and didynamia class of plants. Of this genus there are six species: the most remarkable are,

1. Besleria cristata, with stalks growing single, and a five-leaved involucrum. The calyx is scarlet, the corolla yellow.

2. Besleria lutea, with simple footstalks growing in clusters, and spear-shaped leaves; yellow flowers.

3. Besleria melittifolia, with branching footstalks and oval leaves. All these species are natives of the warm parts of America, and cannot be preserved in this country without artificial heat. But as they are not remarkable for beauty, or any other property yet discovered, we forbear any particular description.

BESORCH, a coin of tin, or some alloyed metal, current at Ormus, at the rate of 7-49th parts of a farthing sterling.

BESTIARII, in Roman antiquity, such as fought against beasts, or who were exposed to them by sentence of the law. There were four kinds of bestiarii: the first were those who made a trade of it, and fought for money; the second were such young men as, to show their strength and dexterity in managing their arms, fought against beasts; the third was where several bestiarii were let loose at once, well armed, against a number of beasts; and the fourth kind were those condemned to the beasts, consisting either of enemies taken prisoners in war, or as being slaves, and guilty of some enormous crime: these were all exposed naked, and without defence.

BETA, a genus of the pentandria digynia class and order of plants; and in the natural method ranking under the 12th order, holoraceæ. The calyx has five leaves; there is no corolla; the seeds are kidney-shaped, and situated within the base of the calyx. There are four species, viz.

1. Beta cicla, the root of scarcity, has been greatly extolled in different publications of late years: but its virtues have perhaps been exaggerated. The beta hortensis, or common white beet, is a variety of this; and is cultivated in gardens for the sake of its leaves, which are frequently used in soups.

2. Beta maritima, the sea beet, grows naturally by the sea-side, in salt marshes, and in many parts of England. It has been supposed by many to be only a variety of the common white beet; but Mr. Miller assures us he has been unable to make any variation in them by culture.

3. B. apatula, a native of Madeira.

4. Beta vulgaris, the red beet, with a pyramidal root, has large, thick, succulent leaves, which are for the most part of a dark green or purple colour. The roots are large, and of a deep red. The larger these roots grow, the tenderer they are; and the deeper their colour, the more they are esteemed. The varieties of this species are the common red beet, the turnip-rooted beet, and the green-leaved red beet.

On many parts of the continent the beet-root has been used for the purpose of extracting sugar from it. The roots are pressed, and the saccharine liquor boiled down to the consistence of a syrup: it of course undergoes many other operations. According to the account of M. Achard, however, the cost of a quantity of beet, in Prussia, that will yield one hundred pounds of raw sugar, is not more than sixpence: twenty pounds of root will yield one of sugar; one hundred pounds of raw sugar give fifty-five of refined, and twenty-five pounds of molasses. It is computed by the same gentleman, who has employed much time in the pursuit, that a German square mile of land (that is, sixteen square miles English), properly cultivated, would produce white beet sufficient to furnish the whole Prussian dominions with sugar.

BETEL, or *betle*, in botany, a kind of long pepper, found in Malabar, and other parts of the East Indies. See PIPER.

BETELGEULE, a fixed star of the first magnitude, in Orion's hind shoulder.

BETHLEHEMITES, in church-history, a religious order, called also star-bearers, *stelliferi*, because they were distinguished by a red star with five rays, which they wore on their breast, in memory of the star that appeared to the wise men, and conducted them to Bethlehem.

There is an order of Bethlehemites still subsisting in the Spanish West Indies, who are habited like capuchins, with this difference; that they wear a leathern girdle instead of a cord, and on the right side of their cloak an escutcheon, representing the nativity of our Saviour.

BETONICA, *betony*, a genus of the gymnospermia order and didynamia class of plants, and in the natural method ranking under the 42d order, verticillatæ. The calyx is awned; the upper lip of the corolla is ascending and flattish: and the tube is cylindric. There are seven species. The most remarkable are,

1. Betonica orientalis, the oriental betony.

2. Betonica stricta, the greater Danish betony.

3. Betonica incana, the hoary Italian betony, has a flesh-coloured flower.

4. Betonica officinalis, is the species chiefly worth notice. It is a low plant, growing in woods and shady places in several parts of England; the flowers come forth in June and July, of a purplish colour, and stand in spikes on the top of the stalks. The leaves and flowers have a roughish, somewhat bitterish taste, accompanied with a very weak aromatic flavour. The powder of the leaves of betony snuffed up the nose provokes sneezing; and hence it is sometimes made an ingredient in sternutatory powders. This effect does not seem to be owing, as is generally supposed, to any peculiar stimulating virtues in the herb, but to the rough hairs with which the leaves are covered. The roots of this plant differ greatly in the quality from the other parts: their taste is very bitter and nauseous; taken in a small dose, they vomit and purge violently, and are supposed to have somewhat in common with the root of hellebore. According to Simon Pauli and Bartholinus, this plant affects those who gather any considerable quantity of it with a disorder resembling drunkenness. Its leaves are sometimes smoked like tobacco.

BETROTHMENT, among civilians, the same with espousals.

BETULA, the birch or alder-tree, a genus of the tetandria order and monœcia class of plants, and in the natural method ranking under the 50th order, *amentaceæ*. The calyx of the male is monophyllous, trifid, and biflorous; and the corolla is parted into four segments: the female calyx is monophyllous, trifid, and biflorous: the seeds have a membranaceous wing on both sides. There are fifteen species: the more remarkable are,

1. Betula alba, the common birch-tree, so well known to *young students* as to need no description: in a proper soil and situation it will rise high, and swell to a considerable size.

There is a spruceness in its general appearance in summer; and in winter its bark often exhibits, in its variegations of red and white, no inelegant object. Were it not so commonly seen upon poor soils, and applied to so many mean and degrading purposes, the birch might well claim a place among the ornamental trees.

2. Betula alnus, the alder-tree, will grow to a large timber tree. The alder is of straggling inelegant growth; and hacked and disfigured in the manner in which they generally are, they have but little effect in effacing the unsightliness of a swamp, which is their natural soil. Wherever the soil is or can be made pasturable, the alder should by no means be permitted to gain a footing. Its suckers and seedlings poison the herbage; and it is a fact well known to the observant husbandman, that the roots of the alder have a peculiar property, of rendering the soil they grow in more moist and rotten, than it would be if not occupied by this aqueous plant. Plantations of alders should therefore be confined to swampy, low, unpasturable places. In this case the native species ought to give place to its more ornamental varieties, of which Hanbury enumerates five; viz. 1. the long-leaved, 2. the white, 3. the black, 4. the hoary-leaved, and 5. the dwarf alder.

3. Betula lenta, the Canada birch, grows to sixty or more feet in height. The leaves are heart-shaped, oblong, smooth, of a thin consistence, pointed, and very sharply serrated. They differ in colour; and the varieties of this species are, 1. dusky Canada birch; 2. white paper birch; 3. poplar-leaved Canada birch,; 4. low-growing Canada birch, &c.

4. Betula nana, the dwarf birch, with roundish leaves, grows naturally in the northern parts of Europe and on the Alps. It seldom rises above two or three feet high. It has slender branches with round leaves, but seldom produces flowers here. It is preserved in some curious gardens for the sake of variety, but is a plant of no use.

5. Betula nigra, the black Virginia birch-tree, will grow to upwards of 60 feet in height. The branches are spotted, and more sparingly set in the trees than the common sorts. The leaves are broader, grow on long footstalks, and add a dignity to the appearance of the tree. As it is naturally of an upright and swift growth, and arrives at so great a magnitude, Hanbury thinks it ought to have a share among our forest trees, and to be planted for the standards in open places, as well as to be joined with other trees of its own growth, in plantations more immediately designed for relaxation and pleasure. There are several varieties of this species, differing in the colour, size of the leaves, and shoots; such as, 1. the broad-leaved Virginian birch, 2. the poplar-leaved birch, 3. the paper birch, 4. the brown birch, &c.

One method of propagating the foreign sorts of birch is from seeds: but they may also be propagated by layers; and this is the way to continue the peculiarities in the varieties of the different sorts. In autumn the young shoots should be plashed near the stools, and they will strike root, and become good plants by the autumn following.

In some of the northern parts of Europe the wood of the white birch is much used for making carriages and wheels, being hard and of long duration. In France it is generally used for making wooden shoes, and in Britain for making women's shoe-heels, packing boxes, brooms, hoops, &c. It also makes very good fuel, and is planted along with hazel to make charcoal for forges. The bark of the birch seems in a manner incorruptible. In Sweden the houses are covered with it, and it lasts many years. It frequently happens that the wood is entirely rotten, when the bark is perfectly sound and good. In Kamtschatka it is used for making drinking cups. It abounds with a resinous matter, to which its durability is certainly owing. In consequence of this, it is highly inflammable: and in the northern countries torches are made of this bark sliced and twisted together. The bark itself consists of two different substances; a thick brittle brownish red one; and several very thin, smooth, white, transparent membranes; in which the inflammable property resides. The thick part is less resinous, and has a roughish taste. It has been thought to possess some medical virtues, but concerning these experience has as yet determined nothing certain. Upon deeply wounding or boring the trunk of the tree in the beginning of spring, a sweetish juice issues, sometimes in so large a quantity as to equal the weight of the whole tree and root; one branch will bleed a gallon or more in a day. This juice is recommended in scorbutic disorders, and other foulnesses of the blood. Its most sensible effect is to promote the urinary discharge. By proper fermentation, with the addition of sugar, this juice makes a pleasant wine. The bark of the Canada birch is very light, tough, and durable; and the inhabitants of America use it for canoes.

BEVEL, among masons, carpenters, joiners, and bricklayers, a kind of square, one leg whereof is frequently crooked, according to the sweep of an arch or vault. It is moveable on a centre, and so may be set to any angle. The make and use of this instrument is pretty much the same as those of the common square and mitre, except that those are fixed, the first at an angle of ninety degrees, and the second at forty-five; whereas the bevel being moveable, it may in some measure supply the place of both, which it is chiefly intended for, serving to set off or transfer angles, either greater or less than ninety or forty-five degrees.

BEVEL-ANGLE, any angle except those of ninety or forty-five degrees.

BEVELLING, in ship-building, the art of hewing timber with a proper and regular curve, according to a mould which is laid on one side of its surface.

BEVILE', in heraldry, a thing broken or opening like a carpenter's rule: thus we say, he beareth argent, a chief bevilé, vert, by the name of beverlis.

BEY, among the Turks, signifies a governor of a country or town. The Turks write it begh, or bek, but pronounce it bey.

BEZANS, cotton cloths, which come from Bengal: some are white, and others striped with several colours.

BEZOAR, originally meant an antidote, or medicine intended to prevent the fatal effects of poison.

BEZOAR, *oriental*, a moderately hard and heavy stone, very variable and uncertain in size, shape, and colour. It is generally of a round form; and its size is between that of a horse-bean and that of a small walnut, though there are some larger, and others smaller than peas. The ordinary colour is a duskish olive, or greenish brown. It is always smooth and glossy on the surface; and, when broken, is found to consist of a great number of coats or crusts of stony matter, laid one over another; and often formed upon a piece of stick, or seed of a fruit, or some such article, for a nucleus or basis. This is a drug of very great price, and of very great fame; but it is not of the number of those things that have been proved to deserve the repute they stand in. It is brought to us from Persia, and many parts of the East Indies: it is to be chosen entire, not in scraps or fragments; of a greenish or olive colour, with some mixture of grey in it; and such as, when rubbed on paper, before whitened with ceruss, gives a yellowish colour. There is also an occidental bezoar, which comes from Mexico.

Bezoars are generally supposed to be concretions formed in the stomach or intestines of different graminivorous animals; but it is not completely ascertained in what animal they are found, or how many species may yield them. Dr. Pearson analysed one specimen, and found it entirely composed of vegetable matter. Several writers attribute very great virtues to the oriental bezoar; but it is probable that if it has any action at all, it is merely that of an absorbent earth, as chalk or magnesia.

BIA, in commerce, a name given by the Siamese to those small shells which are called cowries throughout almost all the other parts of the East Indies. See COWRIE.

BICE, or *bise*, among painters, a blue colour prepared from the lapis armenus.

Bice bears the best body of all bright blues used in common work, as house-painting, &c. but it is the palest in colour. It works indifferently well, but inclines a little to sandy, and therefore requires good grinding. Next to ultramarine, which is too dear to be used in common work, it lies best near the eye of all other blues.

BICEPS, in anatomy, the name of several muscles. See ANATOMY.

BIDENS, a genus of the syngenesia polygamia æqualis class and order, and in the natural method ranking under the 49th order, compositæ oppositifoliæ. The receptacle is paleaceous; the pappus has erect scabrous awns; and the calyx is imbricated. Of this genus there are fourteen species; but none of them appear to merit notice, except the Bidens tripartita, frequently found by the sides of rivulets, ditches, and lakes, in England. It grows to the height of two feet; and has its leaves divided into three, or often five, lobes, with yellow flowers. A decoction of this plant with alum, dyes yarn of a yellow colour. The yarn must be first steeped in alum-water, then dried and steeped in a decoction of the plant, and afterwards boiled in the decoction.

BIDON, a liquid measure, containing about five pints of Paris, that is, about five quarts English wine-measure. It is seldom used but among ship's crews.

BIENNIAL *plants*, are those that have two years duration, or that are in their prime the first and second summers. They consist both of esculent and flowering plants.

BIGAMY, in the canon law, is when a person either marries two women successively, or only marries one woman who had

been married before; both which cases are accounted impediments to be a clerk, or to hold a bishopric. It is also bigamy when a person marries a woman who had been debauched before; or when he has known his own wife after she has been debauched by another.

The Romanists make a kind of bigamy by interpretation: as when a person in holy orders, or that has made profession of some monastic order, marries. This the bishop can dispense with on some occasions.

BIGAMY, by the law of England, is where a person marries a second wife, the first being alive. By the stat. 1 Jac. I. c. 11, it is enacted, that if any person or persons within his majesty's dominions, being married, do marry any person or persons, the former husband or wife being alive, the person or persons so offending shall suffer death, as in cases of felony. But it is provided, that nothing in this statute shall extend to any person or persons whose husband or wife shall be continually remaining beyond seas by the space of seven years together, or whose husband or wife shall absent himself or herself from each other for seven years together, the one of them not knowing the other to be living within that time. Nor shall the said statute extend to any person or persons divorced by a sentence in the ecclesiastical court; nor to any person or persons, for or by reason of any former marriage had or made within age of consent. The offence is now within the benefit of clergy.

BIGHT, among seamen, denotes one roll, or round, of a cable or rope, when coiled up.

BIGNONIA, *trumpet-flower*, or *scarlet jessamine*, a genus of the angiospermia order and didynamia class of plants, and in the natural method ranking in the 40th order, personatæ. The calyx is quinquefid and cupform; the corolla is bell-shaped at the throat, quinquefid, and bellied underneath; the siliqua is bilocular; and the seeds have membranous wings. Of this genus there are 27 species, of which the following are the most remarkable.

1. Bignonia catalpa, a native of Carolina, Virginia, and the Bahama islands. It has a strong woody stem and branches, rising 20 feet high, ornamented with large heart-shaped leaves. This deserves a place in all curious shrubberies, as during the summer season no tree makes a more beautiful appearance. It does not flower, however, till old.

2. Bignonia capreolata, or tendril bignonia, a native of North America, is a climber, which rises by the assistance of tendrils or claspers. The flowers are produced in August from the wings of the leaves; they are of the same nature, and of the shape nearly of the former; are large, of a yellow colour, and succeeded by short pods.

3. Bignonia radicans, the climbing ash-leaved bignonia, is a native of Virginia and Canada, rises 30 or 40 feet high, having pinnated opposite leaves of four pair of serrated lobes, and an odd one: all the shoots and branches being terminated by beautiful clusters of large trumpet-shaped scarlet flowers. The humming-birds delight to feed on these flowers; and by thrusting themselves too far into them are sometimes caught. Of this species there is a variety with smaller flowers.

4. Bignonia sempervirens, or evergreen climbing Virginia bignonia, is a native of Virginia, Carolina, and the Bahama islands. The stalks are more slender than those of the radicans, yet they rise, upon proper supports, to the height of twenty or thirty feet; the flowers are trumpet-shaped, erect, and of a yellow colour, proceeding from the sides and ends of the stalks and branches.

5. Bignonia unguis, the claw-bignonia, a deciduous climber, is a native of Barbadoes and the other West India islands. It rises by the help of claw-like tendrils, the branches being very slender and weak; and by these it will overtop bushes, trees, &c. twenty or thirty feet high.

6. Bignonia grandiflora. This is also a shrubby climbing plant, a native of Japan. The flowers are purple, and as large as a rose.

The cultivation of the bignonia is not difficult. If the shoots are laid upon the ground, and covered with a little mould, they will immediately strike root, and become good plants for setting out where they are wanted, or they will all grow by cuttings. As to the catalpa, whoever has the conveniency of a bark-bed may propagate it in plenty by cuttings: which being planted in pots, and plunged into the beds in the spring, will soon strike root; and may afterwards be so hardened to the open air, that they may be set abroad in the shade before the end of summer: in the beginning of October they should be removed into a green-house, or under some shelter, to be protected from the winter's frost. In the spring, after the bad weather is past, they may be turned out of the pots, and planted in the nursery-way, in a well sheltered place; and if the soil be rich, and rather moist, it will be the better.

BILANCIS *deferendis*, in law, a writ directed to a corporation for carrying weights to a haven, there to weigh wool, that persons were formerly licensed to transport.

BILANDER, a small flat-bottomed vessel, with only one large mast and sail, and its deck raised half a foot above the platboard.

BILBOWS, a punishment at sea, answering to the stocks at land. The offender is laid in irons, or stocks, which are more or less ponderous according to the quality of the offence of which he is guilty.

BILGE of a ship, the bottom of her floor, or the breadth of the place the ship rests on when she is aground. Therefore bilge-water is that which lies on her floor, and cannot go to the well of the pump: and bilge-pumps, or burr-pumps, are those that carry off the bilge-water. They likewise say the ship is bilged, when she has some of her timber struck off on a rock or anchor, and springs a leak.

BILE, a yellow, bitter juice, separated from the blood in the liver, collected in the porus biliarius and gall-bladder, and thence discharged by the common duct into the duodenum. See PHYSIOLOGY, and CHEMISTRY.

BILIOUS *fevers* are those occasioned by the over-copiousness, or bad qualities, of the bile. See MEDICINE.

BILL, an instrument made of iron, edged in the form of a crescent, and adapted to a handle. It is used by plumbers to perform several parts of their work; by basket-makers, to cut the largest pieces of chesnut-trees and other wood; and by gardeners to prune trees. When short, it is called a hand-bill; and when long, a hedge-bill.

BILL, in law proceedings, is a declaration in writing, expressing either the wrong the complainant had suffered by the party complained of, or some fault committed against some law or statute of the realm; and this bill is sometimes addressed to the lord chancellor, especially for unconscionable wrongs done to the complainant; and sometimes to others having jurisdiction, according as the law directs. It contains the fact complained of, the damages thereby sustained, and petition of process against the defendant for redress; and it is made use of in criminal as well as civil matters. In criminal cases, when a grand jury upon presentment, or indictment, finds the same to be true, they indorse on it *billa vera*, and thereupon the offender is said to stand indicted.

Many of the proceedings in the king's-bench are *by bill*, which was the antient form of proceeding.

BILL *of credit*, is that which a merchant or banker gives to a person whom he can trust, empowering him to receive money from his correspondents in foreign countries. Though bills of credit are different from bills of exchange, yet they enjoy the same privileges: for the money paid in consequence of them is recoverable by law.

BILL *in equity*, is in the form of a petition, addressed to the lord chancellor or barons of the exchequer, with which a suit in chancery or the exchequer commences, and which sets forth the circumstances of the case at length.

BILLS *of exchange*. A bill of exchange is an order or request in writing, addressed by one person to another, to pay a certain sum of money on demand, or at a time specified, to a third person, or to his order; or it may be made payable to bearer.

If a bill is made payable to bearer, it is assignable by delivery only; but if it is payable to order, it must be transferred by indorsement and delivery. The person making or drawing the bill is called the *drawer*; the person to whom it is addressed the *drawee*; who, when he has undertaken to pay the amount, is termed the *acceptor*. The person in whose favour the bill is drawn is called the *payee*; but if he appoints some other person to receive the money, he is then termed the *indorser*, and the person so appointed the *indorsee*. No particular form is necessary in a bill of exchange; any order, or promise, which from the time of making it, cannot be complied with, or performed, without *the payment of money*, is a bill or note. Mod. 364.

A promissory note, or note of hand, is an engagement in writing, to pay a sum specified at the time therein limited, to a person therein named, or sometimes to his order, or often to the bearer at large: this is also made assignable, and indorsable like a bill of exchange. Any persons capable of binding themselves by a contract may be parties to a bill of exchange, or other negotiable instrument, or be in any manner concerned in negotiating either of them. An infant therefore, or a married woman (except in certain cases, as where by the custom of London she has the privilege of trading as a *feme*

sole), as they are incapable of binding themselves by contract, cannot be parties to a negotiable instrument; yet such instrument, negotiated by persons incapacitated, will nevertheless *be valid* as to all other *competent* parties. 2 Atk. 181.

Bills of exchange are either *foreign* or *inland: foreign* when drawn by a merchant residing abroad upon his correspondent in England, or *vice versa*; and inland, when both the drawer and the drawee reside in the kingdom. By 9 and 10 W. III. c. 17. and 3 and 4 Anne, c. 9, all distinctions between foreign and inland bills, as far as respect the custom of merchants, are removed; and the same principles of law are generally applicable to both. See STAMPS.

Bills or notes must be certain, and not depend on any particular event or contingency. 3 Wils. 213.

If a bill or note is made in a foreign country, it must be conformable to the laws of that country, or it will not be valid.

If a bill or note is altered while in the hands of the *payee*, or *any other* holder, in any material instance, as date, sum, &c. without consent of the *drawee*, he will be discharged from his liability, although such bill or note may afterwards come into the hands of an *indorsee* not aware of the alteration; but in this case, if altered *before* acceptance or indorsement, the *acceptor* can take no advantage of the alteration; and the *consent* of any one of the parties to the alteration, will in general preclude him from taking an advantage of it. 4 T. R. 320.

If a bill is made with a proper stamp, and afterwards altered by the consent of the parties, though before negotiation a new stamp is necessary, as it is a different contract. 5 T. R. 357. If, however, there be a stamp of equal or superior value, the proper one may be affixed, on payment of 40*s*. *before* the instrument is due, and 10*l*. *after* it is due. But if there is not originally a stamp amounting to the requisite value, *the omission* can never be legally supplied. Evans, p. 6.

The acceptor of a bill is, by the custom of the merchants, as effectually bound by his acceptance, as if he had been the original drawer; and having once accepted it, he cannot afterwards revoke it. Cro. Jac. 303. See ACCEPTANCE. The indorser of a bill is as liable as the first drawer; because the indorsement is in the nature of a new bill. 1 Salk. 125. To indorse a bill with a fictitious name, is forgery, though such indorsement be useless.

A *presentment*, either for payment or acceptance, must be made at seasonable hours. In case a bill is not regularly paid, the holder has a right to recover not only the principal, but also, in certain cases, costs and damages.

Notice is that information which the holder of a negotiable instrument is bound to give to all the antecedent parties. If the drawee refuses to accept, or having accepted, if he refuses payment, or if he offers an acceptance varying from the bill; in either of the above cases the bill is dishonoured; and the holder, in case of neglect to communicate notice within a reasonable time, will not be at liberty to resort to the other parties, who by such negligence will be discharged from their respective obligations. Bur. 2670. Notice of conditional or partial acceptance should be given to the other parties to the bill by the holder, in default of payment; for if under these circumstances a general notice of non-acceptance is given to any of the parties, omitting to mention in such notice the nature of the acceptance offered, the acceptor is discharged, by this act of the holder, from his acceptance. 1 T. R. 182.

A *protest* is an act of a notary-public, stating that a bill has been presented for acceptance, or for payment; and refused, and declaring that the acceptor, indorsers, &c. shall be liable for damages, &c. and to this instrument all foreign courts give entire credit. In the first instance the notary marks or notes the minute of refusal on the bill itself, and afterwards the instrument is drawn out and attested under his hand and seal. The want of a protest can in no case be supplied by noting, which is a mere preparatory minute, of which the law takes no cognizance as distinguished from a protest. If there is no notary resident at or near the place, the bill must, when payable, be protested by some substantial resident, in the presence of two or more witnesses, and should in general be made at the place where payment is refused; but when a bill is drawn abroad, directed to the drawee at Southampton or London, or any other place, requesting him to pay the payee in London, the protest for non-acceptance of such bill may be made either at Southampton or London. Notice should be given on the day of refusal to accept, if any post or ordinary conveyance set out on the day; and if not, by the next earliest conveyance. 4 T. R. 174.

An *usance* is generally understood to mean only a month. Molloy 207. 1 Shaw 217. Instead of an express limitation by months or days, we continually find the bills drawn or payable at Amsterdam, Rotterdam, Hamburgh, Altona, Paris or any other place in France, Cadiz, Madrid, Bilboa, Leghorn, Genoa, or Venice, limited by the usance, that is, the usage between those places and this country. An usance between this kingdom and Amsterdam, Rotterdam, Hamburgh, Altona, Paris, or any place in France, is one calendar month from the date of the bill; an usance between us and Cadiz, Madrid, or Bilboa, two; an usance between us and Leghorn, Genoa, or Venice, three. A double usance is double the accustomed time; a half-usance, half. Upon a half-usance, if it be necessary to divide a month, the division, notwithstanding the difference of the length of months, shall contain fifteen days. Blag. 13.

BILL *of entry*, an account of the goods entered at the custom-houses both inwards and outwards. In this bill must be expressed the merchant exporting or importing the quantity of merchandises, and the divers species thereof, and whither or whence transported.

BILL *of lading*, an acknowledgment signed by the master of a ship, and given to a merchant, &c. containing an account of the goods which the master has received on board from that merchant, &c. with a promise to deliver them at an intended place for a certain sum. Each bill of lading must be treble; one for the merchant who loads the goods, another to be sent to the person to whom they are consigned, and the third to remain in the hands of the master of the ship. It must be observed, however, that a bill of lading is used only when the goods sent on board a ship are but part of the cargo: for when a merchant loads a whole vessel for his own personal account, the deed passed between him and the master of the ship is called charter-party.

BILL *in parliament*, a paper containing propositions offered to the houses, to be passed by them, and then to be presented to the king to pass into an act or law.

BILL *of sale*, is when a person wanting a sum of money, delivers goods as a security to the lender, to whom he gives this bill, impowering him to sell the goods in case the sum borrowed is not repaid, with interest, at the appointed time.

BILL *of store*, a licence granted at the custom-house to merchants, by which they have liberty to carry, custom-free, all such stores and provisions as they may have occasion for during their voyage.

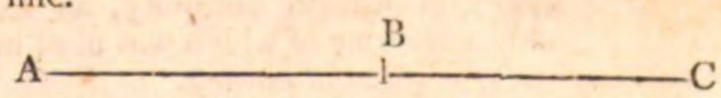
BILL *of sufferance*, a licence granted to a merchant, at the custom-house, suffering him to trade from one English port to another, without paying custom.

BILL, or *beak*, the elongated horny processes or mandibles of birds. The form of the bill varies so greatly in different kinds of birds, that they afford the most permanent character by which these creatures may be arranged. In the distribution of families, Linnæus first notices the structure of the bill, the tongue, and nostrils, and these parts constitute almost exclusively, with the legs, the distinction of the genera likewise. The phœnicopter's bill is a true hyperbole: the upper part moves and the lower is fixed, which is the contrary to what is found in other kinds. The woodpecker's bill will pierce the hardest timber. In the island of Ferro, a fixed reward is given for the bills of ravenous birds. All watermen are obliged to bring a certain number yearly to the country courts, at the feast of St. Olaus, when they are thrown into a heap and burnt in triumph.

BILLET, in heraldry, a bearing in form of a long square. They are supposed to represent pieces of cloth of gold or silver, but Guillim thinks they represent a letter sealed up; and other authors take them for bricks. Billeté signifies that the escutcheon is all over strewed with billets, the number not ascertained.

BILLIARDS, an ingenious kind of game played on an oblong table, covered with green cloth, and placed exactly level, with little ivory balls, which are driven by crooked sticks, made on purpose, into hazards or holes on the edge and corners of the table, according to certain rules of the game.

BIMEDIAL, in mathematics. If two medial lines, as A B and B C, commensurable only in power, containing a rational rectangle, are compounded, the whole line A C will be irrational, and is called a first bimedial line.



See Euclid, lib. X. prop. 38.

BINARY ARITHMETIC, that wherein unity or 1 and 0 are only used.

This was the invention of Mr. Leibnitz, who shews it to be very expeditious in discovering the properties of numbers, and in constructing tables: and M. Dangecourt, in

thehistory of the Royal Academy of Sciences, gives a specimen of it concerning arithmetical progressionals; where he shews that, because in binary arithmetic, only two characters are used, therefore the laws of progression may be more easily discovered by it than by common arithmetic.

All the characters used in binary arithmetic, are 0 and 1; and the cypher multiplies every thing by 2, as in the common arithmetic by 10. Thus 1 is one; 10, two, 11, three; 100, four; 101, five; 110, six; 111, seven; 1000, eight; 1001, nine; 1010, ten; which is built on the same principles with common arithmetic.

The author, however, does not recommend this method for common use, because of the great number of figures required to express a number; and adds, that if the common progression were from 12 to 12, or from 16 to 16, it would be still more expeditious.

Binary arithmetic appears to have been the same with that used among the Chinese 4000 years ago, and left in enigma by Fohi, the founder of their empire and sciences.

BINARY MEASURE, in music, is a measure which is beaten equally, or where the time of rising is equal to that of falling. This is usually called common time, beside which there is a binary triple.

BIND of eels, a quantity consisting of two hundred and fifty; or ten strikes, each containing twenty five eels.

BIND-WEED. See CONVOLVULUS.

BING, in the alum-works, denotes a heap of alum thrown together in order to drain.

BINOMIAL, in algebra, a root consisting of two members connected by the sign + or —. Thus $a + b$ and $8 - 3$ are binomials, consisting of the sum and difference of these quantities.

The powers of any binomial are found by a continual multiplication of it by itself. For example, the cube or third power of $a + b$, will be found by multiplication to be $a^3 + 3a^2b + 3ab^2 + b^3$; and if the powers of $a - b$ are required, they will be found the same as the preceding, only the terms in which the exponent of b is an odd number will be found negative. Thus, the cube of $a - b$ will be found to be $a^3 + 3a^2b + 3ab^2 - b^3$; where the second and fourth terms are negative, the exponent of b being an odd number of these terms. In general, the terms of any power of $a - b$ are positive and negative by turns. See ALGEBRA.

BINOCULAR TELESCOPE, a kind of dioptric telescope fitted with two tubes joined in such a manner, that one may see a distant object with both eyes at the same time.

BIPED, an animal furnished with only two legs. Men and birds are bipeds. Apes occasionally walk on their hind legs, and seem to be of this tribe; but their more natural position is on all four.

The term is used for a genus of reptiles that belong to the lizard family. These have a very long body covered with scales, and the toes of the two little feet are armed with nails.

BIPENNIS, in Roman antiquity, an ax with a double edge, one of which was used in stabbing, and the other in cutting.

BIQUADRATIC POWER, in algebra, the fourth power, or squared square, of a number: as 16 is the biquadratic power of 2; for 2×2 is 4, and 4×4 is equal to 16.

BIQUADRATIC ROOT of a number, is the square root of its square root: thus the biquadratic root of 81 is 3; for the square root of 81 is 9, and the square root of 9 is 3. See ALGEBRA.

BIQUADRATIC EQUATION, an equation where the unknown quantity of one of the terms has four dimensions.

Any biquadratic equation may be conceived as generated by the multiplication of four simple equations. Thus, if $x = a$, $x = b$, $x = c$, $x = d$, or $x - a = 0$, $x - b = 0$, $x - c = 0$, $x - d = 0$; then will $x - a \times x - b \times x - c \times x - d = 0$ beget a biquadratic equation. Or it may be formed of two quadratic equations, as $\overline{x^2 + bx + e} \times \overline{x^2 + dx + e} = 0$; or, lastly, it may be produced from the multiplication of one cubic and one simple equation, as

$$\overline{x - a} \times \overline{x^3 + cx^2 + dx + e} = 0.$$

BIRCH-TREE. See BETULA.

BIRD, avis, in zoology, one of the six general classes of animals, the characters of which are, that their body is covered with feathers, and that they have two wings, two legs, and a bill of a firm bony, or rather horny substance: add to this, that the females are all oviparous.

The knowledge of birds, of the orders and genera into which they are subdivided, and of their nature, uses, figures, &c. constitutes a particular science, under the name of ornithology; in which there are six orders, viz. accipitres, picæ, anseres, grallæ, gallinæ, and passeres.

BIRDS, in heraldry, according to their several kinds, represent either the contemplative or active life. They are the emblems of liberty, expedition, readiness, swiftness, and fear. Birds that are either whole-footed, or have their feet divided and yet have no talons, are said to be membered; but the cock, and all birds of prey with sharp and hooked beaks and talons, for encounter or defence, are termed armed. In the blazoning of birds, if their wings are not displayed, they are said to be borne close; as, he beareth an eagle, &c. close.

BIRD-CATCHING, is the art of taking birds or wild-fowl, either for food, or for the pleasure of their songs in cages, or for preventing the destruction which some species of them occasion to the husbandmen. Some recur to it as an amusing pastime, and others practice it as a profitable employment. There are various methods of catching birds: one of the most systematic and ingenious is practised in the neighbourhood of London, by persons who find a ready market for birds of any kind, which at certain seasons of the year change their situation, and hence are called birds of flight. The birds usually taken on such occasions, are wood-larks, titlarks, linnets, goldfinches, greenfinches, &c. which are taken during what is called their flight, or while they congregate for the purpose of propagating their species. The nets used by bird-catchers are about twelve yards long, and two and a half wide; which are spread on the ground parallel to one another, and at such a distance, that when turned over, they shall coincide. The remaining apparatus consists of lines so fastened to the nets, that the bird-catcher is able by a sudden pull to draw the net over the birds that may have alighted in the space between the parallel sides. These birds are enticed to alight by others usually denominated call-birds, of which there are generally five or six linnets, two goldfinches, two greenfinches, one wood-lark, one red-poll, a yellow-hammer, a tit-lark, an aberdavine, and perhaps a bullfinch. Besides these, they have others which are called flur-birds: but the call-birds are particularly trained for the service; and when the nets are laid, these are properly arranged, and they appear to possess a most malicious desire of bringing the wild ones into the same state of captivity with themselves. When they perceive the approach of the wild birds, the intelligence is announced from cage to cage with the utmost extacy. The note by which they invite them down, has so powerful an ascendancy over the wild birds, that the moment they hear it, they alight on a spot within twenty yards of the bird-catchers. If only half the flock is caught by the first pull of the string, the others that escape will soon return to the net, and share the fate of their companions; such is the fascinating power that the call-birds possess over those that are wild.

Birds are caught in traps of various kinds; and frequently by nooses of hair. In this way, great numbers of wheatears are annually taken on the various downs of England. Small holes are dug by the shepherds in the ground, in each of which is placed a noose. Whenever a cloud obscures the sun, these timid birds seek for shelter under a stone, or creep into any holes that present themselves; and they are thus ensnared by the nooses which fasten around their necks. Woodcocks and snipes are taken likewise by nooses of horse-hair placed along their paths, in marshes and moist grounds. Wild ducks in all their varieties are taken in vast numbers every winter on our coasts by means of decoys. (See DECOY.) Grouse and partridges are taken by means of nets: either at night when resting on the ground, by observing where they alight, and when setted, drawing a net over that part of the field; or, in the day, a very steady dog is used to point at them. The attention of the birds being thus fixed, two persons, drawing the two extremities of a large net, pass it over them, and thus secure a whole pack of grouse, or covey of partridges, at once. Pheasants are sometimes taken by night, by holding flaming sulphur under the trees on which they are observed to perch, the suffocating effluvia of which make them fall senseless.

In various parts of the world, peculiar modes are adopted for ensnaring and taking birds; some of which, whilst they are hazardous to those who practise them, excite no inconsiderable degree of surprise, and even of anxiety, in the spectators. Thus, in the Orkney islands, where the birds that inhabit the rocks, and the eggs which they deposit among the cliffs, supply the principal food of many among the poorer inhabitants, the intrepid and adventurous fowlers climb rocky precipices more than fifty fathoms above the sea, and pass from one shelf or ledge to another, whose breadth is barely sufficient for resting-places to the birds which deposit their eggs upon them. In this hazardous employment, the adventurers are commonly lowered from above by means of a rope, formed often of brittle materials, and held by a single assistant. Fastened to this rope, the intrepid peasant descends, and searches all the cavities for eggs; springing from one projecting ledge to another, by

the help of a pole; whilst the assistant, upon receiving the necessary signals, shifts the rope from one part of the rocky precipice to another. If the weight of the fowler and of his booty should, in these perilous circumstances, overpower his associate above, or the craggy rock cut the rope, inevitable destruction must await the adventurer; for he will either be dashed against the projecting rock, or drowned in the subjacent sea. But the most singular mode of bird-catching is in the holm of Noss; which is a huge rock severed from the isle of Noss by some unknown convulsion, and distant from it about sixteen fathoms. The opposite cliffs are separated by the raging sea. The adventurer, having reached the rock in a boat, and ascended to the top of it, fastens several stakes in the shallow soil that is found on the surface of the rock; and similar stakes are also attached to the edge of the corresponding and opposite cliff. A rope is then fixed to the stakes on both sides, upon which a machine, called a cradle, is contrived to slide; and by the help of a small parallel cord fastened in like manner, the daring adventurer wafts himself over, and returns with his booty.

In the Feroe islands the method of bird-catching is more extraordinary and hazardous than any which has already been recited. The cliffs to which the fowlers recur, are in many cases 200 fathoms high; and they are traversed both from above and below. In the first case, the fowlers provide themselves with a rope 80 or 100 fathoms long; and the adventurer fastens one end about his waist and between his legs, and having recommended himself to the protection of the Almighty, he is lowered down by six associates, who place a piece of wood in the margin of the rock, that the rope may be preserved from being fretted and broken by its sharp edge. To his body is fastened a small line, which serves for enabling him to give the necessary signals, when he wishes to be raised or lowered, or shifted from one place to another. In changing his situation, he is exposed to the hazard of injury from loosened and falling stones; which falling on the head, must inevitably destroy him, if he was not in some degree protected by a strong thick cap. The fowlers, by their astonishing dexterity, contrive to place their feet against the front of the precipice, and to dart themselves some fathoms from it, for the purpose of surveying the roosting-places of the birds, and projecting themselves into the deep recesses where they lodge. There the fowler alights; and disengaging himself from the rope, which he fixes to a stone, collects the booty at his leisure, attaches it to his girdle, and when this is done, resumes his suspended posture. He will also, when occasions require it, spring from the rock; and in this attitude, by means of a fowling-net fixed to the end of a staff, catch the old birds which are flying to and from their retreats. When this hazardous operation is finished, he gives a signal to his companions above; who pull him up, and divide the booty. The feathers are preserved for exportation; the flesh is partly eaten fresh, and the greater part is dried for winter's provision. In fowling from below, the party have recourse to a boat; and when they have arrived at the base of the precipice, one of the most intrepid of them fastens a rope about his waist, and being furnished with a long pole, with an iron hook at one end, either climbs, or is thrust up by his companions, who place a pole under h m, to the next footing-spot within his reach. By means of the rope he hoists up one of the boat's crew; and the rest are drawn up in the same manner, each of them being furnished with his rope and fowling-staff. They then pursue their journey upwards, till they arrive at the region of the birds; and they wander about the cliff in search of them. They next act in pairs; one fastens himself to the end of his associate's rope, and, in places where birds have nestled beneath his footing, he suffers himself to be lowered down, depending for safety on the strength of his companion, by whom he is again hauled up; but it sometimes happens, that the person above is overpowered by the weight, and in this case both inevitably perish. The fowl is flung into the boat, which attends their operations for the purpose of receiving the booty. The fowlers often pass seven or eight days in this perilous occupation, and lodge in the crannies which they find in various parts of the precipice.

BIRD-LIME, a viscid substance, prepared in different ways. The most common bird-lime among us, is made from holly-bark, boiled ten or twelve hours; when the green coat being separated from the other, it is covered up a fortnight in a moist place, then pounded into a tough paste so that no fibres of the wood are discernible, and washed in a running stream till no motes appear; put up to ferment four or five days, skimmed as often as any thing arises, and laid up for use. To use it, a third part of nut-oil, or thin grease, must be incorporated with it over the fire. It is also made from the gluten of wheat.

The Italians make bird-lime of the berries of the misleto-tree. That which comes from Damascus is supposed to be made of sebastens: and it is said that the bark of any of our wayfaring shrubs will make very good bird-lime.

BIRRUS, in Roman antiquity, a cloak made of woollen cloth, worn by the soldiers: also a robe worn by the priests or bishops.

BIRTH. See MIDWIFERY.

BIRTH, or BIRTHING, in the sea-language, a convenient place to moor a ship in; also a due distance observed by ships lying at anchor, or under sail; and a proper place aboard for a mess to put their chests, &c. is called the birth of that mess.

BIRTHWORT. See ARISTOLOCHIA.

BISA, or BIZA, a coin of Pegu, which is current there for half a ducat. It is also a weight used in that kingdom.

BISCUTELLA, BUCKLER-MUSTARD, or bastard Mithridate mustard: a genus of the tetradynamia siliculosa class and order of plants; and in the natural method ranking under the 39th order, siliquosæ. The silicula is flat-compressed, rounded above, and below two-lobed, and the leaves of the calyx are gibbous at the base. There are six species, all natives of France, Italy, Spain, and Germany; of which the most remarkable are:

1. Biscutella apula, with flowers growing in spikes, and a shorter style.

2. Biscutella auriculata, with small pods joined to the style.

3. Biscutella didyma, with a double orbicular pod diverging from the style.

BISECT, to divide into two parts. The rational horizon bisects the globe into two equal parts.

BISELLIARI, or BISELLIARII, in antiquity, those who enjoyed the honour or privilege of the bisellium.

BISELLIUM, in antiquity, a kind of seat or chair, larger and richer than ordinary, big enough to hold two persons, wherein to sit in courts, theatres, and other public assemblies.

BISERRULA, a genus of the decandria order, and diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ: the legumen is bilocular and flat; and the partition contrary. Of this genus there is only one species known, viz.

Biserrula pelecina, an annual plant, with purple flowers; a native of the south of Europe.

BISHOP, signifies an overseer or superintendant. An archbishop, is the chief of the clergy in his own province, who next and immediately under the king has supreme power, &c. in all causes and things ecclesiastical; and has the inspection of all the bishops of that province. He has also his own diocese, where he exercises episcopal jurisdiction, as in his province he exercises archiepiscopal. As archbishop, upon receipt of the king's writ, he calls the bishops and clergy of his province to meet in convocation: to him all appeals are made from inferior jurisdictions within his province. During the vacancy of any see in his province, he is guardian of the spiritualities thereof. If the archiepiscopal see is vacant, the dean and chapter are the spiritual guardians. The archbishop is entitled to present by lapse, to all the ecclesiastical livings in the disposal of the diocesan bishops, if not filled within six months. And he has a customary prerogative, when a bishop is consecrated by him, to have the next presentation to such dignity or benefice in the bishop's disposal, as the archbishop shall chuse; which is therefore called his option. 1 Black. 380. The archbishops may retain and qualify eight chaplains, whereas a bishop can only qualify six.

Bishops are elected by the dean and chapter; in order whereunto, when a bishop dies or is translated, the dean and chapter certify the king thereof in chancery; upon which the king issues a licence to them to proceed to an election, called a congé-d'elire: and with it sends a letter missive, containing the name of the person whom they shall elect; which if they shall refuse to do, they incur the penalty of a præmunire.

A bishop must be full thirty years of age when consecrated.

A bishop has his consistory court, to hear ecclesiastical causes; and is to visit the clergy, &c. He consecrates churches; ordains, admits, and institutes priests; confirms, suspends, excommunicates, grants licences for marriage, makes probates of wills, &c. Co. Lit. 96. Rol. Abr. 230.

In England there are twenty-four bishoprics, and two archbishoprics; in Scotland, none; in Ireland eighteen bishoprics, and four archbishoprics: and in the popish countries abroad they are still more numerous.

All bishops of England are lords of parlia-

ment, except the bishop of Man, and as such sit and vote in the house of lords; they are barons in a threefold manner, viz. feudal, in regard to the temporalities annexed to their bishoprics; by writ, as being summoned by writ to parliament; and lastly, by patent and creation: accordingly, they have the precedence of all other barons, and vote as barons and bishops, and claim all the privileges enjoyed by the temporal lords, excepting that they cannot be tried by their peers; because, in cases of blood, they themselves cannot pass upon the trial, for they are prohibited, by the canons of the church, to be judges of life and death.

BISKET. See BAKER.

BISMILLAH, a solemn form used by the Mahometans, at the beginning of all their books and other writings, signifying "in the name of the most merciful God."

It is also used among the Arabs as a word of invitation to eat. An Arab prince frequently sits down to eat in the street before his own door, or under the shade of a wide-spreading tree, and calls all that pass, even beggars, by this word, who come and sit down to eat with him; "for," says Pocock, "the Arabs are great levellers, and set every body on a footing with themselves."

BISMUTH, in natural history, a genus of the semi-metals, the most usual appearance of which is in form of an ore, intimately mixed with silver, a large quantity of arsenic, and an earthy matter which yields cobalt.

The ancients were acquainted with bismuth, but they confounded it with tin. It is mentioned occasionally by the alchymists and earlier mineralogists; and referred sometimes to tin, sometimes to lead, and sometimes to antimony. The German miners gave it the name of lectum argenti; and appear to have considered it as silver beginning to form, and not yet completed.

Bismuth is of a reddish-white colour, and almost destitute of taste and smell. It is composed of broad brilliant plates adhering to each other. The figure of its particles, according to Hauy, is an octahedron, or two four-sided pyramids applied base to base.

Its hardness is 7. Its specific gravity is 9.8227.

When hammered cautiously, its density, as Muschenbroek ascertained, is considerably increased. It is not therefore very brittle; it breaks, however, when struck smartly by a hammer, and consequently is not malleable. Neither can it be drawn out into wire. Its tenacity has not been ascertained.

When heated to the temperature of 4600, it melts; and if the heat is much encreased, it evaporates, and may be distilled over in close vessels. When allowed to cool slowly, and when the liquid metal is withdrawn, as soon as the surface congeals it crystallizes in parallelopipeds, which cross each other at right angles.

When exposed to the air, it soon loses its lustre, but scarcely undergoes any other change. It is not altered when kept under water.

Only two oxides of bismuth are at present known. But the combination of this metal with oxygen has been more neglected by chemists than almost any other.

When kept melted in an open vessel, its surface is soon covered with a dark-blue pellicle; when this is removed, another succeeds, till the whole metal is oxidized. When these pellicles are kept hot and agitated in an open vessel, they are soon converted into a brownish powder, known by the name of brown oxide. This is the protoxide of bismuth. According to Fourcroy, it is composed of ninety parts of bismuth, and ten of oxygen.

When bismuth is raised to a strong red heat, it takes fire, and burns with a faint blue flame, and emits a yellow smoke. When this is collected, it is a yellow powder, not volatile, which has been called yellow oxide of bismuth.

When bismuth is dissolved in nitric acid, if water is poured into the solution, a white powder precipitates, which was formerly called magistery of bismuth, and at present white oxide of bismuth. According to the experiments of Klaproth, it is composed of 81.3 parts bismuth and 17.7 of oxygen. This oxide is used as a paint under the name of pearl white.

The oxides of bismuth are very easily converted into glass; for that reason bismuth is sometimes used in the process of cupellation instead of lead. It was first proposed for that purpose by Dufay in 1727, and his experiments were afterwards confirmed by Pott.

These oxides are easily reduced when heated with charcoal or other combustible bodies; for the affinity between bismuth and oxygen is but weak.

Bismuth has not been combined with carbon or hydrogen, neither does it seem capable of combining in any notable proportion with phosphorus.

Sulphur combines readily with bismuth by fusion. The sulphuret of bismuth is of a bluish-grey colour, and crystallizes into beautiful tetrahedral needles. It is composed of 85 parts of bismuth and 15 of sulphur.

Bismuth combines with almost all the metals, but few of its alloys are much used. 1. Equal parts of bismuth and gold form a brittle alloy, nearly of the same colour with bismuth; the specific gravity of which is greater than the mean. 2. The alloy of bismuth and platinum is also very brittle. When exposed to the air, it assumes a purple, violet, or blue colour. The bismuth can scarcely be separated by heat. 3. Bismuth combines readily with silver by fusion. The alloy is brittle, lamellar, and nearly of the colour of bismuth. This alloy is sometimes formed, in order to purify silver by the process of cupellation. 4. Mercury combines readily with bismuth, either by triturating the metals together, or by pouring two parts of hot mercury into one part of melted bismuth. This amalgam is at first soft, but it becomes gradually hard. When melted and cooled slowly, it crystallizes. When the quantity of mercury exceeds the bismuth considerably, the amalgam remains fluid, and has the property of dissolving lead and rendering it also fluid. This triple compound may be filtered through shamoy leather without decomposition. Mercury is sometimes adulterated with these metals; but the imposition may be easily detected, not only by the specific gravity of the mercury, which is too small, but because it drags a tail, as the workmen say; that is, when a drop of it is agitated on a plane surface, the drop does not remain spherical, but part of it adheres to the surface, as if it was not completely fluid, or as if it was inclosed in a thin pellicle. 5. Copper forms with bismuth a brittle alloy of a pale-red colour, and a specific gravity exactly the mean of that of the two metals alloyed. 6. Bismuth combines but imperfectly with iron. The alloy is brittle, and attracted by the magnet even when the bismuth amounts to three-fourths of the whole. The specific gravity of this alloy is less than the mean. 7. Bismuth and tin unite readily. A small portion of bismuth increases the brightness, hardness, and sonorousness of tin: it often enters into the composition of pewter. Equal parts of tin and bismuth form an alloy that melts at 280 degrees; eight parts of tin and one of bismuth melt at 390 degrees; two parts of tin and one of bismuth at 330 degrees. 8. The alloy of lead and bismuth is of a dark-grey colour, and close grain. It is ductile, unless the bismuth exceeds the lead considerably. Bismuth encreases the tenacity of lead prodigiously. Muschenbroek found, that the tenacity of an alloy composed of three parts of lead and two of bismuth, was ten times greater than that of pure lead. The specific gravity of this alloy is greater than the mean. 9. When eight parts of bismuth, five of lead, and three of tin, are melted together, a white-coloured alloy is obtained, which melts at the temperature of 212 degrees, and therefore remains fusible under boiling water. 10. The alloy of bismuth is brittle, and formed of thin plates. 11. Bismuth does not combine with zinc.

BISON, see BOS.

BISSECTION, in geometry, the division of a line, angle, &c. into two equal parts.

BISSEXTILE, in chronology, a year consisting of three hundred and sixty-six days, being the same with our leap-year.

The true solar year, or that space of time which flows while the sun is moving from any one point of the ecliptic till he returns to the same point again, consists of 365 days, 5 hours, 48 minutes, 57 seconds. The year made use of by the antient Egyptians consisted of 365 days; which being less than the true solar year by nearly six hours, they lost a day every four years. Julius Cæsar being high-priest among the Romans, and considering the inconveniences arising from this method of computation, ordered that every fourth year should have an intercalary day, and that this additional day should be added to the month of February; wherefore this method of computation is called the Julian account, or old style.

Yet, as the true length of the year consists of 365 days, 5 hours, 49 minutes nearly, it follows that, according to this way of reckoning, at the end of every four years the civil year will begin 44 minutes sooner than it did before, consequently in 331 years it will anticipate by one whole day: for this reason pope Gregory XIII. set himself upon reforming the calendar; and finding, in the year 1582, that the equinox had anticipated ten whole days, he ordered that these ten days should be taken out of the calendar that year, and the 11th of March should be reckoned the 21st; and ordered that every hundredth year, which, according to the Julian form, was to be bissextile, should be a common

year, and consist of 365 days: but because that was too much, every four-hundredth year was to remain bissextile. This method of computation is called the Gregorian, or new style; it was received in most foreign countries ever since the reforming of the calendar; and by act of parliament passed in the twenty-fifth year of his late majesty's reign, viz. 1751, it commenced in all the dominions under the crown of Great Britain, in the year following; ordering that the natural day following the second of September, should be accounted the fourteenth, omitting the intermediate eleven days of the common calendar.

BISTI, in commerce, a small coin of Persia: some say that it is among the current silver coins of Persia, and worth only a little above three farthings of our money; others speak of it again as a money of account.

BISTORT. See POLYGANUM.

BISTOURY, in surgery, an instrument for making incisions, of which there are different kinds; some being of the form of a lancet, others straight and fixed in the handle like a knife, and others crooked with the sharp edge on the inside.

BISTRE, or BISTER, among painters, denotes a glossy soot pulverised and made into a kind of cakes, with gum-water. It is used to wash their designs.

Bistre is made by putting soot of dry wood, as beech, into water, in the proportion of two pounds to a gallon, and boiling them half an hour. After the fluid has settled, pour off the clearer part while it remains hot. Evaporate the fluid to dryness, and what remains is good bistre.

BIT, or BITT, an essential part of a bridle. There are many kinds of bits; the most simple is a short rod of iron, made rather wider than the mouth of the horse, and provided with a hook or ring at each end for fastening the reins to. The next is a rod similar to the former, broken in two pieces, and connected by a joint in the middle; the former is intended for heavy draft horses, the latter for those of light draft. The next is the snaffle, which is provided with two cross pieces that rest against the lips or sides of the mouth; for as the snaffle is intended for the saddle-horse, and the reins go to the hands, so the cross pieces are useful in preventing the bit from being drawn through the mouth. The number of parts of which the mouth-piece of the snaffle is composed, may be increased to any extent, as it may be made with 1, 2, or several joints; and hence it acquires new properties and effects which require attention; its gentleness or rigour will depend almost wholly on these conditions. Another is the curb bit, the mouth-piece of which is usually provided with an upset or arch in the middle, as, if perfectly straight, it would rest upon the tongue, and occasion an unpleasant restraint. It has been sometimes called the liberty bit, on account of the freedom which it allows to the tongue; by others it has been called the porte-mouth bit, vulgarly the Portsmouth-bit; and by a supposed opposite expression we get the Weymouth-bit.

BIT also denotes the iron part of a piercer, augre, and the like instruments.

BIT of a key, the part which contains the wards.

BITS, or BITTS, in ship-building, the name of two great timbers, usually placed abaft the manger, in the ship's loof, through which the cross-piece goes: the use of it is to belay the cable thereto, while the ship is at anchor.

BITTACLE, on ship-board, a square box standing before him that steers the ship, with the compass placed in it, to keep and direct the ship in her course.

BITTER, a sea-term, signifying any turn of the cable about the bits, so as that the cable may be let out by little and little; and when a ship is stopped by a cable, she is said to be brought up by a bitter. Also that end of the cable which is wound about the bits is called the bitter end of the cable.

BITTERN, in the salt-works, the brine remaining after the salt is concreted: this they ladle off, that the salt may be taken out of the pan, and afterwards put in again; when, being farther boiled, it yields more salt. See SALT.

BITUMEN, in natural history, is understood by mineralogists in general, to be an oil which is found in different parts of the earth, in various states of consistence. These different states form distinct species; in the arrangement of which we shall be guided by the observations which Mr. Hatchet has made in his valuable paper on bituminous substances.

Sp. 1. Naphtha. This substance is found sometimes on the surface of the water of springs, and sometimes issuing from certain strata. It is found in great abundance in Persia.

It is as fluid and transparent as water. Colour white, or yellowish white. Smell strong, but not disagreeable. Specific gravity when white .708 or .729; when yellowish .8475. Feels greasy. Catches fire on the approach of flame, burns with a white flame, and leaves scarcely any residuum.

Sp. 2. Petroleum. This substance is also found in Persia, and likewise in many countries in Europe, particularly Italy, France, Switzerland, Germany, Sweden, England, and Scotland. It is not so fluid or transparent as water. Colour yellow, either pale or with a shade of red or green; reddish brown, and reddish black. Smell that of naphtha, but less pleasant. Specific gravity .8783. When burnt it yields a soot, and leaves a small quantity of coaly residuum. By exposure to the air it becomes like tar, and is then called mineral tar.

Sp. 3. Mineral tar. This substance is found in many parts of Asia, America, and Europe. It is viscid, and of a black, brownish black, or reddish colour Smell sometimes strong, but often faint. Specific gravity 1.1. When burned, emits a disagreeable bituminous smell. By exposure to the air it passes into mineral pitch and maltha.

Sp. 4. Mineral pitch and maltha. This substance has a strong resemblance to common pitch. When the weather is warm it is soft, and has some tenacity; it is then called adhesive mineral pitch: when the weather is cold it is brittle: its hardness is 5; and its fracture has a glassy lusture. In this state it is called maltha. Colour black, dark brown, or reddish. Opaque. Specific gravity from 1.45 to 2.07. Does not stain the fingers. On a white hot iron it flames with a strong smell, and leaves a quantity of grey ashes. It is to the presence of the earths which compose these ashes that the great specific gravity of this bitumen is to be ascribed. By farther induration it passes into asphalt.

Sp. 5. Asphalt. This substance is found abundantly in many parts of Europe, Asia, and America, especially in the island of Trinidad.

Colour black, or brownish black. Lustre greasy, 2. Opaque. Fracture conchoidal, of a glassy lustre. Hardness from 7 to 8. Very brittle. Specific gravity 1.07 to 1.165. Feels smooth, but not greasy. Does not stain the fingers. Has little or no smell unless when rubbed or heated. When heated, melts, swells, and inflames; and when pure burns without leaving any ashes.

Sp. 6. Mineral caoutchouc. This substance was found about the year 1786 in the lead-mine of Odin, near Castletown, Derbyshire. It was first mentioned by Mr. De Born.

Colour yellowish or reddish brown, sometimes blackish brown. In its appearance it has a strong resemblance to caoutchouc or Indian rubber; hence its name. Consistency various: sometimes so soft as to adhere to the fingers; sometimes nearly as hard as asphalt. When soft it is elastic; when hard, brittle. Specific gravity 0.9053 to 1.0233.

Insoluble in alcohol, ether, and oil of turpentine, but soluble in oil of olives. Not affected by nitric acid. When distilled it yields a bituminous oil insoluble in alcohol; the residuum is carbonaceous.

There is a variety of this substance found in a rivulet near the mine of Odin, which, when fresh cut, exactly resembles fine cork in colour and texture; but in a few days after being exposed to the air, becomes of a pale reddish brown. This substance contains within it a nucleus of elastic bitumen. It seems to be the elastic bitumen altered in its texture by the water.

BIVALVES, one of the three general classes of shell-fish, comprehending all those, the shells of which are composed of two pieces, joined together by a hinge. The Linnæan genera of bivalve shells are mya solen, tellina, cardium, mactra, donax, venus, spondylus, chama, arca, astrea, anomia, mytillus, and pinna.

BIVENTER, in anatomy, a muscle of the lower jaw, that has its origin in the incisure under the mastoid process. See ANA.

BIXA, the roucou or anotto tree, a genus of the monogynia order, and polyandria class of plants; and in the natural method ranking under the 37th order, columniferæ. The corolla is ten-petaled; the calyx quinquedented; the capsule hispid and bivalved. Of this genus there is but one species known, viz.

Bixa orellana, a native of the warm parts of America. It rises with an upright stem to the height of eight or ten feet, sending out many branches at the top forming a regular bed, with heart-shaped leaves ending in a point, and having long footstalks. The flowers are produced in loose panicles at the end of the branches: these are of a pale peach-colour, having large petals, and a great number of bristly stamina of the same colour in the centre. After the flower is past, the germen becomes a heart-shaped, or rather a mitre-shaped vessel, covered on the outside with bristles opening with two valves, and

filled with angular seeds. These seeds are covered with a red waxen pulp or pellicle, from which the colour called anotta is prepared. These plants, in the countries where they grow, thrive best in a cool rich soil, and shoot most luxuriantly near springs and rivulets. With us, they may be propagated by seeds procured from America. These are to be sown in pots in the spring, and plunged in a bed of tanner's bark: the plants must afterwards be removed into separate pots, and always kept in the stove.

BLACK, something opake, and occasioned by the porosity of bodies, that imbibing the greater part of the light that falls on them, and reflecting little or none, exhibit no colour. Black bodies are more inflammable than others, because the rays of light falling on them are not reflected outwards, but enter the bodies, and are lost in them. Being more porous, they are found cæteris paribus to be specifically lighter than any other-coloured bodies.

The disposition of black bodies to acquire heat beyond those of other colours, has long been known. If a black and a white glove are worn by the same person in the sun, it will be found that the hand with the black glove will acquire the greatest degree of heat. Dr. Watson, the present bishop of Landaff, covered the bulb of a thermometer with a black coating of Indian ink, and the mercury presently rose ten degrees. Black clothes heat more, and dry sooner in the sun, than white clothes: black is therefore a bad colour for clothes in hot climates. Count Rumford has attempted to controvert this position, but his experiments do not appear decisive. See Philosophical Transactions for the year 1804.

BLACK, among dyers, one of the five simple and mother colours used in dying. See DYING.

BLACK, German, called by some Frankfort black, is made with the lees of wine, burnt, washed afterwards in water, then ground in mills made for that purpose, with ivory, bones, or peach-stones, also burnt. It comes from Frankfort, Mentz, and Strasbourg, either in lumps or powder; and must be chosen moist, without having been wetted, of a fine black, soft, friable, light, and with as few shining grains as possible. This black is the principal ingredient used by copper-plate printers for working their engravings.

BLACK, ivory, otherwise called velvet-black, is burnt ivory or bones, which, becoming quite black, and being reduced to thin plates, are ground in water, and made into troches, to be used by painters, and by jewellers, who set precious stones, to blacken the ground of the collets, and give the diamonds a teint or foil. In order to be good, it ought to be tender, friable, and thoroughly ground.

BLACK, hart's, that which remains in the retort after the spirits, volatile salt, and oil, have been extracted from harts-horn. It answers the purposes of painters almost as well as ivory-black.

BLACK, Spanish, is nothing but burnt cork: it is used in several works. It should be light, and have as few grains of sand mixed with it as possible.

BLACK, lamp, (originally, perhaps, the soot collected from lamps,) is generally prepared by melting and purifying rosin or pitch in iron vessels; then setting fire to it under a chimney, or other place made for the purpose, lined with sheepskins, &c. to receive the vapour or smoke; in this way vast quantities of it are prepared at Paris. In England it is prepared at the turpentine-houses, from the dregs of the resinous matters which are manufactured there; but the greater part of lamp-black is brought from Germany, Sweden, and Norway; where the process, in the preparation, is dependant on the manufacture of common resin,

The goodness of lamp-black depends much on its lightness, and on the fullness of its colour. It is used on various occasions, particularly in printers' ink, for which it is mixed with oils of turpentine and linseed. A patent was taken out some years ago by Mr. Row, of Newcastle, for manufacturing lamp-black from pit-coal, or any kind of mineral and fossil coal, which we conceive must answer perfectly well.

BLACK, currier's. See CURRIER.

BLACKBIRD. See TURDUS.

BLACKCAP. See MOTACILLA.

BLACKAMOOR'S *head*, in chemistry, consists of a conical vessel, surrounded with another of a cylindrical form, filled with cold water, with a cock to draw it off when it becomes too warm.

BLACK ACT, is so called, having been occasioned by some devastations committed near Watham in Hants, by persons in disguise, or with their faces blacked; to prevent which it is enacted by 31 Geo. II. c. 42. that persons hunting armed and disguised, and killing or stealing deer, or robbing warrens, or stealing fish out of any river, &c. or any person unlawfully hunting in his majesty's forests, or breaking down the head of any fish-pond, or killing, &c. of cattle, or cutting down trees, or setting fire to house, barn, or wood, or shooting at any person, or sending anonymous letters, or letters signed with a fictitious name, demanding money, &c. or rescuing such offenders; are guilty of felony without benefit of clergy.

BLACK LEAD. Every person who shall unlawfully break into any wad-hole of wad, or black cawke, commonly called black lead, or shall unlawfully take and carry away from thence any wad, black cawke, or black lead, or shall aid or employ others so to do, shall be guilty of felony. 25 Geo. II. c. 10.

BLACK MAIL, signifies, in the counties of Cumberland, Northumberland, Westmoreland, and the bishopric of Durham, a certain rate of money, corn, cattle, or other consideration, paid to some inhabitants near the borders, to be protected from a band of robbers called moss-troopers.

BLACK MAIL, also signifies the rents formerly paid in provisions of corn and flesh.

BLACKBURNIA, a genus of the tetandria monogynia class and order. The essential character is, calyx four-toothed; pet. 4; anther heart-shaped; germ. conic; stigma simple; berry one-seeded. There is one species, a native of Norfolk-island.

BLADDER, a thin membranous substance, found in several parts of an animal, serving as a receptacle of some juice, or of some liquid excrement, as the urinary bladder, gall bladder, &c. See ANATOMY.

BLADHIA, a genus of the class and order pentandria monogynia. The essential character is, corolla wheel-shaped, deciduous, berry containing one arilled seed. There are three species, natives of Japan.

BLÆRIA, in botany, a genus of the tetrandria monogynia class and order of plants. Its characters are; that the calyx is quadripartite, the corolla quadrifid, the stamina inserted in the receptacle; and the fruit a capsule, with four cells, containing many seeds. There are six species.

BLAFART, in commerce, a small coin, current at Cologn, worth something more than a farthing of our money.

BLAIN, among farriers, a distemper incident to beasts; being a certain bladder growing on the root of the tongue, against the wind-pipe, which swells to such a degree as to stop the breath. It comes by great chafing and heating of the stomach; and is perceived by the beast's gaping and holding out his tongue, and foaming at the mouth: to cure it, cast the beast, take forth his tongue, and then slitting the bladder, wash it gently with vinegar and a little salt.

BLAKEA, in botany, a genus of the class and order dodecandria monogynia: with a calyx composed of six leaves below, and entire above; six petals, and a six-celled polyspermous capsule. There are two species, very beautiful shrubs, natives of America and the West Indies.

BLANCHING of copper is done in various ways, so as to make it resemble silver. If it is done for sale, it is felony by 8 and 9 William III. ch. xxvi.

BLANCHING, in coinage, the operation performed on the planchets or pieces of silver, to give them the requisite lustre and brightness. They also blanch pieces of plate, when they would have them continue white, or have only some parts of them burnished.

Blanching, as it is now practised, is performed by heating the pieces on a kind of peel with a wood-fire, in the manner of a reverberatory; so that the flame passes over the peel. The pieces, being sufficiently heated and cooled again, are put successively to boil in two pans, which are of copper: in these they put water, common salt, and tartar of Montpelier. When they have been well drained of this water in a copper sieve, they throw sand and fresh water over them; and when dry, they are well rubbed with towels.

BLANCHING also denotes the operation of covering iron plates with a thin coat or crust of tin.

BLANKET, a coverlet for a bed: a stuff commonly made of white wool, and wrought in a loom like cloth; with this difference, that they are crossed like serges. When they come from the loom, they are sent to the fuller; and after they have been fulled and well cleaned, they are napped with a fuller's teazle.

Blankets made of sheep's wool, are divided into several sorts: of the head and bay wool the widest are made; and narrow ones of the middling and common sort.

There are also blankets made with the hair of several animals; as that of goats, dogs, and others.

BLANQUILLE, in commerce, a small silver coin current in the kingdom of Morocco, and all that part of the coast of Barbary: it is worth about three half-pence of our money.

BLASIA, leather-cup, a genus of the order of algæ, and cryptogamia class of plants; and in the natural method ranking under the 57th

order, algæ. The male calyx is cylindric, replete with grains; the female calyx is naked; the fruit roundish, immersed in the leaves, and many-seeded. Of this genus there is but one species known, viz.

Blasia pusilla, which grows naturally on the banks of ditches and rivulets, in a gravelly or sandy soil, in England. It grows flat upon the ground in a patch, composed of numerous thin, green, pellucid leaves, marked with a few whitish veins near the base, divided and subdivided into obtuse segments obscurely crenated on the edges. The margins of the leaves are a little elevated, but the interior parts adhere close to the ground by a fine down which answers the purpose of roots. The seeds are so small as to be almost imperceptible.

BLASPHEMY: all blasphemies against God; all contumelious reproaches of Jesus Christ; all profane scoffing at the holy scriptures, or exposing any part of them to ridicule; are punishable by fine, imprisonment, and such corporal punishment as to the court shall seem meet, according to the heinousness of the crime. 1 Hew. 6.

BLAST, a disease in grain, trees, &c. The sugar-cane in the West Indies is subject to a disease of this kind, which is thought to be occasioned by the aphis of Linnæus, which is distinguished into the black and yellow; of these, the latter is most destructive. It consists of myriads of insects, invisible to the naked eye, whose proper food is the juice of the cane, in search of which they wound the tender blades, and in the end destroy the vessels. It is said the blast never attacks those plantations where colonies have been introduced of the carnivorous ant, or formica omnivora. These minute and busy creatures soon clear a sugar-plantation of rats; their natural food consists of all kinds of insects and animalcula.

Blast, a term used at iron-foundries to denote the column of air introduced into the furnace for the purpose of combustion.

BLASTING, a term used by miners for the tearing up rocks which lie in their way, by the force of gunpowder.

In order to do this a long hole is made in the rock, which being charged with gunpowder, they fill it up; leaving only a touch-hole, with a train or match to fire the charge.

BLATTA, a genus of hymenopterous insects, called in England cock roaches, or vulgarly and erroneously, black beetles. The head is inflected; antennæ setaceous; feelers unequal and filiform; wings and wing-cases smooth, the latter somewhat coriaceous; thorax flattish, orbicular, and margined; legs formed for running; abdomen terminating in two articulated appendages above the tail. In hotter climates the blatta are a very troublesome race: they enter houses and commit various depredations on the furniture, devour provisions of every kind, destroy clothes, and torment the inhabitants with their bite. The blatta most abundant in England was originally from the east, or as some imagine from America: it is now completely naturalized to our climate; and the best method of clearing houses of them, is to employ the agency of a tame hedgehog, who very soon devours them all.

All the known species of this insect, whether in the larva, pupa, or perfect winged state, secrete themselves in the day-time, and wander about in the night in search of food; hence they were called by the ancients lucifugæ, insects that shun the light. The following species are enumerated by Linnæus and others, viz. gigantea, maderæ, ægyptica, occidentalis, surinamensis, americana, (See Plate, Nat. Hist. fig. 46,) australasiæ, erythocephala, capensis, indica, nivea, irrorata, viridis, brasiliensis, peliveriana, orientalis, cincta, picta, variegata, lapponica, germanica, ruficollis, maculata, marginata, oblongata, nitidula, fusca, deusta, chlorotica, latissima, aterrima, perspecillaris, asiatica, schœferi, sylvestris, pennsylvanica, livida, rufa, grisea, minutissima, aptera, punctulata, ocellata.

BLAZONING, or Blazonry, in heraldry, the art of decyphering the arms of noble families. The word originally signified the blowing or winding of a horn, and was introduced into heraldry as a term denoting the description of things borne in arms, with their proper significations and intendments, from an antient custom the heralds, who were judges, had of winding an horn at justs and tournaments, when they explained and recorded the achievements of knights. In blazoning a coat of arms, you must always begin with the field, and next proceed to the charge; and if there are many things borne in the field, you must first name that which is immediately lying upon the field. Your expressions must be very short and expressive, without any expletives, needless repetitions, or particles. Such terms for the colours must be used, as are agreeable to the station and quality of the bearer. All persons beneath the degree of a noble, must have their colours blazoned by colours and metals; noblemen by precious stones, and kings and princes by planets.

BLEA, in the anatomy of plants, the inner rind or bark. See Physiology of Plants.

BLEACHING. The art of bleaching is of great antiquity. The ancients were acquainted with the detersive quality of some kinds of clay, and the effect produced by the action of the atmosphere, moisture, and light, on the stuffs exposed to them. Health and cleanliness rendered it necessary to devise quicker methods than these; and the property of soaps and leys of ashes was therefore soon discovered.

In the present age, the arts, following science with close steps, have taken advantage of processes and detersive menstrua, the existence of which was before unknown; these discoveries have succeeded each other with such rapidity, that the last eight or ten years have effected a complete revolution in the art of bleaching.

This art is naturally divided into two distinct branches; the bleaching of vegetable, and of animal substances. These being of very different natures, require different processes for whitening them. Vegetables consist of oxygen, hydrogen, and carbon, of which the latter is in the greatest proportion; while animal substances, besides these, contain also a large quantity of azote, and also phosphorus and sulphur.

Bleaching of flax and hemp. If ripe flax is examined, it will be found to be composed of fibres or filaments united together by the sap, enveloping a semiligneous substance, and covered with a thin bark. It is the fibrous part only that is used for making cloth, and it must therefore be previously separated from the other matters.

The sap or succulent part is composed of extractive principle and water, and the first process is to separate this substance, which holds the filaments together. As soon as the flax is pulled, it is steeped in soft water until the putrefactive fermentation takes place. This degree of fermentation begins with the succulent part, as being more susceptible of decomposition than the rest. Was the flax to be continued long in this state, the whole substance of it would be decomposed or destroyed, upon the same principle that malt is injured by too long steeping, or that wort loses its substance by too long a fermentation. It must therefore be taken out of the water while yet green, and before the whole of its sap is separated. Well water and brackish water must be carefully avoided, as well as that which flows over gypseous soil. Such water accelerates putrefaction, and hurts the quality of the hemp and flax. This is perfectly agreeable to the principles of chemistry; it is thus that a little salt accelerates animal putrefaction, while a great quantity tends to prevent it. The portion of saline substances taken up by the water, hastens corruption, by extending the putrid fermentation even to the filaments, which it blackens and spoils, while it ought to operate only on the juices.

The flax, when taken from the water, is spread out upon the grass to dry. During the fermentation and decomposition which thence result, there is a speedy combination of oxygen and carbon. Exposure on the grass facilitates the escape of the carbonic acid into the atmosphere, and the plants become of a whitish grey colour.

It is known that a ley very slightly alkaline may be substituted with advantage, for this long and noxious operation; it is therefore certain, that a chamber from 20 to 30 feet in length, into which the steam of alkaline caustic water, of the strength of one-fourth of a degree only, is introduced, will be sufficient to produce the same effect as watering on an immense quantity of hemp and flax, suspended on basket-work, in less time, and with less expence, than are required for the different manipulations of watering. The losses occasioned by the negligence of workmen, who, by suffering the hemp and flax to macerate too long, give time to the decomposition to reach the filaments, which renders them brittle, and occasions a considerable waste, will also be avoided. In our process, the artist can follow every moment the progress of his operation, and stop it at the favourable period.

Nothing now remains but the wood, and the flax or fibrous part. The wood is a hollow tube covered over very compactly with the flax. To separate the wood, it must be kiln-dried, in order to render it frangible or brittle; but care must be taken not to apply too much heat, for fear of injuring the flax.

It is next to be beaten or broken, by which means the flax is not only divided into small fibres, but most of the wood is separated, and the part which adheres is reduced to small fragments. To separate these again, the flax is to be scutched, or thrashed, in small parcels at a time, either by manual labour, or mills contrived for the purpose. Hackling is the last process; which is nothing

more than drawing or combing the flax in small parcels at a time, through a pile or group of polished and sharp iron spikes, placed firmly in wood through an iron plate. The spikes are placed pretty close together: the first hackle (for different hackles must be used) is coarse, the second finer, and the third finer still.

The process of hackling answers a double or triple purpose; first, it divides the fibres of the flax, as much as this can be effected by mechanical means; secondly, it separates the minute fragments of wood which escaped the process of scutching; and lastly, it separates the short coarse flax, commonly called tow.

Spinning and weaving are too well known to need description. The linen, as it comes from the loom, is charged with what they call the weaver's dressing, which is a paste of flour boiled in water; and as this is brushed into the yarn of the warp before it is woven, it is somewhat difficult to separate it when dry. To discharge this paste, the linen must be steeped in water for about forty-eight hours; when this extraneous substance undergoes a kind of fermentation, which does not extend to the substance of the linen itself, upon the same principle that the green sap is disengaged from the flax without injury to its texture.

When the linen is well washed after this last process, it contains nothing that water; can separate; it is of a greyish white colour, although the fibres of which it is composed, when divested of every adventitious substance, are naturally very white.

The matter which thus colours the linen, is of a resinous nature, insoluble in water, and from its intimate union or dissemination through the very fibres of the flax, is difficult of separation, even by those substances which have a solvent power over it.

To disengage it, however, in as cheap and expeditious a manner as possible, without injuring the texture of the fabric, is the sole object of the process of bleaching.

Potash is the first menstruum which should be used in bleaching. It is most economical to render it caustic, for the purpose of bleaching. This is done by adding quicklime to the mild potash, the former having a stronger affinity for the carbonic acid than the latter. But care must be taken not to use the alkali too strong, otherwise it will attack and destroy the fibrous part. The potash, from its solvent power over the colouring matter, dissolves and separates the part immediately exposed to its action; that is, the part of it which rests superficially upon the fibres of the flax or thread; for it requires ten or twelve repeated boilings, at least, with the alternate agency of the atmosphere, to separate the whole of the resin.

It might be asked, why such an active solvent as potash should not carry away the whole of the resin at once, or at least as much as it alone could in any way separate. This requires an explanation. What appears to us to be a single ultimate fibre of flax in grey linen, is composed of a bundle of minute filaments, closely cemented or agglutinated together by the resinous matter; the potash first used therefore acts only upon the resin of the external coating of filaments; by which means they are loosened or separated, and exposed to the further action of the air. The second boiling in potash opens a second layer, and thus, successively, layer after layer; until the whole is divided, or opened to the centre. Were the solution of potash sufficiently strong to force its way at once to the centre, it would act upon the filaments themselves, and destroy the texture of the cloth.

Each filament, after the process of potash, retains an impregnation of colouring matter, so intimately united, as to resist the further action of it. This can only be removed by the slow and gradual influence of the oxygen gas of the atmosphere.

From the properties of oxygen gas and potash, their manner of operating is very obvious. The oxygen gas dissolves in each boiling a certain quantity of the colouring matter, with which it forms carbonic acid gas, and partly divides the filaments that eluded the action of potash. The carbonic acid gas, from its volatility, flies off and mixes with the atmosphere. Thus, alternately, the one dissolving, and the other burning out (for bleaching is slow combustion), the linen is whitened.

Mankind have at all times employed free air as the most convenient menstruum for bleaching. When tired with the slowness of its action, they assisted it by detersive leys, which abridged the process a little: and this union of boiling and exposure on the grass, formed the whole of the antient art of bleaching. Formerly, when it was necessary to bleach cloth, it was customary to immerse it in pure water, to free it from the dressing. This preliminary operation was sometimes hastened by a cold ley; the cloth was then rinsed in running water, and spread out on a meadow, round which ran a stream of limpid water, that served for watering the different pieces.

After being exposed in this manner some time, the cloth was washed and boiled in a fresh ley; it was then again spread out on the grass: and this operation was several times repeated until the required whiteness was obtained. It was still necessary to wind it through soapy water, not only to give it softness and pliability, but to bleach completely the borders, which oppose the longest resistance.

It was brought to its ultimate state of whiteness by drawing it through whey, or diluted sulphuric acid. By this short description it may be seen, that a considerable time was necessary before the absorption of oxygen could take place; to hasten this operation of nature appeared impossible, until modern chemistry had demonstrated that oxygen might be extracted, and combined with water, to be afterwards applied to substances where its influence might be necessary.

To promote the speedy action of atmospheric air, or rather the oxygenous part of it, in its ordinary elastic state, is well known to be impossible.

The oxygenated muriatic acid gas has been already described under the word Air. This gas, combined with water, forms the oxygenated muriatic acid, which is therefore only a combination of muriatic acid and oxygen; but this principle adheres but weakly to the muriatic acid.

All vegetable colours are attacked by this acid, and whitened with more or less celerity, which depends on their greater or less facility of combining with oxygen. The colouring matter undergoes a real slow combustion, which terminates by the formation of carbonic acid, which escaping under the form of elastic fluid, produces what we call bleaching.

In whatever manner the oxygenated muriatic acid is procured, it is evident that the oxygen adheres to it only weakly; and it is on this property that the possibility depends of producing speedily, in manufactories, that action which the atmosphere produces but slowly, and of bleaching in a space of time proportionably short.

The oxygenated muriatic acid is employed in four different ways for the purposes of bleaching; first, in the state of gas alone; secondly, in the state of gas combined with water, or what is called the acid; thirdly, potash is mixed with the acid to condense the gaseous vapour and destroy its suffocating odour; fourthly, oxygenated muriates, dissolved in water, are employed.

The first method, viz. employing the gas, was never used but for the purpose of experiment; as the vapour is of so noxious a quality, that to breathe it is fatal, and several people fell a sacrifice to their attempts in employing it.

When condensed in water, or in the state of oxygenated muriatic acid, it was found inconvenient in the large way, on account of the expence and difficulty in constructing the necessary apparatus, and the suffocating vapour which escaped.

For the discovery of the oxygenated muriatic acid, its effects on colouring matter, and its inestimable advantages, the arts are indebted to the justly celebrated Scheele. M. Berthollet lost no time in applying this curious and highly interesting substance to the most important practical uses. His experiments of bleaching by oxygenated muriatic acid, proved completely successful, and he did not delay to communicate his valuable labours to the public. The new method of bleaching was quickly and successfully introduced into the manufactories of Manchester, Glasgow, Rouen, Valenciennes, and Courtray; and it has since been gradually adopted in almost all parts of Great Britain, Ireland, France, and Germany. The advantages that result from this method, which accelerates the process of whitening cottons, linens, paper, &c. to a surprising degree, in every season of the year, can be justly appreciated by commercial people only, who experience its beneficial effects in many ways, but particularly in the quick circulation of their capitals.

To save the expence of first preparing the muriatic acid, the usual practice is to mix with the oxide of manganese, muriate of soda or common salt, and sulphuric acid diluted with water. The sulphuric acid acts upon the salt, and disengages from it the muriatic acid, which is oxygenated by the oxyde of manganese. The proportions observed when cotton is to be bleached, are,

Manganese	-	30 parts,
Common salt,		80
Sulphuric acid,		60
Water,	-	120.

For linen-cloth the proportions are as follow:

Manganese,	-	60 parts,

Salt,	-	60
Sulphuric acid,		50
Water,	-	50.

The better these substances are combined together, the more easily will the acid gas be disengaged by the action of the sulphuric acid.

To ascertain the strength of the acid for bleaching, a solution of indigo in the sulphuric acid is employed. The colour of this is destroyed by the oxygenated muriatic acid; and according to the quantity of it that can be discoloured by a given quantity of the liquor, its strength is known.

Cloth is prepared for immersion in oxygenated water, by soaking in a ley of weak potash, and rinsing it afterwards in a large quantity of water, in order to free it completely from the weaver's dressing, and the saliva of the spinners.

In this country, machinery is employed for rinsing and beating; the apparatus must be arranged according to the objects to be bleached; the skeins of thread must be suspended in the tub destined for them, and the cloth must be rolled upon reels in the apparatus. When every thing is thus disposed, the tubs are filled with oxygenated muriatic acid, by introducing a funnel, which descends to the bottom of the tub, in order to prevent the dispersion of the gas. The cloth is wound, or the frame-work on which the skeins are suspended is turned several times, until it is judged, by taking out a small quantity of the liquor from time to time, and trying it by the test of the solution of indigo, that it is sufficiently exhausted. The weakened liquor is then drawn off, and may be again employed for a new saturation.

Great difficulties for a time impeded the progress of this method of bleaching, arising chiefly from prejudice, and the ignorance of bleachers in chemical processes. These obstacles were, however, soon removed by Mr. Watt, of Glasgow, and Mr. Henry and Mr. Cooper at Manchester. Another difficulty presented itself, which had nearly proved fatal to the success of the operation. This was the want of a proper apparatus, not for making the acid and combining it with water, for this had been supplied in a very ingenious manner by Mr. Watt and M. Berthollet; but for the purpose of immersing and bleaching goods in the liquor. The volatility of this acid, and its suffocating vapours, prevented its application in the way commonly used in dye-houses. Large cisterns were therefore constructed, in which pieces of stuff were stratified; and the liquor being poured on them, the cisterns were closed with lids. But this method was soon found to be defective, as the liquor could not be equally diffused; the pieces were therefore only partially bleached, being white in some parts, and more or less coloured in others.

Mr. Rupp, of Manchester, invented an apparatus for bleaching cloth, exceedingly simple in its construction, of small expence, and which contains the liquor in such a manner as to prevent the escape of the oxygenated muriatic acid gas. A consideration of no less importance in the arrangement of this apparatus, is the impossibility of the vapour injuring the health of the workmen.

It was found, however, that the use of the oxygenated muriatic acid alone weakened the cloth, and various methods of preventing its noxious effects upon the health of the workmen were tried without success; till it was discovered that an addition of alkali to the liquor deprived it of its suffocating effects, without destroying its bleaching powers. The process began then to be carried on in open vessels, and has been continued in this manner to the present period. The bleacher is now able to work his pieces in the liquor, and to expose every part of them to its action, without inconvenience.

Potash was at first used for this purpose; and although this advantage was unquestionably great, it was diminished by the heavy expence of the potash, which was entirely lost. Also, the potash which was added to the liquor, though it did not destroy its power of bleaching, diminished it; because a solution of the oxygenated muriate of potash, which differs from this bleaching liquor in nothing but in the proportion of alkali, will not bleach at all. This is a well-known fact, from which we might infer, that the oxygenated muriatic acid will lose its power of destroying the colouring matter of vegetable substances, in proportion as it becomes neutralized by potash.

It was afterwards discovered that the oxymuriatic acid might be combined with the alkaline earths, as lime and barytes, and also with magnesia; by this means forming oxymuriates, which were soluble in water and had the property of bleaching. The oxymuriate of lime is at present used in almost all the bleaching-grounds. For the manner of preparing it, Mr. Tennant took out a patent; but this has been lately contested, and it is now prepared and used by all the bleachers through the country.

If the oxygenated muriatic acid is passed through lime-water, it will combine with the lime, and form oxymuriate of lime; but as the water can only retain a small portion of lime, this was not found of much use. To cause a larger quantity of lime to combine with the oxymuriatic acid gas, the lime is mechanically suspended in the water, into which the gas is made to pass, and agitated, so as to present fresh matter to the gas. By this means, the oxymuriate of lime is formed in a very convenient manner; it is dissolved in water, and used as a bleaching liquor.

This liquor is found to be preferable to the oxygenated muriatic acid, and potash. At the great bleach-field in Ireland, four leys of potash are applied alternately with four weeks exposure on the grass, two immersions in the oxygenated muriate of lime, a ley of potash between the two, and the exposure of a week on the grass between each ley and the immersions. During summer two leys and fifteen days exposure are sufficient to prepare cloth for the action of the oxygenated muriate; then three alternate leys, with immersions in the liquor, will be sufficient to complete the bleaching: nothing then will be necessary, but to wind the cloth through the sulphuric acid.

The oxygenated muriatic acid gas may also be combined with lime in a dry state, or the water may be evaporated, when it is employed for the formation of oxymuriates, which may then be very conveniently transported to any distance without injury to its detersive power; an advantage not possessed by the acid alone, which cannot be transported without the loss of almost half of its strength.

In all the processes for bleaching which have been hitherto described, we have seen that potash acts a distinguished part, either as an auxiliary, or as a principal agent. To find a detersive substance which might be a substitute for it, was an object of the utmost importance. Mr. Kirwan suspected that it would be found in the sulphuret of lime, and his opinion was confirmed by Dr. Higgins.

Sulphur and lime are both cheap articles; they are very easily combined, and this combination completely answers the purposes of potash, without any danger of injuring the linen. The sulphuret of lime is prepared in the following manner for the purpose of bleaching: Sulphur or brimstone, in fine powder, four pounds; lime, well slaked and sifted, twenty pounds; water, sixteen gallons; these are to be well mixed, and boiled for about half an hour in an iron vessel, stirring them briskly from time to time. Soon after the agitation of boiling is over, the solution of the sulphuret of lime clears, and may be drawn off free from the insoluble matter, which is considerable, and which rests upon the bottom of the boiler. The liquor, in this state, is pretty nearly of the colour of small beer, but not quite so transparent.

Sixteen gallons of fresh water are afterwards to be poured upon the insoluble dregs in the boiler, in order to separate the whole of the sulphuret from them. When this clears (being previously well agitated), it is also to be drawn off, and mixed with the first liquor; to these again thirty-three gallons more of water may be added, which will reduce the liquor to a proper standard for steeping the cloth. Here we have (an allowance being made for evaporation, and for the quantity retained in the dregs) sixty gallons of liquor from four pounds of brimstone.

Although sulphur, by itself, is not in any sensible degree soluble in water, and lime but sparingly so, water dissolving only about one seven-hundredth part of its weight of lime; yet the sulphuret of lime is highly soluble.

When linen is freed from the weaver's dressing, in the manner already described, it is to be steeped in the solution of sulphuret of lime (prepared as above) for about twelve or eighteen hours, then taken out and very well washed. When dry, it is to be steeped in the oxymuriate of lime for twelve or fourteen hours, and then washed and dried. This process is to be repeated six times, that is, six alternate immersions in each liquor, which has been found to whiten the linen.

Steam has been lately employed with great success in France. The process was brought from the Levant. Chaptal first made it known to the public.

We have already mentioned, that the bleaching of vegetable substances depends on the destruction of their colouring principle by the combined action of the air, moisture, and light; or rather, by the united influence of these principles to alter their natural colour.

Alkalis have, on the colouring matter of vegetables, an action which produces the effect of a real combustion. Were we intimately acquainted with the nature of potash and soda, we might be able to explain the cause of this burning; but it is sufficient for us at present to know the effect. The expe-

sure of vegetable matters on the grass, subjects them to the action of the solar rays; and moistening them during their exposure, facilitates, with the evaporation of the water, the emanation of the carbonic acid formed by the oxygen of the atmosphere, which combines with the carbon resulting from the alkaline combustion. It even agrees pretty well with theory, in terminating the process of bleaching, to immerse the cloth and thread in sour milk, acidulous liquors, or, what is more convenient, very weak sulphuric acid.

In proportion as the alkali, during the first immersion, destroys the colouring matter, the oxygen of the atmosphere, or that furnished by the oxygenated muriatic acid, joins that carbonized matter, and forms carbonic acid, which afterwards resolves itself into gas. This is contained the more in the principles, as the bases of all the acids are insoluble in water; but when the combination takes place between the carbon and the oxygen, it immediately becomes soluble. Thus, on the one hand to burn the colouring matter, and to dissolve it on the other, form the whole secret of the art of bleaching; and the greater or less tendency of vegetable substances to experience that combustion, constitutes the gradations of their whiteness, and the facility or difficulty of bleaching.

The slowness of the whole process arose, in a great measure, from bleachers being unacquainted with these principles. A long succession of leys, and exposure on the grass, was necessary to penetrate the fibres of the linen from stratum to stratum. The texture was sufficiently close to resist the action of the heat of a common ley, and a considerable time was required to absorb the oxygen presented by the delicate stratum of atmospheric air.

In the process of bleaching by steam, these difficulties are removed. The high temperature of the steam, in the interior part of the apparatus, swells up the fibres of the thread or cloth; the pure alkali, which rises with the elastic fluid, seizes with avidity on the colouring matter, and burns it; seldom does the tissue of the flax or hemp resist the penetrating effect of this vapour-bath. The whole matter, therefore, by which they are coloured, is attacked and decomposed by this single operation; and even if we suppose that a part has been able to resist, nothing is necessary but to repeat the operation, after a previous immersion and exposure on the grass, to ensure its complete effect. The alkali even appears to have a much livelier and more caustic action, when it is combined with caloric, than in ordinary leys, where the temperature never rises above 162° of Fahrenheit. By making the cloth or thread pass through one ley of oxygenated muriatic acid, or oxygenated muriate of lime, an union is effected between the solution and the carbon, arising from the burning of the extracto-mucous matter of the flax; carbonic acid is formed; the water even in which this new compound is diluted, concurs to promote this combination; if the cloth is then exposed on the grass, the carbonic acid is dissipated, and the cloth is bleached.

It was believed that the steam of a pure alkaline ley would not be caustic, and would not produce the same effects as the saline solution; and the reason assigned for this opinion was the concentration of all the salts by the evaporation of the aqueous fluid: but what takes place in the open air, where the atmosphere every moment absorbs the moisture which is evaporated, cannot be applied to a close apparatus, where the temperature is elevated in an extreme degree; besides, the caloric always carries with it a little alkali, even in low temperatures, as is observed when water is poured over potash; the steam which issues from it changes blue vegetable colours to green.

It follows, from these chemical principles, that the action of steam alone does not bleach, and that the concurrence of oxygen is necessary to aid the composition of the carbonic acid; this acid requires for its formation, 28 parts of carbon, saturated with 72 of oxygen: but all the oxygen contained in the apparatus would not be sufficient to saturate the considerable quantity of colouring matter burnt by the alkaline combustion, and converted into carbon; this deficit must be supplied by immersion in any oxygenated liquor whatever, and the dispersion of the elastic fluid thus formed must be then facilitated by exposure on the grass.

To bleach cloth in this manner, it must be immersed in a slight alkaline caustic liquor, and placed in a chamber constructed over a boiler, into which is put the alkaline ley which is to be raised into steam. After the fire has been lighted, and the cloth has remained exposed to the action of the steam for a sufficient length of time, it is taken out, and immersed in the oxygenated muriate of lime, and afterwards exposed for two or three days on the grass. This operation, which is very expeditious, will be sufficient for cotton; but if linen cloth should still retain a yellow tint, a second alkaline caustic vapour-bath, and two or three days on the grass, will be sufficient to give it the necessary degree of whiteness.

Bleaching of cotton. Cotton is a filamentous substance, or a kind of down which envelopes the seeds of the cotton-plant. This plant or shrub comes originally from the East, and grows only in warm climates.

This substance, after being separated from the seeds, is always charged with a coarse colouring matter, which soils it, and renders it opaque. The presence of this unctuous matter is proved by the slowness with which cotton absorbs water before it is scoured, and by the force with which it absorbs it after the operation; by which means, from being opaque, it is rendered clear and transparent.

Cotton varies a great deal in its qualities, according to the different kinds, the climate where produced, and the culture employed. Its colour is sometimes yellow, and sometimes white; but in general it is of a dirty yellow.

To bleach it, does not require the same prepa ations as hemp and flax. The first operation consists in scouring it in a slight alkaline solution, or, what is better, by exposure to steam. It is afterwards put into a basket, and rinsed in running water. The immersing of cotton in an alkaline ley, however it may be rinsed, always leaves with it an earthy deposit. It is well known that cotton bears the action of acids better than hemp or flax; that time is even necessary before the action of them can be prejudicial to it: and by taking advantage of this valuable property in regard to bleaching, means have been found to free it from the earthy deposit, by pressing down the cotton in a very weak solution of sulphuric acid, and afterwards removing the acid by washing, lest too long remaining in it should destroy the cotton.

Bleaching of wool. The substances produced by the animal kingdom, differ essentially in their constituent principles from vegetables. Vegetables serve as the nourishment to the animals and insects, the spoils of which we employ. Animalized by their organs, they acquire other properties. We shall here confine ourselves to the examination of wool and silk, as the animal substances most generally employed for clothing.

Wool is a finer kind of hair with which the bodies of several animals are covered. It is composed of filaments or tubes, filled with an oily or medullary substance. The sides of these tubes are perforated with a multitude of small pores, which communicate with a longitudinal tube. By chemical analysis wool gives a great deal of oil, and carbonate of ammonia; caustic alkaline leys dissolve it entirely. It experiences no change in boiling water; it alters very little when preserved in a place well aired; acids have very little action on it; when exposed to a strong heat, it enters into fusion.

An examination of these chemical facts, is necessary for understanding the principles which ought to direct the artist in the bleaching of this substance. The little action which acids have upon wool, and its unalterableness in water even when aided by heat, render it necessary to have recourse to alkaline or saponaceous leys; but its solubility in these salts shews, that great prudence and caution must be employed. In regard to acids, none have been hitherto used but the sulphureous acid, obtained in the gaseous state by combustion.

In the preliminary operations to which wool is subjected, it is customary to leave a little of its grease, to secure it from insects. Wool is often freed from the grease by the farmers, when they wish to sell it at a high price; but in the subsequent manipulations, it is greased or oiled before it is combed, spun, &c.; and as this fat matter attracts dust, it dirties and thickens the stuffs. The first kind of bleaching to which wool is subjected, is to free it from these impurities. This operation is called scouring. In manufactories, it is generally performed by means of an ammoniacal ley, formed of five measures of river water and one of stale urine; the wool is immersed for about twenty minutes in a bath of this mixture, heated to fifty-six degrees; it is then taken out, suffered to drain, and then rinsed in running water: this manipulation softens the wool, and gives it the first degree of whiteness: it is repeated a second, and even a third time, after which the wool is fit to be employed. In some places, scouring is performed with water slightly impregnated with soap; and indeed, for valuable articles, this process is preferable, but it is too expensive for articles of less value.

Fulling the cloth adds still to the whiteness, and if an increased degree is necessary, it may be procured by the action of the sulphureous acid; that is to say, of the fumes of sulphur in a state of combustion, or the vapour of that acid condensed and combined with water.

Sulphuring is generally performed in an arched or very close chamber, constructed in such a manner, that the articles to be exposed to the action of the sulphur can be suspended on poles. The chamber being filled, a certain quantity of sulphur is put in a state of combustion in flat dishes, having a large surface with very little depth; the entrance is speedily shut, and all the interstices around the door are carefully stopped to prevent the access of the atmospheric air. The acid generated by the combustion of the sulphur, penetrates the stuffs, attacks the colouring matter, destroys it, and effects the bleaching. The stuffs are left in the stoves some time after the deflagration has ceased. This time varies from six to twenty-four hours. They are then taken out, and made to pass through a slight washing with soap, to remove the roughness they have acquired by the action of the acid, and to give them the necessary softness.

This process is imperfect. At first, the acid of the sulphur acts only on the surfaces, and does not penetrate. This aerial immersion is not sufficient; the gas cannot introduce itself to a sufficient depth into the stuffs, and the superficies only are whitened.

A superior method has been lately invented, which is by making use of the sulphureous acid.

The sulphureous acid, or that acid generated by the imperfect combustion of sulphur, differs from the sulphuric acid (oil of vitriol), by its containing less of the acidifying principle, and by being the mean term between the sulphuric acid.

Sulphureous acid gas unites very easily with water, and in this combination it may be employed for bleaching wool and silk. The sulphureous acid in this state of liquidity, may be prepared by making it traverse water in an apparatus nearly similar to that used for preparing oxygenated muriatic acid. The most economical method of obtaining it, is to decompose sulphuric acid (oil of vitriol), by the mixture of any combustible matter capable of taking from it a part of its oxygen. In exact experiments of the laboratory, when the chemist is desirous of having great purity, it is obtained by means of metallic substances, and particularly by mercury; but for the purpose of which we are treating, where great economy is required, we should recommend the most common substances. We shall therefore give the following process. Take chopped straw, or sawdust, and introduce it into a mattress; pour over it sulphuric acid, applying at the same time heat, and there will be disengaged sulphureous acid gas (vapour of sulphur), which may be combined with water in the apparatus.

The pieces are rolled upon the reels, and are drawn through the sulphureous acid by turning them, until it is observed that the whiteness is sufficiently bright. They are then taken out, and are left to drain on a bench covered with cloth, lest they should be stained in consequence of the decomposition of the wood by the sulphureous acid; they are next washed in river water, and Spanish white is employed, if it should be judged necessary. This operation is performed by passing the pieces through a tub of clear water, in which about eight pounds of Spanish white have been dissolved. To obtain a fine whiteness, the stuffs, in general, are twice sulphured. According to this process, one immersion and reeling two or three hours are sufficient. Azuring or bluing is performed by throwing into the Spanish-white liquor, a solution of one part of Prussian blue to 400 parts of water; shaking the cloth in the liquid, and reeling it rapidly. The operation is terminated by a slight washing with soap, to give softness and pliability to the stuffs. The final operations of drying, stretching, pressing, &c. are foreign to our present subject.

Bleaching of silk. Silk is a semitransparent matter, spun by a caterpillar, and formed of a substance contained in its body, which becomes hard in the air. This insect inhabits warm climates, being indigenous in Asia: it was naturalized in Europe about the time of the downfal of the Roman empire.

The filaments prepared by the silkworm are rolled up in a cod or ball. In this state, in which we find it, it is covered with a yellow varnish, which destroys its brilliancy and renders it rough. Silk by chemical analysis gives carbonate of ammonia and oil; water at a boiling heat produces no effect upon it; alcohol makes it experience no change; but concentrated alkaline leys attack and dissolve it.

To give splendour to silk, it must be freed from its varnish. This covering is soluble in alkaline leys. Silk is generally scoured by means of soap, by which it loses one-fourth of its weight. The matter disengaged from it is very fetid, and if the silk is not rinsed in plenty of water, putrid fermentation will take place. Even when the best soap is used, it is generally suspected that it injures the whiteness of the silk. The splendour of the Chinese silk is brighter than that of the European, and the Chinese employ no soap in their operations. A slightly alkaline ley will dissolve the varnish of the silk without using soap, and this has also been effected by the action of boiling water at a very high temperature.

The method which has been used successfully in France is as follows:

Take a solution of caustic soda, so weak as to mark only a fourth of a degree, at most, of the arcometer for salts, and fill with it the boiler of the apparatus for bleaching with steam. Charge the frames with skeins of raw silk, and place them in the apparatus until it is full; then close the door, and make the solution boil. Having continued the ebullition for twelve hours, slacken the fire, and open the door of the apparatus. The heat of the steam, which is always above 250°, will have been sufficient to free the silk from the gum, and to scour it. Wash the skeins in warm water; and, having wrung them, place them again on the frames in the apparatus, to undergo a second boiling. Then wash them several times in water, and immerse them in water somewhat soapy, to give them a little softness.

Notwithstanding the whiteness which silk acquires by these different operations, it must be carried to a higher degree of splendour by exposing it to the action of sulphureous acid gas, in a close chamber, or by immersing it in sulphureous acid, as before recommended for wool.

Bleaching prints, and printed books. An application has been made of the new mode of bleaching, to the whitening of books and prints that have been soiled by smoke and time.

Simple immersion in oxygenated muriatic acid, letting the article remain in it a longer or shorter space of time according to the strength of the liquid, will be sufficient to whiten an engraving: if it is required to whiten the paper of a bound book, as it is necessary that all the leaves should be moistened by the acid, care must be taken to open the book well, and to make the boards rest on the edge of the vessel, in such a manner that the paper alone shall be dipped in the liquid; the leaves must be separated from each other, in order that they may be equally moistened on both sides.

The liquor assumes a yellow tint, and the paper becomes white in the same proportion; at the end of two or three hours, the book may be taken from the acid liquor, and plunged into pure water, with the same care and precaution as recommended in regard to the acid liquor, that the water may exactly touch the two surfaces of each leaf. The water must be renewed every hour, to extract the acid remaining in the paper, and to dissipate the disagreeable smell.

By following this process, there is some danger that the pages will not be all equally whitened; either because the leaves have not been sufficiently separated, or because the liquid has had more action on the front margins than on those near the binding. On this account, the best way is to destroy the binding entirely, that each leaf may receive an equal and perfect immersion; and this is the second process recommended by M. Chaptal.

"They begin," says he, "by unsewing the book, and separating it into leaves, which they place in cases formed in a leaden tub, with very thin slips of wood or glass, so that the leaves, when laid flat, are separated from each other by intervals scarcely sensible. The acid is then poured in, making it fall on the sides of the tub, in order that the leaves may not be deranged by its motion. When the workman judges, by the whiteness of the paper, that it has been sufficiently acted upon by the acid, it is drawn off by a cock at the bottom of the tub, and its place is supplied by clear fresh water, which weakens and carries off the remains of the acid, as well as the strong smell. The leaves are then to be dried, and after being pressed, may be again bound up.

"The leaves may be placed also vertically in the tub; and this position seems to possess some advantage, as they will be less liable to be torn. With this view I constructed a wooden frame, which I adjusted to the proper height, according to the size of the leaves which I wished to whiten. This frame supported very thin slips of wood, leaving only the space of half a line between them. I placed two leaves in each of these intervals, and kept them fixed in their place by two small wooden wedges, which I pushed in between the slips. When the paper was whitened I lifted up the frame with leaves, and plunged them in cold water, to remove the remains of the acid, as well as the smell; this process I prefer to the other.

"By this operation books are not only cleaned, but the paper acquires a degree of whiteness superior to what it possessed when first made. The use of this acid is attended also with the valuable advantage of destroying ink-spots. This liquor has no action upon

sure of vegetable matters on the grass, subjects them to the action of the solar rays; and moistening them during their exposure, facilitates, with the evaporation of the water, the emanation of the carbonic acid formed by the oxygen of the atmosphere, which combines with the carbon resulting from the alkaline combustion. It even agrees pretty well with theory, in terminating the process of bleaching, to immerse the cloth and thread in sour milk, acidulous liquors, or, what is more convenient, very weak sulphuric acid.

In proportion as the alkali, during the first immersion, destroys the colouring matter, the oxygen of the atmosphere, or that furnished by the oxygenated muriatic acid, joins that carbonized matter, and forms carbonic acid, which afterwards resolves itself into gas. This is contained the more in the principles, as the bases of all the acids are insoluble in water; but when the combination takes place between the carbon and the oxygen, it immediately becomes soluble. Thus, on the one hand to burn the colouring matter, and to dissolve it on the other, form the whole secret of the art of bleaching; and the greater or less tendency of vegetable substances to experience that combustion, constitutes the gradations of their whiteness, and the facility or difficulty of bleaching.

The slowness of the whole process arose, in a great measure, from bleachers being unacquainted with these principles. A long succession of leys, and exposure on the grass, was necessary to penetrate the fibres of the linen from stratum to stratum. The texture was sufficiently close to resist the action of the heat of a common ley, and a considerable time was required to absorb the oxygen presented by the delicate stratum of atmospheric air.

In the process of bleaching by steam, these difficulties are removed. The high temperature of the steam, in the interior part of the apparatus, swells up the fibres of the thread or cloth; the pure alkali, which rises with the elastic fluid, seizes with avidity on the colouring matter, and burns it; seldom does the tissue of the flax or hemp resist the penetrating effect of this vapour-bath. The whole matter, therefore, by which they are coloured, is attacked and decomposed by this single operation; and even if we suppose that a part has been able to resist, nothing is necessary but to repeat the operation, after a previous immersion and exposure on the grass, to ensure its complete effect. The alkali even appears to have a much livelier and more caustic action, when it is combined with caloric, than in ordinary leys, where the temperature never rises above 162° of Fahrenheit. By making the cloth or thread pass through one ley of oxygenated muriatic acid, or oxygenated muriate of lime, an union is effected between the solution and the carbon, arising from the burning of the extracto-mucous matter of the flax; carbonic acid is formed; the water even in which this new compound is diluted, concurs to promote this combination; if the cloth is then exposed on the grass, the carbonic acid is dissipated, and the cloth is bleached.

It was believed that the steam of a pure alkaline ley would not be caustic, and would not produce the same effects as the saline solution; and the reason assigned for this opinion was the concentration of all the

the evaporation of the aqueous fluid: but what takes place in the open air, where the atmosphere every moment absorbs the moisture which is evaporated, cannot be applied to a close apparatus, where the temperature is elevated in an extreme degree; besides, the caloric always carries with it a little alkali, even in low temperatures, as is observed when water is poured over potash; the steam which issues from it changes blue vegetable colours to green.

It follows, from these chemical principles, that the action of steam alone does not bleach, and that the concurrence of oxygen is necessary to aid the composition of the carbonic acid; this acid requires for its formation, 28 parts of carbon, saturated with 72 of oxygen: but all the oxygen contained in the apparatus would not be sufficient to saturate the considerable quantity of colouring matter burnt by the alkaline combustion, and converted into carbon; this deficit must be supplied by immersion in any oxygenated liquor whatever, and the dispersion of the elastic fluid thus formed must be then facilitated by exposure on the grass.

To bleach cloth in this manner, it must be immersed in a slight alkaline caustic liquor, and placed in a chamber constructed over a boiler, into which is put the alkaline ley which is to be raised into steam. After the fire has been lighted, and the cloth has remained exposed to the action of the steam for a sufficient length of time, it is taken out and immersed in the oxygenated muriate of lime, and afterwards exposed for two or three days on the grass. This operation, which is very expeditious, will be sufficient for cotton; but if linen cloth should retain a yellow tint, a second alkaline vapour-bath, and two or three days on the grass, will be sufficient to give it the necessary degree of whiteness.

Bleaching of cotton. Cotton is a fine pulpy mentous substance, or a kind of down, which envelopes the seeds of the cotton-tree. This plant or shrub comes originally from the East, and grows only in warm climates.

This substance, after being separated from the seeds, is always charged with a yellow colouring matter, which renders it opaque. The presence of this matter is proved by the fact that when cotton absorbs water it becomes transparent by the force with which it imbibes it. By the operation; by which cotton is rendered opaque, it is rendered white.

Cotton varies in its colour and fineness according to the climate where produced. Its colour is naturally white; but it is low.

To bl… prepa… operat… alkali… post… a b… in…

have been found to… deposit, by pressing… very weak solution… afterwards removing… lest too long remain… the cotton.

Bleaching of … duced by the … tially in their co… getables. Vege… ment to the … of which we … organs, they … shall here co… tion of wool … most genera…

Wool is … bodies of … composed … an oily … of these … tude of … a long… wool … of an… entire… ing… ed… li…

Sulphuring is generally performed in an arched or very close chamber, constructed in such a manner, that the articles to be exposed to the action of the sulphur can be suspended on poles. The chamber being filled, a certain quantity of sulphur is put in a state of combustion in flat dishes, having a large surface with very little depth; the entrance is speedily shut, and all the interstices around the door are carefully stopped to prevent the access of the atmospheric air. The acid generated by the combustion of the sulphur, penetrates the stuffs, attacks the colouring matter, destroys it, and effects the bleaching. The stuffs are left in the stoves some time after the deflagration has ceased. This time varies from six to twenty-four hours. They are then taken out, and made to pass through a slight washing with soap, to remove the roughness they have acquired by the action of the acid, and to give them the necessary softness.

This process is imperfect. At first, the acid of the sulphur acts only on the surfaces, and does not penetrate. This aerial immersion is not sufficient; the gas cannot introduce itself to a sufficient depth into the stuffs, and the superficies only are whitened.

A superior method has been lately invented, which is by making use of the sulphureous acid.

The sulphureous acid, or that acid generated by the imperfect combustion of sulphur, differs from the sulphuric acid (oil of vitriol), by its containing less of the acidifying principle, and by being the mean term between the sulphuric acid.

Sulphureous acid gas unites very easily with water, and in this combination it may be employed for bleaching wool and silk. The sulphureous acid in this state of liquidity, may be prepared by making it traverse water in an apparatus nearly similar to that used for preparing oxygenated muriatic acid. The most economical method of obtaining it, is to decompose sulphuric acid (oil of vitriol), by the mixture of any combustible matter capable of taking from it a part of its oxygen. In eudiometrical experiments of the laboratory, when the chemist is desirous of having great purity, it is obtained by means of metallic substances, and particularly by mercury; but for the purpose of whitening, where great economy is requisite, we should recommend the most common substances. We shall therefore give the following process. Take chopped straw, or dust, and introduce it into a matrass, pour over it sulphuric acid, apply a gentle heat, and there will be disengaged sulphureous acid gas (vapour), which may be combined with water in the apparatus.

The pieces are rolled up [illegible] are drawn through the [illegible] turning them, until the whiteness is sufficient. They are then taken out, and [illegible] washed with cloth [illegible] in consequence of the [illegible] wood by the [illegible] washed in the [illegible] employed for [illegible] This operation [illegible] pieces [illegible] about eight [illegible] been dried [illegible] the silk is [illegible]

According to the nature of the [illegible] and mixing [illegible] According to the [illegible] into the [illegible] one part of [illegible] water; shaking the mixture [illegible] reeling it round. [illegible] nated by a slight [illegible] softness and [illegible] operations [illegible] are foreign to our [illegible]

Bleaching of oils. [illegible] parent matter, [illegible] formed of a [illegible] which becomes [illegible] inhabits warm climates, [illegible] in Asia: it was [illegible] the time of the [illegible]

The [illegible] are called [illegible] in which we [illegible] low vessel, [illegible] resolved into [illegible] gives out [illegible] at a boiling [illegible] alcohol mixed [illegible] concentrated [illegible] it.

To give [illegible] from its [illegible] in alcohol, [illegible] its properties [illegible] of it over [illegible] plate [illegible] perfectly [illegible]

distinct and accurate, we may fairly conclude from the rapidity with which they ascertain the acuteness or gravity of different sounds, and from their exact discernment of the various modifications of sound, and of sonorous objects, if the sounds themselves are in any degree significant of their causes.

When we ruminate on the numberless advantages derived from the use of sight, and its immense importance in extending the human capacity, and improving every faculty of the mind, we might be tempted to doubt the reports concerning such persons as, without the assistance of light, have arrived at high degrees of eminence even in those sciences which appear absolutely unattainable but by the interposition of external mediums. It has, however, been demonstrated by the late ingenious Dr. Reid, that blind men, by proper instruction, are susceptible of almost every idea, and every truth which can be impressed on the mind by the mediation of light and colours, except the sensations of light and colours themselves. Yet there is one phenomenon of this kind which seems to have escaped the attention of that philosopher, and for which no author has offered any tolerable reason, though it certainly merits the attention of a philosopher. For though we should admit that the blind can understand with great perspicuity all the phenomena of light and colours; though it was allowed that on these subjects they might extend their speculations beyond their instructions, and investigate the mechanical principles of optics by the mere force of genius and application, from the data which they have already obtained; yet it will be difficult, if not impossible, to assign any reason why these objects should be more interesting to a blind man than any other abstract truths whatever. It is possible for the blind, by a retentive memory, to tell that the sky is an azure; that the sun, moon, and stars, are bright; that the rose is red, the lily white or yellow, and the tulip variegated. By continually hearing these substantives and adjectives joined, he may be mechanically taught to join them in the same manner; but if he has never had any sensation of colour, however accurately he may speak of coloured objects, his language must be like that of a parrot; without meaning, and without ideas.

It is scarcely possible to lay down a plan, or enter into a detail of particulars, with respect to the mode of education proper to be pursued for the blind. These must be determined by the genius, the capacity, and the circumstances, of those to whom the general rules should be applied. Much therefore must depend on their fortunes, much on their temper and genius; for unless these particulars were known, every answer which could be given to questions of this kind must be extremely general, and of consequence extremely superficial. Besides, the task is so much more arduous, because whoever attempts it can expect to derive no assistance from those who have written on education before him: and though the blind have excelled in more than one science, yet, except in the case of Dr. Saunderson, it does not appear that any of them have been conducted to that degree of eminence at which they arrived upon a premeditated plan. We should rather imagine, that the [illegible] led

[illegible] even [illegible] and irre- [illegible] compen- [illegible] eir misery. [illegible] ned to those [illegible] she can com- [illegible] ures [illegible] his [illegible] na- [illegible] on [illegible] y, [illegible] if these indications [illegible] nned to particular [illegible] these signs, the blind [illegible] nown to perform long [illegible] but even, if we may [illegible] luct others through dan- [illegible] dnight, with the utmost [illegible] ness.

[illegible] dless to recapitulate the va- [illegible] l operations of which they [illegible] their nicety and accuracy of [illegible] ne, the tactile powers are said [illegible] so highly improved, as to per- [illegible] exture and disposition of coloured [illegible] which some rays of light are re- [illegible] d others absorbed, and in this man- [illegible] stinguish colours; but the testimonies [illegible] fact still appear too vague and general [illegible] rve public credit. A person who lost [illegible] e of his sight at an early period of in- [illegible] y, who in the vivacity or delicacy of his [illegible] sations was not perhaps inferior to any [illegible] e, and who had often heard of others in his [illegible] situation capable of distinguishing colours by touch, stimulated, partly by curiosity to acquire a new train of ideas if possible, but still more by incredulity with respect to the facts related, tried repeated experiments by touching the surfaces of different bodies and examining whether any such diversities could be found in them as might enable him to distinguish colours; but no such diversity could he ever ascertain. Sometimes, indeed, he imagined that objects which had no colour, or, in other words, such as were black, were somewhat different and peculiar in their surfaces, but this experiment did not always hold. That their acoustic perceptions

spots of oil or animal grease; but it has been long known that a weak solution of potash will effectually remove stains of that kind.

"When I had to repair prints so torn that they exhibited only scraps pasted upon other paper, I was afraid of losing these fragments in the liquid, because the paste became dissolved. In such cases I inclosed the prints in a cylindric glass vessel, which I inverted on the water in which I had put the mixture proper for extricating the oxygenated muriatic acid gas. This vapour, by filling the whole inside of the jar, acted upon the print, extracted the grease as well as ink-spots, and the fragments remained pasted to the paper."

Easy method of preparing the oxygenated muriatic acid.—To oxygenate the muriatic acid, nothing is necessary but to dilute it, and mix it in a very strong glass vessel with manangese, in such a manner that the mixture may not occupy the whole contents of the glass. Air-bubbles are formed on the surface of the liquor; the empty space becomes filled with a greenish vapour; and at the end of some hours the acid may be farther diluted with water, and then used. It has an acid taste, because the whole is not saturated with oxygen; but it possesses all the virtues of the oxygenated muriatic acid. This process may be followed when there is not time to set up an apparatus for distilling, in order to procure the oxygenated acid.

BLECHNUM, in botany, a genus of plants of the class of the cryptogamia filices; the fructifications of which are disposed in two parallel lines, approaching to the rib of the frond. There are six species, all foreign plants.

BLEEDING. See SURGERY.

BLENDE, or BLACK JACK. This ore very usually accompanies sulphuret of lead. It is common, but seldom in such quantities as to make it worth working. It occurs both in amorphous masses and crystallized. The primitive form of its crystals is the rhomboidal dodecahedron. The figure of its integrant particles is the tetrahedron.

Colour yellow, brown, or black. Streak reddish, brownish, or grey. Lustre vitreous, or that of the diamond. Generally somewhat transparent. Refraction single. Texture foliated. Clivage six-fold. Hardness 6 to 8. Scratches sulphat of barytes. Specific gravity 4.000 to 4.1665. Before the blowpipe decrepitates, and gives out white flowers of zinc, but does not melt. Borax does not affect it. When breathed upon, loses its lustre, and recovers it very slowly. It is usually divided into three subspecies.

1. Yellow blende. Colour commonly sulphur yellow, often passing into olive green or brownish red. Powder pale yellow. Streak yellowish or reddish grey, not metallic. Lustre that of the diamond. Transparency usually 2, sometimes 4. Often phosphoresces when scraped or rubbed. According to Bergman, it is composed of

64 zinc
20 sulphur
5 iron
4 fluoric acid
1 silica
6 water

100.

2. Brown blende. Colour different shades of brown. Surface often tarnished. Powder brownish grey. Streak yellowish grey. Lustre internal, vitreous. Transparency 0 to 2, sometimes 4. A specimen of this variety, analysed by Bergman, contained

44 zinc
17 sulphur
24 silica
5 iron
5 alumina
5 water

100.

3. Black blende. Colour black or brownish black; surface often tarnished blue; tips of the crystals often blood-red. Powder brownish black. Streak reddish grey. Lustre internal, that of the diamond. Transparency 0 to 1; the red parts 2. Hardness 8. A specimen of this variety, analysed by Bergman, contained

52 zinc
26 sulphur
4 copper
8 iron
6 silica
4 water

100.

BLENNIUS, the BLENNY, a genus of fishes belonging to the order of jugulares; the characters of which are: the head slants or declines to one side; there are six rays in the membrane of the gills; the body tapers towards the tail; the belly fins have only two blunt bones; and the tail fin is distinct. The species are 13, among which are:

1. Blennius cornutus, with a simple ray above the eyes, and a single back fin. 2. Blennius galeria, with a transverse membraneous crest upon the head, is found in the European seas. 3. Blennius gattorugine (See Plate, Nat. Hist. fig. 47), with small palmated fins about the eye-brows and neck. It is about seven or eight inches long, and is found in the European seas. 4. Blennius ocellaris, with a furrow betwixt the eyes, and a large spot on the back fin. It is found in the European seas. (See Plate, Nat. Hist. fig. 48). 5. Blennius raninus, with six divisions in the belly fins, is found in the lakes of Sweden. It is remarkable that when this fish appears in the lake, all the other fishes retire; and what is worse, it is not fit for eating. 6. Blennius viviparus, has two tentacula at the mouth. They bring forth 200 or 300 young at a time. Their season of parturition is a little after the depth of winter. Before midsummer they quit the bays and shores, and retire into the deep, where they are commonly taken. They are a very coarse fish, and eaten only by the poor. They are common in the mouth of the Esk, at Whitby, Yorkshire, where they are taken frequently from off the bridge. They sometimes grow to the length of a foot. Their form is slender, and the backbone is as green as that of a sea-needle. See Plate, Nat. Hist. fig. 49).

BLIGHT, in husbandry, a disease incident to plants, which affects them variously, the whole plant sometimes perishing by it, and sometimes only the leaves and blossoms, which will be scorched and shrivelled up, the rest remaining green and flourishing. Various causes have been assigned for this disease, and various cures proposed. It sometimes is in the plant itself from imperfect secretion, but is more commonly the effect of cold winds in the spring. See PLANTS.

BLINDS, or BLINDES, in the art of war, a sort of defence commonly made of oziers, or branches interwoven and laid across between two rows of stakes, about the height of a man, and four or five feet asunder, used particularly at the heads of trenches when they are extended in front towards the glacis; serving to shelter the workmen, and prevent their being overlooked by the enemy.

BLINDNESS, a total privation of sight, arising from an obstruction of the functions of the organs of sight, or from an entire deprivation of them.

The causes of blindness are various; proceeding from cataracts, gutta serena's, &c. There are also periodical blindness, as a defect of sight in some towards night, in others only in the day; the former of which is termed nyctalopia, the latter hemeralopia.

It is said, that in several parts of Persia, there are found vast numbers of blind people of all ages, sexes, and conditions, occasioned by a species of little flies, which prick the eyes and lips, and enter the nostrils, carrying certain blindness with them when they light on the eyes.

If we consider blindness in a moral or philosophical view; as there is not any sense or faculty of the corporeal frame which affords so many sources of utility and entertainment as the power of vision; so is there not any privation which can be productive of disadvantages so various and so bitter as the want of sight. By no avenue of corporeal perception is knowledge, in her full extent, so accessible to the rational soul, as by the glorious and delightful medium of light. To the blind, on the contrary, the visible universe is totally annihilated; he has not even any distinct idea of space, except that in which he stands, or to which his extremities can reach. Sound, indeed, gives him some ideas of distant objects; but these ideas are extremely obscure and indistinct. They are obscure because they consist alone of the objects whose oscillations vibrate on his ear, and do not necessarily suppose any other bodies with which the intermediate space may be occupied; they are indistinct, because sounds themselves are frequently ambiguous, and do not uniformly indicate their real causes. And though by them the idea of distance in general, or even of some particular distances, may be obtained; yet they never fill the mind with those vast and exalting ideas of extension which are inspired by ocular perception. For though a clap of thunder, or an explosion of ordnance, may be distinctly heard after the sound has traversed an immense region of space, yet, when the distance is uncommonly great, it ceases to be indicated by sound; and therefore the ideas acquired by auricular experiments, of extension and interval, are extremely confused and inadequate. The comprehensive eye darts its instantaneous glance over extensive valleys, lofty mountains, protracted rivers, illimitable oceans. It views in an instant the mighty space from earth to heaven, or from one star to another. By the assistance of telescopes, its power is almost infinitely extended, its objects multiplied, and the sphere of its observation immensely enlarged. Thus the imagination,

inured to vast impressions of distance, can not only recal them in their greatest extent, with as much rapidity as they were at first imbibed, but can multiply them, and add one to another, till all particular boundaries and distances are lost in immensity. The blind are apprehensive of danger in every motion towards any place, whence their contracted powers of perception can give them no intelligence. All the various modes of delicate proportion, all the beautiful varieties of light and colours, exhibited in the works of nature and art, are to them irretrievably lost. Dependant for every thing, but mere existence, on the good offices of others; obnoxious to injury from every point, which they are neither capacitated to perceive nor qualified to resist; they are, during the present state of being, rather prisoners at large, than citizens of nature. The sedentary life to which by privation of sight they are destined, relaxes their frame, and subjects them to all the miserable sensations which arise from dejection of spirits. Hence the most feeble exertions create lassitude and uneasiness. Hence the native tone of the nervous system, compatible with health and pleasure, being destroyed by inactivity, exasperates and embitters every disagreeable impression. Natural evils, however, are supportable, being either mild in their attacks, or short in their duration: the miseries inflicted by conscious and reflecting agents almost alone deserve the name of evils. These excruciate the soul with ineffable poignancy, as expressive of indifference or malignity in those by whom such bitter potions are cruelly administered. The negligence or wantonness, therefore, with which the blind are too frequently treated, is an enormity which God alone has justice or power to punish. Those amongst them who have had sensibility to feel, and capacity to express, the effects of their misfortunes, have described them in a manner capable of penetrating the most callous heart. Homer, in the person of Demodocus the Phæatian bard, has pathetically described his own situation; and Milton, with equal force and beauty, has deplored the misfortune of blindness.

Thus dependant on every creature, and passive to every accident, can we be surprised to observe moments when the blind are at variance with themselves and every thing else around them? With the same instinct of self-preservation, the same irascible passions which are common to the species, and exasperated by a sense of debility either for retaliation or defence, can the blind be really objects of resentment or contempt, even when they seem peevish or vindictive? This, however, is not always their character. Their behaviour is often highly expressive not only of resignation, but even of cheerfulness; and though they are often coldly, and even inhumanly, treated by men, yet they are rarely, if ever, forsaken of heaven. The common Parent of nature, whose benignity is permanent as his existence, and boundless as his empire, has neither left his afflicted creatures without consolation nor resource.

The blind often derive advantages even from their loss, however oppressive and irretrievable: not indeed adequate to compensate, but sufficient to alleviate their misery. The attention of the soul, confined to those avenues of perception which she can command, is neither dissipated nor confounded by the immense multiplicity, nor the rapid succession, of surrounding objects. Hence her contemplations are more uniformly fixed upon the revolutions of her own internal frame. Hence her perceptions of such external things as are contiguous and obvious to her observation, become more exquisite. Hence even her instruments of corporeal sensation are more assiduously improved: so that from them she derives such notices of approaching pleasure, or impending danger, as entirely escape the attention of those who depend for security on the reports of their eyes. He distinguishes the approach of his friend by the sound of his steps, by his manner of breathing, and almost by every audible token which he can exhibit. Prepared for the dangers which he may encounter from the surface of the ground upon which he walks, his step is habitually firm and cautious. Hence he not only avoids those falls which might be occasioned by its less formidable inequalities, but from its general bias he collects some ideas how far his safety is immediately concerned; and though these conjectures may be sometimes fallacious, yet they are generally so true as to preserve him from such accidents as are not incurred by his own temerity. The rapid torrent and the deep cascade not only warn him to keep a proper distance, but inform him in what direction he moves, and are a kind of audible cynosures to regulate his course. In places to which he has been accustomed, he in a manner recognises his latitude and longitude from every breath of varied fragrance that tinges the gale, from every ascent or declivity in the road, from every natural or artificial sound that strikes his ear; if these indications be stationary, and confined to particular places. Regulated by these signs, the blind have not only been known to perform long journeys themselves, but even, if we may credit report, to conduct others through dangerous paths at midnight, with the utmost security and exactness.

It would be endless to recapitulate the various mechanical operations of which they are capable by their nicety and accuracy of touch. In some, the tactile powers are said to have been so highly improved, as to perceive that texture and disposition of coloured surfaces by which some rays of light are reflected and others absorbed, and in this manner to distinguish colours; but the testimonies for this fact still appear too vague and general to deserve public credit. A person who lost the use of his sight at an early period of infancy, who in the vivacity or delicacy of his sensations was not perhaps inferior to any one, and who had often heard of others in his situation capable of distinguishing colours by touch, stimulated, partly by curiosity to acquire a new train of ideas if possible, but still more by incredulity with respect to the facts related, tried repeated experiments by touching the surfaces of different bodies and examining whether any such diversities could be found in them as might enable him to distinguish colours; but no such diversity could he ever ascertain. Sometimes, indeed, he imagined that objects which had no colour, or, in other words, such as were black, were somewhat different and peculiar in their surfaces, but this experiment did not always hold. That their acoustic perceptions are distinct and accurate, we may fairly conclude from the rapidity with which they ascertain the acuteness or gravity of different tones, and from their exact discernment of the various modifications of sound, and of sonorous objects, if the sounds themselves are in any degree significant of their causes.

When we ruminate on the numberless advantages derived from the use of sight, and its immense importance in extending the human capacity, and improving every faculty of the mind, we might be tempted to doubt the reports concerning such persons as, without the assistance of light, have arrived at high degrees of eminence even in those sciences which appear absolutely unattainable but by the interposition of external mediums. It has, however, been demonstrated by the late ingenious Dr. Reid, that blind men, by proper instruction, are susceptible of almost every idea, and every truth which can be impressed on the mind by the mediation of light and colours, except the sensations of light and colours themselves. Yet there is one phenomenon of this kind which seems to have escaped the attention of that philosopher, and for which no author has offered any tolerable reason, though it certainly merits the attention of a philosopher. For though we should admit that the blind can understand with great perspicuity all the phenomena of light and colours; though it was allowed that on these subjects they might extend their speculations beyond their instructions, and investigate the mechanical principles of optics by the mere force of genius and application, from the data which they have already obtained; yet it will be difficult, if not impossible, to assign any reason why these objects should be more interesting to a blind man than any other abstract truths whatever. It is possible for the blind, by a retentive memory, to tell that the sky is an azure; that the sun, moon, and stars, are bright; that the rose is red, the lily white or yellow, and the tulip variegated. By continually hearing these substantives and adjectives joined, he may be mechanically taught to join them in the same manner; but if he has never had any sensation of colour, however accurately he may speak of coloured objects, his language must be like that of a parrot; without meaning, and without ideas.

It is scarcely possible to lay down a plan, or enter into a detail of particulars, with respect to the mode of education proper to be pursued for the blind. These must be determined by the genius, the capacity, and the circumstances, of those to whom the general rules should be applied. Much therefore must depend on their fortunes, much on their temper and genius; for unless these particulars were known, every answer which could be given to questions of this kind must be extremely general, and of consequence extremely superficial. Besides, the task is so much more arduous, because whoever attempts it can expect to derive no assistance from those who have written on education before him: and though the blind have excelled in more than one science, yet, except in the case of Dr. Saunderson, it does not appear that any of them have been conducted to that degree of eminence at which they arrived upon a premeditated plan. We should rather imagine, that they have been led

through the general course and ordinary forms of discipline; and that, if any circumstances were favourable to their genius, they rather proceeded from accident than design. This melancholy truth reflects no honour on human nature. When contemplated by a man of benevolence, it is not easy to guess whether his mortification or astonishment will be greatest. A heart that glows with real philanthropy feels for the whole vital creation, and becomes in some measure the sensorium of every suffering insect or reptile. How must our sympathy increase then in tenderness and force, when the distressed individuals of our own species become its objects! Nor do the blind bear so small a proportion to the whole community as, even in a political view, to be neglected. But in this, as in every other political crime, the punishment returns upon the society in which it is committed. Those abandoned and unimproved beings, who, under proper culture and discipline, might have successfully concurred in producing and augmenting the general welfare, become the nuisances and burdens of those very societies who have neglected them. The most important view which we can entertain in the education of a person deprived of sight, is to redress, as effectually as we possibly can, the natural disadvantages with which he is encumbered; or, in other words, to enlarge as far as possible the sphere of his knowledge and activity. This can only be done by the improvement of his intellectual, imaginative, or mechanical, powers; and which of these ought to be most assiduously cultivated, the genius of every individual alone can determine. Were men to judge of things by their intrinsic natures, less would be expected from the blind than others. But, by some pernicious and unaccountable prejudice, people generally hope to find them either possessed of preternatural talents, or more attentive to those which they have than others. Hence it unluckily happens, that blind men, who in common life are too often regarded as raree-shows, when they do not gratify the extravagant expectations of their spectators, frequently sink in the general opinion, and appear much less considerable and meritorious than they really are. This general diffidence of their powers deprives them both of opportunity and spirit to exert themselves; and they descend, at last, to that degree of insignificance in which the public estimate has fixed them. From the original dawning, therefore, of reason and spirit, the parents and tutors of the blind ought to inculcate this maxim upon them; that it is their indispensable duty to excel, and that it is absolutely in their power to attain a high degree of eminence. Not that improvement should be rendered quite easy to them: for all difficulties which are not insuperable heighten the charms, and enhance the value, of those acquisitions which they seem to retard. But care should be taken that these difficulties be not magnified or exaggerated; for the blind have a painful sense of their own incapacity, and consequently a strong propensity to despair. For this reason, parents and relations ought never to be too ready in offering their assistance to the blind in any office which they can perform, or in any acquisition which they can procure for themselves, whether they are prompted by amusement or necessity. Let a blind boy be permitted to walk through the neighbourhood without a guide, not only though he should run some hazard, but even though he should suffer some pain. If he has a mechanical turn, let him not be denied the use of edge tools: for it is better that he should lose a little blood, or even break a bone, than be perpetually confined to the same place, debilitated in his frame, and depressed in his mind. Such a being can have no employment but to feel his own weakness, and become his own tormentor; or to transfer to others the peevishness arising from the natural, adventitious, or imaginary, evils which he feels. Scars, fractures, and dislocations, in his body, are trivial misfortunes compared with imbecility, timidity, or fretfulness, of mind. Besides the dreadful effects which inactivity has in relaxing the nerves and depressing the spirits, nothing can be more productive of jealousy, envy, peevishness, and every passion that corrodes the soul to agony, than a painful impression of dependance on others, and of our insufficiency for our own happiness. The natural curiosity of children renders them extremely inquisitive. This disposition is often peculiarly prevalent in the blind. Parents and tutors, therefore, should gratify it whenever their answers can be intelligible to the pupil: when it is otherwise, let them candidly confess the impossibility or impropriety of answering his questions. Nor will the violence of exercise, and the tumult of play, be productive of such perils as may be apprehended. For the encouragement of parents, we can assure them, that though, till the age of twenty, some blind persons were, on most occasions, permitted to walk, to run, to play at large, they have yet escaped without any corporeal injury from these excursions. Parents in the middle, or higher ranks, who have blind children, ought, by all means, to keep them out of vulgar company. Such persons often have a wanton malignity, which impels them to impose upon the blind, and to enjoy their painful sensations. But the credulity and ignorance of the lower class are no less dangerous than their false wit. The illiterate have often a strong propensity to relate whatever is marvellous and dreadful. These impressions, when early imbibed, can scarcely be eradicated by all the conspiring efforts of mature reason and confirmed experience. Those philosophers who have attempted to break the alliance between darkness and spectres, were certainly inspired by laudable motives. Were we endued with senses to advertise us of every noxious object before its contiguity could render it formidable, our panics would probably be less frequent and sensible than we really feel them. Darkness and silence, therefore, have something dreadful in them, because they supersede the vigilance of those senses which give us the earliest notices of things. In talking, therefore, to a blind boy of invisible beings, let him hear as seldom as possible, even in stories which he knows to be fabulous, of vindictive ghosts, vindictive fiends, or avenging furies. They seize and pre-occupy every avenue of terror which is open in the soul; nor are they easily dispossessed. Sooner may we hope to exorcise a ghost, than to obliterate their images in a warm and susceptible imagination, where they have been habitually impressed, and where these feelings cannot be dissipated by external phenomena. If horrors of this kind should agitate the heart of a blind boy (which may happen, notwithstanding the most strenuous endeavours to prevent it), the stories which he has heard will be most effectually discredited by ridicule. This, however, must be cautiously applied, by gentle gradations. If he is inspired with terror by effects upon his senses, the causes of which he cannot investigate, pains must be taken to explain these phenomena; and to confirm that explication, whenever it can be done, by the testimony of his own senses and his own experience. The exercise of his locomotive and mechanical powers will sensibly contribute to dispel these terrors. His inventive faculties ought likewise to be indulged with the same freedom. The data which they explore may be presented in such a manner as to render discoveries easy: but still let invention be allowed to co-operate. The internal triumph which the mind feels from the attainment of new truths, heightens their charms, impresses them deep on the memory, and gives them a lasting influence in practice. Care should therefore be taken to afford the mind a theatre for its exertions, as extensive as possible, without diverting it from one great end, which, in order to excel, it ought for ever to have in view.

With respect to employments for the blind, if the pupil be not in easy circumstances, music is his readiest and most probable resource. Civil and ecclesiastical employments have either something in their own nature, or in the invincible prejudices of mankind, which renders them entirely inaccessible to such as have not the use of sight. No liberal and cultivated mind can entertain the least hesitation in concluding, that there is nothing, either in the nature of things, or even in the positive institutions of genuine religion, repugnant to the idea of a blind clergyman. As to the law, though there could be no doubt that a blind man might discharge the office of a chamber-counsel with success, yet, as a barrister, his difficulties must appear formidable, if not absolutely insuperable: for he must remember all the sources, whether in natural equity or positive institutions, whether in common or statute law, whence his arguments ought to be drawn. He must be able to specify, and to arrange in their proper order, all the material objections of his antagonists: these he must likewise answer as they are proposed, extempore. When, therefore, it is considered how difficult it is to temper the natural associations of memory with the artificial arrangements of judgment, the desultory flights of imagination with the calm and regular deductions of reason, the energy and perturbation of passion with the coolness and tranquillity of deliberation, some idea may be formed of the arduous task which every blind man must achieve, who undertakes the law as a profession. As to physic, the obstacles which a blind man must encounter, both in the theory and practice of that art, will be easily conceived. If the blind must depend upon the exercise of their own powers for bread, we have already pointed out music as their easiest and most obvious province; but let it be remembered, that mediocrity in this art may prove the bitterest and most effectual curse which a parent can inflict upon his offspring: as it subjects them

to every vicious impression or habit, which may be imbibed or contracted from the lowest and most abandoned of mankind. If your pupil, therefore, is not endowed with natural talents exquisitely proper both for the theory and practice of this art, suffer him by no means to be initiated in it. If his natural genius favours your attempts, the piano, harp, or organ, are the most proper instruments for him to begin; because by these instruments he may be made more easily acquainted wits the extent of musical scales, with the powers of harmony, with the relations of which it ih constituted, and of course with the theory of his art. When he becomes a practical adept, tangible signs may be used, by which he may not only be enabled to read, but even to set music for himself. Such exercises will render him infinitely more accurate, both in his principles and practice, than he would otherwise be.

For the present article we acknowledge ourselves chiefly indebted to the Encyclopedia Britannica, a work of established merit; and we have even extended our limits, contrary to our professed design, beyond the *practical* part of science, because this article cannot fail to be interesting if it is known, as we are informed it is, to be the production of Dr. Blacklock. As an encouragement to the blind, or those who have blind children, we subjoin a few instances of extraordinary attainments in blind persons.

The most illustrious instance is the gentleman whom we have just had occasion to name, Dr. Thomas Blacklock; he was born in 1720, at Annan, in Dumfriesshire. His father was a bricklayer, and his mother the daughter of a dealer in cattle; both respectable in their characters and station. Before he was six years old he lost his sight by the small-pox, which prevented his father from executing his intention of bringing him up to some trade. He therefore encouraged the inclination he had early shewn for books, by reading to amuse him; first, the small publications usually put into the hands of children, and afterwards the works of our best authors, such as Milton, Prior, Pope, Addison, &c. His companions, attached to him by affection as well as compassion, were assiduous in reading to amuse and instruct him. By their aid he acquired some knowlege of Latin. Poetry was early his delight; and at twelve years of age he began to write poems himself, of considerable merit. He had attained the age of nineteen, when his indulgent father, whose kindness made a grateful and indelible impression on his mind, was killed by the fall of a malt-kiln. This loss, severe to any one, but doubly so to one in his circumstances, and endued with his sensibility, led the way, however, to his receiving advantages which, perhaps, had his father lived, he might never have obtained. He had lived with his mother about a year after his father's death, when he began to be spoken of as a young man of uncommon genius; and several of his poetical productions were handed about, which enlarged the circle of his friends and acquaintance. Some of these being shewn to Dr. Stevenson, of Edinburgh, that gentleman formed the benevolent design of carrying him to the metropolis, and giving him a classical education. He accordingly came to Edinburgh in 1741, and was enrolled as a student of divinity in the university, where he continued his studies till 1745; when, on account of the national disturbances, he returned to Dumfries, and resided with Mr. M'Murdo, his sister's husband. In 1746 he published a volume of his poems in 8vo. Upon his return to Edinburgh he obtained, among other literary acquaintance, that of the celebrated David Hume; who warmly interested himself in his favour, and assisted him in the publication, by subscription, of the quarto edition of his poems, which in 1754 had undergone a second edition in octavo. To the quarto edition Mr. Spence, professor of poetry at Oxford, from regard to the author, prefixed an ingenious account of his life and writings. About this time, while prosecuting his studies in the languages, and every other branch of science from which his want of sight did not preclude him, he became a complete master of the French tongue, by his intercourse with the family of provost Alexander, who had married a French lady. After passing the usual trials, he was licensed as a preacher by the presbytery of Dumfries, in 1759; and obtained no small reputation by the different sermons he preached, of which he left some volumes in manuscript. In 1762 he married Miss S. Johnston, daughter of Mr. Jos. Johnston, a respectable surgeon in Dumfries: a connection which proved the great blessing and comfort of his after-life. A few days after, by lord Selkirk's interest, he obtained the royal presentation to the parish of Kirkcudbright: but the inhabitant, from various motives, opposing the presentation, the matter was compromised by settling a moderate annuity on Mr. Blacklock, upon his resigning his right to the living. With this slender provision he removed, in 1764, to Edinburgh; and adopted the plan of keeping young gentlemen as boarders, whose studies he could assist and superintend: which he continued until within four years of his death, when his weak state of health obliged him to give it up. In 1767 the university of Aberdeen conferred on him the degree of D. D. In summer 1791 he was seized by a feverish disorder, which, though at first it appeared slight, and never rose to a violent degree, overpowered his weak frame, and carried him off on the 3d of July, 1791, in his seventy-sixth year. A foreign author characterises this extraordinary man in few words. "Blacklock," says he, "will appear to posterity a fabulous character; even now he is a prodigy."

Another no less striking instance is Dr. Nicolas Bacon, a blind gentleman, descended from the same family with the celebrated lord Verulam, was, in the city of Brussels, with high approbation created LL. D. He was deprived of sight at nine years of age, by an arrow from a cross-brow whilst he was attempting to shoot it. When he had recovered his health, which had suffered by the shock, he pursued the same plan of education in which he had been engaged; and having heard that one Nicasius de Vourde, born blind, who lived towards the end of the 15th century, after having distinguished himself by his studies in the university of Louvain, took his degree as D. D. in that of Cologne, he resolved to make the same attempt; but the public, cursed with prejudices for which the meanest sensitive nature might blush, prejudices equally beneath the brutality and ignorance of the lowest animal instinct, treated his intention with ridicule: even the professors themselves were not far from being of the same sentiment; and they admitted him into their schools rather from an impression that it might amuse him, than become of any use to them. He had the good fortune, however, contrary to their expectations, to obtain the first places among his condisciples. It was then said, that such rapid advances might be made in the preliminary branches of his education, but would soon be effectually checked by studies of a more profound and abstracted nature. This, it seems, was repeated from school to school, through the whole climax of his pursuits; and when, in the course of academical learning, it became necessary to study poetry, it was the general voice that all was over, and at length he had reached his ne plus ultra. But here he likewise disappointed their prejudices, and taught them the immense difference between blindness of body and blindness of soul. After continuing his studies in learning and philosophy for two years more, he applied himself to law, took his degree in that science, commenced pleading counsellor or advocate in the council of Brabant, and had the pleasure of terminating almost every suit in which he was engaged to the satisfaction of his clients. The attainments of professor Saunderson are not less extraordinary, and yet as well established not only on the testimony of his pupils, but by his works. The following anecdotes of Dr. Moyes were not long ago presented to the Manchester society by Dr. G. Bew, and afterwards published. "Dr. Henry Moyes, who occasionally read lectures on philosophical chemistry at Manchester, like Dr. Saunderson, the celebrated professor of Cambridge, lost his sight hy the small-pox in his early infancy. He never recollected to have seen: 'but the first traces of memory I have (says he), are in some confused ideas of the solar system.' He had the good fortune to be born in a country where learning of every kind is highly cultivated, and to be brought up in a family devoted to learning. Possessed of native genius, and ardent in his application, he made rapid advances in various departments of erudition, and not only acquired the fundamental principles of mechanics, music, and the languages, but likewise entered deeply into the investigation of the profounder sciences, and displayed an acute and general knowledge of geometry, optics, algebra, astronomy, chemistry, and in short, of most of the branches of the Newtonian philosophy. Mechanical exercises were the favourite employments of his infant years. At a very early age he made himself acquainted with the use of edged tools so perfectly, that notwithstanding his entire blindness, he was able to make little windmills; and he even constructed a loom with his own hands, which still show the cicatrices of wounds he received in the execution of these juvenile exploits. By a most agreeable intimacy and frequent intercourse which I enjoyed with this accomplished blind gentleman, whilst he resided at Manchester, I had an opportunity of repeatedly observing the peculiar manner in which he arranged his ideas and acquired his information. Whenever he was introduced into company, I remarked that he continued for some time silent. The sound

directed him to judge of the dimensions of the room, and the different voices of the number of persons that were present. His distinction in these respects was very accurate, and his memory so retentive that he seldom was mistaken. I have known him instantly recognize a person on first hearing him speak, though more than two years had elapsed since the time of their last meeting. He determined pretty nearly the stature of those he was speaking with, by the direction of their voices; and he made tolerable conjectures respecting their tempers and dispositions, by the manner in which they conducted their conversation. It must be observed that this gentleman's eyes were not totally insensible to intense light. The rays refracted through a prism, when sufficiently vivid, produced certain distinguishable effects on them. The red gave him a disagreeable sensation, which he compared to the touch of a saw. As the colours declined in violence, the harshness lessened, until the green afforded a sensation that was highly pleasing to him, and which he described as conveying an idea similar to what he felt in running his hand over smooth polished surfaces. Polished surfaces, meandering streams, and gentle declivities, were the figures by which he expressed his ideas of beauty. Rugged rocks, irregular points, and boisterous elements, furnished him with expressions for terror and disgust. He excelled in the charms of conversation; was happy in his allusions to visual objects; and discoursed on the nature, composition, and beauty of colours, with pertinence and precision. Dr. Moyes was a striking instance of the power the human soul possesses of finding resources of satisfaction, even under the most rigorous calamities. Though involved 'in ever-during darkness,' and excluded from the charming views of silent or animated nature; though dependant on an undertaking for the means of his subsistence, the success of which was very precarious; in short, though destitute of other support than his genius, and under the mercenary protection of a person whose integrity he suspected; still Dr. Moyes was generally cheerful, and apparently happy. Indeed it must afford much pleasure to the feeling heart, to observe this hilarity of temper prevail almost unive sally with the blind." There are, in short, few sciences in which the blind have not distinguished themselves: even those whose acquisition seemed essentially to depend upon vision, have at last yielded to genius and industry, though deprived of that advantage. Sculpture is not the most practicable art for a blind man; yet there are instances of persons who have taken the figure of a face by the touch, and moulded it in wax with the utmost exactness; as was the case of the blind sculptor mentioned by De Piles, who thus took the likeness of the duke de Bracciano in a dark cellar. and made a marble statue of king Charles I. with great elegance and justness. In music, there are, at present, living instances how far the blind may proceed. In former periods we shall find illustrious examples how amply nature has capacitated the blind to excel, both in the scientific and practical departments of that enchanting art.

Dr. Bew, in the Transactions of the Manchester Society, above quoted, mentions an instance, which would be beyond belief if we had it not on such respectable authority. "John Metcalf, a native of the neighbourhood of Manchester, where he is well known, became blind at a very early age, so as to be entirely unconscious of light and its various effects. This man passed the younger pars of his life as a waggoner, and occasionally at a guide in intricate roads during the night. or when the tracks were covered with snow, Strange as this may appear to those who can see, the employment he has since undertaken is still more extraordinary: it is one of the last to which we could suppose a blind man would ever turn his attention. His present occupation is that of a projector and surveyor of highways in difficult and mountainous parts. With the assistance only of a long staff, I have several times met this man traversing the roads, ascending precipices, exploring valleys, ane investigating their several extents, forms, and situations, so as to answer his designs in the best manner. The plans which he designs, and the estimates he makes, are done in a manner peculiar to himself, and which he cannot well convey the meaning of to others. His abilities in this respect are nevertheless so great, that he finds constant employment. Most of the roads over the Peak in Derbyshire have been altered by his directions, particularly those in the vicinity of Buxton; and he is at this time constructing a new one betwixt Wilmeslow and Congleton, with a view to open a communication to the great London road, without being obliged to pass over the mountains."

Bishop Burnett, in his Letters, mentions a blind lady, whom he saw at Geneva, who lost her sight at one year old, yet was eminently skilled in most sciences, antient and modern. She spoke French, German, Italian, and Latin; and played exquisitely on several musical instruments. She wrote very legibly with a crayon. The means by which her father taught her to write was, by having letters carved in wood; and by feeling them she acquired a correct idea of their form. The bishop saw her write, which she did very fast, aided only by a machine which held the paper, and kept her always in line.

In the Annual Register for 1762, we have a similar account. "A young gentlewoman of a good family in France, now in her 18th year, lost her sight when only two years old, her mother having been advised to lay some pigeons' blood on her eyes, to preserve them in the small-pox; whereas, so far from answering the end, it ate into them. Nature, however, may be said to have compensated for the unhappy mistake, by beauty of person, sweetness of temper, vivacity of genius, quickness of conception, and many talents, which certainly much alleviate her misfortune. She plays at cards with the same readiness as others of the party. She first prepares the packs allotted to her, by pricking them in several parts; yet so imperceptibly, that the closest inspection can scarcely discern her indexes. She sorts the suits, and arranges the cards in their proper sequence, with the same precision, and nearly the same facility, as those who have their sight. All she requires of those who play with her, is to name every card as it is played; and these she retains so exactly, that she frequently performs some notable strokes, such as show a great combination and strong memory. The most wonderful circumstance is, that she should have learned to read and write; but even this is readily believed on knowing her method. In writing to her, no ink is used, but the letters are pricked down on the paper; and by the delicacy of her touch, feeling each letter, she follows them successively, and reads every word with her finger ends. She herself in writing makes use of a pencil, as she could not know when her pen was dry; her guide on the paper is a small thin ruler, and of the breadth of her writing. On finishing a letter, she wets it, so as to fix the traces of her pencil, that they are not obscured or effaced; then proceeds to fold and seal it, and write the direction: all by her own address, and without the assistance of any other person. Her writing is very straight, well cut, and the spelling no less correct. To teach this singular mechanism, the indefatigable cares of her affectionate mother were long employed: who accustomed her daughter to feel letters cut in cards or paste-board; brought her to distinguish an A from a B, and thus the whole alphabet, anp afterwards to spell words; then, by the remembrance of the shape of the letters, to delineate them on paper; and lastly, to arrange them so as to form words and sentences. She has learned to play on the guitar; and has even contrived a way of pricking down the tunes, as an assistance to her memory. So delicate are her organs, that in singing a tune, though new to her, she is able to name the notes. In figured dances she acquits herself extremely well, and in a minuet with inimitable ease and gracefulness. As for the works of her sex, she has a masterly hand: she sews and hems perfectly well; and in all her works she threads the needles for herself, however small. By the watch, her touch never fails telling her exactly the hour and minute."

These instances afford the happiest encouragement both to those who labour under this misfortune, not to despair of attaining by perseverance the intellectual accomplishments; and a striking admonition to parents not to increase, by their negligence, a calamity to which a darling child may be subjected by the dispensation of Providence. Some benevolent institutions have been lately established for the employment and instruction of the blind poor; and we have little doubt that the views of their projectors will, in many cases, be fully answered.

BLINK *of the ice*, in sea language, denotes that bright appearance produced by the ice near the horizon; and perceptible, in approaching the ice, long before it is itself seen.

BLISTER, in medicine, a thin bladder containing a watery humour, whether occasioned by burns, and the like accidents, or by vesicatories laid on different parts of the body for that purpose.

Cantharides, or Spanish flies, applied in the form of a plaister, are chiefly used with this intention. See MATERIA MEDICA.

BLITUM, the *blite*, or *strawberry spinach*, a genus of the digynia order and monandria class of plants, and in the natural method ranking in the 12th order, holoraceæ. The calyx is trifid; no petals; the seed is

one, included in a berry-shaped calyx. There are four species, viz.

1. Blitum capitatum, with flowers in clustered heads at the joints and crown of the stalks, is a native of Spain and Portugal, but has been long preserved in the British gardens for the beauty of its fruit. It is an annual plant, with leaves somewhat like those of the spinach; the stalk rises two feet and a half high; the upper part of the stalk has flowers coming out in small heads at every joint, and is terminated by a little cluster of the same; after the flowers are past, the heads swell to the size of wood-strawberries, and when ripe have the same appearance, but are not eatable; they are full of purple juice, which stains the hands of those who bruise them of a deep purple colour.

2. Blitum tartaricum, with triangular acutely indented leaves, is a native of Tartary. It rises to near three feet high; the flowers come out from the sides of the stalks, but are smaller than those of the capitatum, as is also the fruit.

3. Blitum virgatum, with small heads growing from the sides of the stalks, is a native of the south of France and Italy. It seldom grows more than a foot high; the leaves are of the same shape with those of the capitatum, but smaller. The flowers are produced at the wings of the leaves, almost the length of the stalk; they are smaller, and not so deeply coloured as the first.

4. Blitum chenopodioides, is a low plant, a native of Tartary.

All these species being annual, must be propagated by seeds, and are very hardy.

BLOCKS, on ship-board, is the usual name for what we call pulleys at land. They are thick pieces of wood, some with three, four, or five shivers in them, through which all the running-ropes run. Blocks, whether single or double, are distinguished and called by the names of the ropes they carry, and the uses they serve for. Double-blocks are used when there is occasion for much strength, because they will purchase with more ease than single blocks, though much slower.

Block-and-block is a phrase signifying that two blocks meet, in haling any tackle or halliard, having such blocks belonging to them. Fish-block is hung in a notch at the end of the davit. It serves to hale up the flooks of the anchor at the ship's prow. Snatch-block is a great block with a shiver in it, and a notch cut through one of its checks, for the more readily receiving of any rope; as by this notch the middle part of a rope may be reeved into a block, without passing it endwise. It is commonly fastened with a strap about the mainmast, close to the upper deck, and is chiefly used for the fall of the winding-tackle, which is reeved into this block, and then brought to the capstan.

Blocks now used in the navy are made in the Portsmouth yard, by means of machinery, which has lately been erected for the purpose, and which performs the several operations from the rough timber to the perfect block in the completest manner possible.

BLOCK *engraving*. See ENGRAVING.

BLOOD, *sanguis*, a red liquor circulating through the arteries, veins, and other vessels of animal bodies; and serving for the support of life, and nourishment of all their parts. See ANATOMY, and PHYSIOLOGY.

BLOOM, a mass of iron after having undergone the first hammering, called blomary.

BLOSSOM, denotes the flowers of plants, but more especially of fruit-trees.

BLOW-PIPE, or *blowing-pipe*, a hollow tube, used by several artificers: as enamellers, glass-makers, jewellers, &c. It is a wind instrument for the purpose of increasing the heat of a candle or lamp, as common bellows are employed for raising the temperature of a fire or furnace. The blow-pipe is of great use in practical chemistry. See CHEMISTRY.

BLOWING *of glass*, one of the methods of forming the divers kinds of works in the glass manufacture.

It is performed by dipping the point of an iron blowing-pipe in the melted glass, and blowing through it with the mouth, according to the circumstances of the glass to be blown. See GLASS.

BLOWING *of tin* denotes the melting its ore, after being first burnt to destroy the mundic.

BLUBBER, denotes the fat of whales and other large sea animals, of which is made train oil.

The blubber is the *adeps* of the animal: it lies under the skin, and over the muscular flesh: it is about six inches in thickness, but about the under lip it is two or three feet thick. The quantity yielded by a good sized whale amounts to from forty to eighty hundredweight, or even more. The use of the blubber to the fish seems to be partly to poise the body, and partly to keep off the water at some distance from the blood; and thus it acts as clothing to keep the fish warm.

BLUE, *painter's*, is made differently, according to the different kinds of painting. In limning, fresco, and miniature, they use indifferently ultramarine, blue ashes, and smalt: these are their natural blues, excepting the last, which is partly natural, and partly artificial.

In oil and miniature they also use indigo prepared, as also a factitious ultramarine.

Enamellers and painters upon glass have also blues proper to themselves, each preparing them after their own manner.

BLUE, *turnsole*, is used in painting on wood, and is made of the seed of that plant: the way of preparing it is, to boil four ounces of turnsole in a pint and a half of water, in which lime has been slaked.

BLUE, *Flanders*, is a colour bordering on green, and seldom used but in landscapes.

BLUEING *of metals* is performed by heating them in the fire till they assume a blue colour; particularly practised by gilders, who blue their metals before they apply the gold and silver leaf.

BLUE, *to dye skins*. Boil elder-berries or dwarf elder, then smear and wash the skins therewith, and wring them out; then boil the berries as before, in a solution of alum-water, and wet the skins in the same manner once or twice; dry them, and they will be very blue.

A BLUE *for painting or staining of glass*. Take fine white sand twelve ounces, zaffer and minium of each three ounces; reduce them to a fine powder in a bell-metal mortar, then putting the powder into a very strong crucible, cover it and lute it well, and, being dry, calcine it over a quick fire for an hour; take out the matter and pound it: then to sixteen ounces of this powder add fourteen of nitre powder; mix them well together, and put them into the crucible again; cover and lute it, and calcine for two hours on a very strong fire.

BLUE, *Prussian*. This blue is next to ultramarine for beauty, if it is used in oil: this colour does not grind well in water.

BLUE-BICE is a colour of good brightness, next to Prussian blue, and also a colour of a body, and will flow pretty well in the pencil.

BLUE, *Saunders*, is also of very good use, and may serve as a shade to ultramarine, or the blue-bice, where the shades are not required to be very deep; and is of itself a pleasant blue, to be laid between the light and shades of such a flower as is of a mazarine blue.

BLUE, *a fine one from Mr. Boyle*. Take the blue leaves of rue, and beat them a little in a stone mortar with a wooden pestle; then put them in water, juice and all, for fourteen days or more, washing them every day till they are rotten; and at last beat them and the water together till they become a pulp, and let them dry in the sun. This is a fine blue for shading.

BLUE, *Indigo*. This makes the strongest shade for blues, and is of a soft warm colour, when it has been well ground, and washed with gum-water, by means of a stone and a muller.

BLUE, *Lacmus*, or *Litmus*. This is a beautiful blue, and will run in a pen as free as ink. It is made of lacmus, and prepared thus: Take an ounce of lacmus, and boil it in a pint of small beer wort, till the colour is as strong as you would have it; then pour off the liquor into a gallipot, and let it cool for use. This affords a beautiful colour, has extraordinary effects, and is a holding colour; if it is touched with aquafortis, it immediately changes to a fine crimson, little inferior to carmine.

BLUE, *Japan*. Take gum-water, what quantity you please, and white lead a sufficient quantity, grind them well on a porphyry; then take isinglass size, what quantity you please, of the finest and best smalt a sufficient quantity, mix them well; to which add, of your white lead before ground, so much as may give it a sufficient body; mix all these together to the consistence of a paint.

BLUENESS *of the skies*. Sir Isaac Newton observes, that all the vapours, when they begin to condense and coalesce into natural particles, become first of such a bigness, as to reflect the azure rays, before they can constitute clouds, or any other colour.

But Mr. Melville supposes, that the clouds only reflect and transmit the sun's light; and that, according to their different altitudes, they may assume all the variety of colours at sun rising and setting, by barely reflecting the sun's incident light, as they receive it through a shorter or longer tract of air; and the change is produced in the sun's rays by the quantity of air through which they pass, from white to yellow, from yellow to orange, and lastly to red.

BLUFF-HEAD, among sailors. A ship is said to be bluff-headed that has an upright stern.

BOA, a genus of serpents belonging to the order of amphibia; the generic character is, scuta, or undivided plates, both on the abdomen and beneath the tail.

This genus of serpents is remarkable for the vast and almost unlimited size of some of the principal species, which in India, Africa, and South America, are occasionally found of not less than twenty, thirty, and even thirty-five feet in length, and of a strength so prodigious as to be able to destroy cattle, deer, &c. by twisting round them in such a manner as to crush them to death by continued pressure, after which they swallow them in a very gradual manner; and when thus gorged with their prey, become almost torpid with repletion, and if discovered in this state, may without much difficulty be destroyed by shooting or other methods. There is reason to suppose that these gigantic serpents are become less common now than some centuries backwards.

There are nineteen species, viz.

1. Boa constrictor. Of all the larger boæ this is most conspicuous, and is at once pre-eminent from superiority of size and beauty of colour: in this respect indeed it appears to be subject to considerable variation from age, sex, and climate, but may be distinguished in every state from the rest of its tribe by the peculiar disposition of its variegations. The ground-colour of the whole animal, in the younger specimens, is a yellowish grey, and sometimes even a bright yellow; on which is disposed along the whole length of the back a series of large, chain-like, reddish-brown, and sometimes perfectly red variegations, leaving large open oval spaces of the ground-colour at regular intervals: between these larger marks are disposed many smaller ones of uncertain forms, and more or less numerous in different parts.

The boa constrictor is a native of Africa, India, the larger Indian islands, and South America, where it chiefly resides in the most retired situations in woody and marshy regions.

It was, in all probability, an enormous specimen of this very serpent that once diffused so violent a terror amongst the most valiant of mankind, and threw a whole Roman army into dismay. Historians relate this surprising event in terms of considerable luxuriance. Valerius Maximus thus mentions it from Livy, in one of the lost books of whose history it was related more at large.

"And since we are on the subject of uncommon phenomena, we may here mention the serpent so eloquently and accurately recorded by Livy; who says, that near the river Bagrada in Africa, a snake was seen of so enormous a magnitude as to prevent the army of Attilius Regulus from the use of the river; and after snatching up several soldiers with its enormous mouth, and devouring them, and killing several more by striking and squeezing them with the spires of its tail, was at length destroyed by assailing it with all the force of military engines and showers of stones, after it had withstood the attack of their spears and darts: that it was regarded by the whole army as a more formidable enemy than even Carthage itself; and that the whole adjacent region being tainted with the pestilential effluvia proceeding from its remains, and the waters with its blood, the Roman army was obliged to remove its station: he also adds, that the skin of the monster, measuring 120 feet in length, was sent to Rome as a trophy."

The flesh of this serpent is eaten by the Indians and negroes of Africa, and they make its skin into garments. Plate Nat. Hist. fig. 50.

2. Boa scytale, or spotted. The spotted boa is sometimes scarcely inferior in size to the constrictor, and is of simimilar manners, destroying, like that animal goats, sheep, deer, &c. It is described as being generally of a grey or glaucous colour, marked with large orbicular black spots on the back; and with smaller ones of similar form, but with white centres, on the sides: while on the abdomen are scattered several oblong spots and marks, interspersed with smaller specks and variegations. It is a native of several parts of South America, and, like other large snakes, is occasionally eaten by the Indians.

3. Boa cenchris, or ringed. This also grows to a large size, though not equal to either of the former species, from which, as well as from most others, it may be easily distinguished by the regular distribution of its colours; the general cast being ferruginous, darkest on the back, where it is marked by a continued series of very large blackish circles from head to tail; while along the sides are interspersed several kidney-shaped blackish spots with white centres: the head is a lengthened form, and is marked by a black longitudinal and two lateral bands. This animal is a native of South America.

4. Boa enydris, or water. This species, according to Linnæus, is variegated with different shades of grey; the teeth in the lower jaw are longer than usual in this genus; the number of abdominal scuta is 270, and of the subcaudal ones 105.

5. Boa orphryas or brown, mentioned by Linnæus from a specimen in the museum of Degeer: has the general habit of the B. constrictor, but is of a dark or dusky colour, and has 281 abdominal and 84 subcaudal scuta.

6. Boa canina, a highly beautiful snake: measuring about four feet in length, and being of moderate size or thickness in proportion: the head is large, and shaped like that of a dog; the colour of the whole animal on the upper parts is a most beautiful Saxon-green, with several short, undulating, transverse white bars down the back, the edges of which are of a deeper or stronger green than the ground colour of the body: the under or abdominal part is white. This species is a native of South America. In the British Museum is an elegant specimen.

7. Boa regia is, in the form of its head and the general shape of the body, most allied to the canina and phrygia. In its colour it appears to vary, the ground-colour being white, but the variegations sometimes dusky or chesnut, and sometimes of a most elegant orange-red, accompanied by a tinge of blossom-colour on the lighter parts. The head is covered in front with large scales: the tail is extremely short, and tapers suddenly.

8. Boa phrygia. Among the whole serpent tribe it may be doubted whether there exists a species more truly elegant than the present. Its general size seems to be nearly that of the boa canina, but its length is rather greater in proportion: the ground-colour of the whole animal is white, with a very slight cast of yellowish-brown on the back, while along the whole upper part is disposed a continued series of black variegations, so conducted as to bear a striking resemblance to an embroidery in needle-work: the head is of the same form with that of the boa canina, and marked by three narrow black streaks, which, running along the top of the head and the cheeks, join with the embroidered pattern of the back.

9. Boa hortulana is of moderate size, measuring only a few feet in length, and being of a slender form; has obtained its Linnæan title from the singular variegations on the head, which are of a blackish brown on a pale ferruginous or yellowish ground, and in some degree represent the form of a parterre in an old-fashioned garden: the variegations on the body are of similar colour, and are disposed into large circular, and sometimes angular patches on the sides. See Plate Nat. Hist. fig. 51.

10. Boa murina is a middle-sized species, measuring about two feet and a half or three feet in length, and being of a moderately thick form: the colour of the whole upper part is grey or blueish-brown, with several moderately large round black spots dispersed in a somewhat irregular manner along the back and sides: the head is marked on each side by two longitudinal black stripes: this species is said to feed principally on rats, and to be found in South America.

11. Boa crotaline is a native of Surinam, and is a large species, marked on the back by a chain of black rhomboid spots, and is furnished with very large and strong fangs.

12. Boa fasciata. It is to Dr. Patrick Russel that we owe the knowledge of this remarkable species, which is a native of India, and is said to be most frequent in the country of Bengal. It is of a yellow colour, marked with pretty numerous dusky-blue transverse bands, continued at equal distances: the head is rather small, and covered in front with large scales: the body is of a trigonal form, the sides sloping very considerably: the whole length of the animal is something more than five feet; the diameter, in the thickest part, being nearly five inches: the length of the tail five inches only, and its termination rather obtuse.

This snake is among the number of poisonous species, and its bite is considered by the Indians as inevitably fatal. A specimen was brought to Dr. Russel in the month of November, 1788, in an apparently weak and languid state, having been bruised in taking. Being set at liberty in a room, it crept slowly towards an obscure corner; where a chicken being presented to him he took no particular notice of it, and even suffered the bird to stand on his back. As he shewed no disposition to bite, his jaws were forcibly opened, and the thigh of the chicken being placed between them, the mouth was so closed over it as to oblige the fangs to act. The bird, when disengaged, shewed immediate symptoms of poi on, and after several ineffectual efforts to rise, rested with the beak on the ground, the head being seized with trembling. In the space of twenty minutes it lay down on one side, and convulsions soon supervening, it expired within twenty-six minutes from the bite.

13. Boa viperina is also an Indian species, first described in the work of Dr. Russel. It is about a foot and a half in length and of a moderately deep brown colour; the back

being marked throughout the whole length by a broad undulating black band, with a narrow yellowish white margin, while along the sides runs a row of somewhat irregular roundish black spots: the under part of the animal is of a pearl-colour. The head is hardly broader than the neck, oblong, roundish, depressed, subtruncate, and covered with small scales: the teeth are small and numerous, and as there is a marginal row in the upper jaw, there are of course no fangs: the trunk or body is round, of nearly equal thickness, and coated with small, orbicular, close-set, carinated scales.

This snake, Dr. Russel informs us, is said to produce by its bite a slow wasting of the fingers and toes, similar to what happens in some leprous cases. A living specimen, however, which he obtained in Dec. 1788, from Ganjam, enabled him to make some experiments with it on chickens; but though it arrived in excellent order, and bit ferociously, the bite was followed by no symptoms of poison.

14. Boa lineata, geedi paragoodoo, or cobra monil, is of an extremely dark blue colour, so as to appear almost black in certain lights, and is marked throughout the whole length of the upper part by several transverse curved and dotted white lines at somewhat unequal distances. The natives of India, who generally exaggerate the noxious character of their serpents, assert that the bite of this animal produces immediate death. The experiments of Dr. Russel, however, prove that it is seldom fatal to chickens in less than half an hour, and to dogs in less than an hour and ten minutes. Its poison was also observed to cause less violent convulsions in the animals infected by it than that of the cobra de capello, and another highly poisonous Indian snake called katuka rekula poda; but produced a greater degree of stupor.

15. Boa horatta is a small species, measuring only about fifteen inches in length. Its colour is a dark brown, with a row of spots on the ridge of the back, from the neck to the end of the tail, varying a little in size and figure, but all of a dull yellowish colour edged with black. The fangs or poisoning organs of this snake show it to be noxious; but in what degree could not be ascertained by Dr. Russel, who could not meet with a living subject to make the necessary experiments with. It is reported, however, to be one of the most fatal of serpents.

16. Boa siamese, a small species, but very long in proportion to its breadth; the circumference of the body being scarcely more than an inch and a half, and the length from two to three feet: the head shaped like that of the boa canina: the colour of the whole animal pale yellow above, with pretty numerous transverse broken bars of white, with black or deep brown edges; the abdomen yellow. This species is said to be a native of the East Indies, and particularly of the kingdom of Siam.

17. Boa contorix, a small species, seldom exceeding the length of about fifteen inches: head large, with the cheeks swelling out like those of vipers; the nose turning up, like that of a hog: the body very thick towards the head: colour pale brown, with several large black spots or patches disposed along the back and sides. This species is a native of North America, and is of a poisonous nature: it is slow in its motions, and has a malevolent aspect: the tail is nearly a third of the length of the whole animal.

18. Boa palpebrosa. Length about fifteen inches: head rather large, and covered in front with large scales: eyebrows remarkably prominent; body thick in proportion to its length: colour pearly grey above, with obscure transverse dusky or blueish undulations; beneath pale yellow-brown: native country unknown.

19. Boa annulata. This is rather a small species, measuring about two feet in length: in its general appearance it is allied to the boa hortulana; but the back is marked with large round black spots, almost encircled by a narrow zone of the same colour. It is a native of South America.

BOAR. See Sus.

BOARD, among seamen. To go aboard, signifies to go into the ship. To slip by the board, is to slip down by the ship's side. Board and board, is when two ships come so near as to touch one another, or when they lie side by side. To make a board, is to turn to windward; and the longer your boards are, the more you work into the wind. To board it up, is to beat it up sometimes upon one tack, and sometimes upon another. She makes a good board, that is, the ship advances much at one tack. The weather board, is that side of the ship which is to windward.

BOAT, a small open vessel, commonly wrought by rowing.

The structure, and even the names of boats, are different, according to the different uses they are designed for, and the places where they are to be used.

The several boats and their names are as follow: a long-boat, a jolly-boat, a skiff, a pinnace, a water-boat, a yaul; the preceding six are boats for ships. Other boats are, a gondola, a Greenland boat, a Bermudas boat, a ballon of Siam, a horse-boat, a periaga, a pleasure-boat, a ponton, a canoe, a crucle, a curry-curry, a deal hooker, a felucca, a ferry-boat, a praw, a flying-praw, a punt, a tilt-boat, a tod-boat, a well-boat, a wherry, &c.

The boats or wherries plying about London, are either scullers, wrought by a single person with two oars; or oars, wrought by two persons, with each an oar. All boats rowed with more than four oars above or below London-bridge, are forfeited.

BOAT, *life*, a boat invented by Mr. Henry Greathead, of South Shields, for the purpose of preserving the lives of shipwrecked persons. The following circumstance gave rise to this invention:

In September 1789, the ship Adventure, of Newcastle, was stranded on the Herd sand, on the south side of Tynemouth haven, in the midst of tremendous breakers; and all the crew dropped from the rigging one by one, in the presence of thousands of spectators; not one of whom could be prevailed upon, by any reward, to venture out to her assistance, in any boat or coble of the common construction.

On this occasion the gentlemen of South Shields called a meeting of the inhabitants, at which a committee was appointed, and premiums were offered for plans of a boat which should be the best calculated to brave the dangers of the sea, particularly of broken water.

Many proposals were offered; but the preference was unanimously given to that of Mr. Greathead, who was immediately directed to build a boat at the expence of the committee.

This boat went off on the 30th of January, 1790; and so well has it answered, and indeed exceeded, every expectation, in the most tremendous broken sea, that since that time, not fewer than two hundred lives have been saved at the entrance of the Tyne alone, which otherwise must have been lost; and in no instance has it ever failed.

The principle of this boat appears to have been suggested to Mr. Greathead by the following simple fact: Take a spheroid, and divide it into quarters; each quarter is elliptical, and nearly resembles the half of a wooden bowl, having a curvature with projecting ends; this, thrown into the sea or broken water, cannot be upset, or lie with the bottom upwards.

The length of the boat is thirty feet; the breadth ten feet; the depth, from the top of the gunwale to the lower part of the keel in midships, three feet three inches; from the gunwale to the platform (within), two feet four inches; from the top of the stems (both ends being similar) to the horizontal line of the bottom of the keel, five feet nine inches. The keel is a plank of three inches thick, of a proportionate breadth in midships, narrowing gradually towards the ends, to the breadth of the stems at the bottom, and forming a great convexity downwards. The stems are segments of a circle, with considerable *rakes*. The bottom section, to the floor-heads, is a curve fore and aft, with the sweep of the keel. The floor timber has a small rise curving from the keel to the floor-heads. A bilge plank is wrought in on each side, next the floor-heads, with a double rabbit or groove, of a similar thickness with the keel; and, on the outside of this, are fixed two bilge-trees, corresponding nearly with the level of the keel. The ends of the bottom section form that fine kind of entrance observable in the lower part of the bow of the fishing-boat called a *coble*, much used in the north. From this part to the top of the stem it is more elliptical, forming a considerable projection. The sides, from the floor-heads to the top of the gunwale, flaunch off on each side, in proportion to above half the breadth of the floor. The breadth is continued far forwards towards the ends, leaving a sufficient length of straight side at the top. The sheer is regular along the straight side, and more elevated towards the ends. The gunwale fixed to the outside is three inches thick. The sides, from the under part of the gunwale, along the whole length of the regular sheer, extending twenty-one feet six inches, are cased with layers of cork to the depth of sixteen inches downwards; and the thickness of this casing of cork being four inches, it projects at the top a little without the gunwale. The cork, on the outside, is secured with thin plates or slips of copper, and the boat is fastened with copper nails. The thwarts, or seats, are five in number, *double-banked*: consequently the boat may be rowed with ten oars. The thwarts are firmly stanchioned. The side oars are short, with iron tholes and rope grom-

mets, so that the rower can pull either way. The boat is steered with an oar at each end; and the steering oar is one-third longer than the rowing oar. The platform placed at the bottom, within the boat, is horizontal, the length of the midships, and elevated at the ends for the convenience of the steersman, to give him a greater power with the oar. The internal part of the boat next the sides, from the under part of the thwarts down to the platform, is cased with cork; the whole quantity of which, affixed to the life-boat, is nearly seven hundredweight.] The cork indisputably contributes much to the buoyancy of the boat, is a good defence in going alongside a vessel, and is of principal use in keeping the boat in an erect position in the sea, or rather for giving her a very lively and quick disposition to recover from any sudden *cant* or *lurch* which she may receive from the stroke of a heavy wave. But, exclusively of the cork, the admirable construction of this boat gives it a decided pre-eminence. The ends being similar, the boat can be rowed either way; and this peculiarity of form assists her in rising over the waves. The curvature of the keel and bottom facilitates her movement in turning, and contributes to the ease of the steerage, as a single stroke of the steering oar has an immediate effect, the boat moving as upon a centre. The fine entrance below is of use in dividing the waves, when rowing against them; and, combined with the convexity of the bottom, and the elliptical form of the stem, admits her to rise with wonderful buoyancy in a high sea, and to launch forward with rapidity, without shipping any water, when a common boat would be in danger of being filled. The flaunching or spreading form of the boat, from her floor-heads to the gunwale, gives her a considerable bearing; and the continuation of the breadth, well forward, is a great support to her in the sea; and it has been found by experience that boats of this construction are the best sea boats for rowing against turbulent waves. The internal shallowness of the boat from the gunwale down to the platform, the convexity of the form, and the bulk of cork within, leave a very diminished space for the water to occupy: so that the life-boat, when filled with water, contains a considerable less quantity than the common boat, and is in no danger either of sinking or overturning. It may be presumed by some, that in cases of high wind, agitated sea, and broken waves, a boat of such a bulk could not prevail against them by the force of oars; but the life-boat, from her peculiar form, may be rowed a-head, when the attempt in other boats would fail. Boats of the common form, adapted for speed, are of course put in motion with a small power; but, for want of buoyancy and bearing, are over-run by the waves, and sunk when impelled against them; and boats constructed for burthen meet with too much resistance from the wind and sea when opposed to them, and cannot in such cases be rowed from the shore to a ship in distress.

Mr. Greathead gives the following instructions for the management of the life-boat:

The boats, in general, of this description, are painted white on the outside; this colour more immediately engaging the eye of the spectator when rising from the hollow of the sea than any other. The bottom of the boat is at first varnished (which will take paint afterwards), for the more minute inspection of purchasers. The oars she is equipped with are made of fir of the best quality; having found by experience that a rove ash oar, that will dress clean and light, is too pliant among the breakers; and when made strong and heavy, from rowing double-banked, the purchase being short, sooner exhausts the rower; which renders the fir oar, when made stiff, preferable.

In the management of the boat she requires twelve men to work her: that is, five men on each side rowing double-banked, with an oar slung over an iron thole, with a grommet (as provided), so as to enable the rower to pull either way, and one man at each end to steer her, and to be ready at the opposite end to take the steer-oar when wanted. As, from the construction of the boat, she is always in a position to be rowed either way, without turning the boat: when manned, the person who steers her should be well acquainted with the course of the tides, in order to take every possible advantage: the best method, if the direction will admit of it, is to head the sea. The steersman should keep his eye fixed upon the wave or breaker, and encourage the rowers to give way as the boat rises to it; being then aided by the force of the oars, she launches over it with vast rapidity, without shipping any water. It is necessary to observe, that there is often a strong reflux of sea occasioned by the stranded wrecks, which requires both dispatch and care in the people employed that the boat be not damaged. When the wreck is reached, if the wind blows to the land, the boat will come in shore without any other effort than steering.

BOATSWAIN, a ship-officer, to whom is committed the charge of all the tacklings, sails and rigging, ropes, cables, anchors, flags, pendants, &c. He is also to take care of the long-boat and its furniture, and to steer her either by himself or his mate. He calls out the several gangs and companies aboard, to the due execution of their watches, works, spells, &c. He is likewise provost-marshal, who sees and punishes all offenders sentenced by the captain, or a court-martial of the fleet.

BOB, or *ball*, is a metallic weight, attached to the lower extremity of a pendulum-rod, by means of a tapped adjusting nut, at such a distance from the point of suspension as the time of a given vibration requires.

BOBBIN, a small piece of wood turned in the form of a cylinder, with a little border jutting out at each end, bored through to receive a small iron pivot. It serves to spin with the spinning-wheel; or to wind thread, worsted, hair, cotton, silk, gold, and silver.

BOCARDO, among logicians, the fifth mode of the third figure of syllogisms, in which the middle proposition is an universal affirmative, and the first and last particular negatives, thus:

Bo Some sickly persons are not students;
CAR Every sickly person is pale:
DO Therefore some persons are pale that are not students.

BOCCONIA, *greater tree celandine:* a genus of the monogynia order, and dodecandria class of plants, and in the natural method ranking under the 27th order, rhœadeæ. The calyx is diphyllous; there is no corolla; the stylus is bifid; the berry is dry, and monospermous. Of this genus there is but one known species, viz.

Bocconia *frutescens*, which is esteemed for the beauty of its large foliage. It is very common in Jamaica and the warm parts of America, where it grows to the height of 10 or 12 feet, having a straight trunk as large as a man's arm, and covered with a white smooth bark. At the top it divides into several branches, on which the leaves are placed alternately. These leaves are 8 or 9 inches long, and 5 or 6 broad; and are of a fine glaucous colour. The whole plant abounds with a yellow juice of an acrid nature; so that it is used by the inhabitants of America to take off warts and spots from the eyes. The singular beauty of this plant renders it worthy of a place in every curious collection: and it seems the Indians are very fond of it; for Hernandez tells us, their kings used to plant it in their gardens. It is propagated by seeds from America, and must always be kept in a stove.

BOCK-LAND, in the Saxons' time, is what we now call freehold lands, held by the better sort of persons by charter or deed in writing; by which name it was distinguished from folkland, or copy-hold land, holden by the common people without writing.

BODY, in physics, an extended solid substance, of itself utterly passive and inactive, indifferent either to motion or rest; but capable of any sort of motion, and of all figures and forms.

Descent of Bodies. Heavy bodies, in an unresisting medium, fall with an uniformly accelerated motion; whence the spaces descended are in the duplicate ratio of the times and velocity, and increase according to the uneven numbers 1, 3, 5, &c. The times and velocities are in a subduplicate ratio of the spaces. The velocity of descending bodies is in proportion to the times from the beginning of their fall; and the spaces described by a falling body, are as the squares of the times from the beginning of their fall. See Mechanics.

Body, in geometry, the regular bodies, or those which have all their angles and sides similar and equal, are five, viz. tetrahedron, octahedron, dodecahedron, icosahedron, and the cube.

Body, among painters, as to bear a body, a term signifying that the colours are of such a nature as to be capable of being ground so fine, and mixing with the oil so entirely, as to seem only a very thick oil of the same colour.

BOEHMERIA, a genus of the monœcia tetrandria class and order. The essential character is, male, calyx four-parted; corolla none. Female, calyx none; germ obovate; style single; seed single, compressed.

There are 5 species, natives of America and the West Indies.

BOERHAAVIA, a genus of the monogynia order, and monandria class of plants. There is no calyx; the corolla is monopetalous, campanulated, and plaited; and the seed is one, naked, and below. There are 7 species, all natives of the Indies. Some of these plants rise 5 or 6 feet high, but most of them only 18 inches or 2 feet. They bear flowers of a yellow or red colour.

BOG properly signifies a quagmire, covered indeed with grass, but not solid enough

to support the weight of the body; in which sense it differs only from marshes or fens, as a part from the whole: some even restrain the term bog to quagmires pent up between two hills; whereas fens lie in champaign and low countries, where the descent is very small. To drain boggy lands, a good method is, to make trenches of a sufficient depth to carry off the moisture; and if these are partly filled up with rough stones and then covered with thorn bushes and straw to keep the earth from filling up their interstices, a stratum of good earth and turf may be laid over all; the cavities among the stones will give passage to the water, and the turf will grow at top as if nothing had been done.

BOILING, or *ebullition*, in physics, the agitation of a fluid body, arising from the application of fire, &c.

It has been proved that all fluidity is the effect of a certain quantity of caloric, or the matter of heat, absorbed by a body in passing from a solid to a fluid state, as is shewn in the melting of ice, tallow, wax, &c. Boiling is the act of a body passing from a fluid state to that of vapour, occasioned by a further absorption of caloric.

If the heat is applied to the bottom of the vessel containing the liquids, as is usually the case, after the whole liquid has acquired a certain temperature, those particles of it which are next the bottom, become elastic, and rise up, as they are formed, through the liquid, like air-bubbles, and throw the whole into a violent agitation. The liquid is then said to boil.

A pleasing experiment is related by that elegant and ingenious philosopher, the present bishop of Landaff, which is illustrative of the nature of boiling in general, and particularly of what has been just advanced. With an intent on of exhibiting a striking instance of the increase of dimensions produced by heat in fluids, he took a glass vessel not unlike the thermometer in form; the bulb contained above a gallon, the stem had a small diameter, and was about two feet in length. This vessel he filled with boiling water to the very top of the stem, and corked it close with a common cork. The water and the cork were at first contiguous, but as the water cooled it contracted, and sunk visibly in the stem; and thus the first intention of the experiment was answered. But here an unexpected phenomenon presented itself. The water, though it was removed from the fire, though it was growing cold, and had for some time entirely ceased from boiling, began to boil very violently. When a hot iron was applied to that part of the stem, through which the water in contracting itself had descended, the ebullition presently ceased; it was renewed when the iron was removed; and it became more than ordinarily violent, when, by the application of a cloth dipped in cold water, that part was cooled. To account for these appearances, it is only necessary to recollect, that by the sinking of the water in the stem, a kind of vacuum is left between its surface and the cork; the water therefore necessarily boils with a lower degree of heat than it would under the pressure of the atmosphere. The space between the cork and the water is not however a perfect vacuum: it is occupied either by the vapour of the water, or by a small portion of air, or by both. Heat increases the elasticity both of air and vapour, and thus augments the pressure upon the surface of the water, hence the ebullition ceases upon the application of the hot iron. Cold, on the contrary, diminishes the elasticity of the air, and condenses vapour; and thus the pressure upon the surface being lessened by the application of a cold cloth, the ebullition of the water became more violent. The heat of the water when it ceased boiling was 130 degrees.

An experiment of another distinguished philosopher affords perhaps a better illustration of the whole theory which has been just advanced. This gentleman placed a quantity of vitriolic ether under the receiver of an air-pump, which was so contrived that he was able to let down a thermometer at pleasure without admitting the external air. He no sooner began to extract the air, than the ether was thrown into a violent ebullition, at the same time its temperature sunk surprizingly. When the ether was first put in, its temperature was about 58 degrees, but it became so cold when boiling, that a quantity of water in a vessel contiguous to it was suddenly frozen. The manner in which these phenomena may be explained is this:—The weight of the atmosphere being removed, the heat which the ether contained was sufficient to make it boil. The elementary fire which the ether lost in boiling was disposed of in forming a vapour more subtile than the ether itself; which could not, consistently with the principles established, be formed without the absorption of a considerable quantity of the matter of fire. Now as it appears that water and spirit of wine boil in vacuo at 122 degrees below their ordinary boiling point, it is natural that ether, which boils in the open air at about the heat of the human blood, should boil in vacuo at 24 degrees below 0, a degree of cold sufficient to freeze any water that might happen to be in contact with the vessel which contains the ether.

Every particular liquid has a fixed point at which boiling commences, and this is called the boiling point of the liquid. Thus water begins to boil when heated to 212 degrees. After a liquid has begun to boil, it never becomes hotter, however strong the fire may be to which it is exposed. A strong heat, indeed, makes it boil more rapidly, but does not increase its temperature. This fact was first observed by Dr. Hooke. The following table shows the boiling point of a number of liquids:

Bodies.	*Boiling point.*
Æther	98
Ammonia	140
Alcohol	176
Water	212
Muriat of lime	230
Nitric acid	248
Sulphuric acid	590
Phosphorus	554
Oil of turpentine	560
Sulphur	570
Linseed oil	600
Mercury	660.

The boiling point however is found to depend on the degree of pressure to which the liquid is exposed. If the pressure is diminished, the liquid boils at a lower temperature; if it is increased, a higher temperature is necessary to produce ebullition. From the experiments of professor Robison, it appears that, in a vacuum, all liquids boil about 145 degrees lower than in open air, under a pressure of 30 inches of mercury: therefore water would boil in vacuo at 67 degrees, and alcohol at 34 degrees. In Papin's digester, the temperature of water may be raised to 300 degrees, or even 400 degrees without ebullition; but the instant that this great pressure is removed, the boiling commences with prodigous violence.

BOLE, in mineralogy. This mineral occurs chiefly in the isle of Lemnos, at Sienna in Italy, and in Silesia. Its colour is generally an obscure Isabella yellow, or reddish or whitish brown: it is sometimes, though rarely, met with of a greyish yellow, or flesh red; its surface is often marked with black spots, and dendritic figures. It generally occurs massive; its texture is earthy; fracture conchoidal. Internally it exhibits a slight glimmering lustre, and acquires a polish by friction. When broken with a hammer it flies into irregular sharp-edged fragments. The dark coloured varieties are opaque, the lighter coloured are more or less translucid. It has a greasy feel, adheres strongly to the tongue, gives a shining streak, is very soft, and is easily frangible. Specific gravity 1.4 to 2.0.

When put into water it absorbs a little with great eagerness, and breaks down into small fragments with a crackling noise. When finely pulverized, and diffused through boiling water, it remains suspended a less time than any of the plastic clays, and is entirely separable by the filtre. Before the blow-pipe it turns black and melts, without any addition, into a porous, greenish, grey flag. The Lemnian bole, according to Bergman, contains

47.0	Silica
19.0	Alumina
6.0	Carbonate of magnesia
5.4	Carbonate of lime
5.4	Oxide of iron
17.0	Water and air
99.8	

The only use of the bole at present is as a coarse red ingredient; for which purpose it is calcined and levigated, and is sold in Germany under the name of Berlin or English red.

BOLETUS, in botany, spunk; a genus of the order of fungi, belonging to the cryptogamia class of plants. Botanists enumerate 170 species, of which the following are the most remarkable.

1. Boletus bovinus, or cow spunk, is frequent in woods and pastures. It is generally of a brown colour, though sometimes it is tawny, yellowish brown, reddish brown, deep red, purple, or greenish brown. The flesh is yellow, white, or reddish. The young plants are eaten in Italy, and esteemed a great delicacy. The Germans also account them a dainty, calling them *gombas*, and *brat-bulz*. Cows, deer, sheep, and swine, will feed upon this and other boleti, but are sometimes greatly disordered by them. In cows and other cattle they have been known to create bloody urine, nauseous milk, swellings of the abdomen, inflammations of the bowels, stoppages, diarrhœas, and death. In sheep they are said to bring on a schirrhous liver, a cough, a general wasting, and dropsy. *Scarabs*, *dermestes*, and many other insects, feed upon and breed in them abundantly.

2. Boletus igniarius, or touchwood spunk, is frequent on the trunks of old trees of all kinds, especially ash. It consists of a very hard woody substance, in shape like a horse's hoof; and grows of various sizes, from a man's fist to that of his head and larger. The upper side is smooth, but uneven, distinguished near the rim by elvated zones of different colours, brown, grey, tawny, &c. The flesh is of a tawny brown colour, extremely hard and tough. This fungus is made use of in Germany and some parts of England for tinder. The Germans boil it in strong ley, dry it, and boil it again in solution of saltpetre. The Laplanders burn it about their habitations, in order to keep off a species of the gadfly, which is fatal to the young rein-deer. It has been used to stop the bleeding of the vessels after amputations. (Phil. Trans. vol. xlviii. p. 2.) For this purpose the hard outer part is cut off, and the soft inner substance is beaten with a hammer to make it still softer. It is best when gathered in August or September.

3. Boletus pini laricis, or agaric of the shops, grows on old larch trees. This fungus is an irregular spongy substance, extremely light, and of an uniform snowy whiteness; except the cortical part, which is usually taken off before the agaric is brought into the shops.

4. Boletus suberosus, or white cork spunk, grows commonly on the trunks of birch and willow trees. It grows sessile and horizontal; its figure is semicircular; the upper side convex, the under nearly plain; of various sizes, from that of an ass's hoof to a peck measure. The upper surface is quite white, generally covered with a short strong down, but sometimes smooth. The internal substance is thick, white, tough, light, and spongy, like cork; and is sometimes cut and shaped by the country people in Scotland for corks.

BOLLITO, a name by which the Italians call a sea-green colour in artificial crystal. To prepare this colour, you must have in the furnace a pot filled with forty pounds of good crystal, first carefully skimmed, boiled, and purified, without any manganese: then you must have twelve ounces of the powder of small leaves of copper, thrice calcined, half an ounce of zaffer in powder; mix them together, and put them at four times into the pot, that they may the better mix with the glass; stirring them well each time of putting in the powder, for fear that it should swell too much and run over.

BOLLOS, in the mines of Peru, a denomination given to the ingots or bars of silver procured there from the ore, by the operation of fire, and the use of aquafortis.

BOLONIAN *stone*, is a kind of mineral found near Bologna; which, when duly prepared by calcination, makes a species of phosphorus. The property of this stone is, that though it has no lucid appearance in the dark, until it undergoes a particular calcination, it becomes capable by previous preparation, of imbibing, when exposed for a few minutes to the light of day, or even the flame of a candle, such a quantity of light, that it afterwards shines in the dark for several minutes, like a glowing coal, but without any sensible heat.

BOLSTERS, in sea language, small cushions, or bags, filled with tarred canvas or rope-yarn, &c. and placed under the shrouds and stays, to prevent their chafing against the trestle-trees, by the motion of the mast, when the ship rocks at sea.

BOLT, among builders, an iron fastening fixed to doors and windows. They are generally distinguished into three kinds, viz. plate, round, and spring bolts.

Bolts, in gunnery, are of several sorts. See Gunnery.

Bolts, in a ship, are iron pins, of which there are several sorts, according to their different make and uses. Such are drive bolts, used to drive out others: ray bolts, with jags or barbs on each side, to keep them from flying out of their holes: clench bolts, which are clenched with rivetting hammers: forelock bolts, which have at the end a forelock of iron driven in to keep them from starting back: set bolts, used for forcing the planks, and bringing them close together: fend, or fender bolts, made with long and thick heads, and struck into the uttermost bends of the ship, to save her sides from bruises: and ring bolts, used for brinking to the planks, and those parts whereto are fastened the breeches and tackles of the guns.

Bolt *of canvas*, in commerce, the quantity of 28 ells.

BOMB, in military affairs, a globe or shell of cast iron, having a vent to receive the fuse, which is made of wood. The shell being filled with gunpowder, the fuse is driven into the vent or aperture, within an inch of the head, and fastened with a cement made of quick-lime, ashes, brick-dust, and steel-filings, worked together in a glutinous water; or of four parts of pitch, two of colophony, one of turpentine, and one of wax. This tube is filled with a combustible matter, made of two ounces of nitre, one of sulphur, and three of gunpowder-dust, well rammed. To preserve the fuse, they pitch it over, but uncase it when they put the bomb into the mortar, and cover it with gunpowder-dust; which having taken fire by the flash of the powder in the chamber of the mortar, burns all the time the bomb is in the air; and the composition in the fuse being spent, it fires the powder in the bomb, which bursts with great force, blowing up whatever is about it. The great height the bomb goes in the air, and the force with which it falls, make it go deep into the earth.

Bomb-*chest*, a kind of chest filled usually with bombs, sometimes only with gunpowder, placed under ground to tear it and blow it up into the air, with those who stand on it. It was set on fire by means of a saucisse fastened at one end, but is now much disused.

BOMBARDMENT, the act of assaulting a city or fortress, by throwing shells into it, in order to set fire to and ruin the houses, churches, magazines, &c. and to do other mischief. As one of the effects of the shell results from its weight, it is never discharged as a ball from a cannon, that is, by pointing it point blank at a certain object; but the mortars in England are fixed at an elevation of 45 degrees; that is, inclined so many degrees from the horizon, that the shell describes a curve, called the military projectile. Hence a mortar, whose trunnions are placed at the breech, can have no point-blank range. Mortars should be so contrived, that they may be elevated to any degree required, as much preferable to those fixed at an angle of 45°; because shells should never be thrown at that angle but in one single case only, which seldom happens; that is, when the battery is so far off, that they cannot otherwise reach the works: for when shells are thrown from the trenches into the works of a fortification, or from the town into the trenches, they should have as little elevation as possible, in order to roll along, and not bury themselves; whereby the damage they do, and the terror they cause to the troops, is much greater than if they sink into the ground. On the contrary, when shells are thrown upon magazines, or any other buildings, with an intention to destroy them, the mortar should be elevated as high as possible, that the shells may acquire a greater force in their fall.

Shells should be loaded with no more powder than is requisite to burst them into the greatest number of pieces, and the length of the fuses should be exactly calculated according to the required ranges; for, should the fuse set fire to the powder in the shell before it falls on the place intended, the shell will burst in the air, and probably do more mischief to those who fired the mortar than to those against whom it was discharged. To prevent this, the fuses are divided into as many seconds as the greatest range requires, consequently may be cut to any distance, at an elevation of 45 degrees.

Mortars are not to be fired with two fires; for when the fuse is properly fixed, and both fuse and shell dredged with mealed powder, the blast of the powder in the chamber of the mortar, when inflamed by the tube, will likewise set fire to the fuse in the shell.

BOMBASINE, a name given to two sorts of stuffs, the one of silk, and the other crossed of cotton.

Bombasine of silk pays duty on importation as other foreign silks. See Silk. That of cotton pays each piece, a duty according to its width.

BOMBAX, in botany, the silk cotton-tree: a genus of the polyandria order, and monodelphia class of plants; and in the natural method ranking under the 37th order, columniferæ. The calyx is quinquifid; the stamina are five or more; the capsule is ligneous, quinquelocular, and quinquevalved; the seeds are woolly, and the receptacle pentagonous. The species are:

1. Bombax ceiba, with a prickly stalk.

2. Bombax heptaphyllum, with leaves cut into seven parts. The cotton is of a fine purple colour, but the size of the tree is not particularly mentioned by botanical writers.

3. Bombax pentandrum, with a smooth stalk. This and the ceiba grow naturally in both the Indies, where they arrive at a great magnitude, being some of the largest trees in these parts. Bosman says, he has seen in Guinea trees of this kind so widely diffused, that 20,000 armed men might stand under the branches of one. They generally grow with straight stems. Those of the ceiba are armed with short strong spines; but the pentandrum has a very smooth stem, which in the young plant is of a bright green; but after a few years is covered with a grey or ash-coloured bark, which turns brown as they grow older. The branches towards the top are furnished with leaves composed of five, seven, or nine, oblong smooth little leaves, spear-shaped, and joined to one common centre at their base, where they adhere to the long foot-stalk. The flower buds appear at the end of the branches; and soon after the flowers ex-

pand, which are composed of five oblong purple petals, with a great number of stamina in the centre; when these fall off, they are succeeded by oval fruit as large as a swan's egg, having a thick ligneous cover, which, when ripe, opens in five parts, and is full of a dark short cotton, inclosing many roundish seeds as large as small peas.

4. Bombax gossipinum. Besides the species above described, Mr. Miller mentions another which he saw in the gardens of the late duke of Richmond at Goodwood, and was raised from seeds which came from the East Indies.

These plants, being natives of warm climates, must always be kept in a stove. They are raised from seeds procured in the capsules from the places where they grow naturally. They must be watered plentifully in summer, but moderately in winter.

The dark short cotton of the first and third species is used by the poorer inhabitants of those places where such trees grow, to stuff pillows or chairs, but is generally deemed unwholesome to lie upon. The beautiful purple down of the heptaphyllum is spun, wrought into clothes, and worn without being dyed any other colour, by the inhabitants of the Spanish West Indies, where the tree naturally grows. Large pirogues, or canoes fit to carry a sail, are made both at Senegal and in America, of the trunk of the silk-cotton tree, the wood of which is very light, and unfit for any other purpose. In Columbus's first voyage, it was reported that a canoe was seen at Cuba made of the hollowed trunk of one of these trees, capable of containing 150 men.

BOMB-KETCH. The modern bomb vessels carry two ten-inch mortars, four 68-pounders, and six 18-pounders, carronades; and the mortars may be fired at as low an angle as 20 degrees: their principal use being to cover the landing of troops, and to protect our coasts and harbours. A bombketch is from 60 to 70 feet long, and draws eight or nine feet water.

BOMBIC *acid*. The silkworm has a small reservoir near the anus, from which, when full-grown, or especially when it is in the chrysalis state, a minute quantity of acid liquor is seen to ooze out. If the entire animal is bruised, it gives a liquor containing the usual soft animal matters, with a native acid. Alcohol separates the former, and leaves the latter in solution; which, by evaporation, furnishes a very sour pungent yellow fluid, which exhibits all the marks of an acid, by reddening blue vegetables, and uniting with alkalies.

BOMBYLIUS, in entomology, a genus of dipterous insects distinguished by the following character: beak or sucker very long, setaceous, straight, and consisting of two unequal valves, within which three setaceous bristles are contained; feelers two, short and hairy: antennæ subulate, and connected at the base.

The antennæ are short, and contain three articulations, the first of which is long, the second short, and the third or last conical, and terminating in a kind of appendage, almost forming a fourth joint, as is to be observed with the assistance of glasses. Those who have carefully examined the structure of the trunk with the microscope affirm, that the number of valves or bristles concealed within the external bivalve sheath are four, instead of three as Gmelin describes them. The antennæ are inserted at the base of the trunk.

Insects of this genus have the head comparatively of a small size, of a form somewhat rotund, and almost wholly occupied by the eyes. The thorax large, the abdomen bulky and rounded at the extremity, as in the bee. Both the thorax and abdomen are hairy, or covered with down. The wings longer than the body, and extended horizontally. Legs long and slender. The size and rotundity of the body afford an excellent natural character, by which this tribe of insects may be distinguished from those of the genera empis and asilus, with which some naturalists have confounded them. The Fabrician species of volucella, cytherea, and anthrax, have been referred to the bombylius genus with very little propriety. The true bombylius is a lively active tribe of insects, that subsist entirely on the nectareous juices they extract from flowers, with the assistance of their long proboscis or trunk. They fly with much rapidity, making all the time a soft humming noise similar to that of the bee. In England the largest species (major) has acquired the name of the humble-bee fly. The insects of this tribe are found in the winged state in the summer, but their metamorphose is utterly unknown. Only a small number of species in this genus are at present known. See Plate Nat. Hist. fig. 52. and 53.

BOMBYX, a genus of lepidopterous insects, or rather one of the subdivisions of the phalæna, an extensive genus, in which all the insects of the moth tribe are comprised by Linnæus. Fabricius, in his "Entomologia systematica," admits the bombyx as a genus, applying the term phalæna, which Linnæus gave indiscriminately to all the species of the moth tribe, as a generical name to that particular description of moths which have the palpi cylindrical, the tongue advanced and membranaceous, and the antennæ filiform. In the Systema Naturæ, Linnæus divides the bombyces into sections in the following order: the elingues, or those without a manifest spiral tongue; and the spirilingues, having an involuted tongue. These two principal sections are subdivided again; the elingues, into those with the back smooth or not crested, with expanded wings, with reversed wings, with deflected wings, with erect crests or tufts on the backs; and the spirilingues, those smooth, with expanded wings, and with deflected wings, and with the back crested.

The insects of the bombyx tribe never fly except in the evening. During the day-time they secrete themselves under the leaves, or beneath the branches, in the clefts of trees, where they may remain secure till about sunset, at which time they appear to be on the alert; at first crawling about the branches, then fluttering their wings, and becoming brisker in all their motions as the evening advances. The larger sort of moths, which we see first starting from the woods or hedges after some of the geometræ, are the swifts, the Fabrican hepiali; which fly swiftly, as their trivial name implies, but low or near the surface of the ground: these at twilight are succeeded by the bombyces and noctuæ, whose flight is more elevated. They continue to sport about till it becomes quite dark. The males of the bombyces are commonly first upon the wing in search of the females; which latter are, in some few species, entirely destitute of wings, or at least have only the rudiments of them close to the thorax; in which case the female waits upon the trees or herbage for the arrival of the male: the female of bombyx antiqua, the vapourer moth, is a striking proof of this; for it has so little the appearance of a moth that any one, except an entomologist, would mistake it for an apterous or wingless insect. Those females which have wings are commonly larger even than the males.

The bombyces are produced from a larva, or as it is more usually termed by common observers, a caterpillar. This is of a long cylindrical form, having in some species a smooth skin, or in others more or less tuberculated; sometimes the skin is covered with a fine silky down, or with hairs; and some of the larger kinds are armed with spines and bristles. All the larvæ of the bombyces subsist on vegetables. Their jaws are strong, and of a horny texture; and below them is a small opening, through which the creature draws the silky thread of so much utility in its general economy. Most of these larvæ have 16 feet, some have only 14 feet, and others no more than 12; six of which are hooked, and situated on the three first annulations near the head, the others towards the lower extremity of the body are short, broad, and very different in structure.

The greater number of species in the bombyx tribe, when in the larva state, lead a solitary life; in which case they separate as soon as they are hatched from the eggs, and crawl about to provide for themselves, the smallest of these even being able to obtain its own subsistence; they can eat as readily, and spin, or throw out the silky thread with as much facility, as when grown bigger. The latter is of considerable utility to the larva; for when it wishes to descend from one branch of the tree or bush to another, instead of being obliged to pursue a circuitous course, by crawling or walking, it need only fasten one end of the silken thread to any particular spot, and lower itself by its assistance to the branch desired; or when suspended mid-way between the branches, it can pass aside with a swing to any other point within a convenient distance. In like manner, when observed by birds or other enemies, it can drop in an instant, and elude the enemy; waiting concealed below among the leaves or on the ground till the danger is over, and then remounting to the former spot by the aid of this thread. This is a provision of nature for the security of the larvæ of the bombyces, in common with that of other lepidopterous insects.

Some species of the bombyces live in societies, as may be observed, for instance, in bombyx neustria of entomologists, (the lackey-moth of English collectors.) The larvæ of this species, by their united labours, spin a capacious habitation, in which the infant brood is hatched from the egg, and after undergoing their several transformations, finally become moths.

Like other larvæ of the moth tribe, those of the bombyces cast their skin several times. When full grown, and approaching the pupa state, those of the bombyx kind spin a sort of web, in which we find the most valuable silk produced by these creatures at any time of their lives. The silk spun by the hairy larvæ is observed to be of little value, because the

creature interweaves it with the hairs it plucks off its skin for this purpose. The common silkworm (bombyx mori), whose cocoon consists of the most valuable kind of silk, as is well known, has the skin perfectly smooth, or free from hair. There are certain species of the larger bombyces, the larvæ of which have smooth skins, but still beset with annular series of spines or bristles, that produce very strong silk, and are reared with the view of obtaining the cocoons for the manufacture of silk in the East Indies. The breed of these useful insects has long been cultivated in India, although the silk produced from them is very little, if at all, known in Europe. The bombyces remain in the pupa state for a certain time, varying according to the species, some only a few days or weeks, others six or twelve months, two years, or even three. The same day that the creatures emerge from the pupa state they are in a condition to perpetuate their race. Almost immediately after coupling, the males die; the females live long enough to deposit the eggs in a proper place for their security, and where the infant brood may find subsistence, after which they perish likewise.

The species of the bombyx tribe are numerous. Those already described by naturalists amount to a large number; and there are, in the cabinets of the curious, many more, especially of the extra-European species, that have never been described; even in the collections of this country, those of the latter description are numerous.

BONA NOTABILIA, are such goods as a person dying has in another diocese than that wherein he dies, amounting to the value of 5*l.* at least; in which case the will of the deceased must be proved, or administration granted, in the court of the archbishop of the province, unless by composition or custom any dioceses are authorised to do it, when rated at a greater sum.

BOND. A bond, or obligation, is a deed whereby the obligor, or person bound, binds himself, his heirs, executors, and administrators, to pay a certain sum of money, or do some other act; and there is generally a condition added, that if he do perform such act, the obligation shall be void, or else remain in full force; as performance of covenants, standing to an award, payment of rent, or repayment of a principal sum of money with interest, which principal sum is usually half the sum specified in the bond. 2 Black. 340.

All persons who are enabled to contract, and whom the law supposes to have sufficient freedom and understanding for that purpose, may bind themselves in bonds and obligations. 1 Rol. Abr. 340.

If the condition of a bond is impossible at the time of making it, if it is to do a thing contrary to some rule of law, or to do a thing that is malum in se, the obligation itself is void. The bond of a feme covert is void, as is that of an infant. If a person is illegally restrained of his liberty, and during such restraint enters into a bond to a person who causes the restraint, the same may be avoided for duress of imprisonment. 2 Inst. 482.

To avoid controversies, three things are necessary to making a good obligation, signing, sealing, and delivery. A bond, on which neither principal nor interest has been demanded for 20 years, will be presumed in equity to be satisfied. If several obligors are bound jointly and severally, and the obligee makes one of them his executor, it is a release of the debt, and the executor cannot sue the other obligor. 8 Cor. 136.

If one obligor makes the executor of an obligee his executor, and leaves assets, the debt is deemed satisfied; for he has power by way of retainer to satisfy the debt. A release to one obligor is a release to all, both in law and equity. 1 Atk. 294.

BOND, *post obit*, one and the main condition of which is, that it only becomes payable after the death of some person, whose name is therein specified. The death of any person being uncertain as to time, the risk attached to such bonds frees them from the shackles of the common law of usury. It has been determined, that bonds bought for half their value did not amount to usury, on account of the risk with which they were attended.

BOND, in carpentry, a term among workmen; as, to make good bond, means that they should fasten the two or more pieces together either by tenanting, mortising, or dovetailing, &c.

BOND, in masonry and bricklaying, is when bricks or stones are so interwoven that the joints are not made over or upon other joints, but reach at least six inches both within the wall and on the surface, as the art of building requires.

BONDAGE *by forelock*, was when a freeman renounced his liberty, and became slave to some great man: which was done by the ceremony of cutting off a lock of hair on the forehead, and delivering it to his lord; denoting that he was to be maintained for the future. Such bondman, if he reclaimed his liberty, or was fugitive from his master, might be drawn again to his servitude by the nose: hence is said to be the origin of the popular menace to pull a man by the nose.

BONE, in chemistry and the arts. The bones are the most solid part of animals. Their texture is sometimes dense, at other times cellular and porous, according to the situation of the bone. They are white, of a lamellar structure, and not flexible nor softened by heat. Their specific gravity differs in different parts. That of adults' teeth is 2.2727: the specific gravity of children's teeth is 2.0833. It must have been always known that bones are combustible, and that when sufficiently burnt they leave behind them a white porous substance, which is tasteless, absorbs water, and has the form of the original bone. The nature of this substance embarrassed the earlier chemists. In 1771, Scheele mentioned in his dissertation on fluor spar, that the earthy part of bones is phosphat of lime. This discovery was the first and the great step towards a chemical knowledge of the composition of bones. Afterwards, some new facts were made known by Berniard, Bouillon, and Rouelle; but for by far the most complete analysis that has hitherto appeared we are indebted to Mr. Hatchett.

The component parts of bones are chiefly four: namely, the earthy salts, fat, gelatine, and cartilage.

1. The earthy salts may be obtained either by calcining the bone to whiteness, or by steeping it for a sufficient length of time in the acids. In the first case, the salts remain in the state of a brittle white substance. In the second, they are dissolved, and may be thrown down by the proper precipitants. These earthy salts are three in number: 1. Phosphat of lime, which constitutes by far the greatest part of the whole. 2. Carbonate of lime. 3. Sulphat of lime, which forms the smallest part. To estimate these substances, calcined bones, or the raspings of bones, may be dissolved in nitric or muriatic acid. During the solution carbonic acid gas makes its escape. Pure ammonia dropt into the solution throws down the phosphat of lime in the state of a fine powder, readily soluble without effervescence by nitric, muriatic, and acetic acids. Nitrat of barytes afterwards causes a small precipitate insoluble in muriatic acid, and therefore consisting of sulphat of barytes. Its weight indicates the quantity of sulphuric acid in bones, from which the sulphat of lime which they contain may be estimated. Carbonate of ammonia now throws down pure carbonate of lime. These three constituents were found by Hatchett in all the bones of quadrupeds and fish which he examined. The carbonate scarcely exceeds the fifth part of the phosphat, and the proportion of sulphat is still smaller.

2. The proportion of fat contained in bones is no less various. By breaking bones in small pieces, and boiling them for some time in water, Mr. Proust obtained their fat swimming on the surface of the liquid. It weighed, he says, one fourth of the weight of the bones employed. This proportion appears excessive, and can scarcely be accounted for without supposing that the fat still retained water.

3. The gelatine is separated by the same means as the fat, by breaking the bones in pieces, and boiling them long enough in water. The water dissolves the gelatine, and gelatinizes when sufficiently concentrated. Hence the importance of bones in making portable soups, the basis of which is concrete gelatine, and likewise in making glue. By this process Proust obtained from powdered bones about 1-16th of their weight in gelatine.

4. When bones are deprived of their gelatine by boiling them in water, and of their earthy salts by steeping them in diluted acids, there remains a soft white elastic substance, possessing the figure of the bones, and known by the name of cartilage. From the experiments of Mr. Hatchett, it appears that this substance has the properties of coagulated albumen. Like that substance, it becomes brittle and semitransparent when dried, is readily soluble in hot nitric acid, is converted into gelatine by the action of diluted nitric acid; for it is soluble in hot water and gelatinizes on cooling, and ammonia dissolves it and assumes a deep orange colour. Like coagulated albumen, it forms an animal soap with fixed alkalies.

This cartilaginous substance is the portion of the bone first formed. Hence the softness of these parts at first. The phosphat of lime is afterwards gradually deposited, and gives the bone the requisite firmness. The gelatine and fat, especially the first, gave the bone the requisite degree of toughness and strength; for when they are removed, the bone becomes brittle. The relative proportion of phosphat of lime and cartilage differs exceedingly in different bones and in different animals.

41

Asterias glacialis

42

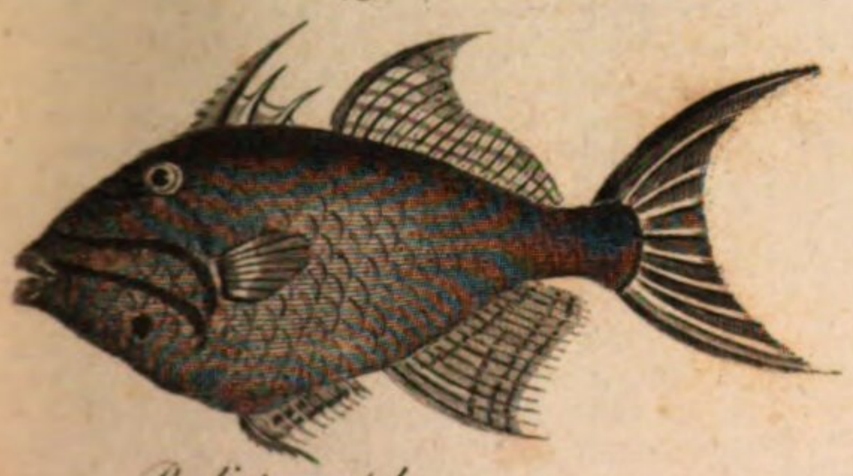
43

Ascaris vermicularis

44

Balaena physalus
Fin fish

45



Balistes vetula

46

Blatta Americana

47

Blennius galliorugine

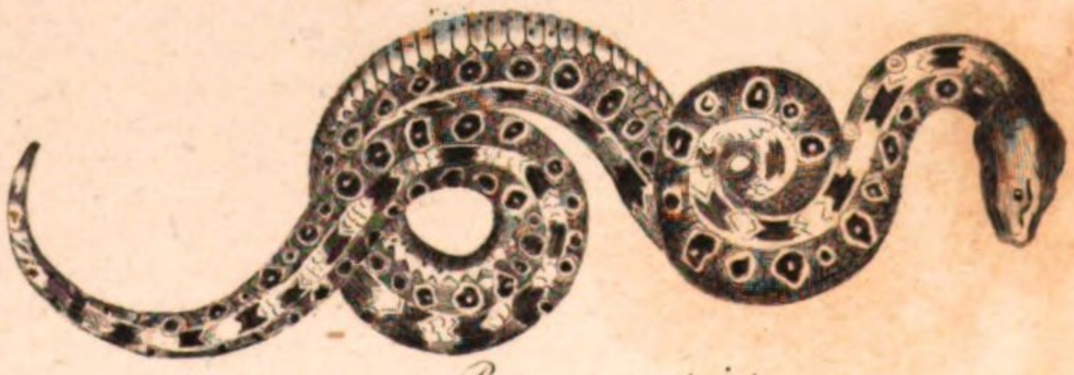
48

Blennius ocellaris

49

Blennius viviparus

50



Boa constrictor

51

Boa hortulana

52

Bombylius medius

53

Bombylius morio

Printed Apr.1.1805. for Richard Phillips, 6 New Bridge Blackfriars

Heath Sculp.

One hundred parts contain	Gelatine.	Phos. of lime.	Car. of lime.	Loss.
Human bones from a burying ground	16	67	1.5	15.5
Do. dry, but not from under the earth	23	63	2	2
Bone of ox	3	93	2	2
calf	25	54	trace	21
horse	9	67.5	1.25	22.25
sheep	16	70	0.5	13.5
elk	1.5	90	1	7.5
hog	17	52	1	30
hare	9	85	1	5
pullet	6	72	1.5	20.5
pike	12	64	1	23
carp	6	45	0.5	48.5
Horse-teeth	12	85.5	0.25	2.25
Ivory	24	64	0.1	11.15
Hartshorn	27	57.5	1	14.5

BONES, diseases of, see SURGERY.

BONES, fossile or petrified, are those found in the earth, frequently at great depths in all strata, even in the bodies of stones and rocks. Some of these bones are of a huge size, usually supposed to be the bones of giants, but more truly of elephants or hippopotami, others smaller, as the vertebræ, teeth, and the like. It has indeed been disputed whether these are really animal substances or mineral; but a chemical investigation proves them to be animal; and they were probably deposited in those strata at a time when all things were in a state of solution, and they incorporated and petrified with the bodies where they happened to be lodged.

Mr. Hatchett examined some fossil bones from the rock of Gibraltar. He found them to consist of phosphat of lime without any cartilage or soft animal part. Their interstices were filled with carbonate of lime. Hence they resemble exactly bones that have been burnt. They must then have been acted on by some foreign agent; for putrefaction, or lying in the earth, does not soon destroy the cartilaginous part of bones. On putting a human os humeri, brought from Hythe in Kent, and said to have been taken from a Saxon tomb, into muriatic acid, he found the cartilaginous residuum nearly as complete as in a recent bone.

BONE-*ace*, properly *bon* (or good) *ace*, an easy game at cards, played thus: The dealer deals out two cards to the first hand, and turns up the third, and so on through all the players, who may be seven, eight, or as many as the cards will permit; he that has the highest card turned up to him carries the bone, that is, one half of the stake, the other remaining to be played for. Again, if there are three kings, three queens, three tens, &c. turned up, the eldest hand wins the bone; but it is to be observed, that the ace of diamonds is bon-ace, and wins all other cards whatever. Thus much for the bone; and as for the other half of the stake, the nearest to 31 wins it, and he that turns up or draws 31 wins it immediately.

BONING, in surveying and levelling, is the placing of three or more rods or poles, all of the same length, in or upon the ground in such a manner that their tops may be all in one continued straight line, whether it is horizontal or inclined, so that the eye may look along the tops of them all, from one end of the line to the other.

BONNET, in fortification, a small work, consisting of two faces, having only a parapet with two rows of palisadoes, of about ten or twelve feet distance. It is generally raised before the salient angle of the counterscarp, and has a communication with the covered way by a trench cut through the glacis, and palisadoes on each side.

BONNET *à pretre*, or priest's bonnet, in fortification, is an outwork, having at the head three salient angles, and two inwards. It differs from the double tenaille only in this; that its sides, instead of being parallel, are like the *queue d'aronde*, or swallow's tail, that is, narrowing or drawing close at the gorge, and opening at the head.

BONNET, in the sea language, denotes an addition to a sail: thus they say, lace on the bonnet, or shake off the bonnet.

BONTIA, wild olive of Barbadoes, a genus of the angiospermia order and didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is quinquepartite; the corolla is bilabiated, the inferior lip tripartite and revolute; the drupe is ovate and monospermous, with the apex turned to one side. There is one species, viz.

Bontia daphnoides has a woody stem and branches, rising to the height of ten feet, with narrow, smooth, thickish leaves, and flowers from the sides of the branches, succeeded by large oval fruit that sometimes ripens in England. This species is generally cultivated in the gardens at Barbadoes for hedges; for which it is exceedingly proper, being an evergreen of very quick growth. It is said that from cuttings planted there in the rainy season, when they have immediately taken root, there has been a complete hedge four or five feet high in 18 months.

BONZES, Indian priests, who, in order to distinguish themselves from the laity, wear a chaplet round their heads, consisting of an hundred beads, and carry a staff, at the end of which is a wooden bird. They live upon the alms of the people, and yet are very charitably disposed, maintaining several orphans and widows out of their own collections.

BOOK-*binding*, the art of gathering and sewing together the sheets of a book, and covering it with a back, &c. It is performed thus: the leaves are first folded with a folding-stick, and laid over each other in the order of the signatures, which are the letters with the numbers annexed to them at the bottom of the pages of the first one, two, or more leaves in each sheet. The leaves thus folded are then beaten on a stone with a hammer, to make them smooth and open well, and afterwards pressed. While in the press they are sewed upon bands, which are pieces of cord or packthread; six bands to a folio book, five to a quarto, octavo, &c. which is done by drawing a thread through the middle of each sheet, and giving it a turn round each band, beginning with the first and proceeding to the last. After this the books are glued, and the bands opened and scraped, for the better fixing the pasteboards; the back is turned with a hammer, and the book fixed in a press between two boards, in order to make a groove for fixing the pasteboards; these being applied, holes are made for fixing them to the book, which is pressed a third time. Then the book is at last put to the cutting-press, betwixt two boards, the one lying even with the press for the knife to run upon, the other above it for the knife to run against: after which the pasteboards are squared.

The next operation is the sprinkling the leaves of the book, which is done by dipping a brush into vermilion and sap-green, holding the brush in one hand, and spreading the hair with the other; by which motion the edges of the leaves are sprinkled in a regular manner, without any spots being larger than the other.

The covers (which are either of calf or of sheep-skin), being moistened in water, are next cut out to the size of the book, then smeared over with paste made of wheat flour, and afterwards stretched over the pasteboard on the outside, and doubled over the edges withinside, after having first taken off the four angles, and indented and platted the cover at the head-band; which done, the book is covered and bound firmly between two bands, and then set to dry. Afterwards it is washed over with a little paste and water, and then sprinkled fine with a brush; unless it should be marbled, when the spots are to be made larger by mixing the ink with vitriol. After this the book is glazed twice with the white of an egg beaten, and at last polished with a polishing-iron passed hot over the glazed cover.

The letters or other ornaments on books are made with gilding-tools engraved in relievo, either on the points of puncheons, or around little cylinders of brass. The puncheons make their impressions by being pressed flat down, and the cylinders by being rolled along by a handle, to which they are fitted on an iron axis. To apply the gold, the binders glaze the parts of the leather with a liquor made of whites of eggs diluted with water, by means of a piece of sponge; and when nearly dry, the pieces of gold leaf are laid on, and the tools being made hot in a charcoal fire, are applied.

BOOK-*keeping*, an art teaching how to record and dispose the accounts of business, so that the true state of every part and of the whole may be easily and distinctly known.

Merchants' books are kept either single, or according to the method of double entry. Those who keep them in the former method have occasion for few books, as a journal or day-book, and a ledger or post-book; the former to write all the articles, following each other as they occur in the course of their business, and the other to draw out the accounts of all the debtors and creditors on the journal. This method is only proper for retail dealers, or at least for traders who have but very little business; but as for wholesale dealers and great merchants, who keep their books according to the double entry, or Italian method, as is now most commonly done, their business requires several other books, the usefulness of which will be seen from what follows.

The most considerable books, according to the method of double entry, are the waste-book, the journal, and the ledger; but besides these three, which are absolutely necessary, there are several others, to the number of thirteen, or even more, called subservient or auxiliary books, which are used in proportion to the business a man has, or to the

nature of the business that he carries on. These books are the cash-book, the debt-book, the book of numeros, the book of invoices, the book of accounts current, the book of commissions, orders, or advices, &c.

The waste-book may be defined a register, containing an inventory of a merchant's effects and debts, with a distinct record of all his transactions and dealings, in a way of trade, related in a plain simple style, and in order of time as they succeed one another.

The waste-book opens with the inventory, which consists of two parts; first, the effects, that is, the money a merchant has by him, the goods he has in hand, his part of ships, houses, farms, &c. with the debts due to him; the second part of the inventory is the debts due by him to others; the difference between which and the effects is what the merchants call neat stock. When a man begins the world, and first sets up to trade, the inventory is to be gathered from a survey of the particulars that make up his real estate, but ever after it is to be collected from the balance of his old books, and carried to the new.

After the inventory is fairly related in the waste-book, the transactions of trade come next to be entered down, which is a daily task, to be performed as they occur. The narrative ought to exhibit transactions with all the circumstances necessary to be known, and no more. It should contain the names of persons with whom the merchant deals upon trust, the conditions of bargains, the terms of payment, the quantity, quality, and prices of goods, with every thing that serves to make the record distinct, and nothing else. The waste-book, if no subsidiary books are kept, should contain a record of all the merchant's transactions and dealings in the way of trade; and that not only of such as are properly and purely mercantile, but of every occurrence that affects his stock, so as to impair or increase it, such as private expences, servants' fees, house-rents, money gained, &c.

The journal is the book in which the transactions recorded in the waste-book are prepared to be carried to the ledger, by having their proper debtors and creditors ascertained and pointed out: whence it may be observed that the great design of the journal is to prevent errors in the ledger: again, after the ledger is filled up, the journal facilitates the work required in revising and correcting it; for first the waste-book and journal are compared, and then the journal and ledger; whereas to revise the ledger immediately from the waste-book would be a matter of no less difficulty than to form it without the help of a journal: lastly, the journal is designed as a fair record of a merchant's business, for neither of the other two books can serve this purpose; not the ledger, by reason of the order that obtains in it, and also on account of its brevity, being little more than a large index: nor can the waste-book answer this design, as it can neither be fair nor uniform, nor very accurate, being commonly written by different hands, and in time of business. Hence it is that in case of differences between a merchant and his dealers, the journal is the book commonly called for and inspected by a civil judge.

In the journal, persons and things are charged debtors to other persons and things as creditors; and in this it agrees with the ledger, where the same style is used, but differs from it as to forms and order; so that it agrees with the waste-book in those very things where it differs from the ledger; and, on the other hand, it agrees with the latter, in the very point wherein it differs from the former; but in order to state the comparison betwixt the waste-book and journal, we shall turn two or three examples of the waste-book into a journal form.

WASTE BOOK.

July 1st.			
Bought of William Pope 40 yards of black cloth at 14*s.* per yard, payable in three months	28	00	00
Bought of James Sloane 100 yards of shalloon, at 10*d.* per yard.			
Whereof paid	02	00	00
Rest due, at two months	02	03	04
	4	03	04
4th.			
Sold William Pope four pipes of port wine, at 27*l.* 10*s.* per pipe.	*l.*	*s.*	*d.*
Whereof received	55	00	00
Rest due on demand	55	00	00
	110	00	00

JOURNAL.

July 1st.	*l.*	*s.*	*d.*
BLACK CLOTH Dr. to WILLIAM POPE, 28*l.*			
For 40 yards, at 14*s.* per yard, payable in three months	28	00	00
SHALLOON Dr. to SUNDRIES, 4*l.* 3*s.* 4*d.*	*l.*	*s.*	*d.*
To cash paid in part for 100 yards, at 10*d.* per yard	02	00	00
To J. Sloan, for the rest, due at two months	02	03	04
	4	03	04
4th.			
SUNDRIES Drs. to PORT WINE, 110*l.*	*l.*	*s.*	*d.*
Cash, received in part for four pipes, at 27*l.* 10*s.* per pipe	55	00	00
William Pope, for the rest on demand	55	00	00
	110	00	00

It may be here observed, that every case or example of the waste-book, when entered into the journal, is called a journal post or entrance; thus the examples above make three direct posts. Again, a post is either simple or complex: a simple post is that which has but one debtor and one creditor, as the first of these above; a complex post is either when one debtor is balanced by one or more creditors, as in the second post; or when two or more debtors are balanced by one creditor, as in the third post; or when several debtors are balanced by several creditors, and then the post is said to be complex in both terms. This being premised, the following rules are to be observed for writing in the journal.

1. In a simple post, the debtor is to be expressly mentioned, then the creditor, and lastly the sum, all in one line; after which the narrative or reason of the entry, in one or more lines, as in the first of these three posts above.

2. In a complex post, the several debtors or creditors are expressed in the first line by themselves, with their respective sums subjoined to them; which are to be added up, and their total carried to the money columns, as in the second and third posts.

3. The debtors and creditors should be written in a large letter or text hand, both for ornament and distinction.

Before we proceed to explain the ledger, we shall previously inquire into the nature and use of the terms debtor and creditor, as the whole art of book-keeping entirely depends on a true idea of those terms, the nature and use of which will be obvious from the following considerations:

Accounts in the ledger consist of two parts, which in their own nature are directly opposed to and the reverse of one another, which are therefore set fronting one another, and on opposite sides of the same folio. Thus all the articles of the money received go to the left side of the cash account; and all the articles or sums laid out are carried to the right. In like manner the purchase of goods is posted to the left side of the accounts of the said goods, and the sale or disposal of them to the right.

Transactions of trade, or cases of the waste-book, are also made up of two parts, which belong to different accounts, and to opposite sides of the ledger, *e. g.* If goods are bought for ready money, the two parts are the goods received and the money delivered; the former of which goes to the left side of the account of the said goods, and the latter to the right side of the cash account.

The two parts in any case in the waste-book, when posted to the journal, are denominated the one the debtor, the other the creditor of that post; and when carried thence to the ledger, the debtor or debtor part is entered upon the left side (hence called the debtor side) of its own account, where it is charged debtor to the creditor part. Again, the creditor or creditor part is posted to the right side or creditor side of its account, and made creditor by the debtor part. Hence Italian book-keeping is said to be a method of keeping accounts by double entry, because every single case of the waste-book requires at least two entries in the ledger, viz. one for the debtor and another for the creditor.

From what has been said it is evident that the terms debtor and creditor are nothing else but marks or characteristics stamped upon the different parts of transactions in the journal, expressing the relation of these parts to one another, and shewing to which side of their respective accounts in the ledger they are to be carried.

Having thus far explained the meaning of the terms debtor and creditor, we shall now proceed to the ledger, or principal book of accounts.

Of the ledger. The ledger is the principal book wherein all the several articles of each particular account that lie scattered in other books, according to their dates, are collected and placed together in spaces allotted for them, in such a manner that the opposite parts of every account are directly set fronting one another, on opposite sides of the same folio.

The ledger's folios are divided into spaces for containing the accounts, on the head of which are written the titles of the accounts, marked Dr. on the left hand page, and Cr. on the right; below which stand the articles, with the word *To* prefixed on the Dr. side, and the word *By* on the Cr. side; and upon the margin are recorded the dates of the articles, in two small columns allotted for that purpose. The money columns are the same as in other books: before them stand the folio column, which contains figures directing to the folio where the corresponding ledger-entrance of each article is made; for every thing is twice entered in the ledger, viz. on the Dr. side of one account, and again on the Cr. side of some other account; so that the figures mutually refer from the one to the other, and are of use in examining the ledger. Besides these columns, there must be kept in all accounts, where number, measure, weight, or distinction of coins is considered, inner columns to insert the quantity; and for the ready finding any account in the ledger, it has an alphabet or index, wherein are written the titles of all accounts, with the number of the folio where they stand.

How the ledger is filled up from the journal. 1. Turn to the index, and see whether the Dr. of the journal post, to be transported, is written there: if not, insert it under its proper letter, with the number of the folio to which it is to be carried.

2. Having distinguished the Dr. and the Cr. sides, as already directed, recording the dates, complete the entry in one line, by giving a short hint of the nature and terms of the transaction, carrying the sum to the money columns; and inserting the quantity, if it is an account of goods, &c. in the inner columns, and the referring figure in the folio column.

3. Turn next to the creditor of the journal-post, and proceed in the same manner with it, both in the index and ledger; with this difference only, that the entry is to be made on the Cr. side, and the word By prefixed to it.

4. The post being thus entered in the ledger, return to the journal, and on the margin mark the folios of the accounts, with the folio of the Dr. above, and the folio of the Cr. below, and a small line between them thus $\frac{1}{2}$. These marginal numbers of the journal, are a kind of index to the ledger, and are of use in examining the books, and on other occasions.

5. In opening the accounts in the ledger, follow the order of the journal; that is, beginning with the first journal-post, allow the first space in the ledger for the Dr. of it, the next for the Cr. the third for the Dr. of the following post, if it is not the same with some of those already opened, and so on till the whole journal be transported: and supposing that, through inadvertency, some former space has been allowed too large, you are not to go back to subdivide it, in order to erect another account in its stead.

Though these rules are formed for simple posts, where there is but one Dr. and one Cr. yet they may be easily applied to complex ones.

As an example how articles are to be entered in the ledger, take the two accounts of Cash and William Pope, so far as mentioned in the above waste-book and journal.

JOURNAL.

1806.		Cash Dr.	Fo.	*l.*	*s.*	*d.*	1806.		Contra Cr.	Fo.	*l.*	*s.*	*d.*
July	4	To port-wine received in part for four pipes, at 27*l.* 10*s.* per pipe.	6	55	00	00	July	1	By shalloon, paid in part for 100 yards at 10*d.* per yard.	12	2	00	00
							July	1	Contra Cr.				
July	4	Wil. Pope, Dr. To port-wine, as per journal.	6	55	00	00			By black cloth, for 40 yards, at 14*s.* per yard.	3	28	00	00

Cash Book. This is the most important of the auxiliary books. It is so called, because it contains, in debtor and creditor, all the cash that comes in, and goes out of, a merchant's stock; the receipts on the debtor side; the persons of whom it was received, on what, and on whose account, and in what specie: and the payments on the creditor side; mentioning also the specie, the reasons of the payments, to whom, and for what account they are made.

Book of debts or payments, is a book in which is written down the day on which all sums become due, either to be received or paid, by bills of exchange, notes of hand, merchandizes bought or sold, or otherwise. By comparing receipts and payments, one may, in time, provide the necessary funds for payments, by getting the bills, notes, &c. due to be paid, or by taking other precautions.

Book of numeros or wares. This book is kept in order, to know easily all the merchandizes that are lodged in the warehouse, those that are taken out of it, and those that remain therein.

Book of invoices. This book is kept to preserve the journal from erasures, which are unavoidable in drawing up the accounts of invoices of the several merchandizes received, sent out, or sold; wherein one is obliged to enter very minute particulars. It is also designed to render those invoices easier to find than they can be in the waste-book or journal.

Book of accounts current. This book serves to draw up the accounts which are to be sent to correspondents, in order to settle them in concert, before they are balanced in the ledger; it is properly a duplicate of the accounts in the ledger which is kept to have recourse to occasionally.

The other mercantile books generally in use are, the book of commissions, orders, or advices; the book of acceptances of bills of exchange; the book of remittances; the book of expences; the copy-book of letters; the book of postage; the ship-books; and the book of workmen. To these may be added others, which depend on the greater or lesser accuracy of the merchants and bankers, and on the several kinds of trade carried on by particular dealers.

Books. By 8 Anne, c. 19. the author of any book, and his assigns, shall have the sole liberty of printing and reprinting the same for twenty-one years, to commence from the day of the first publication thereof, and no longer; except that if the author be living at the expiration of the said term, the sole copy-right shall return to him for other fourteen years; and if any other person shall print, or import, or shall sell or expose it to sale, he shall forfeit the same, and also one penny for every sheet thereof found in his possession. But this shall not expose any person to the said forfeitures, unless the title thereof shall be entered in the register-book of the company of stationers.

By 41 Geo. III. eleven copies of each book, on the best paper, shall, before publication, be delivered to the warehouse-keeper of the company of stationers, for the use of the royal library, the libraries of the two universities in England, the four universities in Scotland, the library of Sion-college, the library belonging to the college of advocates in Edinburgh, the library of Trinity-college Dublin, and the king's inns Dublin, on pain of forfeiting the value thereof, and also 5*l.*

By stat. 34 Geo. III. c. 20. and 41 Geo. III. c. 107, persons importing for sale books first printed within the united kingdom, and reprinted in any other, such books shall be seized and forfeited; and every person so exposing such books to sale, for every such offence shall forfeit the sum of 10*l.* The penalties not to extend to books not having been printed for twenty years.

By the act of union, 40 Geo. III. c. 67. all prohibitions and bounties on the export of articles (the produce and manufacture of either country) to the other shall cease; and a countervailing duty of two-pence for every

pound weight avoirdupois of books, bound or unbound, and of maps and prints, imported into Great Britain, directly from Ireland, or which shall be imported into Ireland from Great Britain, is substituted.

BOOM, in the sea-language, a long piece of timber with which the clew of the studding-sail is spread out; and sometimes the boom is used to spread or boom out the clew of the mainmast.

The different kinds of booms have different names according to the purposes for which they are intended.

Boom denotes also a cable stretched athwart the mouth of a river or harbour; with yards, top-masts, battling, or spars of wood, lashed to it, to prevent an enemy's coming in.

BOOMKIN, in sea language, a short bar of timber projecting from each bow of a ship, to extend one edge of the fore-sail to the windward; for which purpose there is a large block fixed to its outer end, through which the rope is passed that is fastened to the lower corner of the sail to windward, called the tack; and this being drawn tight down brings the corner of the sail close to the block, which being performed, the tack is said to be aboard. The boomkin is secured by a strong rope, which confines it downward to the ship's bow, to counteract the strain it bears from the foresail above, dragging it upwards.

BOOTES, a constellation of the northern hemisphere, consisting of 23 stars according to Ptolemy's catalogue, of 28 in Tycho's, of 34 in Bayer's, of 52 in Hevelius's, and of 45 in Mr. Flamsteed's catalogue.

BOQUINIANS, in church-history, a sect of heretics, so called from Boquinus their founder, who taught that Christ did not die for all mankind, but only for the faithful, and consequently was only a particular saviour.

BORACIC acid. The word borax first occurs in the works of Geber, an Arabian chemist of the 10th century. It is a name given to a species of white salt much used by various artists. Its use in soldering metals appears to have been known to Agricola.

Borax is found mixed with other substances in Thibet. It seems to exist in some lands adjacent to lakes, from which it is extracted by water, and deposited in those lakes; whence in summer, when the water is shallow, it is extracted and carried off in large lumps. Sometimes the water in these lakes is admitted into reservoirs; at the bottom of which, when the water is exhaled by the summer's heat, this salt is found. Hence it is carried to the East Indies, where it is in some measure purified and crystallized: in this state it comes to Europe, and is called tincal. In other parts of Thibet, it seems, by accounts received from China, they dig it out of the ground at the depth of about two yards, where they find it in small crystalline masses.

Though borax has been in common use for nearly three centuries, it was only in 1702 that Homberg, by distilling a mixture of borax and green vitriol, discovered the boracic acid. He called it narcotic or sedative salt, from a notion of his that it possessed the properties indicated by these names. Lemery the younger soon after discovered, that it could likewise be obtained from borax by means of the nitric and muriatic acids. Geoffroy afterwards discovered, that borax contained soda; and at last Baron proved, by a number of experiments, that borax is composed of barocic acid and soda; and that it may be reproduced by combining these two substances.

The easiest method of procuring boracic acid is the following: Dissolve borax in hot water, and filtre the solution; then add sulphuric acid, by little and little, till the liquid has a sensibly acid taste. Lay it aside to cool, and a great number of small shining laminated crystals will form. These are the boracic acid. They are to be washed with cold water, and drained upon brown paper.

Boracic acid, thus procured, is in the form of thin hexagonal scales, of a silvery whiteness, having some resemblance to spermaceti, and the same kind of greasy feel. It has a sourish taste at first, then makes a bitterish cooling impression, and at last leaves an agreeable sweetness. It has no smell; but when sulphuric acid is poured on it, a transient odour of musk is produced.

It reddens vegetable blues. Its specific gravity is 1.479, while in the form of scales; after it has been fused it is 1.803.

It is not altered by light. It is perfectly fixed in the fire. At a red heat it melts, and is converted into a hard transparent glass; which becomes somewhat opaque when exposed to the air, but does not attract moisture. It is much less soluble in water than any of the acids hitherto described. Boiling water scarcely dissolves 0.02 of boracic acid, and cold water a still smaller quantity. When this solution is distilled in close vessels, part of the acid evaporates along with the water, and crystallizes in the receiver. Water, therefore, renders it in some measure volatile, though it is perfectly fixed when in a state of dryness.

Neither oxygen gas, the simple combustibles, the simple incombustibles, nor the metals, produce any change upon boracic acid, as far as is at present known. It is soluble in alcohol; and alcohol containing it burns with a green flame. Paper dipped into a solution of boracic acid burns with a green flame.

Though mixed with fine powder of charcoal, it is nevertheless capable of vitrification; and with soot it melts into a black bitumen-like mass, which is, however, soluble in water, and cannot be easily calcined to ashes, but sublimes in part.

With the assistance of a distilling heat it dissolves in oils, especially in mineral oils; and with these it yields fluid and solid products, which give a green colour to spirit of wine.

When boracic acid is rubbed with phosphorus, it does not prevent its inflammation; but an earthy yellow matter is left behind.

It is hardly capable of oxidizing or dissolving any of the metals except iron and zinc, and perhaps copper.

Boracic acid combines with alkalies, alkaline earths, and alumina, and most of the metallic oxides, and forms compounds which are called borats.

Sub-borat of soda, or common borax. See Borax.

BORAGO, in botany, a genus of the pentandria monogynia class and order of plants, the flower of which consists of a single petal of the length of the cup, and divided into five segments: there is no pericarpium, but the cup grows larger and inflated; and contains four seeds of a roundish figure, rugose, carinated outwardly from the point, globose at the base, and inserted into a hollow receptacle. There are five species. The leaves of borage are accounted good in removing faintness; for which reason the tops are frequently put into wine and cool tankards. Boerhaave recommends the expressed juice in all inflammatory diseases. The flowers are one of the four cordial flowers. The only officinal preparation is the conserve of the flowers.

BORASSUS, in botany, a genus of plants, of the dioecia hexandria class and order. The male and female flowers grow on separate plants, and give the plant such a different figure, that they are called by different names in the Hortus Malabaricus; the male being called ampana, and the female carimpana. The male has for the cup of its flower the whole compound spatha, which is amentaceous and imbricated: the flower is divided into three segments, the petals being hollowed, and of an oval figure: the stamina are six thick filaments, and the antheræ are thick and striated. In the female, the cup is the same as in the male; but the petals of the flower, which is divided into three parts, in the manner of the male, are very small, of a roundish figure, and remain when the pistil, &c. fall off. The germen of the pistil is roundish; the styles are three, and small, and the stigmata are small; the fruit is a roundish obtuse berry, of a rigid structure, and containing only one cell; the seeds are three, and of an oval compressed figure. There is one species, a native of Ceylon.

BORAX, or sub-borat of soda. This salt, according to Bergman, is composed of

39 acid
17 soda
44 water

100.

It is decomposed by the following salts, according to Fourcroy: 1. Sulphats of lime, ammonia, magnesia, glucina, alumina, zirconia. 2. Sulphats of ammonia, magnesia. 3. Nitrats of barytes, strontian, lime, ammonia, magnesia, glucina, alumina, zirconia. 4. Muriats of barytes, strontian, lime, ammonia, magnesia, glucina, alumina, zirconia. 5. Super-phosphat of lime. 6. Phosphats of ammonia, magnesia, glucina, alumina, zirconia. 7. Fluats of barytes, strontian, magnesia, ammonia, glucina, alumina, zirconia.

Borax is sometimes used in medicine as an astringent. It is used as a flux for metals, and enters into the composition of some of the coloured glass pastes made in imitation of gems; but its great use is to facilitate the soldering of the more precious metals. It is employed also as a flux by mineralogists in essaying the properties of minerals by the blow-pipe.

Borat of ammonia may be formed by saturating boracic acid with ammonia. It has scarcely been examined. Fourcroy affirms, that when its solution is evaporated, the ammonia is volatilized, and the acid crystallizes.

Borat of alumina may be formed by mixing together the solutions of borat of soda and sulphat of alumina. It is said to be

scarcely soluble in water, and not to crystallize.

When boracic acid and silica are exposed to a strong heat, they melt together into a transparent glass. This compound has received the name of borat of silica.

BORBONIA, a genus of the decandria order, and diadelphia class of plants. The stigma is emarginated; the calyx has pointed spines; and the legumen is pointed. There are six species, all natives of warm countries. They are a kind of broom; and rise to the height of ten or twelve feet, but in Europe seldom above four or five. They are greenhouse plants, and may be propagated by layers; but as these are generally two years before they put forth roots, the best method is by seeds, which must be procured from their native places.

BORBORITES, borboritæ, in church-history, a sect of gnostics in the second century, who, besides embracing the errors of these Christians, denied the last judgment. Their name comes from βορβορος, filth, on account of a custom they had of daubing their faces and bodies with dirt and filth.

BORDARII, a term mentioned in the Domesday-inquisition; they were distinct from the servi and villani, and were of a somewhat higher rank; having a bord, or cottage, with a small parcel of land allowed to them, on condition that they should supply the lord with poultry and eggs, and other small provisions for his board and entertainment. The same term is used to denote servants employed in fetching wood, drawing water, grinding corn, cleaning yards, &c. by which they are distinguished from villani, employed in the tillage of lands.

BORDURE, in heraldry, a cutting off from within the escutcheon all round it about one-fifth of the field, serving as a difference in a coat of arms, to distinguish families of the same name, or persons bearing the same coat.

If the line constituting the bordure is straight, and the bordure plain, then in blazoning you must only name the colour of the bordure.

BOREAL SIGNS, in astronomy, are the first six signs of the zodiac, or those northwards of the equinoctial.

BORECOLE, see BRASSICA.

BORER, an implement invented for the purpose of searching or exploring the nature of soils. It is composed of two rods of iron, each about six feet long, and an inch in diameter, which screw into one another. By this instrument two men will easily sound the depth of twelve feet in less than a quarter of an hour, if they do not meet with many stones. Thus, without much charge, or any hazard, there is a certainty of discovering what earths are under the upper soil, and whether other substances lie concealed there, such as marl, chalk, fullers' earth, fossile shells, coals, quarries of slate or stone, ores, &c.

BORING, in mineralogy, a method of piercing the earth by a set of scooping-irons, made with joints so as to be lengthened at pleasure. The mineralogist can guess where a vein of ore may lie, though there are none of the common outward signs of it upon the surface of the earth, and in this case he has recourse to boring: the scooping-irons are drawn back at proper times, and the samples of earth and mineral matters they bring up are examined, to know whether it will be worth while to open a mine in the place.

BORING *of water-pipes*. The method of boring water-pipes is as follows. The poles of alder, which is a very useful wood in making pumps, water-pipes, &c. being laid on horses or tressels of a foot in height, to rest the auger upon while they are boring, they set up a lathe to turn the least end of the poles, to fit them to the cavities of the great end of the others. They turn the small ends of the poles about five or six inches in length, to the size they intend to bore the larger ends about the same depth, viz. 5 or 6 inches. This is designed to make a joint to shut each pair of holes together; the concave part being the female part, and the other part the male, of the joint. In turning the male part they turn a channel in it, or a small groove at a certain distance from the end; and in the female part, they bore a small hole to fit over this channel. This being done, they bore the poles through; and to prevent them from boring out at the side, they stick great nails at each end to be a guide in boring. It is usual, however, to bore them at both ends; so that if a pole is crooked one way, they can bore it through and not spoil it.

The operation is now performed with a horse-mill, as at Dorset-stairs, for the New River company.

BOROUGH, BURROUGH, BOROW, or BURGH, a corporation or town which is not a city. The word in its original signification meant a company consisting of ten families, which were bound together as each other's pledge. Afterwards borough came to signify a town, having a wall or some kind of inclosure round it; and all places which formerly had the name of borough, it is said, were fortified, or fenced in some shape or other.

The name is now particularly appropriated to such towns or villages as send burgesses or representatives to parliament, whether they are incorporated or not. They are distinguished into those by charter or statute, and those by prescription or custom: The number in England and Wales, including cities and cinque ports, which elect members, is 215; some of which send one, and some two representatives.

Royal BOROUGHS, in Scotland, are corporations made for the advantage of trade, by charters granted by several of their kings, having the privilege of sending commissioners to represent them in parliament, besides other peculiar immunities. They form a body of themselves, and send commissioners each to an annual convention at Edinburgh, to consult the benefit of trade and their general interest.

BOROUGH-ENGLISH, a customary descent of lands or tenements, in certain places, by which they descend to the youngest instead of the eldest son; or, if the owner has no issue, to the younger instead of the elder brother. This custom goes with the land, although there be a devise or feoffment at the common law to the contrary. The reason of this custom, says Littleton, is because the youngest is presumed, in law, to be least able to provide for himself.

BOROUGH-HEAD, see HEADBOROUGH.

BORRELLISTS, in church-history, a Christian sect in Holland. They are a kind of anabaptists, but they have some very particular opinions. They reject the use of churches, of sacraments, public prayer, and all other external acts of worship.

BOS, in zoology, the ox, a genus of quadrupeds of the order of pecora. The generic character is, horns concave, turned outwards, lunated, smooth; front teeth eight in the lower jaw; canine teeth none.

1st. The Bison, from which the several races of common cattle have been gradually derived, is found wild in many parts both of the old and new continent; inhabiting woody regions, and arriving at a size far larger than that of the domestic or cultivated animal. In this its native state of wildness, the Bison is distinguished, not only by his size, but by the superior depth and shagginess of his hair; which about the head, neck, and shoulders, is sometimes of such a length as almost to touch the ground: his horns are rather short, sharp-pointed, extremely strong, and stand distant from each other at their bases, like those of the common bull. His colour is sometimes of a dark blackish brown, and sometimes rufous brown; his eyes large and fierce; his limbs extremely strong, and his whole aspect in degree savage and gloomy. See Plate Nat. Hist. fig. 59.

The principal European regions where this animal is at present found, are the marshy forests of Poland, the Carpathian mountains, and Lithuania. Its chief Asiatic residence is the neighbourhood of mount Caucasus; but it is also found in other parts of the Asiatic world.

The American bison seems to differ in no respect from the European, except in being more shaggy, and having a more protuberant bunch or fleshy substance over the shoulders.

It grows to a vast size, and has been found to weigh sixteen hundred, and even two thousand four hundred pounds; and the strongest man cannot lift one of the skins from the ground.

These were the only animals which bore any affinity to the European cattle, on the first discovery of the American continent; and might have been made to answer every purpose of the European cow; but the natives, being in a savage state, and living chiefly by chace, had never attempted the domestication of the animal.

2nd, Common ox. This is, in reality, the bison reduced to a domestic state; in which, in different parts of the world, it runs into as many varieties as the sheep; differing widely in size, form, and colour, according to climate and other circumstances. Its importance in this its domestic state needs not be mentioned. Formerly the ox constituted the whole riches of mankind; and he is still the basis of the wealth of nations, which subsist and flourish in proportion to the cultivation of their lands and the number of their cattle. See Plate Nat. Hist. fig. 54. 55.

The British breed of horned cattle has been so much improved by a foreign mixture, that it is difficult to point out the original kind of these islands. Those which may be supposed to have been purely British, are far inferior in size to those of the northern parts of the continent. The cattle of the highlands of Scotland are exceedingly small; and many of them, males as well as females, are hornless. The Welsh runts are much larger: the black cattle of Corn-

wall are of the same size with the last. The large kind that is now cultivated throughout most parts of Great Britain, are either entirely of a foreign extraction, or our own improved by a cross with the foreign kind. The Lincolnshire kind derive their size from the Holstein breed; and the large hornless cattle that are bred in some parts of England came originally from Poland.

3d. Indian ox. This variety is found in many parts of India, also in the Indian and African islands, and particularly in Madagascar. It is of a reddish colour, of a very large size, and is distinguished by a very large protuberance above the shoulders.

4th. Zebu. This variety resembles the preceding, but is extremely small, being found in some parts of India of a size scarcely larger than a great dog. In colour it differs like the common cattle; being either grey, brown, white, &c. or variously spotted. See Plate Nat. Hist. fig. 60.

5th. Loose-horned ox. This is said to be found in Abyssinia and Madagascar, and to be distinguished by pendulous ears, and horns attached only to the skin, so as to hang down on each side.

6. Boury. Of the size of a camel, and of a snowy-whiteness, with a protuberance on the back. Native of Madagascar, and some other islands, called by the name of Boury.

7. Tinian ox. Of a white colour, with black ears. Inhabits the island of Tinian.

II. Bos ARNEE. (Ox with upright lunated horns, flat and wrinkled on their upper surface.)

This is an Indian species, known chiefly from its vast horns, which are sometimes seen in museums, and from Indian paintings, in which it is occasionally represented. It is said to have been met with by a British officer, in the woods above Bengal, and to have been about fourteen feet high, which is to be understood of the measure from the hoofs to the top of the horns. It partakes of the form of the horse, the bull, and the deer, and is a very bold and daring animal.

III. Bos BABYLUS, or Buffalo, (ox with horns lying backwards, turning inwards, and flat on the fore part.) See Pl. Nat. Hist. fig. 61.

In its general appearance, the buffalo is so nearly allied to the common ox, that without an attentive examination, it might pass for a variety of the same animal. It differs, however, in the form of its horns, and in some particulars relative to its internal structure. The buffalo is rather superior in size to the common ox; the head larger in proportion; the forehead higher; the muzzle of a longer form, but at the same time broad and square. But it is principally the form of the horns that distinguishes the buffalo. They are large, and of a compressed or depressed form, with the exterior edge sharp. The buffalo has an appearance of great strength, and a more ferocious or malignant aspect than the bull; owing to the convexity of his forehead, the smallness of his eyes, the flatness of his muzzle, and the flatter and more inclined position of his horns. The general or prevailing colour of the buffalo is blackish, except the hair on the top of the forehead, and that at the tip of the tail, which is of a yellowish white: the skin itself is also of a black colour; and from this general cast it is but very seldom observed to vary.

As the buffalo in his domesticated state is, in general, larger and stronger than the ox, he is employed with advantage in different kinds of labour. Buffaloes are made to draw heavy loads, and are commonly directed and restrained by means of a ring passed through the nose. Two buffaloes yoked, or rather chained, to a cart, are able to draw as much as four strong horses. As they carry their neck and head low, the whole weight of their body is employed in drawing; and their mass much surpasses that of a laboring horse. In its habits the buffalo is much less cleanly than the ox; delighting to wallow in the mud; and, next to the hog, may be considered as the dirtiest of domesticated quadrupeds. His voice is deeper, more uncouth and hideous, than that of the bull. The milk of the female buffalo is said by some authors to be not so good as that of the cow; but it is more plentiful, and is used for the purposes of the dairy in the warmer regions. Italy is the country where buffaloes are at present most common in a domesticated state; being used, as in India, both for the dairy and for draught. The district of the Pontine marshes is the spot which may be considered as their principal station. In India this animal is occasionally used for the saddle, as a substitute for the horse.

The buffalo, like other animals of this genus, admits of varieties as to size and figure. Of these the most remarkable is the small naked Indian buffalo of Mr. Pennant, which is the size of a runt, with a nearly naked body, thinly beset with bristly hair: the rump and thighs quite bare; the first being marked on each side with dusky stripes pointing downwards, the last with two transverse stripes: the horns compressed sideways, taper, and sharp at the point. It is a native of India.

Another variety, still smaller, is said to occur in the mountains of the Celebes, which are full of caverns. This variety is of the size of a middling sheep, and is seen in small herds, very wild, and difficult to be taken; and even in confinement are so fierce, that Mr. Pennant records an instance of fourteen stags being destroyed in the space of a single night by one of these animals which was kept in the same paddock.

IV. Bos MOSCHATUS, or musk ox, having very long pendant hair, and horns (in the male approximated at the base) bending inwards and downwards, and outwards at the tips.

It is a native of North America, where it appears to be a very local animal; being found first in the tract between Churchill river and that of the Seals, on the west side of Hudson's-bay; and is very numerous between the latitudes 66 and 73 north, which is as far as any tribes of Indians go.

This animal is but of small size, being rather lower than the deer, but larger or thicker in body. The hair, in the male, is of a dusky red colour, extremely fine, and so long as to trail on the ground, and render the animal a seemingly shapeless mass, without distinction of head or tail: the legs are very short; the shoulders rise into a lump, and the tail is very short, being a kind of stump of a few inches only, with very long hairs. Beneath the hair, on all parts of the animal, is an extremely fine cinereous wool, which is said to be more beautiful than silk when manufactured into stockings and other articles. The horns are closely united at the base, bending inwards and downwards; but turning outwards towards the tips, which are very sharp: near the base the horns are two feet in girth, but are only two feet long when measured along the curvature: the weight of a pair, separated from the head, is sometimes sixty pounds.

The cow, or female, differs from the male in having the horns much smaller, and placed at the distance of nine inches from each other at the base.

The general colour of the cow is black, except that the legs are whitish, and between the horns there is a bed of white hair intermixed with rust-colour; a dusky mane, or elevated ridge of hair, runs along the back, and on the middle of the back is an oblong patch or bed of pure white.

These creatures delight most in rocky and barren mountains, and seldom frequent the wooded parts of the country. They run nimbly, and are very active in climbing the rocks. Their flesh tastes very strongly of musk; and the heart in particular is said to be so thoroughly impregnated with the flavour as to be scarcely eatable. The flesh, however, is supposed to be very wholesome, and has been found a speedy restorative to sickly crews who have made it their food.

V. Bos GRUNNIENS, or Yak, (having with cylindric horns curving outwards, very long pendant hair, and extremely villose horse-like tail,) is about the height of an English bull, which he resembles in the general figure of the body, head, and legs; it is covered all over with a thick coat of long hair. The head is rather short, crowned with two smooth round horns, which, tapering from the root upwards, terminate in sharp points: they are arched inwards, bending towards each other, but near the extremities are a little turned back.

They are a very valuable property to the tribes of itinerant Tartars, called Duckba, who live in tents and tend them from place to place: they at the same time afford their herdsmen an easy mode of conveyance, a good covering, and wholesome subsistence. They are never employed in agriculture, but are extremely useful as beasts of burden; for they are strong, sure-footed, and carry a great weight. Tents and ropes are manufactured of their hair; and amongst the humbler ranks of herdsmen, caps and jackets are made of their skins. Their tails are esteemed throughout the East, as far as luxury and parade have any influence on the manners of the people. In India no man of fashion ever goes out, or sits in form at home, without two chowrabadars, or brushers, attending him, each furnished with one of these tails mounted on silver or ivory handles, to brush away the flies. The Chinese dye them of a beautiful red, and wear them as tufts to their summer bonnets.

The yak is the most fearful of animals, and very swift; but when chased by men or dogs, and finding itself nearly overtaken, it will face its pursuers, and hide its hind parts in some bush, and wait for them; imagining that if it could conceal its tail, which was the object they were in search of, it would escape unhurt.

VI. Bos CAFFER, or Cape ox, (having the horns very broad at the base, then spreading

NATURAL HISTORY,

BOS TAURUS.

54 Male

Domestic Bull

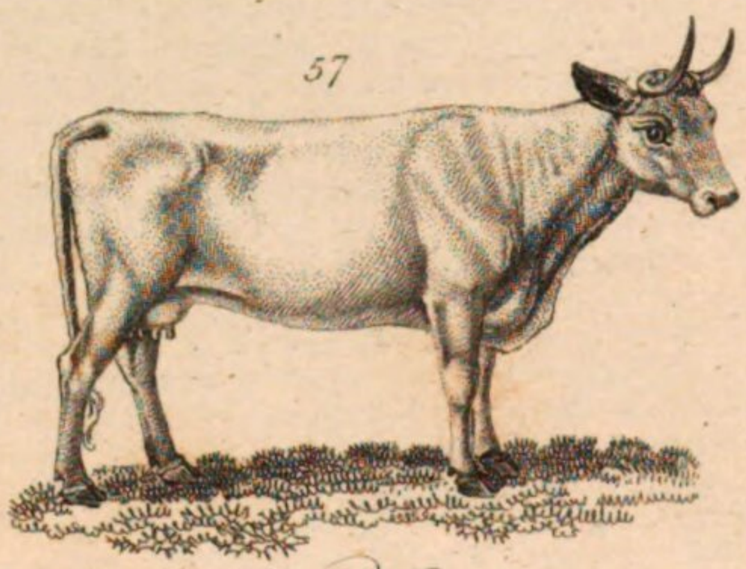
55 Female

Domestic Cow

56

Wild Bull

57



Wild Cow

58

Urus

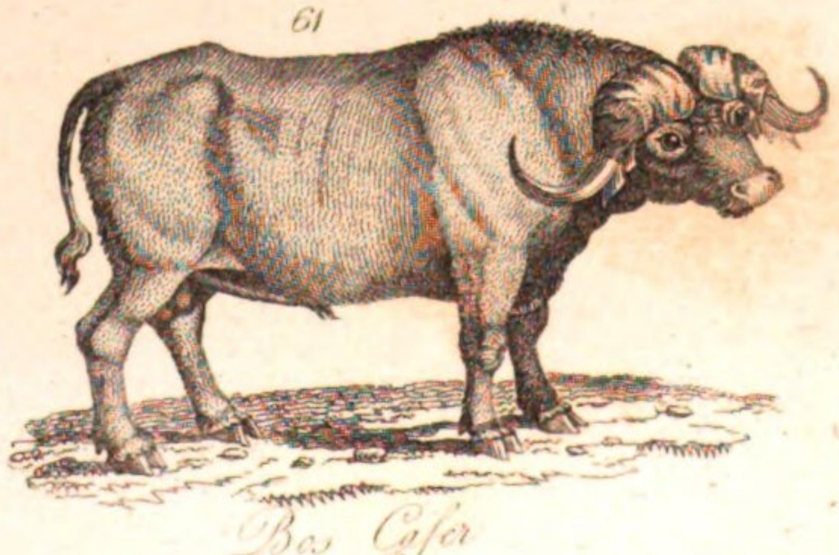
59

Bison

60

Le Jin

61



Bos Cafer
Cape Ox

Printed 1806. for Richard Phillips. 6 Bow Bridge Street, Blackfriars

downwards, next upwards, and at the tips curving inwards); inhabits the interior parts of Africa, north of the Cape of Good Hope, and is greatly superior in size to the largest English ox. It is of a very strong and muscular form, with a fierce and malevolent aspect. Its colour is a deep cinereous brown: the hair on the body is rather short, but that on the head and breast very long, coarse, and black, hanging down the dewlap, like that of a bison: from the hind part of the head to the middle of the back is also a loose black mane: the tail is nearly naked at the base; the remainder being covered with long loose hair.

These animals are found in large herds in the desert parts beyond the Cape; and if met in the narrow parts of woods, are extremely dangerous, rushing suddenly on the traveller, goring and trampling both man and horse under foot. It is also said that they will often strip off the skin of such animals as they have killed, by licking them with their rough tongues, as recorded by some of the ancient authors of the bison. The urcus is the same animal with the common bull in its natural and wild state. See Plate Nat. Hist. fig. 58. See also figs. 56 and 57.

BOSCOI, or Bosci, a tribe of monks in Palestine, who fed on grass like the beasts of the field. They are ranked among the number of Adamites, on account of the little care they took about provision; when they were hungry, they went into the fields, each with his knife in his hand, and gathered and ate what they could find.

BOSEA, GOLDEN-ROD TREE: a genus of the digynia order, and pentandria class of plants; and in the natural method ranking under the 53d order scabridæ. The calyx is pentaphyllous; there is no corolla, and the berry is monospermous. Of this genus there is but one species, viz.

Bosea yervamora. It is a native of the Canary and Caribbee islands, and has been long an inhabitant of the British botanic gardens. It is a pretty strong woody shrub, growing with a stem as large as a man's leg. It may be propagated by cuttings planted in spring; and the plants must be housed in winter.

BOSS, among bricklayers, denotes a wooden utensil in which the mortar used in tiling is to be put. It has an iron hook by which it may be hung on the laths or on the ladder.

BOSSAGE, in architecture, a term used for any stone that has a projecture, and is laid rough in a building to be afterwards carved into mouldings, capitals, coats of arms. It is also that which is otherwise called rustic work, and consists of stones which advance beyond the naked or level of the building, by reason of indentures or channels left in the joinings.

BOSTANGIS, in the Turkish affairs, persons employed in the garden of the seraglio, out of whose number are collected those who are to row in the grand-signior's brigantines.

BOSTRYCHITES *lapis*, a name given to a stone supposed to contain women's hair included in it. Some have understood by it those pieces of crystal which have accidental foulnesses in them resembling hair; others call by this name those German agates which contain either the confervæ or other capillary water-plants. It is also a name given to a species of pyrites, the irradiations of which were supposed to imitate hair.

BOTANY (from Βοτανη, Greek, an herb or plant) formerly implied a knowledge of the nature, uses, and cultivation of plants. In our accounts of the different genera, we have endeavoured to combine these three objects. But as a modern science, botany chiefly applies to the classification of plants; or that systematic arrangement by which, from general marks or characters, the botanist is enabled, first to trace the class, next the order, then the genus, and last of all the species, to which any plant he meets with belongs.

Various systems have been invented for the classification of the vegetable tribes; but that of Linnæus, as the simplest and most decisive, has superseded them all. It is founded on the sexual system, or that which supposes all plants to have male and female parts of generation; a system which there is every reason to believe physiologically true, but which in that view will be more properly treated of under the article PHYSIOLOGY of PLANTS.

SECT. I.—*Of the parts of plants.*

The principal outlines of a plant are thus delineated by Linnæus:

A plant consists of a root, trunk, leaves, props, fructification, and inflorescence, to which may be added the habit.

I. The root consists of two parts, viz. the caudex and the radicula, distinguished according to shape, direction, duration, &c.

1. Caudex, the stump, is the body or knob of the root, from which the trunk and branches ascend, and the fibrous roots descend, and in different plants is either solid, bulbous, or tuberous. Solid, as in trees, shrubs, and many of the herbs. Bulbous is explained under HYBERNACULUM. Tuberous knobs are also solid and hard, containing one or more embryos or eyes. They are either only one knob, as turnip, carrot, &c. containing only one eye at the top; or consist of many knobs connected together by slender fibres, as in potatoes, Jerusalem artichokes, &c. each containing many eyes dispersed over the surface; and are either pitted, when the eyes lie inward, as in potatoes, &c. or tuberculated, containing the eyes outward, as in Jerusalem artichokes, &c. In tuberous knobs, the fibres or stringy parts issue from every part of the surface, which is an essential difference from bulbous knobs, where they are confined to the caudex of the bulb only, and are the true and genuine roots, the bulb itself being only a large bud under ground. Those tuberous knobs with only one eye, differ as to duration, but are in general biennial; those with many eyes are perennial; both seem to be produced by the nutriment of the stemlike buds, and not by the fibrous roots, for the stem is first formed and becomes strong, and as it grows to maturity, the tuberous knobs increase.

2. Radicula, a little root, is the string or fibrous part of the root, descending from the caudex: it is really the principal and essential part of every root, and by which the nourishment is drawn from the earth for the support of the plant.

II. The trunk rises immediately from the caudex; and produces the leaves, flowers, and fruit. It is either herbaceous, shrubby, or arborescent; and is distinguished according to its shape, substance, surface, &c. as follows:

1. Caulis, a stalk or stem, is the main trunk which elevates the leaves and fructification, and is applied to trees, shrubs, and herbs. It is denominated simple when it does not divide, and compound when it is divided into branches.

2. Culmus, a straw or haulm, is the proper trunk of grasses, and also elevates both the leaves and fructification. It is sometimes jointed, and sometimes not: it is also sometimes round and sometimes angular.

3. Scapus, a stalk, is an herbaceous trunk which elevates the fructification, but not the leaves; that is, it is a stalk proceeding immediately from the root, and terminated by the flowers, as in narcissus, hyacinth, &c.

4. Stipes, a trunk, used by Linnæus for the trunk of mushrooms, as also for that slender thread or footstalk which elevates the feathery or hairy down with which some seeds are furnished, and connects it with the seed.

III. The leaves are either simple or compound, and are distinguished by their figure, situation, insertion, number, divisions, &c.

1. A simple leaf is such as adheres to the branch singly, or whose footstalk is terminated by a single expansion, not parted to the middle rib, and is determined by its shape, surface, and divisions.

2. A compound leaf is such whose footstalk is furnished with several separate simple expansions, or whose divisions extend to the middle rib, now called a common petiole or footstalk, supporting several lobes or little simple leaves, of which the compound leaf consists. They are distinguished by shape, &c. and the form by which they are attached to the common footstalk, as palmated, winged, feathered, &c. Sometimes leaves are twice or more compounded, which divisions admit of many modifications, and give rise to as great variety of terms. It may sometimes be difficult, at first sight, to know a common footstalk to a compound leaf from a branch; but a common footstalk, where it issues from the branch, is either flat or hollow on one side, and convex on the other; whereas branches are alike on both sides, whether round, flat, or angular: again, buds are never found at the angles formed by the lobes of a compound leaf with the footstalk, but at the angles formed by the footstalk of the whole compound leaf and the stem; and it may always be certainly distinguished by its falling off with the little leaves which it supports. The manner or place in which leaves are attached to the plant, is called the determination of leaves, and is distinguished by several terms, according to number, disposition, insertion, figure, &c. For the different kinds of leaves, see Plates I. II. III. Botany.

IV. The props, fulcra, a term used to express those external parts which strengthen, support, or defend, the plants on which they are found, or serve to facilitate some necessary secretion, are as follow:

1. Petiolus, the footstalk or support of a leaf.

2. Pedunculus, the footstalk or support of a flower.

3. Stipula, haulm or husk, a sort of scale or small leaf stationed on most plants, (when

present) on each side the base of the footstalk of leaves and flowers, at the first appearance, for the purpose of support. They are placed either single or double, and sometimes on the inside, as in the fig and mulberry; or on the outside, as in the birch, lime, and papilionaceous flowers. They are also either sitting, extended downwards, or sheathing along the stem, as in the plane-tree. As to duration, they sometimes fall before the leaves, and sometimes are equally persistent. They often afford a good distinction for the species.

4. Cirrhus, a clasper or tendril, is the fine spiral string or fibre by which plants fasten themselves to some other body for support. They are sometimes placed opposite to the leaves; sometimes at the side of the footstalks of the leaves; sometimes they issue from the leaves themselves; and sometimes they put out roots, as in ivy, &c.

5. Pubes, a term applied to the hair, down, wool, beard, bristles, glands, and several other appearances on different parts of plants, serving the double purpose of defence and vessels of secretion.

6. Arma, the defensive weapons of plants, as thorns, prickles, &c.

7. Bracteæ, the floral leaves, mean not only those leaves situated on the stalk nearest to the lower parts of the flower, but those which sometimes terminate the flower-stalk, being composed of large bracteæ, resembling a bush of hair. They are then called bracteæ comosæ, as in crown-imperial, lavender, and some species of sage.

V. The fructification, or mode of fruit-bearing, consists of the calyx, corolla, stamina, pistillum, pericarpium, semina, and receptaculum, which are afterwards explained.

VI. The inflorescence, or mode by which flowers are joined to their several peduncles, whether common or partial.

i. A flower, in the sexual system, has a very different signification from the same term of former botanists; for if the antheræ and stigma are present, though the calyx, corolla, filaments of the stamina, and style of the pistillum, be wanting, it is still a flower; and if all the parts are present, it is a complete flower. The seed also constitutes the fruit, whether there is a pericarpium or not.

ii. Complete flowers are either simple or aggregate; simple, when no part of the fructification is common to many flowers or florets, but is confined to one only; aggregate, when the flower consists of many florets collected into a head, by means of some part of the fructification common to them all, as by a common receptacle, or common calyx; as in dipsacus, scabiosa, &c. From the different structure, disposition, and other circumstances of the receptacle or calyx, being the only part common to aggregate flowers, arise seven subdivisions.

1. Aggregate flowers, properly so called, are formed by the union of several lesser flowers, placed on partial peduncles on a common dilated receptacle, and within a common perianthium; and in those flowers where each floret has its proper calyx, that is also a perianthium. A flower is said to be radiate, when the florets in the radius or circumference differ from those in the disk; in which case they are generally larger, and are called semiflorets, from their difference in form, and in distinction from those of the disk, which are called proper florets; and they also differ as to sex, which gives rise to several of the orders in the class syngenesia, which contains the compound flowers.

2. Compound aggregate flowers consist also of several florets, placed sitting (or without partial peduncles) on a common dilated receptacle, and within a common perianthium; and where each floret has its proper calyx, it is also a perianthium. Compound flowers also admit of a further description, viz. each floret consists of a single petal, with generally five divisions, and having five stamina distinct at the base, but united at the top by the antheræ into a cylinder, through which passes the style of the pistillum, longer than the stamina, and crowned by a stigma with two divisions rolled backwards, and having a single seed placed upon the receptacle under each floret. This is the general character of a compound flower, to which there are a few exceptions; it also differs when the flower is radiate; but the essential character of a regular floret consists in the antheræ being united so as to form a cylinder, and having a single seed placed upon the receptacle under each floret.

3. Umbellate aggregatæ are when the flower consists of many florets placed on fastigiate peduncles proceeding from the same stem or receptacle, and which, though of different lengths, rise to such a height as to form a regular head or umbel, whether flat, convex, or concave. Both the common and partial calyx Linnæus calls an involucrum. It is called a simple umbel when it has no lesser divisions; a compound umbel when each peduncle is subdivided at its extremity into many lesser peduncles for supporting the flowers, so as to form several little umbellas, uniting in one head; the whole together is called an universal umbel, and the little umbellas are called partial umbels. In some genera, that have radiated umbels, the florets of the centre and those of the circumference differ both as to sex and size; but in general each have five petals, five stamina, and two styles; or one that is bifid, with a germen placed beneath, and two naked seeds, which when ripe, separate below, but remain connected at the top.

4. Cymous aggregate, (from cyma, a sprout,) called by Linnæus a receptacle, is when several fastigiate peduncles proceed from the same centre like the umbel, and rise to nearly an even height; but unlike the umbel, the secondary or partial peduncles proceed without any regular order, as in sambucus, viburnum, &c.

5. Amentaceous aggregate are such flowers as have a long common receptacle, along which are disposed squamæ or scales, which form that sort of calyx called amentum or catkin, as in corylus, pinus, juglans, &c. Amentaceous flowers generally want the petals, and all of them are of the classes monœcia and diœcia.

6. Glumose aggregate are such flowers as proceed from a common husky calyx belonging to grasses, called gluma; many of which are placed on a common receptacle called rachis, collecting the florets into the spike, as triticum, hordeum, secale, lolium, &c.

7. Spadiceous aggregate are also such flowers as have a common receptacle protruded from within a common calyx, called spatha, along which are disposed several florets. Such a receptacle is called spadix: and is either branched, as in phœnix, or simple, as in narcissus, &c. In this last case, the florets may be disposed either all round it, as in calla, dracontium, pothos, &c. on the lower side of it, as in arum, &c. or in two sides, as in zostera, &c. These flowers have generally no partial calyx.

Under the head of inflorescence might also be mentioned the sexes of plants. There are, besides the above, several other modes of flowering, properly so called, that come under the general term inflorescence, and often afford the best marks to discriminate the species. They are chiefly expressed as follows:

1. Verticillus, a whorl, when the flowers are placed in whorls at each joint round the common stalk: they have very short partial peduncles, are all of the labiated kind, and have either two or four stamina, and four naked seeds, as in salvia, marubium, mentha, &c. A verticil has several distinctions, as naked, bracted &c. and all those genera with four stamina are of the class didynamia, as is seen in mint, thyme, &c.

2. Capitulum, a little head, is when many flowers are connected into nearly a globular form or head, on the summit of the common stalk, sometimes with and sometimes without partial peduncles, as in gomphrena, &c. and is distinguished by its shape and other circumstances. Under capitulum is now introduced the term fasciculus, (a little bundle,) which was formerly considered as distinct. It means when the peduncles are erect, parallel, approaching each other, and raised to the same height, as in sweet-william, where they generally proceed from different parts of the common stalk, opposite to each other.

3. Spica, a spike, is when the flowers, having no partial peduncles, are arranged alternately around a common simple peduncle. It is called spica secunda, (a single-rowed spike,) when the flowers are all turned one way, following each other; and spica disticha, (a double-rowed spike,) when the flowers stand pointing two ways, as in lolium, &c.; and it is distinguished by shape and other circumstances.

4. Corymbus, a cluster of ivy-berries, when the lesser peduncles of the flowers proceed from different parts of the common peduncle or stalk; and though of unequal lengths, and sometimes single, sometimes branched, yet form a regular surface at the top, as in the siliquose plants. The corymbus may be supposed to be formed from a spike, by adding partial peduncles to the flowers, and seems to be the mean between the racemus and umbella, the peduncles rising gradually from different parts of the common stalk, like those of the raceme, and proceeding to a proportionable height like those of the umbel.

5. Thyrsus, a young stalk, a mode of flowering resembling the cone of a pine. Linnæus defines it a panicle contracted into an ovate or egg-shaped form; the lower peduncles, which are longer, horizontally; and the upper, which are shorter, mount vertically, as syringa, &c.

Racemus, a bunch of grapes, is when the flowers are placed on short partial peduncles, proceeding as little lateral branches from and along the common peduncle. It

resembles a spike in having the flowers placed along a common peduncle, but differs from it in having partial peduncles: it also differs from a corymbus in the shortness and equal length of its peduncles, not forming a regular surface at the top, as in ribes rubrum, vitis, &c.

6. Panicula, the tuft upon reeds, is when the flowers are dispersed upon peduncles variously subdivided; or it is a sort of branching spike, composed of several smaller spikes, attached along a common peduncle, as in avena, panicum, and several other grasses, and many other plants. When the partial peduncles diverge and hang loose, it is called a diffuse, and when they converge, it is called a close, panicle.

7. Axillares, such flowers as proceed from the angle formed by the leaf and the stem, as is most common.

8. Terminales, such flowers as terminate the stalk or branch. Every other mode of flowering is called the inflorescence, whether opposite to the leaves, lateral, single, double, erect, bending, &c.

Luxuriant, or double flowers, are considered only as varieties. A luxuriant flower is supposed generally to be owing to superabundant nourishment; the luxuriant part is generally the corolla, butsometimes the calyx also. There are three degrees of luxuriant flowers, viz. 1. multiplicatus; 2. plenus; and 3. prolifer.

1. Flos multiplicatus is when the petals of the corolla are only so far multiplied as to exclude part of the stamina; and is called duplicate, triplicate, quadruplicate, &c. according to the number of rows of petals.

2. Flos plenus is when the corolla is so much multiplied as to exclude all the stamina, which is occasioned by the stamina turning petals, and the flower is often so crowded as to exclude or choke the pistillum also. Therefore, as the essential parts of generation are thus wholly or in part destroyed, the plants become barren and imperfect, and no seed, or very little, can be expected from them. Flowers with one petal are not very subject to fullness; when they are, it generally arises from an increase of the divisions of the petal. It is most usual in flowers of many petals, where it arises various ways; sometimes by multiplication of the petals only, sometimes of the calyx or nectarium, and sometimes of all. Compound flowers are also subject to luxuriance, arising several ways.

3. Flos prolifer is when one flower grows out of another; this generally happens in full flowers, from their greater luxuriancy. In simple flowers it rises from the centre, and proceeds from the pistillum, shooting up into another flower, standing on a single footstalk. In aggregate flowers (properly so called) many footstalked flowers are produced out of one common calyx. In umbellate flowers, a second umbel proceeds from the centre of the first umbel, producing little umbels, which by a greater exertion of luxuriancy, may produce others with little umbels, and thus may produce several heads of flowers, each growing out of that immediately below it, furnished with little umbels variously compounded. A prolific flower is also called leafy (frondosus,) when it produces branches with flowers and leaves; which, though rare, sometimes happens in rosa, anemone, monarda, and others. As in luxuriant flowers many parts of the natural character are deficient in the whole, or in any part, they can only be distinguished by the general habit, and by such parts as remain in the natural state; as very often by the calyx, and in the polypetalous flowers, the lowest series or rows of petals remain the same, as in rosa, papaver, nigella, &c.

4. Flos mutilatus is the opposite imperfection, being such a flower as occasionally is deprived of all, or the greatest part of the petals, yet bears seeds, as in some species of tussilago, campanula, &c. This term is opposed to luxuriance, and is supposed by Linnæus to be caused by a defect of heat, though it may also happen from other causes.

VII. The habit of plants, by which antient botanists meant the whole external appearance of every part, whereby they were arranged in their several systems, is by Linnæus applied to the agreement of plants of the same genus, or natural order, chiefly in the following circumstances:

1. Gemmation. The structure and disposition of the bulb, as solid, coated, scaly, stem. Also of the bud; its origin petioled, stipuled, cortical; its contents leafy, floral, common.

2. Vernation. The complication of the leaves within the bud, as conduplicate or doubled together; convolute or rolled together; involute or rolled in; revolute or rolled back; imbricated or tiled; equitant or riding; obvolute or rolled against each other; plaited or folded over; spiral or coiled like a watch-spring, one end in the centre.

3. Æstivation. The state of the bud in summer, as convolute, imbricated, conduplicate, valved, unequally valved.

4. Tortion. The twisting or bending of the parts, as uniform, dissimilar, from the right, from the left, reciprocal, resupine, spiral.

5. Nuptials. Male, female, androgynous, hermaphrodite.

6. Semination. The shape and other circumstances of the seed, as tail, wing, tuft, awn, hooks, gluten, curvature. Also of the pericarpium; as berrying, inflation, viscosity, elasticity, structure.

7. Placentation. The number and disposition of the cotyledons; or if wanting.

8. Variation. Of colour, size, pubesence, age. 1. External: plaited, bundled, broad-leaved, curled, awnless. 2. Internal: mutilated, great-flowered, luxuriant, crested, viviparous, bulb-bearing. By variation or variety, are meant such differences as are only incidental to vegetables, and are not found constant and unchangeable; that is, where plants raised from the same seed, by some accidental cause differ in their form and appearance from the true character of the species to which they belong; which cause being removed, the plant is restored to its true specific character; and these incidental varieties chiefly arise by difference of soil or culture in some of the above circumstances. And though it is as necessary to collect varieties under their proper species, as the species under their proper genera, yet it is often more difficult: 1st, from the difficulty of ascertaining the genus, and, 2dly, from the danger of confounding the species; and sometimes some parts of the specific character itself are also subject to variety, particularly the leaves; though in general the true specific character is constant and unchangeable, arising only from circumstances in which plants of the same genus are found to disagree, which distinctions are commonly taken with most certainty from the parts explained in this section.

VIII. The hybernaculum, winter lodgment, is that part of a plant which defends the embryo or future shoot from external injuries during the winter, and is either a bulb or a bud.

i. A bulb, bulbus, is a large sort of bud produced under ground, placed upon the caudex of certain herbaceous plants, hence called bulbous plants, all of which are perennial, that is, perpetuated by their bulbs or ground buds, as well as by seeds; they are therefore improperly called roots, being only the hybernacle of the future shoot. Bulbs are of the following sorts:

1. Squamous, consisting of scales laid over each other like tiles, as in the lily.

2. Solid, consisting of a close substance, as in tulips.

3. Coated, consisting of many coats infolding each other, as in onions.

4. Cauline, produced not only from the sides of the principal bulb, called a sucker or offset, but from other parts of the stem; as in crow or wild garlic, and in some species of onion, hence called bulbiferous, where they are produced at the origin of the umbel of flowers.

ii. A bud, gemma, is the embryo of the plant, seated upon the stem of the branches, covered with scales. In general there are three sorts of buds: that containing the flower only, as in poplar, ash, &c. where the leaf-buds and flower-buds are distinct; that containing the leaves only, as in birch, &c.; and that containing both flower and leaves, as in the generality of plants; and these last sometimes contain leaves and male flowers, sometimes leaves and female flowers, sometimes leaves and hermaphrodite flowers. Annual plants are only renewed from seeds; and several other plants, both trees and shrubs, have no winter buds. It is also observed in hot countries, that few plants have buds; or at least that they are without that scaly covering which seems essential to a bud, and constitutes the hybernacle; instead whereof are protruded small featherlike branches from the wings of the leaves, (defence and protection from cold not being necessary;) whereas in cold countries most plants have buds, which are wrapped up all the winter, in readiness to greet the approaching spring.

Analogous to the protection afforded by the buds, is the sleep of plants, which, according to Linnæus, happens various ways; as by converging, including, surrounding, fortifying, conduplicating, involving, diverging, depending, inverting, imbricating. This disposition in plants is very remarkable in chickweed, pimpernell, dandelion, goat's-beard, &c. which expand their flowers only at certain times of the day, and shut them up at the approach of night or a storm; from which may be prognosticated a change of weather. In many plants, not only the flowers, but the young shoots, are defended from external injuries by the nearest leaves converging and inclosing the tender rudiments.—Thus we have delineated the principal outlines of plants; but a more parti-

cular description of those parts which serve chiefly to characterise the different classes, orders, genera, and species, will be given in the following sections, particularly

SECT. II.—*Of the classes of plants.*

The flowers of plants Linnæus very properly made the sole foundation of his beautiful system of botany. Being the same in all parts of the globe capable of producing plants, the classification founded upon them affords a kind of universal language (so to speak) to botanists, whereby they can no longer mistake each others' meaning, as has unfortunately been the case, less or more, with almost all former botanical systems.

Flowers, in respect of sex, are distinguished into male, female, hermaphrodite, and neuter. Male flowers are such as have only the stamina, as in the classes monœcia, diœcia, and polygamia. Female flowers are such as have only the pistilla, as in the same classes. Hermaphrodite flowers are such as have both the stamina and pistilla in the same flower, as in almost all the other classes: hermaphrodites are also distinguished into male hermaphrodites, when the female is ineffectual; and female hermaphrodites, when the male is ineffectual. Neuter flowers are such as have neither stamina nor pistilla perfect.

The plants themselves also take a denomination from the sex of their flowers. Male plants are such as bear male flowers only; female plants bear female flowers only; hermaphrodite plants bear hermaphrodite flowers only. Androgynous plants are such as bear male and female flowers, distinct upon the same root, as in the class monœcia. Polygamous plants are such as bear hermaphrodite flowers, and male or female flowers, or both distinct, on the same or on different roots.

When on the same root, the flowers are either male hermaphrodites and female hermaphrodites; or hermaphrodites and male; or hermaphrodites and female, distinct: if on different roots, the flowers are either hermaphrodites and male; hermaphrodites and female; hermaphrodites and both male and female; or are androgynous and male; and sometimes androgynous and male and female on three distinct plants.

TABLE OF THE CLASSES.

1. Monandria, *i. e.* one male or stamen in an hermaphrodite flower.
2. Diandria, *i. e.* two stamina,
3. Triandria, — three ditto.
4. Tetrandria, — four ditto.
5. Pentandria, — five ditto.
6. Hexandria, — six ditto.
7. Heptandria, — seven ditto.
8. Octandria, — eight ditto.
9. Enneandria, — nine ditto.
10. Decandria, — ten ditto.
11. Dodecandria, - twelve ditto.
12. Icosandria, — twenty or more ditto, inserted into the calyx.
13. Polyandria, *i. e.* all above twenty stamina inserted into the receptacle.
14. Didynamia, *i. e.* four stamina, two long and two short.
15. Tetradynamia, *i. e.* six stamina, four long and two short.
16. Monadelphia, the stamina united into one body by the filaments.
17. Diadelpia, the stamina united into two bodies by the filaments.
18. Polyadelphia, the stamina united into three or more bodies by the filaments.
19. Syngenesia, the stamina united in a cylindrical form by the antheræ.
20. Gynandria, the stamina inserted into the pistillum.
21. Monoecia, male and female flowers distinct, in the same plant.
22. Dioecia, males and females in different plants, of the same species.
23. Polygamia, male, female, and hermaphrodite flowers in the same or different plants.
24. Cryptogamia, the flowers invisible, so that they cannot be ranked according to the parts of fructification, or distinctly described.

These 24 classes comprehend every known genus and species. It is easy to class a plant belonging to any of the first 11 classes, as they all depend on the number of stamina, without regard to any other circumstance: only it is to be observed that the 11th class, dodecandria, although its title is expressive of 12 stamina only, consists of such plants as are furnished with any number of stamina from 11 to 19 inclusive. The reason of the chasm in the classes from 10 to 12 stamina, is, that no flowers have yet been found with only 11, so as to form a class. The reseda indeed has sometimes 11, but often more; and those of the brownea are united below, which brings it under monadelphia.

The 12th class requires more attention. When the stamina amount to above 20, a young botanist will be apt to imagine that the plant belongs to the polyandria class. In reducing plants of this kind to their classes, particular regard must be had to the insertion of the stamina. If they are inserted into the calyx, the plant belongs to the icosandria class; if into the receptacle, it belongs to the polyandria. This distinction it is very necessary to observe, as the fruits of the latter class are frequently poisonous.

The 14th class is likewise in danger of being confounded with the 4th, the number of stamina being the same; but in the 14th, two of them are uniformly much shorter than the other two; at the same time each particular stamen belonging to the different pairs stands directly opposite to one another. The plants of this class are all labiate, or gaping blossoms, as in the snapdragon, foxglove, ground ivy, &c. The 15th class may be mistaken for the 6th, as they consist of the same number of stamina; but in the 15th, four of them are uniformly longer than the other two, and these two are always opposite to each other. The plants of this class are all cruciform; that is, four-petalled, like a cross, as in the cabbage, wall-flower, &c.

In the 16th class, the stamina are united below, but distinct above. The pistilla are also united below in one substance with the receptacle, which is prominent in the centre, but divided above into as many threads as there are germina.

In the 17th class, the corolla is papilonaceous, butterfly-shaped, and the petals are expressed by distinct names; viz. vexillum, the uppermost, which covers the rest; alæ, the two at each side of the flower; and carina, the lowest, which is often bipartite, and placed between the alæ. The antheræ are most frequently 10, one on the upper filament, and 9 on the lower. The pistillum grows out of the receptacle within the calyx. See the common pea.

The 19th class consists of plants whose flowers are composed of a great number of small flowers, inclosed in one common calyx, and therefore styled compound flowers. The whole compound flower in its aggregate state is styled flosculose, because composed of these flosculi or florets. The essence of a flosculose flower consists in having the antheræ united in a cylinder, and a single seed below the receptacle of the floret.

In the 20th class, the stamina grow either upon the pistillum, or upon a receptacle that stretches out in the form of a stylus, and supports both the stamina and the pistillum. The other classes are sufficiently distinguished in the table.

SECT. III.—*Of the orders of plants.*

The orders are inferior divisions, which lead us a step nearer the genus. In the first 13 classes they are taken from the female parts, in the same manner as the classes from the male; and named monogynia, digynia, trigynia, tetragynia, &c. *i. e.* one, two, three, four, &c. pistilla, or female parts. When the pistils have no stalk or filament like the stamina, they are numbered by the stigmata or tops of the pistils, which in that case adhere to the capsule in the form of small protuberances, as may be observed in the flowers of the poppy, &c.

In the 14th class the orders are derived from a different source. The plants belonging to it have their seeds either inclosed in a capsule, or altogether uncovered. Hence they are divided into gymnospermia, comprehending such as have naked seeds; and angiospermia, comprehending such as have their seeds covered, or inclosed in a capsule.

The 15th class is divided into two orders, viz. the siliculosa, or those which have a short pod: and the siliquosa, or those which have a longer one.

The orders of the 16th, 17th, 18th, and 20th classes, are taken from the number of stamina; *e. g.* monadelphia pentandria, decandria, polyandria, &c.

The orders of the 19th class are, 1. polygamia æqualis, those whose floscules are all furnished with stamina and pistils. Polygamia spuria, comprehends plants that have hermaphrodite floscules in the disk, and female floscules in the margin; which is made the foundation of the three next orders, viz. 2. Polygamia superflua, those whose hermaphrodite flowers in the disk are furnished with stigmata, and bear seed, and whose female flowers in the radius likewise produce seeds. 3. Polygamia frustranea, such as have hermaphrodite seed-bearing floscules in the disk; but whose floscules in the radius, having no stigmata, are barren. 4. Polygamia necessaria, is the reverse of the former: the hermaphrodite flowers in the disk want stigmata, and are barren; but the female floscules in the radius are furnished with stigmata, and produce seeds. 5. Polygamia segregata, many floscules inclosed in one common calyx, and each of the floscules likewise furnished with a perianthium proper to itself. 6. Monogamia. This order consists only of seven genera. none of which have properly com-

pound flowers, but are ranked under this class merely from having their stamina united by the antheræ.

The orders of the 21st class are partly taken from the number of stamina, and partly from the names and characters peculiar to some of the other classes; *e.g.* monœcia triandria, monœcia syngenesia, monœcia gynandria.

The orders of the 22d class are founded upon the number, union, and situation of the stamina in the male flowers. The orders of the 23d are all taken from classical characters; *e. g.* polygamia monœcia, polygamia diœcia, and polygamia triœcia.

The 24th class is divided into 4 orders: 1. Filices, comprehending all plants that bear their seeds in the back or edges of the leaf, and those that are called capillary plants. 2. Musci, which comprehends all the moss kind. 3. Algæ, including the lichens, fuci, and many others whose parts of fructification are either altogether invisible or exceedingly obscure. 4. Fungi, comprehending all the mushroom tribe.

For a delineation of the classes, &c. see Plates, Botany, IV. and V.

TABLE OF THE ORDERS.

Classes.	Number and Names of the Orders.
1. Monandria	2 Monogynia, Digynia.
2. Diandria	3 Monogynia, Digynia, Trigynia.
3. Triandria	3 Monogynia, Digynia, Trigynia.
4. Tetrandria	3 Monogynia, Digynia, Tetragynia.
5. Pentandria	6 Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Polygynia.
6. Hexandria	5 Monogynia, Digynia, Trigynia, Tetragynia, Polygynia.
7. Heptandria	4 Monogynia, Digynia, Tetragynia, Heptagynia.
8. Octandria	4 Monogynia, Digynia, Trigynia, Tetragynia.
9. Enneandria	3 Monogynia, Trigynia, Hexagynia.
10. Decandria	5 Monogynia, Digynia, Trigynia, Pentagynia, Decagynia.
11. Dodecandria	5 Monogynia, Digynia, Trigynia, Pentagynia, Dodecagynia.
12. Icosandria	5 Monogynia, Digynia, Trigynia, Pentagynia, Polygynia.
13. Polyandria	7 Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Hexagynia, Polygynia.
14. Didynamia	2 Gymnospermia, Angiospermia.
15. Tetradynamia	2 Siliculosa, Siliquosa.
16. Monadelphia	8 Triandria, Pentandria, Octandria, Enneandria, Decandria, Endecandria, Dodecandria, Polyandria.
17. Diadelphia	4 Pentandria, Hexandria, Octandria, Decandria.
18. Polyadelphia	4 Pentandria, Dodecandria, Icosandria, Polyandria.
19. Syngenesia	6 { Polygamia æqualis, Polygamia superflua, Polygamia frustranea, Polygamia necessaria, Polygamia segregata, Monogamia.
20. Gynandria	9 { Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Octandria, Decandria, Dodecandria, Polyandria.
21. Monoecia	11 { Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Heptandria, Polyandria, Monadelphia, Syngenesia, Gynandria.
22. Dioecia	15 { Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Octandria, Enneandria, Decandria, Dodecandria, Icosandria, Polyandria, Monadelphia, Syngenesia, Gynandria.
23. Polygamia	3 Monœcia, Diœcia, Triœcia.
24. Cryptogamia	4 Filices, Musci, Algæ, Fungi.
Appendix	1 Palmæ.

Some botanists rank these last as a 25th class; but this is improper, as they are all capable of being arranged in the preceding classes of the system, although on account of their singular structure, Linnæus placed them in an appendix. They contain such genera as have a spadix and spatha, *i. e.* whose flowers and fruit are produced on that particular receptacle called a spadix, protruded from a common calyx in form of a sheath, called spatha. This order consists of trees and shrubs only. These have always a simple stem, not branched, bearing leaves at the top, resembling those of fern, being a composition of a leaf and a branch, called frondes; and the corolla has always 3 petals. See Plates IV. and V. Botany.

Sect. IV.—*The genera of plants.*

In investigating the genus of a plant, we must first consider its essence. The essence of every vegetable, says Linnæus, consists in the fructification; the essence of the fructification in the flower and fruit; the essence of the flower consists in the antheræ and stigma, and the essence of the fruit in the seed. Hence he makes the flower and fruit the foundation of his generic distinctions.

These are generally composed of seven parts; the calyx, the corolla, the stamina, the pistillum, the pericarpium, the semina, and the receptaculum; and the presence or absence, the number, figure, proportion, and situation, of the several parts, constitute the genus. But as there are few genera wherein all the parts of the natural character are constant in every one of the species, it is necessary to fix upon such circumstances as are constant in both genus and species, and call those the essential or ruling character; both to distinguish one genus from another, and to fix the several species and their varieties to their respective genera; for which purpose, in some cases, Linnæus was obliged to have recourse to the nectarium. The first four parts of the fructification are properly parts of the flower, and the last three of the fruit.

I. The calyx, or cup, is the termination of the outer bark of a plant. Its chief use is to inclose, support, and pro ect, the other parts of the fructification. When present, it is seated on the receptacle: and is distinguished by its figure; by the number, division, and shape of its leaves, or segments; and by the following names, according to the circumstances with which it is attended.

1. Perianthium, when its station is close to, and surrounds, the other parts of the fructification, is called the perianthium of the fructification: if it includes many floscules, as in scabiosa, and other aggregate and compound flowers, it is called a common perianthium: if it includes only one floscule, it is called a proper perianthium; if it includes the stamina, and not the germen, it is the perianthium of the flower, and is said to be above, as in lonicera, ribes, campanula, &c.; if it includes the germen, but not the stamina, it is the perianthium of the fruit, and is said to be below, as in linnea and morina, each of which have two calyxes and two receptacles above each other, one of the flower and the other of the fruit.

2. Involucrum, when stationed at the foot of an umbel, below the common receptacle, and at a distance from the flower, is called universal, if placed under the universal umbel; and partial, if placed under a partial umbel.

3. Amentum, consists of a great number of chaffy scales, disposed along a slender axis or common receptacle, which, from its resemblance to a cat's tail, has obtained the name of catkin; and these flowers have generally no petals: sometimes the same amentum supports both male and female flowers, distinct, on the same plant, as in carpinus, &c. sometimes the male and female flowers are removed from each other on the same plant, and the amentum supports only the male flowers, and the female flowers are inclosed by a perianthium, as in corylus, fagus, &c. and sometimes an amentum only supports male flowers on one plant, and female flowers on another plant, as in salix, populus, &c.

4. Spatha, a sort of calyx growing from the stalk, bursting lengthways, and protruding a spadix, supporting one or more flowers, which have often no perianthium. It consists either of one leaf, with a valve on one side only, as in the greater number of spathaceous plants; or of two leaves, with two valves, as in stratiotes, &c. or is imbricated, as in musa, &c. with one or two valves.

5. Gluma, a husk, chiefly belongs to corn and grasses, consisting of one, two, three, or more valves, folding over each other like scales, and frequently terminated by a long, stiff, pointed prickle, called the arista.

6. Calyptra, the proper calyx of mosses, is placed over the antheræ of the stamina, resembling an extinguisher, a hood, or monk's cowl.

7. Volva, so named from its infolding, is the proper calyx of funguses, being membranaceous, and surrounding the stalk, before their expansion.

It is often difficult to distinguish the calyx from the bracteæ, which are found on many plants, situated on the flower-stalks: and are often so near to the lower parts of the fructification as to be mistaken for the calyx, as in tilia, passiflora, &c. but they may be best distinguished by this rule; the bracteæ differ in shape and colour from the other leaves of the plant, but are commonly of the same duration; whereas the calyx always withers when the fruit is ripe, if not before.

II. The corolla is the termination of the inner bark of the plant; which accompanies the fructification, in the form of leaves variously coloured. It is generally seated on the receptacle, sometimes on the calyx; serving as an inner work of defence to the part it incloses; as the calyx, which is usually of stronger texture, does for an outer. The leaves of the corolla are called petals; by the number, division, and shape of which, it is distinguished. It is said to be inferior or below, when it includes the germen, and is attached to the part immediately below it, as in borago, &c. and it is said to be superior or above, when it is placed above the germen, as in cratægus, &c. In respect to duration, the corolla either continues till the fruit is ripe, as in nymphæa; or falls off at the first opening of the flower, as in actæa; or with the stamina and other parts of the flower, as in most plants; or does not fall, but withers, as in campanula, &c.

The nectarium, Linnæus says, principally belongs to the corolla, as an appendage to the petals: and contains the honey, which is the principal food of bees and other insects. But though, in plants where it is found, it may be attached to the corolla, and be then most evident; yet it is almost as often attached to other parts of the fructification: Linnæus therefore chiefly makes use of it as an essential character in many of the genera, as being less variable than others; and observes, that when it is not united with the substance of the petals, those plants are generally poisonous: the tube or lower part of monopetalous flowers, he considers as a true nectarium, because it contains a sweet liquor. But as it affords very singular varieties in other instances, it has the following distinctions.

1. Calycine nectaria, such as are situated upon, and make a part of, the calyx; as in tropæolum, monotropa, &c.

2. Corollaceous nectaria are attached to the corolla, and are called calcariate when they resemble a spur. They are either on flowers of one petal, as in valeriana, &c. or on flowers of many petals, as in viola, &c. or within the substance of the petals, as in lilium, iris, &c.

3. Stamineous nectaria attend the stamina, and are either seated upon the antheræ, as in adenanthera; or upon the filaments, as in laurus, &c.

4. Pistillaceous nectaria accompany the pistillum, and are placed upon the germen, as in hyacinthus, butomus, &c.

5. Receptaculaceous nectaria join the receptacle, as in polygonum, sedum, &c.

6. Nectaria that crown the corolla, are placed in a row within the petals, though entirely unconnected with their substance, as in silene, &c. and in this situation often resemble a cup, as in narcissus, &c.

7. Nectaria of singular construction, are such as cannot properly be placed under any of the foregoing distinctions, as in amomum, curcuva, saliva, urtica, &c. The proper use of the nectarium, is not yet discovered.

III. The stamina, or chives, are the males of the flower, proceeding from the wood of the plant. Each stamen consists of two parts, viz. the filament and the antheræ. In most flowers they are placed upon the receptacle, within the corolla, and round the germen; and are chiefly distinguished by number.

1. The filament is the thread-shaped part of the stamen, serving as a footstalk to elevate the antheræ, and sometimes has jags or divisions; which are either two, as in salvia; three, as in fumaria; or nine, as in the class diadelphia. They are also distinguished by their form or figure, as awl-shaped, thread-shaped, hair-like, spiral, revolute, &c. by their proportion, as equal, unequal, irregular, long, or short: and by their situation, being generally opposite to the leaves or divisions of the calyx, and alternate with the petals; that is, when the divisions of the calyx are equal in number to the petals, and to the stamina. In monopetalous flowers they are generally inserted into the corolla; but scarcely ever in flowers of more than one petal, but into the receptacle: yet in the class icosandria they are inserted into the calyx or corolla (though the flowers have many petals), as also in a few other plants. But in the class polyandria, and most other polypetalous plants, they are inserted into the receptacle, like the calyx and corolla. The class gynandria, however, is an exception to the above rules, where the stamina are sometimes without filaments.

2. The anthera, from ανθος, a flower, emphatically so called from its great utility in the fructification, is the top of the filament, containing the impregnating pollen; and is either one to each filament, as in most plants; or one common to three filaments, as in cucurbita, &c. or one common to five filaments, as in the class syngenesia: or sometimes there are two antheræ to each filament, as in ranunculus and mercurialis; three to each filament, as in fumaria; five to three filaments, as in bryonia; or five to each, as in theobroma. The anthera is also distinguished by its form or figure, as oblong, round, angular, &c. It consists of one or more cells, which burst differently in different parts; either in the side, as in most plants; on the top; or from the top to the base. It is also fastened to the top of the filament; either by its base, as in most plants; or horizontally by its middle to the top of the filament, so poised as to turn like a vane: or it is fixed by its side, leaning to the top of the filament, then called incumbent. Sometimes it grows to the nectarium, as in costus; to the receptacle, as in arum; or to the pistillum, in the class gynandria.

IV. The pistillum, or the female of the flower, proceeding from the pith of the plant, is that erect column which is generally placed in the centre of the flower, amidst the stamina; and consists of three parts, the germen, the style, and the stigma.

1. The germen is the base of the pistillum, supporting the style. After some time, it becomes a seed-vessel, and may therefore be considered as the rudiment of the pericarpium. It is distinguished by its shape, number, and situation; and is said to be above or below, according to its situation above or below the attachment of the corolla.

2. The style elevates the stigma from the germen, to receive the influence of the stamina, and to convey it down to the germen as through a tube. It is distinguished either by its number, which, when present (or when absent, the number of stigmata) gives rise to most of the orders, and are called so many females; or by its divisions, being double, treble, or quadruple, &c. though joined at the base; or by its length, being longer, shorter, or equal with the stamina; or by its proportion, being thicker or thinner than the stamina; or by its figure, being regular, cylindric, awl-shaped, bent, &c.; or by its situation, being generally on the top of the germen, though in some instances supposed to be both above and below, as in capparis and euphorbia; unless the lower part in these genera are considered as the extension of the receptacle. It is often placed on the side of the germen, as in hirtella, suriana; also in rosa, rubus, and the rest of the plants in the class icosandria and order polygynia. With respect to duration, it generally falls with the other parts of the flower; but in some plants it is permanent, and attends the fruit to its maturity, as in the class tetradynamia. In flowers which have no style, the stigma adheres to the germen.

3. The stigma, when single, is generally placed like a head on the summit of the style: when several, they are placed on the top, or regularly disposed along the side; and covered with moisture, to retain the pollen of the antheræ. It is distinguished either by its number, being single in most plants; or by its divisions, figure, length, thickness, or duration; as in most plants it withers when the germen is become a seed-vessel; in some it is permanent, as in papaver.

V. The pericarpium is the germen grown to maturity, and become a matrix. All plants, however, are not furnished with a seed-vessel, as corylus, &c. In many, it is supplied chiefly by the calyx, which converging incloses the seeds till they arrive at maturity; as is the case with the rough-leaved plants, and the labial and compound flowers of the classes pentandria, didynamia, and syngenesia. Sometimes the receptacle supplies the office of seed-vessel, as in gundelia; and sometimes the nectarium, as in carex.

The pericarpium is situated at the receptacle of the flower, either above or below, or both, as in saxifraga and lobelia: and is distinguished by the following appellations, according to its different structure.

1. Capsula is frequently succulent whilst green; but when ripe, it is a dry husky seed-vessel, that parts to discharge its contents: and by some elastic motion, the seeds are often darted forth with considerable velocity, as in dictamnus, &c. It opens either at the top, as in most plants; at the bottom; at the side, horizontally across the middle; or longitudinally; and if it is articulated or jointed, it opens at each of the joints, which contains a single seed. It is distinguished externally, by its number of valves; and internally, by the number of its cells, wherein the seed is inclosed; as well as by its shape and substance.

2. Siliqua, a pod, is a pericarpium of two valves; but as some are long, others round or broad, Linnæus distinguishes them by their form into siliqua and silicula, which give name to the two orders in the class tetradynamia. The siliqua is a long pod, being much longer than broad, as in brassica, sinapis, &c.; the silicula, a little pod, is a roundish pod, either flat or spherical, and the length and breadth nearly equal, as in lunaria, draba, &c. In both, the apex, which had been the style, is often so long beyond the valves, as to be of equal length with the pod; and the seeds in both are fastened alternately by a slender thread, to both the sutures or joinings of the valves.

3. Legumen, pulse, is also a pod, and is likewise a pericarpium of two valves, wherein the seeds are fastened to short receptacles along the upper suture only, on each side, alternate: this chiefly belongs to the papilionaceous flowers, or the class diadelphia.

4. Folliculus, or conceptaculum, is a pericarpium of one valve only, opening lengthways on one side, and the seeds not fastened to the suture, but to a receptacle within the fruit, as in asclepias, &c.

5. Drupa is a pericarpium that is pulpy, having no valve. It contains within its substance a nut, or seed inclosed with a hard ligneous crust, as olea, cornus, &c. and when the drupa is seated below the calyx, it is furnished with an umbilicus like the pomum.

6. Pomum, an apple, is also a pulpy pericarpium without a valve; but containing in the middle a membranous capsule, with several cells containing the seeds; and at the end opposite to the footstalk there is generally a small cavity, called umbilicus from its resemblance to the navel in animals; and which was formerly the calyx, seated above the fruit, and persistent, as in pyrus, cucumis, &c.

7. Bacca, a berry, is also a pulpy pericarpium without valve, inclosing one or more seeds, which have no membranous capsule or covering, but are disposed promiscuously through the pulp, as in solanum, &c. and are generally placed on footstalks attached to receptacles within the pulp, as in ribes, &c. The berry also admits of the following distinction: it is said to be proper, when it is a true pericarpium formed of a germen; and improper, when it is formed from other parts of the fructification, as in rosa, juniperus, &c. A large succulent calyx becomes a berry; and in juniperus, the three petals become the umbilicus; in poterium the berry is formed of the tube of the corolla; in fragraria, &c. it is formed of the top of the receptacle; in rubus, &c. it is formed from a seed, which is the receptacle of the berry; in ruscus, &c. it is inclosed within and is a part of the nectary. The berry is commonly either round or oval, and is frequently furnished with an umbilicus, as in ribes, &c. it does not naturally open to disperse the seeds like the capsule, that office being performed by birds and other animals.

8. Strobilus is a pericarpium formed of an amentum, being a seed-vessel composed of woody scales placed against each other in the form of a cone, opening only at the top of the scales, being firmly fixed below to a sort of axis or receptacle, occupying the middle of the cone; as in pinus, &c. For parts of flowers and fruits, see Plates III and V. Botany.

VI. Semina, the seeds, are the essence of the fruit of every vegetable, and defined by Linnæus to be "a deciduous part of the plant, containing the rudiments of a new vegetable, fertilized by the sprinkling of the pollen." They are distinguished according to number, shape, texture, appendage, &c. A seed, properly so called, consists of the five following parts; to which are added the nux and propago.

1. The corculum, (from cor, a heart) is the essence of the seed, and principle of the future plant; and consists of two parts, viz. plumula and rostellum. The plumula is the part which shoots up into the stem, and the rostellum is what forms the root. See Physiology of Plants.

2. The cotyledons, (from cotyledon, the hollow of the huckle-bone), are the thick porous side-lobes of the seed, such as the two sides into which a bean divides when soaked in water, and which afterwards come up as the seed-leaves of the plant. If a plant is cut below the cotyledons, it will scarcely ever put out fresh leaves, but withers and decays; if it is cut above the cotyledons, it generally shoots out afresh, and continues to grow: therefore, if plants whose cotyledons rise above ground, as turnips, &c. are cut or eaten into the ground by cattle, they decay; but where the cotyledons remain below ground, as in grasses, and are cut or eaten to the ground, they will shoot out afresh. Some plants have only one, as in grasses and in cuscuta, &c.; others two, as in vicia, &c.; linum has four; cupressus, five; and pinus, ten.

3. The hilum, the black spot on a bean, called the eye, is the external mark on the seed, where it was fastened within the pericarpium.

4. The arillus, the proper exterior coat of the seed, that falls off spontaneously, is either cartilaginous or succulent: yet seeds are said to be naked, when not inclosed in any sort of pericarpium, as in the class and order didynamia gymnospermia.

5. The coronula is either a small sort of calyx adhering to the top of the seed, like a little crown, and assisting to disperse it by flying, as in scabiosa, knautia, &c. where the little calyx of the floret becomes the crown of the seed: or a down, which is either feathery, as in valeriana, &c. or hairy, as in tussilago, &c. This down has generally been thought intended to disperse the seed. The coronula is either also sitting, that is, attached close to the seed, as in hieracium, &c.; or footstalked by a thread elevating and connecting the tuft with the seed, as in crepis, &c. Some seeds are furnished with a wing, a tail, a hook, an awn, &c. all coming under the term coronula, and tending either to disperse or fix the seeds. Some have an elastic force, to disperse them; which is either in the calyx, as in oats and some others; in the pappus, as in centurea crupina; or in the capsule, as in geranium, &c. Other seeds, especially those whose pericarpium is a berry, as also the nutmeg and other nuts, are dispersed by birds and other animals.

Nux, a nut, a seed inclosed in a hard woody substance, called the shell, which is one-celled, two-celled, &c. and the inclosed seed is called the kernel.

Propago, a slip or shoot, the seed of a moss, which has neither coat nor cotyledon, but consists only of a naked plumula, where the rostellum is inserted into the calyx of the plant.

VII. The receptaculum is the base which receives, supports, and connects, the other parts of the fructification. It is only mentioned by Linnæus, when it can be introduced as a character varying in shape and surface, as principally in the class syngenesia. It is called proper when it supports the parts of a single fructification only; when it is a base to which only the parts of the flower are joined, and not the germen, it is called a receptacle of the flower; in which case the germen, being placed below the receptacle of the flower, has a proper base of its own, which is called the receptacle of the fruit: and it is called a receptacle of the seeds, when it is a base to which the seeds are fastened within the pericarpium. In some simple flowers, where the germen is placed above the receptacle of the flower, the fruit has a separate receptacle, as in magnolia, uvaria, &c. in which genera the numerous germina are seated upon a receptacle rising like a pillar above the receptacle of the fructification. It is styled common, when it supports and connects a head of flowers in common; as in the amentum, and other aggregate flowers. The umbella and cyma are also called receptacles. Rachis, a filiform receptacle, collecting the florets longitudinally into a spike, in many of the glumose flowers, as wheat, barley, rye, &c. Spadix anciently only signified the receptacle of a palm issuing out of a spatha, and branched; but now every flower-stalk that is protruded from a calyx called spatha, is denominated a spadix, as in narcissus, &c.

Sect. V.—*The species of plants.*

The genera include a great number of species, distinguished by the specific difference of the root, the trunk, the branches, the leaves, &c. yet all agreeing in the essential generic character. They are called by trivial names, expressive of the difference of some other circumstance, added to the generic name. To investigate the species, therefore, it is necessary to understand those differences, and to be acquainted with the names by which they are expressed. Several of these have been already incidentally explained; but for a complete enumeration, the reader must have recourse to the glossary.

In general it may be observed, that spe-

Hispid

Ciliated

Rugose

Venose

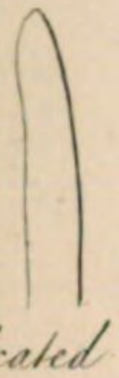
Acutely crenated

Obtusely crenated

Plicated

Crenated

Rounded



Sulcated

Binate

Acute & Emarginated

Cuneiform & Emarginated

Retuse

Pilose

Tomentose

Pinnated abrupt

Nervose

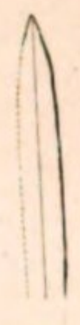
Papillose

Linguiform

Acinaciform

Dolabriform

Deltoide



Triquetrous

Canaliculate

Duplicato ternate

Ternate sessile

Ternate petiolated

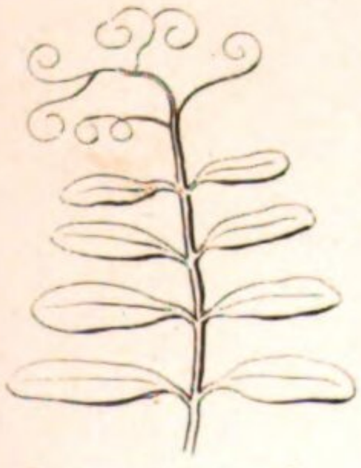
Digitated

Pedated

Pinnated abrupt

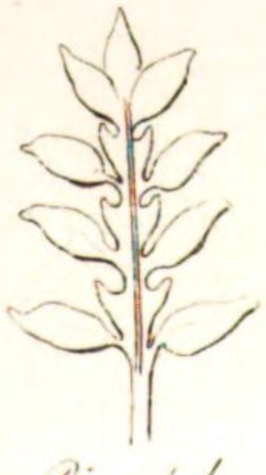
Pinnated alternately

Pinnated interruptedly



Pinnated & cirrhose

Pinnated conjugately



Pinnated decursively

Pinnated articulately

Lyrated

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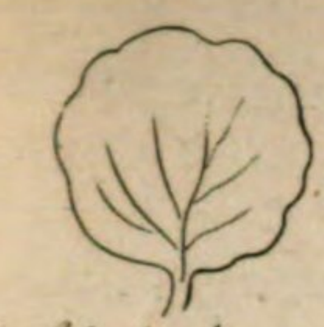


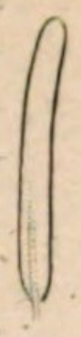
Subrotund

Ovated

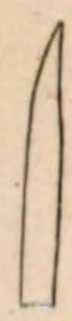
Oval

Oblong

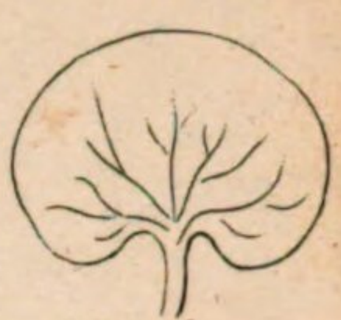
Lanceolated



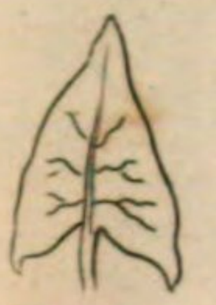
Linear



Subulated



Reniform



Triangular

Sagittated

Cordate sagittated

Hastated

Obversely cordated

Trilobate

Orbiculated

Quinquangular

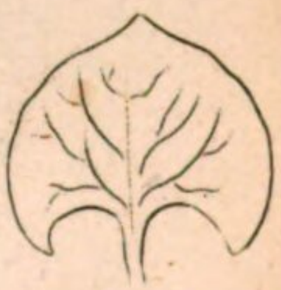
Eroded

Palmated

Pinnatifid

Laciniated

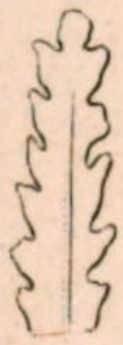
Cordated



Lunulated

Partite

Repandose



Dentated

Serrated

Duplicately serrated

Duplicately crenated

Cartilaginous

Præmorse

Lobated

Curled

Obtuse

Acute

Acuminated

Obtuse with a point

Sinuated

Repand sinuated

Retrorse si

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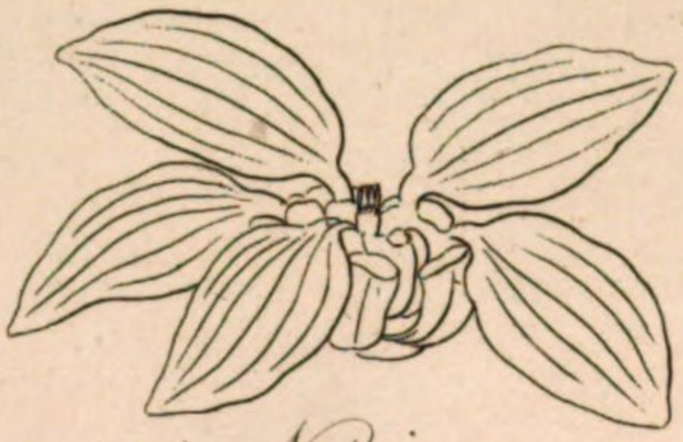
Gynandria

Polygamia

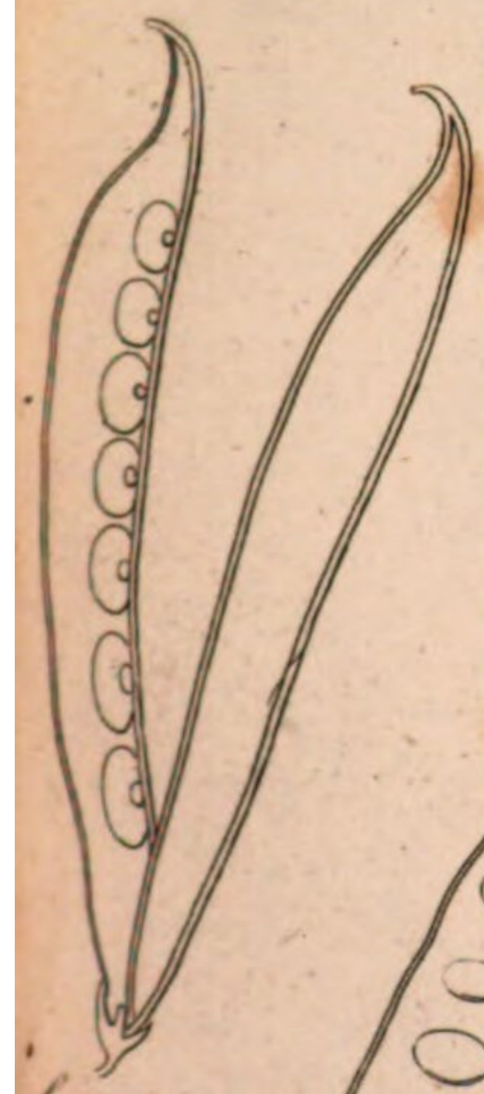
Monoecia

Dioecia

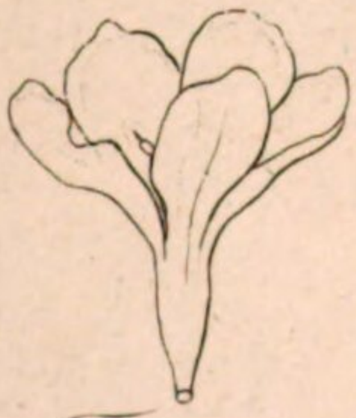
Cryptogamia



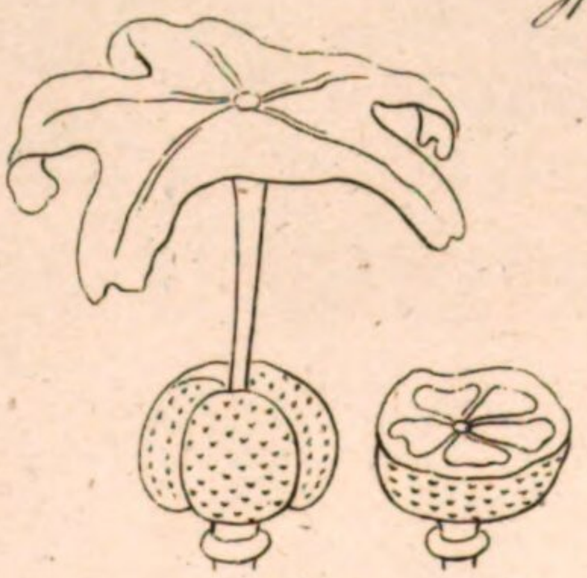
Nectaria



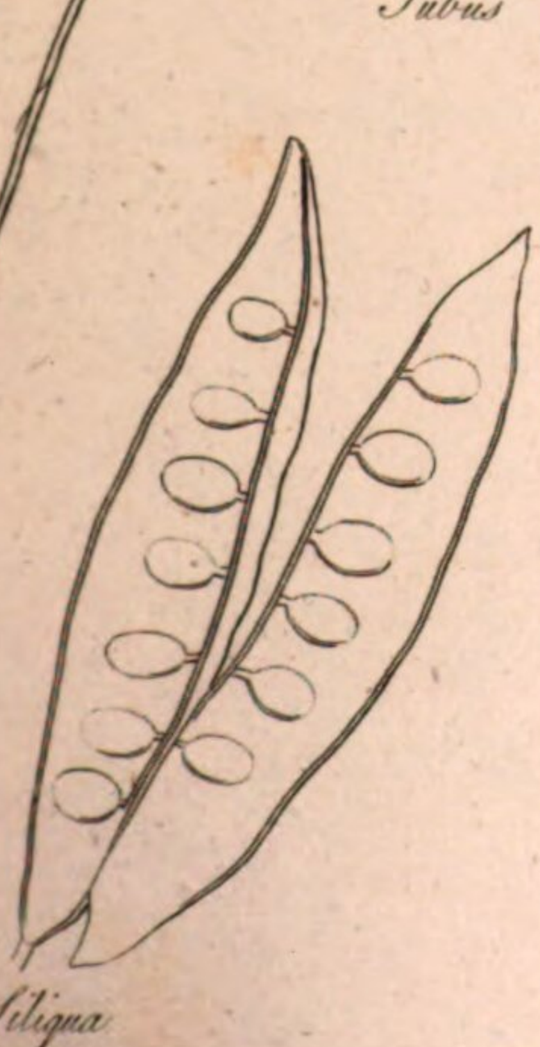
Legumen



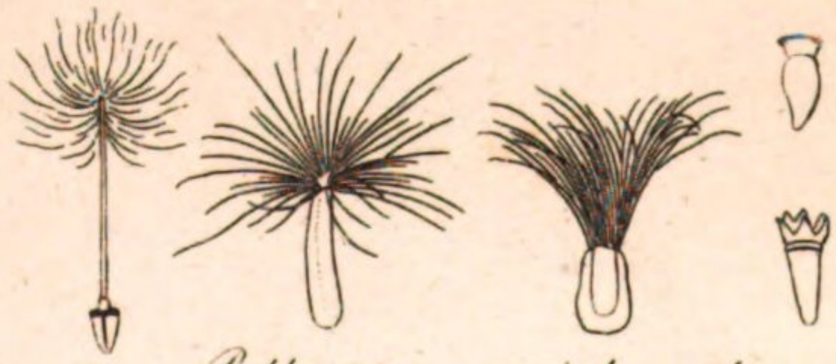
Tubus



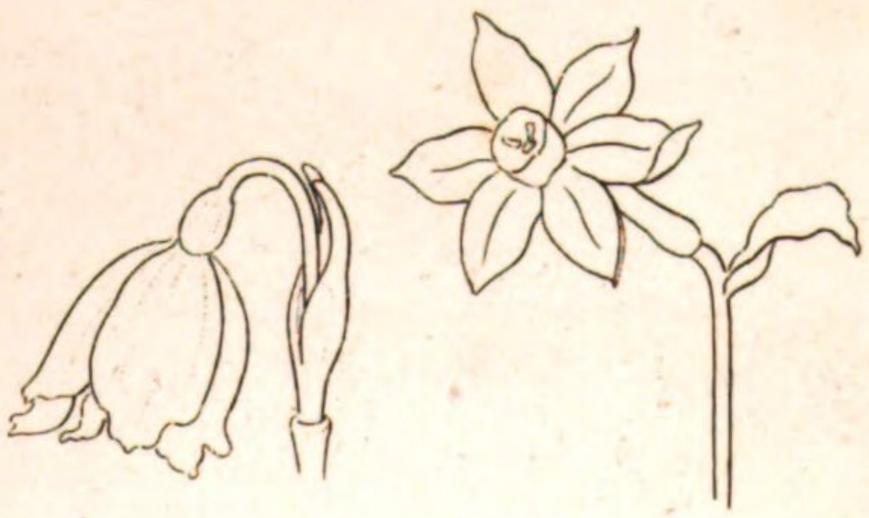
Pericarpium



Siliqua



Pappous & corronaled seeds



Spatha

Monandria

Diandria

Triandria

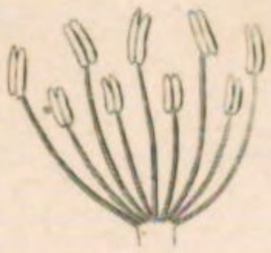
Tetrandria

Pentandria

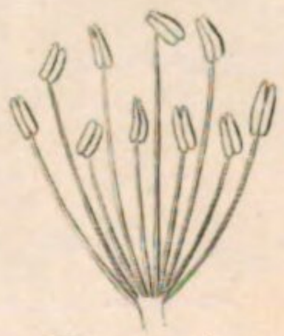
Hexandria

Heptandria

Octandria

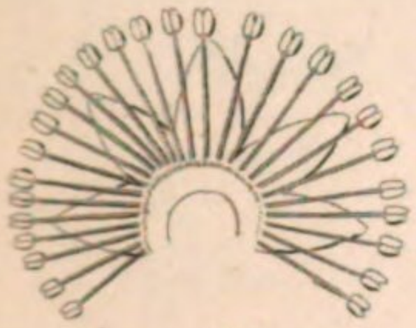


Enneandria

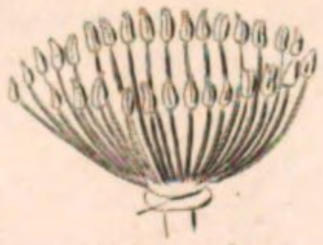


Decandria

Dodecandria

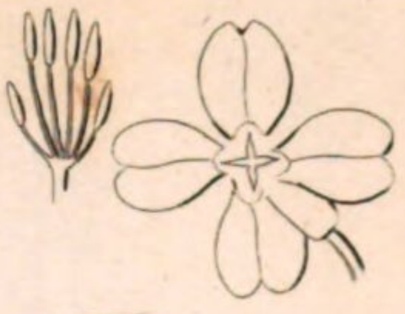


Icosandria

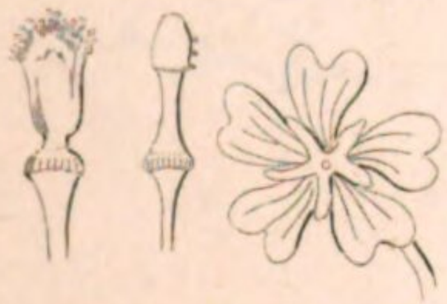


Polyandria

Didynamia

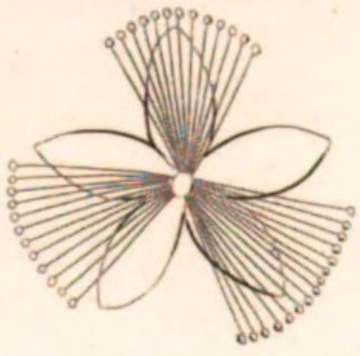


Tetradynamia

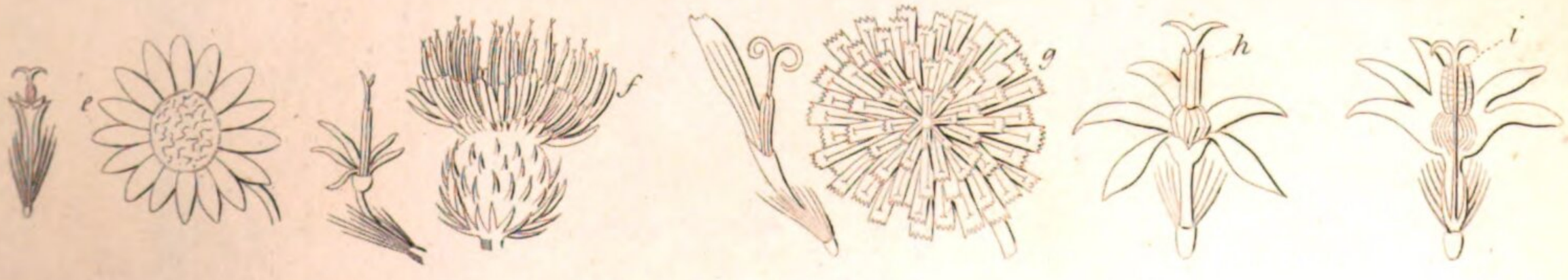


Monadelphia

Diadelphia



Polyadelphia



Syngenesia

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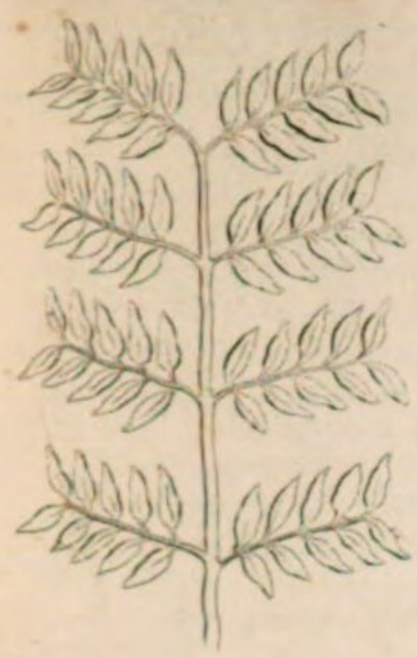
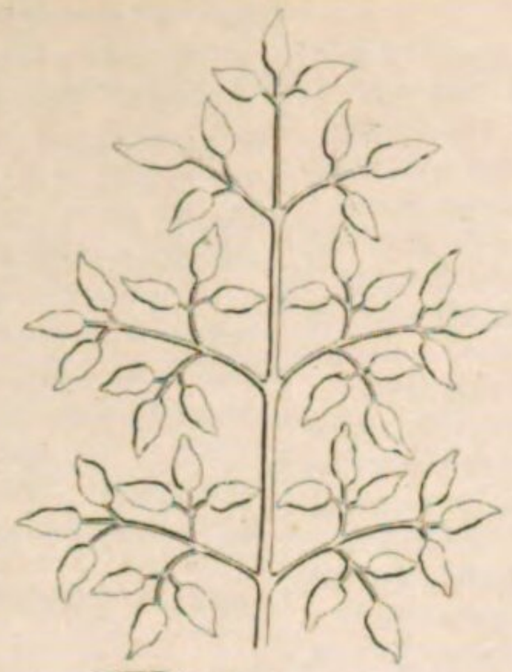
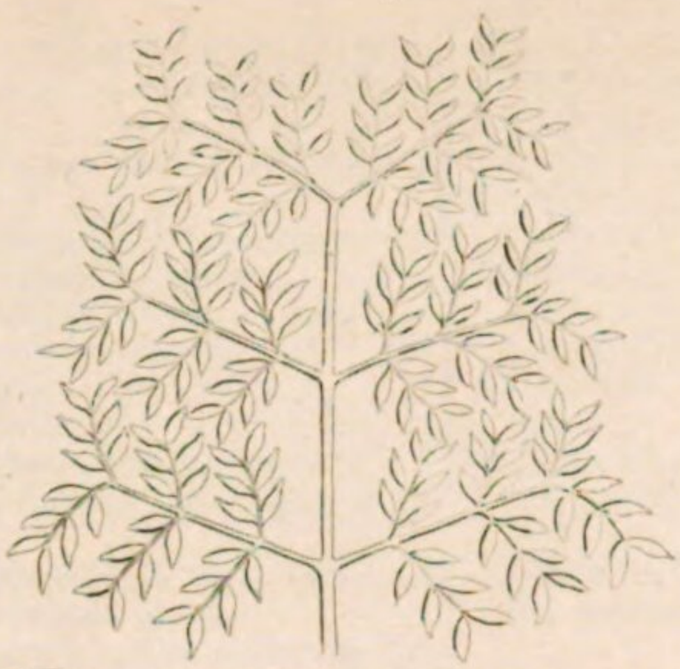


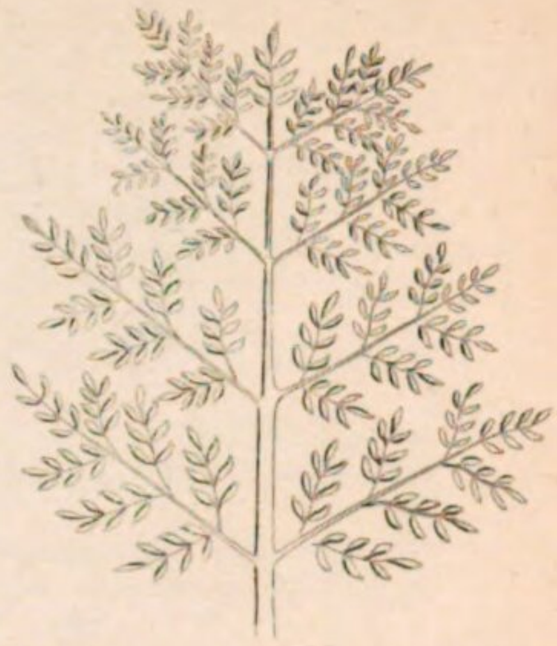
Duplicato pinnated



Triplicato ternate



Triplicato pinnated abrupt Fasciculated



Triplicato pinnated with an odd leaf

Revolute

Reclinate

Horizontal

Patent

Erect

Inflex

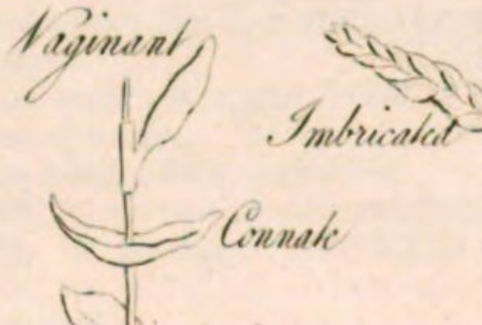
Floral

Ramose

Cauline

Decurrent

Seminal



Vaginant

Connate

Perfoliate

Amplexicaul

Sessile

Petiolated

Peltate

Imbricated

Acerose

Alternate

Opposite

Quaternate

Stellate

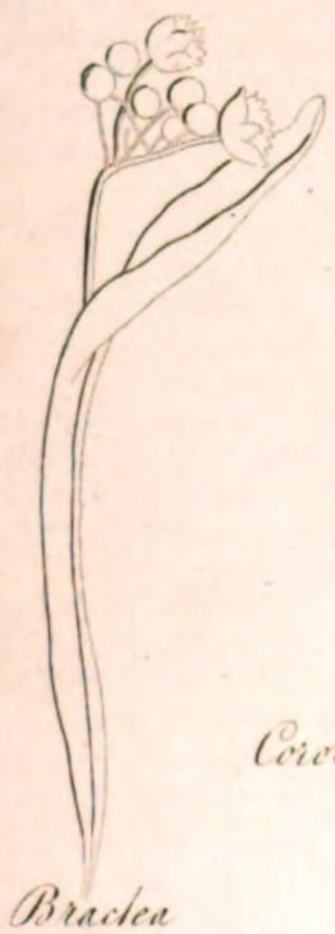
Articulated

Frondis pinnatus

Frondis articulatus

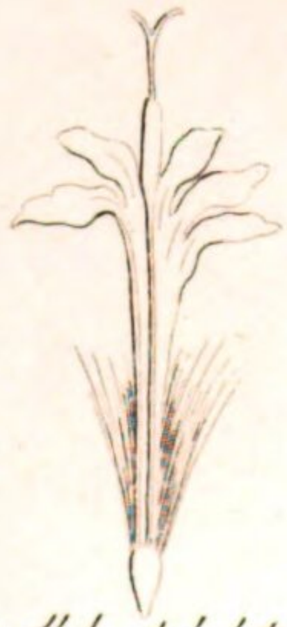
Parts of Flowers & Fruits

Amenta



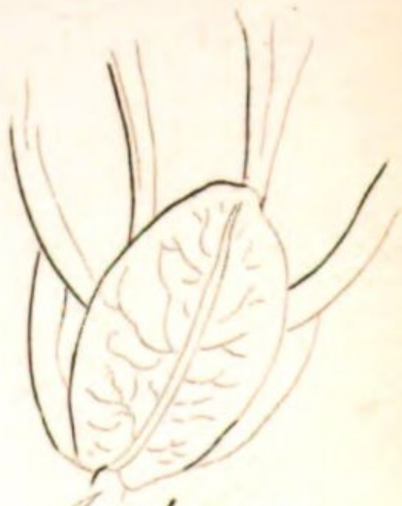
Bractea

Corollula ligulata



Corollula tubulata

Gluma



Involucrum

Printed Apr. 1-1798 for Richard Phillips, 6. New Bridge St Blackfriars

lich, particularly ivy and vine, branches, which attach themselves or tendrils to other bodies.

...ellatæ, from stella, a star, consist of ...s with two naked seeds, and leaves disposed round the stem in form of a radiant star. Spigelia, dogwood, &c. belong to this order. They are opening and cordial.

48. Aggregatæ, plants which have aggregate flowers, consist of a number of florets, each of which have a proper and common calyx: as dipsacus, scabius, &c.

49. Compositæ, plants with compound flowers. Carduus, xeranthemum, &c. are of this tribe.

50. Amentaceæ, plants bearing catkins: salix, &c.

51. Coniferæ, from conus, a cone, and fero, to bear: plants whose female flowers, placed at a distance from the male, either on the same or distinct roots, are formed into a cone. The fir, pine, cypress, &c. all rank under this order. They are gummy and odorous.

52. Coadunatæ, from coadunare, to join, are so termed from the general appearance of the seed-vessels, which are numerous, and being slightly attached below, form all together a single fruit in the shape of a sphere or cone; the parts of which, however, are easily separated. Such are the magnolia, tulip-tree, &c.

53. Scabridæ, from scaber, rough, consist of plants with rough leaves, which seem to be akin to the asperifoliæ; only their degree of roughness is much greater. Hemp, fig, &c. They are astringent. Their taste is bitter and styptic.

54. Miscellaneæ, miscellaneous plants. This order consists of such genera as are not connected together by very numerous relations.

55. Filices, ferns, bear their flower and fruit on the back of the leaf or stalk. They are opening and attenuating.

56. Musci, mosses, resembling the pines, firs, and other evergreens of that class, in the form and disposition of their leaves, and manner of growth of the female flowers, which are generally formed into a cone. They frequently creep, and extend like a carpet upon the ground, trees, and stones; being generally collected into bunches and tufts; the smallest are only one-third of an inch in height, and the largest do not exceed five or six.

57. Algæ, flags, or rather sea-weeds, consist of marine plants, &c. whose root, leaf, and stem, are all one.

58. Fungi, mushrooms, are rarely branched, sometimes creeping, but most commonly erect. These plants are very astringent. As food, they are at best suspicious; some of them are rank poison.

Plantæ dubii ordinis, plants of uncertain order. Under this name Linnæus classes all the other genera which cannot be reduced to any of the above-mentioned orders, and which are near 120 in number.

Though we have already explained the most essential botanical terms, yet the student will often find it advantageous to have recourse to the following glossary; which we would even recommend, should he in any of our descriptions of genera find a term which he does not understand.

A.

Abbreviatum perianthium, a shortened cup, when the cup is shorter than the tube of the flower.
Abortiens flos, a barren flower, such as produces no fruit.
Abrupta folia pinnata, winged leaves, ending without either foliole or cirrhus.
Acaulis, without stalk or stem.
Acerosa folia, chaffy leaves, when they are linear and abiding.
Acicularis, needle-shaped.
Acinaciform, falchion or cimeter-shaped.
Acini, the small berries of a mulberry or bramble.
Acotyledones, plants whose seeds have no cotyledons or seminal leaves.
Aculei, prickles, fixed in the surface of the bark.
Aculeatus caulis, a stalk or stem furnished with prickles.
Acuminatum folium, a leaf ending in a point.
Acutum folium, a leaf terminating in an acute angle.
Adnatum folium, the disk of the leaf pressing close to the stem of the plant.
Adpressum folium, the disk of the leaf pressed to the stem.
Adscendens caulis, or ramus, a stalk or branch inclining upwards.
Adversum folium, an opposite leaf.
Alæ, wings, the side petals of a papilionaceous blossom, or membranes added to a seed, stalk, &c.
Alated, winged.
Alatus petiolus, the footstalk of a leaf winged with membranes.
Alburnum, the white substance that lies between the inner bark and the wood of trees.
Alterni rami folia, leaves that come out singly, and follow alternately in gradual order.
Alveolated, deeply pitted, resembling a honey-comb.
Amentum, a thong, or a catkin.
Amplexicaule folium, a leaf embracing the stalk, when the base of the leaf embraces the stem sideways.
Anceps caulis, a double-edged stalk, i. e. compressed, and forming two opposite acute angles.
Ancipitous, two-edged.
Angulatus caulis, an angulated stalk.
Angustifolious, narrow-leaved.
Angiospermia, plants whose seeds are covered with a capsule.
Annua radix, an annual root; that which lives but one year.
Anthera, the summit of the stamen.
Apertura, an opening in some species of antheræ.
Apetalous, having no petals or corolla.
Apex, the top or summit.
Aphyllous, destitute of leaves.
Apophysis, an excrescence from the receptacle of the musci.
Appendiculatus petiolus, a little appendage hanging from the extremity of the footstalk.
Appressed, approaching to the stem.
Approximata folia, leaves growing near each other.
Arbor, a tree.
Arboreus, arborescent; of the nature of a tree; producing buds.
Arbustiva, a copse of shrubs or trees.
Arcuatum legumen, a curved or bent pod.
Arista, the beard of corn or grasses.
Articulatus caulis, a stem with knots or joints.
Articulus culmi, the straight part of the stalk between the two joints.
Assurgentia folia, leaves first bent down, but rising erect towards the apex.
Attenuatus pedunculus, a footstalk that grows smaller towards the flower.
Auctus calyx, an augmented flower-cup, having a series of distinct leaves, shorter than its own, that surround its base.
Avenia folia, leaves which have no visible veins.
Auriculatum folium, an ear-shaped leaf, when the leaf towards the base has a lobe on each side.
Axillaria folia, leaves growing out of the angles formed by the branches and the stem.

B.

Barba, a beard, a species of pubescence, sometimes on the leaves of plants.
Barbata folia, leaves terminated by a bunch of strong hairs.
Bicapsular, having two capsules.
Biennis radix, a biennial root, which continues to vegetate two years.
Bifaria folia, leaves pointing two ways.
Biferæ plantæ, leaves that flower twice a year.
Bifidum folium, a leaf divided into two parts.
Biflorus pedunculus, a footstalk bearing two flowers.
Bigeminum folium, a forked footstalk, with two little leaves on the apex of each division.
Bijugum folium, a winged leaf bearing two pair of foliola.
Bilabiata corolla, a corolla with two lips.
Bilobatum folium, a leaf consisting of two lobes.
Binatum folium, a digitate leaf, consisting of two foliola.
Bipartitum folium, a leaf divided into two segments.
Bipinnatum folium, a double-winged leaf, when the folioles of a pinnate leaf are also pinnate.
Biternatum folium, a leaf where there are three folioles on a petiole, and each foliole is ternate.
Bivalve, consisting of two valves.
Brachiatus caulis, a stem branching in pairs, each pair standing at right angles with those above and below.
Brachium, the arm, the tenth degree in the Linnæan scale for measuring plants, being 24 Parisian inches.
Bracteatus, having a bractea growing out of it.
Bulbiferus caulis, a stalk bearing bulbs, as in lilium bulbiferum.
Bulbosa radix, a bulbous root.
Bullatum folium, a leaf whose surface rises above the veins, so as to appear like blisters.

C.

Caducus calyx, a flower-cup that falls off at the first opening of the flower.
Calcariatus, resembling a spur.
Calyculatus calyx, a little calyx added to a larger one.
Calyptra, a veil or covering.
Campanulata corolla, a bell-shaped flower.
Canaliculata folia, leaves having a deep channel running from the base to the apex.
Capillaceum folium, a capillary leaf.
Capillaris pappus, hairy down.
Capillus, hair, the first degree of the Linnæan

scale for measuring plants; the diameter of a hair, and the 12th part of a line.
Capitati flores, flowers collected into heads.
Capitulum, a little head; a species of inflorescence, in which the flowers are connected into close heads on the tops of the peduncles, as in gomphrena.
Capreolus, a tendril.
Capsula, a little chest or capsule.
Carina, a keel, the lower petal of the papilionaceous corolla.
Carinatum folium, a leaf whose beak resembles the keel of a ship.
Carnosum folium, a fleshy leaf.
Cartilagineum folium, a leaf whose brim is furnished with a margin of different substance from the disk.
Caryophyllæus flos, a flower growing like a carnation.
Catenulata scabrities, a species of glandular roughness, hardly visible, resembling little chains, on the surface of some plants.
Caudex, the stem of a tree.
Caulescens, having a stalk or stem.
Caulina folia, leaves growing immediately on the stem.
Caulis, a stem, a species of trunk.
Cernuus, nodding or hanging down the head.
Cespitosæ, plants which produce many stems from one root, and form a surface of turf or sod.
Ciliatum, ciliated, with the margin guarded by parallel bristles, formed like the eyelash.
Circinalea folia, leaves within the bud, rolled spirally downward.
Circumscissa capsula, a capsule cut transversely.
Cirrhiferus pedunculus, a peduncle bearing a tendril.
Cirrhosum folium, a leaf that terminates in a tendril.
Cirrhus, a clasper, or tendril.
Classis, a class; defined by Linnæus to be an agreement of several genera in the parts of fructification, according to the principles of nature distinguished by art.
Clavatus petiolus, or pedunculus, a footstalk with the leaf or flower club-shaped, tapering from the base to its apex.
Clavicula, a little key or tendril.
Clausa corolla, a corolla with its neck close shut in with valves.
Coarctati rami, branches close together.
Cochleatum legumen, a pod like the shell of a snail, as in medicago.
Coloratum folium, a leaf of any colour different from green.
Columnella, a little column, the substance that passes through the capsule, and connects the several partitions and seeds.
Columniferæ, pillar-shaped.
Coma, a bush; a species of fulcrum composed of large bracteæ, which terminate the stalk.
Communis gemma, the common contents of the bud, both flower and fruit.
Communis calyx, a common flower-cup containing both receptacle and flower.
Comosa radix, a bulbous root with fibres resembling hair.
Compactum folium, a leaf of a compact and solid substance.
Completus flos, a complete flower, having a perianthium and corolla.
Compositus caulis, a compound stem, diminishing as it ascends.
Compositum folium, a compound leaf, when the petiole bears more than one leaf.
Compressum folium, a leaf resembling a cylinder compressed on the opposite sides.
Concavum folium, a hollowed leaf, the margin forming an arch with the disk.
Conceptaculum, a receiver.
Conduplicatum folium, a leaf doubled together, when the sides are parallel, and approach.
Conferti rami, branches crowded together.
Confertus verticillus, a species of inflorescence, wherein flowers and leaves are crowded, and formed into whorls round the stalk.
Confluentia folia, leaves flowing together, as in the pinnated leaf, when the pinnæ run into one another.
Conglobatus flos, a flower collected into a globular head.
Conglomerati flores, flowers irregularly crowded together.
Congesta umbella, flowers collected into a spherical shape.
Conica scabrities, a species of cetaceous scabrities, formed like cones, scarce visible, on the surface of plants.
Coniferæ, plants bearing cones.
Conjugatum folium, a pinnated leaf, where the folioles come by pairs.
Connata folia, two opposite leaves united at their base, so as to have the appearance of one leaf.
Connivens corolla, a corolla wherein the apices of the petals converge so as to close the flower.
Conniventes antheræ, antheræ approaching together.
Continuatum folium, a continued leaf, or one which appears to be a continuation of the substance of the stalk.
Contrariæ valvulæ, contrary valves, i. e. when the dissepimentum is placed transversely between them.
Convexum folium, a leaf rising from the margin to the centre of the leaf.
Convolutus cirrhus, a tendril twining in the same direction with the sun's motion.
Convolutum folium, a leaf rolled up like a scroll.
Cordatum folium, a heart-shaped leaf.
Cordiformis, shaped like a heart.
Corolla, a wreath or little crown.
Corollula, a little corolla.
Corona seminis, a crown adhering to many kinds of seeds serving them as wings, which enables them to disperse.
Cortex, the outer rind or bark.
Crenatum folium, a notched leaf.
Crispum folium, a curled leaf, when the circumference becomes larger than the disk admits of.
Cristatus flos, a flower with a tufted crest.
Cruciated flowers, } cross-shaped flowers,
Cruciformes flores, } consisting of four petals disposed in the form of a cross.
Cubitus, a cubit, the 9th degree of the Linnæan scale for measuring plants, from the elbow to the extremity of the middle finger, or 17 Parisian inches.
Cucullata folia, leaves rolled up lengthways in the form of a cone.
Culmen, the top or crown of any thing.
Culmus, a reed or straw, the stem of a grass.
Cuneiforme folium, a wedge-shaped leaf.
Cuspidatum folium, a leaf whose apex resembles the point of a spear.
Cyathiformis corolla, a flower of the form of a cup.
Cylindracea spica, a spike in the form of a cylinder.
Cymbiform, keel-shaped.

D.

Dædaleum folium, a leaf whose texture is remarkably beautiful.
Debilis caulis, a weak feeble stalk.
Decaphyllus calyx, a calyx consisting of ten leaves.
Decidua folia, leaves that fall off in winter.
Declinatus caulis, a stalk bending towards the earth.
Decompositum folium, when a petiole once divided connects many folioles.
Decumbens, lying down.
Decurrens folium, a leaf running down, is applied to the base of a sessile leaf extending itself downwards along the stem, beyond the proper termination of the leaf.
Decursive folium pinnatum, a pinnated leaf, wherein the bases of the foliole are continued along the sides of the petiolus.
Decussata folia, } leaves growing in pairs,
Decussated leaves, } and opposite to each other.
Deflexus ramus, a branch bent a little downwards.
Deflorata stamina, stamina that have shed their farina.
Defoliatio, the falling of the leaves.
Deltoides folium, a leaf like the Greek Δ.
Demersa folia, leaves sunk in the water.
Dentata folia, leaves having horizontal points of the same consistence with the leaf, and standing at a little distance from each other.
Dependens folium, a leaf pointing towards the ground.
Depressum folium, a leaf pressed down, when the sides rise higher than the disk.
Dichotomi caules, forked stalks, when the divisions come by two and two.
Dicotyledones, plants whose seeds have two cotyledons, that are the placenta of the embryo plant, and afterwards the seed-leaves.
Didymæ antheræ, twin antheræ, i. e. when they occur by two on each filament.
Didynamia, the superiority of two.
Diformia folia, leaves on the same plant of different forms.
Diffusi caules, the branches of a stalk spread different ways.
Digitatum folium, a fingered leaf, i. e. when the apex of a petiole connects many folioles.
Dimidiatum, halved.
Dipetalous, consisting of two petals.
Diphyllous, consisting of two leaves.
Discus, a disk, the middle part of a radiate compound flower.
Dispermous plants, plants producing their seeds by two.
Dissecta folia, leaves cut into divisions.
Dissepimentum, a partition of the fruit, which divides the pericarpium into cells.
Dissiliens siliqua, a pod that bursts with elasticity.
Distans verticulus, a species of inflorescence, wherein the whorls of verticillate flowers stand at a great distance from one another.
Disticha folia, leaves in two rows, on two sides of the branches only.
Divaricati rami, branches standing wide from each other in different directions.

Divergentes rami, branches widening gradually.
Dodrans, the 7th degree in the Linnæan scale for measuring the parts of plants, or nine Parisian inches.
Dodrantalis, nine inches long.
Dolabriforme folium, a leaf resembling an ax.
Dorsalis arista, an awn fixed to the back of the glumа.
Drupa, a pulpy pericarpium.
Duplica radix, a double root; a species of bulbous root, consisting of two solid bulbs.
Duplicato-serratum folium, a leaf sawed double, with lesser teeth within the greater.

E.

Ebracteatus, without a bractea.
Ecaudata corolla, a corolla without a tail or spur.
Echinatum pericarpium, a pod beset with prickles, like a hedgehog.
Efflorescentiæ tempus, the time of efflorescence, when a plant shews its first flowers.
Elliptical, resembling an oval.
Emarginated, terminated by a notch.
Enervia folia, leaves having no apparent nerves.
Enneapetala corolla, a flower consisting of nine petals.
Enodis, having no knots or joints.
Ensatæ, plants having sword-shaped leaves.
Ensiformia folia, leaves shaped like a two-edged sword, tapering towards the point.
Epiphyllospermous, bearing the fruit on the back of the leaf.
Equitantia folia, leaves riding, i. e. when their sides approach so, that the outer embrace the inner.
Erectus, upright, perpendicular.
Erosum folium, a gnawed leaf, i. e. when the margin appears as if it were gnawed or bitten.
Exserta stamina, stamina standing forth, when they appear above the corolla.
Exstipulatus, without stipulæ.
Exsuccum folium, a leaf whose substance is dry.
Extrafoliaceæ stipulæ, stipulæ growing on the outside of the leaves.

F.

Farctum folium, a stuffed leaf.
Fasciata planta, a plant with many stalks grown together, like a bundle.
Fascicular, consisting of fleshy parts connected to the base without the intervention of threads.
Fascicularis radix, a bundled root, i. e. tuberous roots growing in bundles.
Fasciculata folia, bundled leaves; growing in bunches.
Fastigiati pedunculi, peduncles pointed at the apex.
Fauces, } the jaws or opening between the
Faux, } segments of the corolla, where the tube terminates.
Fibrosa radix, a fibrous root.
Filamentum, from filum, a thread, the part that supports the antheræ.
Filiform, thread-shaped.
Fimbricata petala, fringed petals.
Fissum folium, a leaf split half-way down.
Fistulosus caulis, a hollow stem.
Flabellatum folium, a fan-shaped leaf.
Flaccidus pedunculus, the footstalk of a slender flower.
Flagellum, a twig or shoot, like a whip.
Fleshy, filled with a firm pulp.
Flexosus caulis, a stalk having many turnings or bendings, taking a different direction at every joint.
Floralia folia, floral leaves, that immediately attend the flower.
Floralis gemma, a flower-bud.
Flos, a flower.
Flosculus, a little flower.
Foliaceæ glandulæ, glands growing on the leaves.
Foliaris cirrhus, a tendril growing from a leaf.
Foliaris gemmatio, a leaf-bud.
Foliatio plantæ, the complication of the leaves whilst folded within the bud.
Foliatus caulis, a leafy stalk.
Folifera gemma, a bud producing leaves.
Foliolum, a little leaf, one of the single leaves, several of which united constitute a compound leaf.
Foliosum capitulum, a leafy head, i. e. covered with leaves amongst the flowers or tops of the plant.
Folium, a leaf.
Folliculus, a little bag.
Fornicatum petalum, a vaulted or arched petal.
Frequens planta, a common plant, growing every where.
Frondescentiæ tempus, the season when the leaves of plants are unfolded.
Frondosus cordex, a species of trunk composed of a branch and a leaf blended together.
Fructescentiæ tempus, the time when a plant scatters its ripe seeds.
Fructificatio, the temporary part of a vegetable appropriated to generation, terminating the old plant and beginning the new.
Frustranea, to no purpose.
Frutex, a shrub.
Fruticosus caulis, a shrubby stalk.
Fugacissima petala, petals of short duration.
Fulcratus caulis, a branch having a prop.
Fulcrum, a prop or support.
Furcata, forked.
Fusiform, spindle-shaped.

G.

Galea, a helmet, applied to the corolla of the class gynandria.
Galeatum labium, the lip of a flower, shaped like a helmet.
Geminæ stipulæ, stipulæ growing in pairs.
Geminatus pedunculus, a double footstalk growing from one point.
Gemmiparous, bearing buds.
Geniculatus, jointed.
Geniculæ, little joints.
Germen, a sprout or bud.
Gibbum folium, a leaf bunching out.
Glaber, smooth, having an even surface.
Glabrous, of a slippery nature.
Gladiata siliqua, a sword-shaped pod.
Glandulæ, glands, or secretory vessels.
Glandulifera scabrities, a kind of bristly roughness on the surface of some plants, on which there are minute glands at the extremity of each bristle.
Glareosi loci, gravelly places.
Glaucophyllus, an azure-coloured leaf.
Globosa radix, a round root.
Globularis scabrities, a species of glandular roughness, scarce visible to the naked eye, the small grains of which are exactly globular.
Glochoides, the small points of the pubes of plants. Linnæus applies this term only to the hami triglochoides, with three hooked points.
Glomeratæ spicæ, flowers crowded together in a globular form.
Gluma, a husk or chaff.
Glutinosity, a slippery juice like glue or paste.
Gramina, grasses.
Granulatæ radices, } consisting of many little
Granulated roots, } knobs, like seeds or grain, attached to one another by small strings.
Gymnospermous, naked-seeded.
Gynandria, male and female parts united.

H.

Hamosæ setæ, hooked bristles.
Hamus, a hook; an acuminated crooked point.
Hastata folia, leaves resembling the head of a spear.
Hemisphericus calyx, a half-round flower-cup.
Herba, an herb; the part of the vegetable arising from the root, terminated by the fructification, and comprehending the stem, leaf, props, and hybernacula.
Herbaceæ plantæ, perennial plants, which annually perish down to the root.
Herbacei caules, stalks that die annually.
Hexagonus caulis, a stalk with six angles.
Hexapetalæ corollæ, flowers consisting of six petals.
Hexaphyllus calyx, a flower-cup consisting of six leaves.
Hians corolla, a gaping flower.
Hirsutus, rough, hairy.
Hispidus caulis, a stalk covered with strong fragile bristles.
Holeraceæ, pot-herbs.
Horizontalis flos, a horizontal flower, growing with its disk parallel to the horizon.
Hybridæ plantæ, mule plants.
Hypocrateriformis corolla, a monopetalous flower, shaped like a cup or salver.

I. J.

Imberbis corolla, a flower without a beard.
Imbricatus, tiled, i. e. when the scales of a stalk, or flower-cup, lie over one another like tiles upon a house.
Immutatæ, unaltered.
Impar, odd, applied to a pinnated leaf terminating in an odd lobe.
Inane, filled with spongy matter.
Inanis caulis, a hollow or empty stalk.
Incana folia, leaves covered with whitish down.
Incisa folia, leaves cut into irregular segments.
Incompletus flos, an imperfect flower without petals.
Incrassati pedunculi, footstalks that increase in thickness as they approach the flowers.
Incumbens anthera, an anthera affixed to the filament sideways.
Incurvatus caulis, a stalk bowed towards the earth.
Indivisum folium, an undivided leaf.
Inerme folium, a leaf unarmed, i. e. without prickles.
Inferus flos, a flower whose receptacle is situated below the germen.
Inflated, puffed out like a bladder.
Inflexa folia, leaves bending inwards to the stem.
Infundibuliform, shaped like a funnel.
Insertus petiolus, a footstalk inserted into the stem.
Integrum folium, an undivided leaf.
Integerrimum folium, an entire leaf, whose margin is destitute of incisions.

Interfoliaceus pedunculus, a flower-stalk arising from between opposite leaves.
Interrupta spica, a spike of flowers, interrupted by small clusters of flowers between the larger ones.
Interruptum folium pinnatum, the large folioles of a winged leaf, interrupted alternately by pairs of smaller ones.
Intorsion, twisting to one side.
Intrafoliaceæ stipulæ, stipulæ growing on the inside of the leaves of a plant.
Inundata loca, is applied by Linnæus to places that are overflowed only in winter.
Involucellum, a partial involucrum.
Involucrum, a cover.
Involuta folia, leaves rolled in, i. e. when their lateral margins are rolled spirally inwards on both sides.
Irregularis flos, an irregular flower.
Juba, a crest of feathers.
Iulus, a catkin.

K.

Kernel, a seed covered with a shell.
Kidney-shaped, having a notch cut out of the base, without posterior angles.

L.

Labiatus flos, a lipped flower.
Lacera folia, leaves whose margin is cut into segments, as if rent or torn.
Laciniæ, segments or divisions.
Laciniatum folium, a leaf cut into irregular segments.
Lactescentia, milkiness.
Lacunosa folia, leaves deeply furrowed by the veins being sunk below the surface.
Lacustres plantæ, plants which grow in lakes.
Lævis, smooth, having an even surface.
Lamina, a thin plate, the upper expanded part of a polypetalous flower.
Lana, wool, a species of pubescence which covers the surface of plants.
Lanatum folium, a woolly or downy leaf.
Lanceolatum folium, a lance-shaped leaf.
Lappet, the superior spreading part of a monopetalous corolla.
Laterales flores, flowers coming from the sides.
Laxus caulis, a loose or slender stalk.
Leguminous plants, plants whose seeds are inclosed in pods.
Lenticularis scabrities, a species of glandular scabrities, in the form of lentils.
Leprosus, spotted like a leopard.
Liber, the inner rind of a plant.
Lignosus caulis, a woody stem.
Lignum, wood.
Ligulated, } a flower whose petals are tu-
Ligulatus flos, } bulated at the base, plain on the outside, linear towards the middle, and widest at the extremity, in form of a bandage.
Liliaceous, like a lily.
Limbus, a border, the upper expanded part of a monopetalous flower.
Linea, a line, the second degree in the Linnæan scale for measuring plants; the 12th part of an inch.
Lineare folium, a narrow leaf, whose opposite margins are almost parallel.
Lineata folia, leaves whose superficies are marked with parallel lines, running lengthways.
Lingulatum folium, a leaf shaped like a tongue.
Lobata folia, } leaves divided to the middle
Lobed leaves, } into parts that stand wide from each other, and have their margins convex.
Loculamentum, a cell, a division of a capsula.
Locus foliorum, the particular part of a plant to which the leaf is affixed.
Lomentaceous, like bean-meal.
Longiusculus, somewhat long.
Longum perianthium, a long perianthium, i. e. when the tube of the calyx is equal in length to that of the corolla.
Lucidum folium, a clear shining leaf.
Lunata folia, moon-shaped leaves, round and hollowed at the base like a half-moon.
Lunulated, shaped like a crescent.
Luridus, pale, wan, or dismal.
Lyratum folium, a leaf shaped like a lyre.

M.

Marcescens corolla, a flower withering on the plant.
Margo folii, the margin of the leaf.
Masculus flos, a male flower, containing antheræ, but no stigma.
Masked flower, a flower gaping, but shut close between the lips.
Mas planta, a male plant.
Matrix, a seed-vessel.
Medulla, marrow, the pith of a plant.
Membranacea folia, leaves which have no distinguishable pulp between their surfaces.
Membranatus caulis, a stalk covered with thick membranes.
Miliaria scabrities, a species of glandular roughness on some plants, like grains of millet.
Milky plants, plants whose juices are white, red, or yellow.
Monocotyledones, plants whose seeds have a single cotyledon.
Monoecia, one house.
Monopetalous, having but one petal.
Monophyllous, consisting of one leaf.
Monospermous, having one seed.
Mucronatum folium, a leaf terminating in a sharp point.
Multifidum folium, a leaf divided into many linear segments.
Multiflorous, bearing many flowers.
Multipartitum folium, a leaf divided into many parts.
Multisiliquæ, plants with many pods.
Muricatus caulis, a stalk whose surface is covered with sharp points, like the murex.
Muticous, without a beard or prickle.

N.

Naked, without bristles or hairs.
Natans folium, a leaf which swims on the surface of water.
Navicularis valvula, the valve of a seed-vessel resembling a ship.
Nervosum folium, a leaf whose surface is full of nerves or strings.
Nervous, having unconnected small vessels, like nerves, running from the base to the top.
Nidulantia semina, seeds in the pulp of a berry.
Nitidum folium, a bright glossy leaf.
Nucleus, a kernel.
Nudus, naked.
Nutans caulis, a nodding stalk.

O.

Obcordatum petalum, a heart-shaped petal, with its apex downwards.
Obliquum folium, a leaf whose apex points obliquely towards the horizon.
Oblongum folium, an oblong leaf.
Obsoleta lobata folia, leaves having lobes scarcely discernible.
Obtusa folia, leaves rounded at the apex.
Obvoluta folia, leaves rolled against each other, when their respective margins alternately embrace the straight margin of the opposite leaf.
Officinales, plants used in medicine, and kept in the apothecaries' shops.
Operculum, a cover.
Oppositifolious, } branches and leaves
Oppositi rami folia, } that grow by pairs opposite each other.
Orbiculatum folium, a round leaf.
Orgya, a fathom, or six Parisian feet.
Ovale folium, an oval leaf.
Ovarium, the germen.
Ovatum folium, an egg-shaped leaf.

P.

Pagina folii, the surface of a leaf.
Palea, chaff, a thin membrane rising from a common receptacle, which separates the flosculi.
Paleaceus pappus, chaffy down.
Palmata radix, a handed root.
Palmatum folium, a leaf shaped like an open hand.
Palustris, marshy or fenny.
Panduriform, shaped like a guitar.
Papilionaceous, butterfly-shaped.
Papillosum folium, a leaf covered with dots or points like nipples.
Pappus, down.
Papulosum folium, a leaf whose surface is covered with pimples.
Parabolical, in form of a parabola.
Parallelum dissepimentum, the dissepiment parallel to the sides of the pericarpium.
Parasiticæ plantæ, plants that grow only out of other plants.
Partialis umbella, a partial umbel.
Partiale involucrum, a cover at the base of the partial umbel.
Partitum folium, a divided leaf.
Parvum perianthium, a little flower-cup.
Patens, spreading.
Patulus calyx, a spreading cup.
Pauciflorous, having few flowers.
Pedalis caulis, a stalk a foot in height.
Pedatum folium, a species of compound leaf, whose divisions resemble the toes of the foot.
Pedicellus, a little footstalk.
Peduncularis cirrhus, a tendril proceeding from the footstalk of a flower.
Pedunculati flores, flowers growing on footstalks.
Pedunculus, the footstalk of a flower.
Peltatum folium, a leaf in which the footstalk is inserted into its disk instead of its base.
Penicilliforme stigma, a stigma in the form of a painter's pencil.
Pentagonus caulis, a five-angled stalk.
Pentapetalous, consisting of five petals.
Pentaphyllous, consisting of five leaves.
Perennial, continuing for many years.
Perfecti flores, flowers having petals; the perfect flowers of Ray, Tournefort, and other botanists.
Perfoliatum folium, a leaf whose base entirely surrounds the stem, or through whose centre the stalk grows.
Perforati cotyledones, perforated cotyledons.
Perianthium, i. e. surrounding the flower, a species of calyx.
Pericarpium, i. e. round the fruit, a pod.

Perichætium, a circular tuft of fine hair-like leaves, surrounding the bases of the filaments in the musci and algæ.
Petaliforme stigma, a stigma resembling the shape of a petal.
Petaloides flos, a flower having petals.
Petiolaris cirrhus, a tendril proceeding from the footstalk of a leaf.
Petiolatum folium, a leaf growing on a footstalk.
Petiolus, a little footstalk.
Pileus, a hat or bonnet, the orbicular expansion of a mushroom, which covers the fructification.
Pilosum folium, a leaf whose surface is covered with long distinct hairs.
Pinnatifidum folium, a winged leaf; applied to simple leaves whose laciniæ are transverse to the rachiæ.
Pinnatum folium, a winged leaf.
Pixidatum folium, a kind of foliage where one leaf is let into another by a joint.
Planipetalous, with plain flat petals.
Planum folium, a plain flat leaf.
Plicatum folium, a plaited leaf.
Plumata seta, a feathered bristle.
Plumosus pappus, a kind of soft down.
Pollex, a thumb, the length of the first joint of the thumb, or a Parisian inch.
Polycotyledones, many cotyledons.
Polygamia, many marriages.
Polygynia, many females.
Polypetalous, consisting of many petals.
Polyphyllous, consisting of many leaves.
Polyspermous, containing many seeds.
Polystachius culmus, a stalk of grass having many spikes.
Præmorsa radix, a bitten root, ending abruptly.
Prismaticus calyx, a triangular flower-cup.
Procumbent, lying on the ground.
Prominulous, jetting out beyond the valves.
Pronum discum folii, a leaf with its face downwards.
Proprium involucrum, an involucrum at the base of an umbellated flower.
Pulposum folium, a pulpy leaf.
Pulveratum folium, a leaf powdered with a kind of dust like meal.
Punctatum folium, a leaf sprinkled with hollow dots or points.
Putamineous, like a shell.

Q.

Quadrangulare folium, a leaf with 4 prominent angles in the edge of its disk.
Quadrifidum folium, a leaf divided into 4 parts.
Quadrijugum folium, a leaf having 4 pair of folioles.
Quadrilobum folium, a leaf consisting of 4 lobes.
Quadripartitum folium, a leaf consisting of 4 divisions down to the base.
Quaterna folia, verticillate leaves, having 4 in each whorl.
Quina folia, verticillate leaves by fives.
Quinatum folium, a digitate leaf with 5 folioles.
Quinquangulare folium, a leaf with 5 prominent angles in the edge of its disk.
Quinquefidum folium, a leaf consisting of 5 divisions, with linear sinuses, and straight margins.
Quinquejugum folium, a pinnated leaf with 5 pair of folioles.
Quinquelobum folium, a leaf with 5 lobes.
Quinquepartitum folium, a leaf consisting of 5 divisions down to the base.

R.

Rachis folii pinnati, the middle rib of a winged leaf, to which the folioles are affixed.
Radiatus flos, a species of compound flowers, in which the florets of the disk are tubular, and those of the radius ligulate.
Radicalia folia, leaves proceeding immediately from the root.
Radicans caulis, a stalk bending to the ground, and taking root where it touches the earth.
Radicata folia, leaves shooting out roots.
Radius, a ray, the ligulate margin of the disk of a compound flower.
Ramea folia, leaves that grow only on the branches, and not on the trunk.
Ramosissimi caules, stalks abounding with branches irregularly disposed.
Ramosus caulis, a stalk having many branches.
Ramus, a branch of a tree.
Reclinatum folium, a leaf bending downwards.
Recurvatum folium, a leaf bent backwards.
Reflexus ramus, a branch bent back towards the trunk.
Remotus verticillus, a species of inflorescence, wherein the whorls of flowers and leaves stand at a distance from one another.
Reniforme folium, a kidney-shaped leaf.
Repandum folium, a leaf having a bending or waved margin without any angles.
Repens caulis, a creeping stalk, either running along the ground, or on trees or rocks, and striking roots at certain distances.
Repens radix, a creeping root extending horizontally.
Reptans flagellum, a twig creeping along the ground.
Restantes pedunculi, footstalks remaining after the fructification has fallen off.
Resupinatio florum, the upper lip of a flower facing the ground, and the lower lip turned upwards.
Resupinatum folium, a leaf, the lower disk of which looks upward.
Retroflexus ramus, a branch bent in different directions.
Retrofractus pedunculus, a footstalk bent back towards its insertion, as if it were broken.
Retusum folium, a leaf with its apex blunt.
Revolutum folium, a leaf rolled back.
Rhombeum folium, a leaf whose shape nearly resembles a rhombus.
Rhomboideum folium, a leaf of a geometrical figure, whose sides and angles are unequal.
Rigidus caulis, a stiff or rigid stem.
Rimosus caulis, a stalk abounding with clefts and chinks.
Ringens, grinning or gaping.
Rosaceus flos, a flower whose petals are placed in a circle like those of a rose.
Rostellum, a little beak.
Rotaceous, like a wheel.
Rotatus limbus corollæ, a wheel-shaped flower, expanded horizontally, having a tubular basis.
Rotundatum folium, a roundish leaf.
Rubra lactescentia, red milkiness.
Ruderata loca, rubbishy places.
Rugosum folium, a rough or wrinkled leaf.

S.

Sagittatum, arrow-shaped.
Sarmentosus caulis, the shoot of a vine, naked between each joint, and producing leaves at the joints.
Scaber caulis, a scabby and rough stalk, having tubercles.
Scabrities, a species of pubescence, composed of particles scarcely visible, on the surface of plants.
Scandens caulis, a climbing stalk.
Scariosa folia, leaves dry on the margin, that sound when touched.
Scorpioides flos, a flower resembling the tail of a scorpion.
Scutellum, a species of fructification which is orbicular, concave, and elevated in the margin.
Scyphifer, cup-bearing.
Secretoria scabrities, a species of glandular roughness on the surface of some plants.
Securiformis pubescentia, a species of pubescence on some plants, the bristles resembling an axe.
Seminalia folia, seed-leaves.
Semiteres caulis, a half-round stalk, flat on one side.
Sempervirens folium, an evergreen leaf.
Sena folia, leaves growing in sixes.
Sericeum folium, a leaf whose surface is of a soft silky texture.
Serratum folium, a sawed leaf.
Sessile folium, a leaf growing immediately to the stem, without any footstalk.
Setæ, bristles.
Setacea folia, leaves shaped like bristles.
Simplex caulis, a single stem.
Sinuatum folium, a leaf whose sides are scalloped.
Solidus caulis, a solid stalk.
Solitarius pedunculus, a solitary flower-stalk, i. e. when only one proceeds from the same part.
Solutæ stipulæ, loose straw.
Sparsus, scattered without order.
Spathaceous, like a sheath.
Spatulatum folium, a leaf in the form of a spatula.
Spica, a spike; a species of inflorescence in grasses, ressmbling an ear of corn.
Spicula, a little spike.
Spinæ, thorns, or rigid prickles.
Spinescent, hard and pricking.
Spinosus caulis, a stalk with strong prickles, whose roots proceed from the wood of the stem, and from the surface of the bark.
Spirales cotyledones, seminal leaves twisted spirally.
Spithama, a span, or 7 Parisian inches.
Splendentia folia, shining leaves.
Squamosa radix, a scaly root.
Squarrosum, rough, scaly, or scurfy.
Stamineus flos, flowers having stamina, but no corolla.
Statuminatæ, an order of plants in the former Fragmenta Methodi Naturalis of Linnæus.
Stellata folia, leaves surrounding a stemlike the rays of a star.
Stellatæ setæ, bristles arising from a centre in form of a star.
Sterilis flos, a barren flower; masculus of Linnæus.
Stigma, a mark, the apex of the pistillum.
Stimuli, stings.

Stipitatus pappus, a kind of trunk that elevates the down and connects it with the seed.
Stipulares glandulæ, glands produced from stipulæ.
Stolo, a shoot which, running on the surface of the ground, strikes root at every joint.
Striati caules, culmi, &c. channelled streaks running lengthways in parallel lines.
Strictus caulis, a straight stiff shoot.
Strigæ, ridges or rows.
Stylus, the style, from stylus a pillar.
Submersum folium, the leaf of an aquatic plant, sunk under the surface of the water.
Subramosus caulis, a stalk having few branches.
Subrotundum folium, a leaf almost round.
Subulatum folium, an awl-shaped leaf.
Suffrutex, an under shrub.
Sulcatus caulis, or culmus, a stalk deeply furrowed lengthways.
Superus flos, a flower whose receptacle stands above the germen.
Supra-axillaris pedunculus, the footstalk of a flower whose insertion is above the angle formed by the branch.
Supra decomposita folia, composite leaves which have little leaves growing on a subdivided footstalk.
Supra-foliaceus pedunculus, the footstalk of a flower inserted into the stem immediately above the leaf.
Surculus, a twig, the stalk of a moss.
Swob, a legumen, or pod.
Syngenesia, generating together.

T.

Tegumentum, a cover.
Teres caulis, a cylindrical stalk.
Tergeminum folium, a leaf 3 times double, when a dichotomus petiolus is subdivided, having two foliola on the extremity of each division.
Ternata of folia, leaves in whorls by threes.
Tessalatum folium, a chequered leaf, whose squares are of different colours.
Tetradynamia, the superiority of 4.
Tetragonus caulis, a square stalk.
Tetrapetalous, consisting of 4 petals.
Tetraphyllous, consisting of 4 leaves.
Tetraspermous, producing 4 seeds.
Thalamus, a bed, the receptacle.
Theca, a sheath.
Tomentosus, covered with a whitish down like wool.
Tomentum, a species of woolly or downy pubescence, covering the surface of some plants.
Torosum pericarpium, a brawny protuberance, like the swelling of the veins, when a pericarpium is bunched out by the inclosed seeds.
Torta corolla, a flower with the petals twisted.
Tortillis arista, a twisted awn.
Transversum dissepimentum, the dissepiment at right angles with the sides of the pericarpium.
Trapeziforme folium, a leaf having 4 prominent angles, whose sides are neither equal nor opposite.
Triangulare folium, a triangular leaf.
Tricocca capsula, with 3 cells, and a single seed in each.
Tricuspidated, three-pointed.
Trifidum folium, a leaf divided into 3 linear segments, having straight margins.
Triflorus, bearing 3 flowers.
Trigonus caulis, a three-sided stalk.
Trihilatum semen, a seed having three eyes.
Trijugum folium, a winged leaf with three pairs of foliola.
Trilobum folium, a leaf with three lobes.
Trilocular folium, a leaf having the pericarpium divided into three loculaments.
Trinervum folium, a leaf having three strong nerves running from the base to the apex.
Triœcia, three houses.
Tripartitum folium, a leaf divided into three parts down to the base.
Tripetalous, consisting of three petals.
Tripetaloideæ, three-petalled.
Triphyllous, consisting of three leaves.
Tripinnatum folium compositum, a leaf having a triple series of pinnæ, or wings.
Triplinerve folium, a leaf having three nerves running from the base to the apex.
Triquetrum folium, or triquetra caulis, a leaf, or stalk, having three plain sides.
Trispermous, three-seeded.
Triternatum folium compositum, a compound leaf when the divisions of a triple petiolus are subdivided into threes.
Trivalve pericarpium, a pod consisting of 3 valves.
Truncatum folium, a leaf having its apex as it were cut off.
Truncus, the body or stem of a tree.
Tuberculatus, having pimples or tubercles.
Tuberculum, a little pimple.
Tuberosa radix, a knobbed root.
Tubulatum perianthium, a tubular flower.
Tubulosi flosculi, tubular florets nearly equal.
Tubus, a tube.
Tunicatus radix, a species of bulbous root, having coats lying one over another from the centre to the surface; as in the onion, &c.
Turbinatum pericarpium, a kind of pod shaped like a top, narrow at the base, and broad at the apex.
Turgidum legumen, a swollen pod.
Turiones, the young buds of pines.

V. U.

Viginalis, sheathed.
Vaginans folium, a leaf like a sheath.
Valvula, a valve.
Venosum folium, a leaf whose whole surface is run over by veins.
Ventricosa spica, a spike narrowing at each extremity, and bellying out in the middle.
Ventriculosus calyx, a flower-cup bellying out in the middle, but not in so great a degree as ventricosus.
Verrucosa capsula, a capsule having little knobs or warts on its surface.
Versatilis anthera, an anthera fixed by the middle on the point of the filament, and so poised as to turn like the needle of a compass.
Verticalia folia, leaves so situated that their base is perpendicular above the apex.
Verticillated branches, flowers, or leaves; such as surround the stem, like the rays of a wheel.
Vesicula, a little bladder.
Vesicula is scabrities, a kind of glandular roughness, resembling vesicules.
Vexillum, a standard, the upright petal of a papilionaceous flower.
Villosus, covered with soft hairs.
Virgatus caulis, a stalk shooting out.
Viscidum folium, a clammy leaf.
Viscositas, clamminess.
Uliginosa loca, boggy places.
Umbella, an umbel or umbrella.
Umbellatus flos, an umbellated flower.
Umbellula, a little umbel.
Umbilicatum folium, a leaf shaped like a navel.
Uncinatum stigma, a hooked stigma.
Undatum folium, a waved leaf, whose surface rises and falls in waves towards the margin.
Undulata corolla, a flower whose petals are waved.
Unguis, a nail or claw; that part of a petal that is joined to the receptacle.
Unicus flos, a single flower.
Unicus radix, a single root.
Uniflorus pedunculus, a footstalk with one flower.
Unitelateralis, growing on one side.
Universalis umbella, an universal umbel.
Volubilis caulis, a twining stalk.
Urecolata corolla, a pitcher-shaped flower.
Urens caulis, or folium, a stalk or leaf burning, or stinging, as nettles.
Utricula, a species of glandular secretory vessels, on the surface of various plants.

W.

Waved, having the disk alternately bending up and down in obtuse plaits.
Wedge-shaped, growing narrower towards the base.
Whirl, or Whorl, { leaves, flowers, &c. surrounding a stalk or trunk at the joints in great numbers.

BOTE, *bota*, in our old law books, signifies recompence or amends: thus man-bote, is a compensation for a man slain. There are likewise house-bote and plough-bote, privileges to tenants, of cutting wood for making ploughs, repairing tenements, and likewise for fuel.

BOTTOM, in navigation, is used to denote as well the channel of rivers and harbours, as the body or hull of a ship: thus, in the former sense, we say a gravelly bottom, clayey bottom, sandy bottom, &c. and in the latter sense, a British bottom, a Dutch bottom, &c. By statute, certain commodities imported in foreign bottoms, pay a duty called petty customs, over and above what they are liable to if imported in British bottoms.

BOTTOMRY, in commerce, a marine contract for the borrowing of money upon the keel or bottom of a ship; that is, when the master of a ship binds the ship itself, that if the money be not paid by the time appointed, the creditor shall have the ship.

Bottomry is also where a person lends money to a merchant, who wants it in traffic, and the lender is to be paid a greater sum at the return of the ship, standing to the hazard of the voyage; on which account, though the interest be greater than what the law commonly allows, yet it is not usury, because the money being furnished at the lender's hazard, if the ship perishes he shares in the loss.

It is enacted by 19 Geo. II. cap. xxxvii. that after August 1, 1746, every sum of money lent on bottomry, upon the ships of any subjects to or from the East Indies, shall be lent only on the ship, or the merchandizes laden on board her, and so expressed in the condition of the bond; and the benefit of

salvage shall be granted to the lender, his agents, &c. who only shall have a right to make assurance on the money lent; and no borrower of money on bottomry shall recover more on any assurance than the value of his interest on the ship or effects, exclusive of the money borrowed. And if the value of his interest does not amount to the money borrowed, he shall be responsible to the lender for the surplus, with lawful interest for the same, together with the assurance, and all charges whatsoever, &c. notwithstanding the ship and merchandize shall be totally lost.

BOTTONY. A cross bottony, in heraldry, terminates at each end in three buds, knots, or buttons, resembling, in some measure, the trefoil; on which account Segoing, in his Tresor Héraldique, terms it croix trefflée. It is the badge of the order of St. Maurice.

BOTTS. See OESTRIS.

BOUGIE, in surgery, originally a wax taper, but the term is now generally applied to several instruments which are used by surgeons in diseases of the urinary passage. See SURGERY.

BOULTINE, a term which workmen use for a moulding, the convexity of which is just one-fourth of a circle; being the member next below the plinth in the Tuscan and Doric capitals.

BOUNTY, in commerce, a premium paid by the government to the exporters of certain British commodities, on their taking oath, or, in some cases, giving bond, not to reland the same in England.

Bounties, as they respect the fisheries, are either perpetual or temporary. The former are payable on the export of pilchards, cod-fish, ling whether wet or dried, salmon, white herrings, red herrings, and dried red sprats, being of British fishery and curing. The latter are payable on the tonnage of ships carrying on the British and Greenland fisheries, on the quantity of fish taken in the British and Newfoundland fisheries, on the quantities of oil, blubber, and whale-fins, taken in the southern whale-fishery. The bounty on cordage manufactured in Great Britain, is 2*s*. 4¼*d*. per cwt. Bounties have been granted by several statutes on the exportation of corn, when it does not exceed stipulated prices at the port of exportation. Those trades only require bounties, in which the merchant is obliged to sell his goods for less than they cost him; and the bounty is given to compensate this loss, and to encourage him to continue, or perhaps to commence, a trade that may be important to the interests of the country.

BOUNTY, Queen Anne's, for augmenting poor livings under 50*l*. per annum, consists of the produce of the first-fruits and tenths, after the charges and pensions payable out of the same are defrayed. To remedy the inconveniences that result from an absurd statute enforcing the residence of the clergy, by stat. 44 Geo. III. c. 2, the sum of 8000*l*. was granted out of the consolidated fund to the governors of Queen Anne's bounty, for the relief of curates deprived of their cures on account of the residence of incumbents.

BOURIGNONISTS, the name of a sect among the Low-country protestants, being such as follow the doctrine of Antoinette Bourignon, a native of Lisle, and apostate from the Roman-catholic religion. The principles of this sect bear a very near resemblance with those of the quietists and quakers.

BOUTANT, or ARCH-BOUTANT, in architecture, a flat arch or part of an arch abutting against the reins of a vault, to prevent its giving way A pillar boutant is a large chain or pile of stone, made to support a wall, terrace, or vault.

BOW, *arcus*, a weapon of offence made of steel, wood, horn, or other elastic matter. The use of the bow is, without all doubt, of the earliest antiquity. It has likewise been the most universal of all weapons, having obtained amongst the most barbarous and remote people, who had the least communication with the rest of mankind. The figure of the bow is pretty much the same in all countries where it has been used; for it has generally two inflections or bendings, between which, in the place where the arrow is drawn, is a right line. The Grecian bow was in the shape of a Σ, of which form we meet with many, and generally adorned with gold or silver. The Scythian bow was distinguished from the bows of Greece and other nations by its incurvation, which was so great as to form a half-moon or semicircle. The Persians had very great bows made of reeds, probably the bamboo; and the Indians had also, not only arrows, but bows made of the reeds or canes of that country; the Lycian bows were made of the cornel-tree; and those of the Æthopians, which surpassed all others in magnitude, were made of the palm-tree.

Though it does not appear that the Romans made use of bows in the infancy of their republic, yet they afterwards admitted them as hostile weapons, and employed auxiliary archers in all their wars.

In drawing the bow, the primitive Grecians did not pull back their hand towards the right ear, according to the fashion of modern ages, and of the antient Persians, but placing their bow directly before them, returned their hand upon the right breast. This was also the custom of the Amazons.

The bow is a weapon of offence amongst the inhabitants of Asia, Africa, and America, at this day; and in Europe, before the invention of fire-arms, a part of the infantry were armed with bows. Lewis XI. first abolished the use of them in France, introducing in their place the halberd, pike, and broad sword. The long bow was formerly in great use in England, and many laws were made to encourage it. The parliament under Henry VII. complained of the disuse of long bows, heretofore the safeguard and defence of this kingdom, and the dread and terror of its enemies.

Bow, among builders, a beam of wood or brass, with three long screws that direct a lath of wood or steel to any arch; chiefly used in drawing draughts of ships, and projections of the sphere; or wherever it is requisite to draw large arches.

Bow *of a ship*, that part which begins at the loof, and compassing the ends of the stem, finishes at the sternmost part of the forecastle.

That part upon the right-hand side of the stem, to a person on deck and looking forward, is called the starboard bow, and on the left-hand side is called the larboard bow.

Bow, *weather*, is that part of the bow towards the wind when a ship is close-hauled; and the other part is called the lee-bow.

Bow, *on the*, an expression to denote the position of any object, as a ship, the land, &c. appearing in the direction of some particular part of the bow. If a ship is sailing directly towards the object, it is said to be right ahead; if not, the object is said to be on the starboard or larboard, or on the weather or lee-bow.

BOWER, in the sea-language, the name of an anchor carried at the bow of a ship. There are generally two bowers, called first and second, great and little, or best and small bower.

BOW-LINE, in sea-language, a rope fastened near the middle of the leech, or perpendicular edge of the principal square sails, by three or four subordinate parts called bridles, and leading forward towards the bow, whence it derives its name. It is always used when the wind is so unfavourable, that the sails must be all braced sideways, or close-hauled to the wind: in this situation, the bow-lines are employed to keep the weather or windward edges of the principal sails right forward and steady, without which they would be perpetually shivering, and rendered incapable of service. The bow-line is fastened by two, three, or four ropes, like a crow's foot, to as many parts of the sail; only the mizen-bowline is fastened to the lower end of the yard. This rope belongs to all sails, except the sprit-sail and sprit-topsail. The use of the bow-line is to make the sails stand sharp or close, or by a wind.

Sharp the bowline, is hale it tawt, or pull it hard. *Hale up the bowline*, that is, pull it harder forward on. *Check* or *ease*, or *run up* the bowline, that is, let it be more slack.

BOWSE, in the sea-language, signifies as much as to hale or pull. Thus bowsing upon a tack, is haling upon a tack. Bowse away, that is, pull away all together.

BOWSPRIT, or *bolt-sprit*, a kind of mast, resting slopewise on the head of the main stem, and having its lower end fastened to the partners of the fore-mast, and farther supported by the fore-stay. It carries the sprit-sail, sprit-topsail, and jack-staff; and its length is usually the same with that of the fore-mast.

BOWYERS, artificers whose employment or occupation it is to make bows. There is a company of bowyers in the city of London, first incorporated in 1623.

BOX, or *box-tree*. See BUXUS.

BOYAU, in fortification, a ditch covered with a parapet, which serves as a communication between two trenches. It runs parallel to the works of the body of the place, and serves as a line of contravallation, not only to hinder the sallies of the besieged, but also to secure the miners. But when it is a particular cut that runs from the trenches to cover some spot of ground, it is drawn so as not to be enfiladed, or scoured by the shot from the town.

BOYES, idolatrous priests among the savages of Florida.

BRABEJUM, the *African almond*: a genus of the monœcia order, and polygamia class of plants. In the male the corolla is four or five-parted; there are four stamina inserted in the throat; the style is bifid and abortive; the hermaphrodite has a four-parted corolla, revolute upwards, with four stamina,

one pistil with two stigmas; the fruit is a roundish drupa with a globular seed. Of this genus there is but one species, viz.

Brabejum stellatifolium, the star-leafed African almond, a native of the Cape of Good Hope. In Europe it seldom grows above eight or nine feet high, but in its native soil is a tree of a middling growth. It rises with an upright stem, which is soft, and full of pitch within, and covered with brown bark. The leaves come out all round the branches at each joint: they are indented at their edges, standing on very short footstalks. The flowers are produced towards the end of their shoots, of a pale colour inclining to white. They may be propagated, though with difficulty, by layers made in April. In winter they should have a good greenhouse; but in summer they should be placed abroad in a sheltered situation.

BRACE, in architecture, a piece of timber framed in with bevil joints, the use of which is to keep the building from swerving either way. When the brace is framed into the kinglesses, or principal rafters, it is by some called a strut.

Braces, in the sea-language, are ropes belonging to all the yards of a ship, except the mizen, two to each yard, reeved through blocks that are fastened to penants, seized to the yard-arms. Their use is either to square or transverse the yards.

Brace, in writing, a term used to signify a crooked line, as }, made at the end of two or more articles in an account, the amount of which is usually placed in the centre of the brace. It is used also in printing to enclose an entire passage, as a triplet in poetry.

BRACED, in heraldry, a term for the intermingling three cheoronels.

BRACHIÆUS. See Anatomy.

BRACHIALIS. See Anatomy.

BRACHIUM, *arm*. See Anatomy.

BRACHMANS, or *bramins*, a sect of Indian philosophers, known to the antient Greeks by the name of gymnosophists. The antient Brachmans lived upon herbs and pulse, and abstained from every thing that had life in it. They lived in solitude, without matrimony, and without property. The modern Brachmans constitute one of the casts or tribes of the Banians. They are the priests of that people, and perform their office of praying and reading the law, with several mimic gestures, and a kind of quavering voice. They believe in rewards and punishments after this life; and have so great a veneration for cows, that they look on themselves as blessed if they can but die with the tail of one of them in their hand. They have preserved some noble fragments of the knowledge of the antient Brachmans. They are skilful arithmeticians, and calculate, with great exactness, eclipses of the sun and moon. They are remarkable for their religious austerities. One of them has been known to make a vow to wear about his neck a heavy collar of iron for a considerable time: another to chain himself by the foot to a tree, with a firm resolution to die in that place: and another to walk in wooden shoes stuck full of nails on the inside. Their divine worship consists chiefly of processions, made in honour of their deities. They have a college at Banara, a city seated on the river Ganges.

BRACHYGRAPHY, the art of short-hand-writing. See Tachygraphy.

BRACKETS, in a ship, the small knees, serving to support the galleries, and commonly carved. Also, the timbers that support the gratings in the head are called brackets.

Brackets, in gunnery, are the cheeks of the carriage of a mortar: they are made of strong planks of wood, of almost a semicircular figure, and bound round with thick iron plates; they are fixed to the beds by four bolts, which are called bed-bolts; they rise up on each side of the mortar, and serve to keep her at any elevation, by means of some strong iron bolts, called bracket-bolts, which go through these cheeks or brackets.

BRACTEARIA, in natural history, a genus of tales, composed of small plates in form of spangles, each plate being either very thin, or fissile into very thin ones. See Mineralogy.

BRADS, among artificers, a kind of nails used in building, which have no spreading heads, as other nails have. They are distinguished, by ironmongers, by six names; as joiner's-brads, flooring-brads, batten-brads, bill-brads or quarter-heads, &c. Joiner's-brads are for hard wainscot, batten-brads for soft wainscot; bill-brads are used when a floor is laid in haste, or for shallow joists subject to warp. See Nail.

BRADYPUS, or *sloth*, a genus of animals of the order of bruta. The generic character is: 1st, Bradypus tridactylus, or three-toed sloth. The general appearance of the sloth is extremely uncouth; the body is of a thick shape: the fore-legs short, the hinder ones far longer; the feet on all the legs are very small, but are armed each with three most excessively strong and large claws, of a slightly curved form, and sharp-pointed. The head is small: the face short, with a rounded or blunt snout, which is naked, and of a blackish colour; the eyes are small, black, and round; the ears rather small, flat, rounded, lying close to the head, and not unlike those of monkeys. The hair on the top of the head is so disposed as to project somewhat over the forehead and sides of the face, giving a very peculiar and grotesque physiognomy to the animal. The general colour of the hair on all parts is a greyish brown; and the hair is extremely coarse, moderately long, and very thickly covers the body, more especially about the back and thighs. A remarkable character as to colour in this species, is a wide patch or space on the upper part of the back, of a bright ferruginous or rather pale orange colour, spotted on each side with black, and marked down the middle with a very conspicuous black stripe; wide at its origin, and gradually tapering to its extremity: it reaches more than half-way down the back, and terminates in a sort of trifid mark. The tail is nearly imperceptible, being so extremely short as to be concealed from view by the fur.

The count de Buffon is not willing to allow this creature any share in contributing to the general beauty in the scale of animated nature, but considers it as an ill-constructed mass of deformity, created only for misery.

Notwithstanding this appearance of wretchedness and deformity, the sloth is, perhaps, as well-fashioned for its proper modes and habits of life, and feels as much happiness in its solitary and obscure retreats, as the rest of the animal world of greater locomotive powers and superior external elegance.

The sloth feeds entirely on vegetables, and particularly on leaves and fruit. Its voice is said to be so inconceivably singular, and of such a mournful melancholy, attended, at the same time, with such a peculiarity of aspect, as at once to excite a mixture of pity and disgust: and it is added, that the animal makes use of this natural yell as its best mode of defence; since other creatures are frightened away by the uncommon sound. This, however, is far from being its only refuge; for so great is the degree of muscular strength which it possesses, that it is capable of seizing a dog with its claws, and holding it, in spite of all its efforts to escape, till it perishes with hunger; the sloth itself being so well calculated for supporting abstinence, that the celebrated Kircher assures us of its power in this respect having been exemplified by the very singular experiment of suffering one, which had fastened itself to a pole, to remain in that situation, without any sustenance, upwards of forty days. This extraordinary animal is an inhabitant of the hotter parts of South America. It is nearly as large as a middle-sized dog. See Plate, Nat. Hist. fig. 62.

2d. Bradypus didactylus, or two-toed sloth, is also a native of South America; and it is asserted, on good authority, that it is likewise found in some parts of India, as well as in the island of Ceylon. In its general appearance, as well as in size, it bears a considerable resemblance to the former species: it is, however, somewhat more slender in its shape, covered with smoother or less coarse and harsh hair, and is of a more uniform or less varied tinge, and, in particular, is strikingly distinguished, as a species, by having only two claws on the fore-feet; it is also a much more active animal, and, even when imported into Europe, has been known, according to the testimony of the count de Buffon, to ascend and descend from a tall tree several times in a day; whereas the three-toed sloth with difficulty performs that operation in a whole day, and can scarcely crawl a few hundred yards in the space of many hours.

3d. Bradypus ursinus, or ursine sloth, is by far the largest species: it is a native of India, and has been but lately introduced to the knowledge of European naturalists. It was brought from the neighbourhood of Patna in Bengal. This animal has, at first sight, so much of the general aspect of a bear, that it has actually been considered as such by some observers: but it is no otherwise related to the bear than by its size and habit, or mere exterior outline.

It is about the size of a bear, and is coverad all over, except on the face, or rather the snout, which is bare and whitish, with long, shaggy, black hair; which on the neck and back is much longer than elsewhere. On the fore part of the body the hair points forwards; on the hinder part backwards. The eyes are very small: the ears rather small, and partly hid in the long hair of the head, It is totally destitute of incisores or front-teeth: in each jaw there are two canine teeth of a moderate size. The nose or snout is of a somewhat elongated form; it also appears as if fur-

nished with a sort of transverse joint, or internal cartilage, which admits of a peculiar kind of motion in this part.

It is a gentle and good-natured animal; it feeds chiefly on vegetables and milk, is fond of apples, and does not willingly eat animal food, except of a very tender nature, as marrow, which it readily sucked from a bone presented to it. Its motions are not, as in the two former species, slow and languid, but moderately lively; and it appears to have a habit of turning itself round and round every now and then, as if for amusement, in the manner of a dog when lying down to sleep. It is said to have a propensity to burrowing under the ground.

BRAG, a game at cards, wherein as many may partake as the cards will supply; the eldest hand dealing three to each person at one time, and turning up the last card all round. This done, each gamester puts down three stakes, one for each card. The first stake is won by the best card turned up in the dealing round, beginning from the ace, king, queen, knave, and so downwards. When cards of the same value are turned up to two or more of the gamesters, the eldest hand gains; but it is to be observed that the ace of diamonds wins, to whatever hand it is turned up.

The second stake is won by what is called the brag, which consists in one of the gamesters challenging the rest to produce cards equal to his: now it is to be observed, that a pair of aces is the best brag, a pair of kings the next, and so on; and a pair of any sort wins the stake from the most valuable single card. In this part consists the great diversion of the game; for, by the artful management of the looks, gestures, and voice, it frequently happens that a pair of fives, treys, or even duces, out-brags or induces the holder to throw up a higher pair, and even some pairs royal, to the no small merriment of the company. The knave of clubs is here a principal favourite, making a pair with any other card in hand, and with any other two cards a pair royal.

The third stake is won by the person who first makes up the cards in his hand one-and-thirty; each dignified card going for ten, and drawing from the pack, as usual in this game.

BRAIL, or Brails, in a ship, are small ropes made use of to furl the sails across: they belong only to the two courses and the mizen-sail.

BRAIN. See Anatomy.

BRAN, the skins or husks of corn, especially wheat ground, separated from the corn by a sieve or boulter. It is of wheat bran that starch-makers make their starch. The dyers reckon bran among the not-colouring drugs, and use it for making what they call the sour waters, with which they prepare their dyes.

BRANCHIÆ, *gills*, in the anatomy of fishes, the parts corresponding to the lungs of land-animals, by which fishes take in and throw out again a certain quantity of water impregnated with air. All fishes, except the cetaceous ones and the lamprey, are furnished with these organs of respiration, which are always eight in number, four on each side the throat. That next the heart is always the least, the rest increasing in order as they stand near the head of the fish.

Each of these gills is composed of a bony lamina, in form of a semicircle, for the most part; and on its convex side stand the leaves or lamellæ, like so many sickles. The whole convex part of the lamellæ is beset with hairs, which are longest near the base, and decrease gradually as they approach towards the point. There are also hairs on the concave side of the lamellæ, but shorter than the others, and continued only to its middle. The convex side of one lamina is fitted into the concave side of the next superior one; and all of them are connected together by means of a membrane, which reaches from their base half-way their height, where it grows thicker, and in some measure resembles a rope. The rest of the lamina is free, and terminates in a very fine and flexible point. The use of these gills seems to be to receive the blood protruded from the heart into the aorta, and convey it into the extremities of the lamellæ; whence being returned by veins, it is distributed over the body of the fish.

BRANCHIARUM *foramina*, apertures of the gills. In most fishes there is only one aperture; in the cartilaginous ones, these apertures are ten in number, five on each side; and in the lamprey there are no less than fourteen of these apertures, seven on each side.

Cetaceous fishes have no aperture of this kind; and the reason seems to be because they are furnished with lungs.

BRANCHIDÆ, in Grecian antiquity, priests of the temple of Apollo, which was at Didymus in Ionia.

BRANCHIOSTEGI, in ichthyology, one of the five general orders of fishes into which they were formerly divided: the rays of the fins are bony: they have no bones or ossiculæ in the branchiæ or gills.

BRANDY, a spirituous and inflammable liquor, extracted from wine and other liquors by distillation.

Brandy is prepared in many of the wine countries of Europe, and with peculiar excellence in Languedoc, in Anjou, and other parts of the south of France, whence is the Coniac brandy. In distilling brandy, the strong heavy wines are preferred. It is expected that all wines used for this purpose should yield at least one-sixth of their quantity of spirit. The apparatus is composed of three parts: the alembic, or boiler, the capital fitted on the top of the boiler to receive the spirituous vapour, and a worm immersed in cold water, in which the vapour is condensed, and flows out in the form of distilled spirit. In general, the slower the process, and the smaller the stream of spirit from the worm-pipe, the finer and better is the brandy. That part of the spirit which comes over first has the strongest, richest, and highest flavour. See Alcohol.

Brandy is naturally clear and colourless as water. The different shades of colour which it has in commerce arise partly from the casks in which it is kept, but chiefly from the addition of burnt sugar, saunders wood, and other colouring matters that are intentionally added by the manufacturer, and which are neither of advantage nor disadvantage to the quality of the spirit.

Besides the brandy made of wine, there is some also made of beer, cyder, syrups, sugar, molasses, fruit, grain, &c.: however, these are not properly called brandy, but go under the general denomination of spirits.

BRASIL-wood, or Brazil-wood, an American wood of a red colour, and very heavy. It is denominated variously, according to the places whence it is brought: thus we have brasil from Fernambuco, Japan, Lamon, &c. See Cæsalpina.

This wood must be chosen in thick pieces, close, sound, without any bark on it, and such as, upon splitting, of pale becomes reddish, and, when chewed, has a saccharine taste. It is much used in turned work, and takes a good polish; but its chief use is in dying.

When the sulphuric acid is added slowly to a fresh watery decoction of Brasil wood, a small quantity of red precipitate falls down, and the liquor becomes yellow. Nitric acid produces a similar change; but the liquor is orange. Most of the other acids produce red precipitates. The alkalies restore in part the colour of the liquor. The action of the solutions of tin and of alum is the most important. Alum gives a fine red precipitate in great abundance; and in this manner a fine crimson lake and carmine are sometimes prepared, which consist of alumina, united with the natural colour of the wood. Nitro-muriat of tin, added to the decoction, separates the whole of the colouring matter, which falls down in great abundance, united with the oxide of tin, and the liquor remains colourless. The solutions of iron blacken Brazil wood, manifesting the presence of gallic acid.

The colour of Brazil wood, though very beautiful, is fugitive, and is readily darkened and rendered purple by alkalies, or by soap that contains an alkali. When it is used by dyers, they employ acids and tin to fix the colour.

BRASS is a factitious metal made of copper and zinc, in proper proportions. It is of a beautiful yellow colour, more fusible than copper, and not so apt to tarnish. It is malleable, and so ductile that it may be drawn out into wire. Its density is greater than the mean density of the two metals. By calculation it ought to be 7.63 nearly, whereas it is actually 8.39; so that its density is increased by about 1-10th. The antients do not seem to have known accurately the difference between copper, brass, and bronze. They considered brass as only a more valuable kind of copper, and therefore used the word *æs* to denote either. They called copper *æs cyprium*, afterwards *cyprium*; and this in process of time was converted into *cuprum*.

The method of preparing brass is as follows: The zinc having been calcined and ground fine as flour, is mixed with fine charcoal, and incorporated, by means of water, into a mass: this being done, about seven pounds of zinc is put into a melting-pot that will contain about a gallon, and over that about five pounds of copper; this pot is let down into a wind-furnace, where it remains for eleven hours, in which time it is converted into brass. The metal then is cast, either into plates or lumps; forty-five pounds of crude zinc will produce thirty pounds when calcined or burnt. Sometimes brass-shruff is used instead of copper; but that is not always to be procured in quantities sufficient, it being no other than a collection of old brass.

Pure brass is not malleable, unless when it is hot; for when it is cold it will break; and

after it has been melted twice, it will be no longer in a condition to bear the hammer at all: but in order to render it capable of being wrought, they put seven pounds of lead to an hundred weight of brass, which renders it more soft and pliable.

The most important properties of brass are that its colour is much brighter and nearer approaching to gold than copper. It is also more fusible, and less subject to rust, and to be acted upon by a vast variety of substances which corrode copper: it is also more capable of extension, and peculiarly adapted for wire. Mr. Smeaton found that 12 inches in length of cast brass at 32°, expanded by 180° of heat, $\frac{225}{10000}$ parts: brass wire under the same circumstances, expanded $\frac{232}{10000}$. The expansion of hammered copper is only $\frac{204}{10000}$, but that of zinc is $\frac{353}{10000}$; so that brass holds a middle place in this respect between its two component metals.

There is a vast variety in the proportions of the different species of brass used in commerce; nor is it easy to determine whether the perfection of this alloy depends on any certain proportion of the two metals. In general the extremes of the highest and lowest proportions of zinc are from 12 to 25 parts in the 100. The ductility of brass is not injured with the highest proportion. This metal is much used in the escapement wheels, and other nicer parts of watch-making; and bars of brass very carefully made will fetch for this work almost any price.

The use of brass is of very considerable antiquity. Most of the antient genuine relics are composed of various mixtures of brass with tin and other metals, and are rather to be denominated bronzes.

The best proportion for brass guns is said to be 1000 pounds of copper, 900 pounds of tin, and 600 pounds of brass, in 11 or 12 hundred weight of metal.

The best brass guns are made of malleable metal, not of pure copper and zinc alone; but worse metals are used to make it run closer and sounder, as lead and pot-metal. See CANNON.

BRASS, *Corinthian*, has been famous in antiquity, and is a mixture of gold, silver, and copper.

BRASS-*colour*, one prepared by the braziers and colourmen to imitate brass. There are two sorts of it, the red brass or bronze, and the yellow or gilt-brass: the latter is made only of copper-filings, the smallest and brightest that can be found; with the former they mix some red ochre, finely pulverized: they are both used with varnish.

BRASSICA, the cabbage, a genus of the class and order tetradynamia siliquosa. The essential character is: calyx erect, converging; seeds globular; a gland between the shorter stamens and the pistil, and between the longer and the calyx.

There are sixteen species, viz.

1. Brassica orientalis; perfoliate cabbage. 2. Brassica austriaca; Austrian cabbage. 3. Brassica campestris; yellow field cabbage. 4. Brassica arvensis; purple field cabbage. 5. Brassica alpina; Alpine cabbage. 6. Brassica napus; wild cabbage, rape, or navew. 7. Brassica rapa; turnep. 8. Brassica oleracea; common cabbage. 9. Brassica chinensis; Chinese cabbage. 10. Brassica violacea. 11. Brassica polymorpha. 12. Brassica erucastrum; wild rocket. 13. Brassica eruca; garden rocket. 14. Brassica vesicaria. 15. Brassica muralis; wall rocket. 16. Brassica Richerii.

The first has the petals white; all the leaves smooth; stem-leaves ovate, blunt at the end, heart-shaped at the base, smooth, glaucous, perfectly entire; petals white with a tinge of straw-colour; siliques slender, pointing upwards, and approaching the stem; root fusiform. Mr. Hudson affirms, that this is very nearly allied to the campestris; and Dr. Stokes thinks it probable that the plant of hort. ups. supposed to be the B. orientalis of Tournefort and our European species, are distinct. There is certainly great confusion in the three first species of brassica; and in a genus so subject to vary, perhaps mere local differences may have been exalted into species.

It is a native of corn-fields and cliffs, in the Levant, about Montpellier; in Germany, Switzerland, Austria, Carniola, Piedmont, &c. In England, near Harwich; Bardsey near Orford, Suffolk; Godstone and Maresfield, Sussex: annual, flowering in June.

The second is a native of Austria, a biennial: root white, rather woody, sometimes branched, about half a foot long, very thin, with an acrid smell; stem in the wild plant commonly single, in the cultivated or garden ones generally more, about two feet high; leaves entire, rounded at the ends, thick, glaucous, embracing the stalk, very smooth. The flowers are yellow, and open in small numbers at once. The siliques are about three inches long, smooth, sharp, and parallel, or nearly so, with the stalk, standing in an upright manner. It is a plant which naturally grows in rough uncultivated places, and in fields.

3. Root annual; root-leaves lyrate, slightly hispid; stem-leaves smooth and even; corolla yellow, never white. It grows among summer corn, in the north of Europe; and in some parts of Sweden it is a common weed.

4. Stem a foot high, smooth and even, flexuose, branched, perennial at bottom; leaves smooth, quite blunt, rather fleshy; calyx closed, smooth, with a double protuberance at the base. Native of the south of Europe, in moist fields.

5. This differs from the foregoing sort in having a narrower stem; the leaves more tender and longer; those next the ground on long petioles: but it differs principally in having almost upright, white petals, and the small flower of a Turritis. Native of Germany and Sweden.

6. Root biennial; stem somewhat branched, cylindrical, smooth, from a foot to two feet in height; root-leaves lyrate; stem-leaves smooth, glaucous, sessile, stem-clasping, of an oblong heart-shaped figure, very slightly toothed on the edges; calyx yellowish green, spreading as in Sinapis. The silique has frequently three or four warty excrescences. The roots, when cultivated, may be eaten, but have a stronger taste than the turnep. Under the title of rape or coleseed, it is much cultivated in the isle of Ely, and some parts of England, for its seed, from which the rape-oil is drawn; and for feeding cattle. What remains after the oil is expressed, is called oil-cake or rape-cake. It is a very efficacious manure, and is sold from four to six pounds a ton. It is not this but the lint-cake, or residuum of flax-seed, used in making lintseed-oil, that is used in fatting beasts.

Linnæus says that the navew grows wild on the sandy shores of Gotland, Holland, and England. With us it is found among corn, and on ditch-banks.

7. The turnep, now so common in cultivation, is sufficiently known by its round fleshy roots. These, however, vary exceedingly in their form, size, and colour, in a cultivated state, in which only we are apt to view them.

The variations of turnep are chiefly in the root, and arise from the different soils, situations, and modes of cultivation. The varieties enumerated by Mr. Miller are, 1. the round, red, or purple-topped; 2. the green-topped; 3. the yellow; 4. the black-rooted; 5. the early Dutch. He allows that these may be varieties accidentally obtained from seeds, although he has sown them several years, and has always found them to retain their differences. The yellow turnep seems most unlikely to have been an accidental variety, because the roots are yellow within, whereas the others have white flesh, notwithstanding they are of different colours on the outside. He thinks that the long-rooted turnep is a distinct species; the form of the root, and its manner of growth, being totally different from those before enumerated. The roots are sometimes as long as those of the parsnep, and nearly of the same shape.

The general use of this root for the table and feeding of cattle is well known: and it has been a considerable improvement of light lands, particularly in the county of Norfolk, whence other counties have derived the culture. The red-rooted turnep was formerly more cultivated in England than at present; but since the large green-topped turnep has been introduced, all skilful farmers prefer it to the others, because the roots grow to a large size, and continue much longer good. It also grows above ground more than any of the others, which renders it preferable for feeding cattle; and being the softest and sweetest, even when very large, it is most esteemed for the table. In very severe winters, however, this is in greater danger of suffering by frost than those whose roots lie deeper, especially if the ground is not covered with snow; for when the roots are alternately frozen and thawed, they rot sooner than those which are more covered, and less tender. We have known roots of this sort which were more than a foot in diameter, boiled, and were as sweet and tender as any of the smallest roots. At Stowe, in Gloucestershire, a farmer produced four turneps weighing an hundred weight; and offered to produce, from a small given space, eighty turneps which should weigh a ton.

The next in goodness to the green-topped is the red or purple-topped turnep, which will also grow large, and be extremely good for some time; but the roots will become stringy much sooner than the others. The long-rooted, the yellow, and the black-rooted turneps are now rarely cultivated, except for the sake of variety, none of them being so good for the table or for feed as the red and green-topped sorts.

The early Dutch turnep is chiefly sown in the spring, to supply the table before the others can be procured; and when drawn off

young, this sort is tolerably good; but if the roots are left to grow large, they become stringy, rank, and unfit for use.

Turnep-roots are reputed to relax the bowels, and to sweeten the blood; to be hurtful to pregnant and hysterical women, and to all who are subject to flatulencies. The juice well fermented, affords by distillation an ardent spirit. The rind is acrimonious. The tender tops boiled are frequently eaten in the spring as greens with meat.

8. The cabbage, as it is found in its wild state on the sea-shores of Britain, has the stem-leaves very much waved, and variously indented; the colour sea-green, frequently with a mixture of purple; the lower ones somewhat ovate and sessile; the upper almost linear. The flowers are large; the leaflets of the calyx ovate, broad, and yellow; the siliques short and swelling.

Early in the spring the sea-cabbage is preferable to the cultivated sorts; but when it is gathered on the coast, it must be boiled in two waters, to take away the saltness. When old it is said to occasion giddiness. The roots may also be eaten, but they are not so tender as those of the turnep and navew. All the different varieties of garden cabbage originate from this.

These varieties may, it should seem, be reduced to three general divisions: the first comprehending those which grow in the natural way, without forming the leaves or stalks into a head. This section or division, besides the sea cabbage or wild colewort, would comprehend the green colewort, the borecoles, and turnep cabbage. Secondly, those which form the leaves into a head, as the white cabbage, the red, the savoy, &c. Thirdly, those which form their stalks into a head, as the cauliflower, and the different varieties of broccoli. The first section might be subdivided into the wild, with broad leaves, and an even stem; the turnep cabbage, with broad leaves, and a protuberant stem; and the borecoles, with fine-cut leaves, and an even stem. The second section contains the cabbages commonly so called: as the red; the numerous varieties of the white, such as the sugar-loaf, the early, the foreign musk, the small Russia, the large-sided, the flat-topped, the Yorkshire, Scotch, American, &c. &c.; and those with wrinkled leaves, as the common savoy, the green savoy, &c. Of the borecoles in the first, and the broccoli in the third section, there are also variations in colour, the purple and the white.

The common colewort, or Dorsetshire kale, is now almost lost near London, where the markets are usually supplied with cabbage-plants instead of them; these being more tender and delicate. The common colewort, indeed, is better able to resist the cold in severe winters; but it is not good till it has been pinched by frost; and our winters being generally temperate, cabbage-plants are now constantly brought to market; which, if they are of the sugar-loaf kind, are the sweetest greens from December to April yet known, the variegated kale excepted.

The curled coleworts or borecoles are more generally esteemed than the common one, being like that so hardy as never to be injured by cold, and at the same time much more tender and delicate: these, however, are always sweeter in severe winters than in mild seasons.

Of the heading cabbages, the red is chiefly cultivated for pickling; the common white, flat, long-sided, and savoy, for winter use. The musk cabbage is almost lost, though for eating it is one of the best we have.

The early York and sugar-loaf cabbages are generally sown for summer use, and are commonly called Michaelmas cabbages. The Russian cabbage was formerly in much greater esteem than at present, it being now only to be found in particular gentlemen's gardens, and rarely brought to market. The other heading cabbages, together with many others, for it would be endless to enumerate all the varieties which are perpetually rising into fame, and falling into oblivion, are cultivated chiefly for feeding cattle; for which they are certainly well adapted on strong lands; but they are undoubtedly a very exhausting crop.

The cauliflower was first brought to England from the island of Cyprus, where it is in great perfection at present; but it is supposed it was originally brought thither from some other country: most of the old writers mention it to have been brought from that island to the different parts of Europe. Although this plant was cultivated in a few English gardens long since, yet it was not brought to any degree of perfection till about the year 1680, at least not to be sold in the markets. Since the year 1700, the cauliflower has been so much improved in England, that such plants as before would have been greatly admired, are at present little regarded. It has indeed been much more improved in England than in any other parts of Europe. In France they rarely have cauliflowers till near Michaelmas; and Holland is generally supplied with them from England. In many parts of Germany they were not cultivated till within a few years past; and most parts of Europe are supplied with seeds from hence.

Purple and white broccoli are only varieties of the cauliflower; for although with care they may be kept distinct, yet if they were to stand near each other for seed, they would probably intermix. When, however, these are cultivated with care, they may be kept distinct. The variations are not occasioned by soil, but by the mixture of the farina of the anthers in the flowers; those persons, therefore, who are curious to preserve them distinct, never suffer the different sorts to stand near each other for seed.

9. Leaves oblong or oval, very like those of hound's-tongue, blunt but smooth; stem-leaves embracing, oblong, quite entire; flowers, as in the common cabbage, yellow; calyx longer than the claws of the petals, whence it gapes and is prominent between them; stamens longer; siliques a little compressed. Native of China.

10. This is an annual plant, which, if sown in April, will flower in July, and perfect the seeds in October. It never closes the leaves to form a head, but grows open and loose, more like the wild navew. This sort came from China, where it is cultivated as an esculent plant. There are two or three varieties of it, and it is as changeable as our common cabbage.

11. This species is a native of Siberia, and is an annual plant. The root is thin and fibrose. The stems numerous, growing oblique, two feet or more in length, smooth, and branching upwards; the leaves are of dissimilar forms, but in general are linear-lanceolate, thick, and alternate; those on the stalk generally dentated; the denticles nearly subulate. The shoots are leafy, proceeding from the axillas of the branches, so as to cause a kind of clustering appearance; the flowers are pale-yellow. It is a plant which varies extremely in the appearance of its leaves.

12. Root annual, fusiform; stems many, from a foot to eighteen inches high and more, round, smooth, sometimes having a few hairs and small red dots, bright or glaucous green; branches alternate; flowers in a long, loose, terminating raceme; peduncles alternate, round, smooth, one-flowered; corollas yellow, with dark-yellow and green veins; siliques spreading, obtusely quadrangular. Native of the southern countries of Europe, in sandy fields, by way-sides, and on walls; flowering from June to August.

13. Root annual: stem angular, upright, branching, two feet high and more; leaves smooth, pulpy, with a leafy nerve, and three or four pair of pinnas, larger as they approach the nerve, confluent, oblong, acute, toothed; the outer largest, ovate, or rhomboidal, often semibifid and semitrifid; calyx erect, livid, with the leaflets, especially two of them, gibbous; claw of the petals erect, long; border broad, roundish, lemon-colour, with black veins, sometimes white; siliques on short peduncles; seeds round on one side and flat on the other. Native of Switzerland, Austria, and Piedmont. It was formerly much cultivated in the gardens as a salad herb, but at present is little known, having been long rejected on account of its strong ungrateful smell. It also stood in the list of medicinal plants, but is now seldom used, though it is reckoned a strong diuretic.

14. Root annual, spindle-shaped; leaves lanceolate, pinnatifid-toothed, smooth above; stem hairy, branching; racemes erect, terminating; corollas yellow, with darker veins; calyx cylindrical; but in the fruit it becomes inflated and permanent. It differs from the foregoing, in having a calyx under the fruit, inflated like a bladder; leaves not lyrate but lanceolate; siliques hispid backward, not smooth; calyxes permanent till the fruit is ripe, not deciduous. Native of Spain and Aleppo.

15. Root perennial, somewhat woody, penetrating deep into walls; stem a foot and a half high, branched, round, at bottom somewhat woody and perennial; leaves pinnatifid and jagged, smooth, spreading, having a disagreeable smell; petals rather large, twice the length of the calyx, yellow; the two glands on the outside of the filaments are unusually long, externally bent in at the top; the other two shorter and roundish; silique an inch and a half long, round, marked on each side with a prominent line.

It grows on old buildings and walls in many parts of England, as Yarmouth, Chester, &c.

16. Root woody, perennial; root-leaves elliptic, obtuse, obscurely sinuate-angular; petiole channelled, the length of the leaves; stem round, striated, hollow, a cubit and a half high, simple or a little branched; stem-leaves few, distant, like the others, but on shorter petioles, and scarcely angular; flowers in umbels; petals ovate, yellow, scarcely emarginate; veins darker; siliques tortuose,

subquadrangular, drawn to a point at both ends. The whole plant is very smooth, tender, juicy, and glaucous. Native of the south of France, and the mountains of Piedmont.

BRAULS, Indian cloths with blue and white stripes: they are otherwise called turbans, because they serve to cover those ornaments of the head, particularly on the coast of Africa.

BRAWN, the flesh of a boar soused or pickled; for which end the boar should be old; because the older he is, the more horny will the brawn be.

The method of preparing brawn is as follows: the boar being killed, it is the flitches only, without the legs, that are made brawn; the bones of which are to be taken out, and then the flesh sprinkled with salt, and laid in a tray, that the blood may be drawn off: then it is to be salted a little, and rolled up as hard as possible. The length of the collar of brawn, should be as much as one side of the boar will bear; so that when rolled up, it may be nine or ten inches diameter.

The collar being thus rolled up, is to be boiled in a copper, or large kettle, till it is so tender, that you can run a straw through it: then set it by, till it is thoroughly cold, and put it into the following pickle. To every gallon of water, put a handful or two of salt, and as much wheat bran: boil them together, then drain the bran as clear as you can from the liquor: and when the liquor is quite cold, put the brawn into it.

BRAZED, in heraldry, a term serving to describe three cheverons, one clasping another.

BRAZIER, an artificer who makes kettles, pans, candlesticks, and other kitchen utensils in brass. Some of the articles manufactured by the working brazier are beaten out with the hammer, and united in their several parts by solder: others are cast, but those which are cast belong more properly to the business of the founder, excepting the polishing and finishing, which require the art of the brazier.

BRAZING, the soldering or joining two pieces of iron together by means of thin plates of brass, melted between the pieces that are to be joined. If the work is very fine, as when two leaves of a broken saw are to be brazed together, they cover it with pulverized borax, melted with water, that it may incorporate with the brass powder, which is added to it: the piece is then exposed to the fire without touching the coals, and heated till the brass is seen to run.

BREACH, in fortification, a gap made in any part of the works of a town by the cannon or mines of the besiegers, in order to make an attack upon the place. To make the attack more difficult, the besieged sow the breach with crow-feet, or stop it with chevaux-de-frize.

A practicable breach is that where the men may mount and make a lodgment, and ought to be 15 or 20 fathoms wide. The besiegers make their way to it by covering themselves with gabions, earth-bags, &c.

BREACH, in a legal sense, is where a person breaks through the condition of a bond or covenant, on an action upon which the breach must be assigned; and this assignment must not be general but particular, as in an action of covenant for not repairing houses, it ought to be assigned particularly what is the want of reparation; and in such certain manner that the defendant may take an issue.

BREAD, *panis*, a mass of dough, kneaded and baked in an oven. See BAKING.

BREAD-ROOM, in a ship, that destined to hold the bread or biscuit. The boards of the bread-room should be well joined and caulked, and even lined with tin plates or mats. It is also proper to warm it well with charcoal for several days before the biscuit is put into it; since nothing is more injurious to the bread than moisture.

BREAK, in the art of war, or to break ground, is to open the trenches before a place.

BREAKERS, a name given to those billows that break violently over rocks lying under the surface of the sea. They are distinguished both by their appearance and sound, as they cover that part of the sea with a perpetual foam, and produce a hoarse and terrible roaring, very different from what the waves usually have in a deeper bottom. When a ship is unhappily driven among breakers, it is hardly possible to save her; as every billow that heaves her upward serves to dash her down with additional force, when it breaks over the rocks or sands beneath it.

BREECHINGS, in the sea-language, the ropes with which the great guns are lashed or fastened to the ship's side.

They are thus called, because made to pass round the breach of the gun.

BREEZE, a shifting wind, that blows from sea or land for some certain hours in the day or night.

The sea-breeze which takes place in tropical climates, is only sensible near the coasts; it commonly rises in the morning, about nine, proceeding slowly in a fine small black curl on the water, towards the shore; it increases gradually till twelve, and dies about five. Upon its ceasing, the land-breeze commences, which increases till 12 at night, and is succeeded in the morning by the sea-breeze again.

In some countries, the sea-breezes appear only to be the efforts of the trade-wind, as at Barbadoes, and in many places between the tropics, where the general wind, if not impeded by mountains or islands, blows fresh in the day-time, but after sun-set, the terrestrial exhalations being precipitated, produce a new wind, which is not only able to make head against the trade-wind, but to repel it from their coasts. The sea-breezes do not all come from the same point of the compass, but from different points as the land lies. Breezes are more constant in summer than in winter, and more between the tropics than in the temperate zone. Breezes differ from the trade-winds, as the former occur daily, and are perceived only near the shore, whereas the latter are periodical at certain seasons, and blow at a distance from the land.

BREHONS, hereditary judges belonging to the inferior provincial kings, and also to the nobles or chieftains, among the ancient Irish, by whom justice was administered, and controversies decided.

BRENTA, a liquid measure used at Rome.

BRENTUS, a genus of coleopterous insects, having the head protracted into a very long projecting snout, beyond the middle of which, the antennæ, which are moniliform, are inserted. There are several species, as the anchorago, Plate, Nat. Hist. fig. 63. barbicornis, &c.

BREST-SUMMERS, in timber-buildings, are pieces in the outward, into which the girders are framed: this, in the ground-floor, is called a cell; and, in the garret-floor, a beam.

BREST, or BREAST, in architecture, a term sometimes used for the member of a column, more usually called torus.

BRETHREN, *and sisters of the free Spirit*, an appellation assumed by a new sect which sprung up in the thirteenth century, and gained many adherents in Italy, France, and Germany. They derived their name from the words of St. Paul, Rom. viii. ver. 1—14. They maintained that all things flowed by emanation from God; and that by the power of contemplation, they were united to the Deity, and thereby acquired a glorious and sublime liberty, both from the lusts and the instincts of nature; hence they inferred that the person who was thus absorbed in the Deity, became a part of the Godhead, and was the son of God in the same sense that Christ was. They treated with contempt all Christian ordinances, and all external acts of religion, as unsuitable to the state of perfection at which they had arrived.

BREVE, in law, is any writ directed to the chancellor, judges, sheriffs, or other officers, whereby a person is summoned, or attached, to answer in the king's courts, &c.

BREVE PERQUIRERE, the purchasing of a writ or licence for trial in the king's courts: whence comes the present usage of paying 6s. 8d. fine to the king in suit, for money due on bond, where the debt is 40l. and of 10s. where it is 100l, &c.

BREVE, in music, a note or character of time, in the form of a diamond, or square, without any tail, and equivalent to two measures, or minims.

BREVET, in the French customs, denotes the grant of some favour or donation from the king, in which sense it partly answers to our warrant, and partly to letters patent.

BREVIARY, a daily office, or book of divine service, in the Romish church. It is composed of matins, lauds, first, third, sixth, and ninth vespers, and the compline, or post communio.

The institution of the breviary is not very antient: there have been inserted in it the lives of the saints, full of ridiculous and ill attested stories, which gave occasion to various reformations of it, by several councils, particularly those of Trent and Cologn; by several popes, particularly Pius V. Clement VIII. and Urban VIII. also by several cardinals and bishops, each lopping off some extravagances, and bringing it nearer to the simplicity of the primitive offices.

Originally every person was obliged to recite the breviary every day; but by degrees the obligation was reduced to the clergy only, who are enjoined under penalty of mortal sin and ecclesiastical censures, to recite it at home, when they cannot attend in public. In the 14th century there was a particular reserve granted in favour of bishops, who were allowed on extraordinary occasions, to pass three days without rehearsing the breviary.

This office was originally called cursus

and afterwards the breviarium; which latter name imports, that the old office was abridged, or rather that this collection is a kind of abridgment of all the prayers.

BREVIATOR, an officer under the eastern empire, whose business it was to write and translate briefs. At Rome those are still called breviators, or abbreviators, who dictate and draw up the pope's briefs.

BREVIBUS A ROTULIS LIBERANDIS, a writ or command to a sheriff, to deliver to his successor, the county, with the appurtenances, and the rolls, writs, and other things to his office belonging.

BREVIER, among printers, a small kind of type, or letter, between nonpareil and bourgeois.

BREWING, the art of making beer or ale. The art of brewing is undoubtedly a part of chemistry, and depends on fixed and invariable principles. These principles have never yet been thoroughly investigated, and on that account a just and certain theory has not been obtained. We shall, however, give the best rules, as far as practical observation and experience have hitherto gone, for the information of those who have not had the opportunity of attending to the subject.

Malt liquor is essentially composed of water, the soluble parts of malt and hops, and of yeast. There are several kinds of malt, which are distinguished by their colour, and the colour depends upon the mode of malting and drying. Whether the pale or the brown malt is used, it must be coarsely ground, or bruised between rollers, which is rather to be preferred.

The next consideration in brewing is the quality of the water to be employed; and here soft water is universally allowed to be preferable to hard, both for the purposes of mashing and fermentation. Transparency is however more easily obtained by the use of hard than soft water. But it is not well adapted to the brewing of porter, or such beers as require a fulness of palate, as in the London brewery, and some country situations. The purity of water is determined by its lightness; and in this respect, distilled water only can claim any material degree of perfection. Rain-water is the purest of all naturally produced; but having once descended to the surface of the earth, it is liable to a variety of intermixtures unfavourable to the purposes of brewing. With regard to others, though a matter of considerable importance, no precise rule can be laid down. Where there is liberty of choice, a preference should doubtless be given to that water, which from natural purity is equally free from saline substances and vegetable putrefaction, has a soft fulness upon the palate, is totally flavourless, inodorous, and colourless; whence it is the better prepared for the reception and retention of such qualities as brewing is to communicate.

The first step in the process of brewing is mashing, which is performed in a large circular wooden vessel, shallow in proportion to its extent, and furnished with a false bottom, pierced with small holes, and moveable or fixed a few inches above the real bottom. There are two side openings in the interval between the real and false bottom; to one is fixed a pipe for the purpose of conveying water into the tun, and the other for drawing the liquor out of it. The malt is to be strewed evenly over the false bottom of the same tun, and then by means of the side pipe, a proper quantity of hot water is introduced from the upper copper. The water rises up through the malt, or as it is called, the grist, and when the whole quantity is introduced, the mashing begins, the object of which is to effect a perfect mixture of the malt with the water, so that the soluble parts may be extracted by it: for this prupose, the grist is incorporated with the water by means of iron rakes, and then the mass is beaten and agitated by long flat wooden poles resembling oars, which are either worked by the hand or by machinery connected with the steam-engine or some other moving power. When the mashing is completed, the tun is covered in to prevent the escape of the heat, and the whole is suffered to remain still, in order that the insoluble parts may separate from the liquor: the side hole is then opened, and the clear wort allowed to run off, slowly at first, but more rapidly as it becomes fine, into the lower or boiling copper.

The chief thing in mashing is the temperature of the mash, which depends on the heat of water, and on the state of the malt. If the water was let in upon the grist boiling hot, the starch which it contains would be dissolved and converted into a gelatinous substance, in which all the other parts of the malt, and most of the water, would be entangled, beyond the possibility of recovery by any after process. The most eligible temperature appears to be from 185° to 190° of Fahrenheit: for the first mashing the heat of the water must be somewhat below this temperature, and lower in proportion to the dark colour of the malt made use of; for pale malt, the water may be 180°, but for brown, it ought not to be more than 170°. The wort of the first mashing is always by much the richest in saccharine matter; but to exhaust the malt, a second and a third mashing is required, in which the water may be safely raised to 190° or upwards. The proportion of wort to be obtained from each bushel of malt, depends entirely on the proposed strength of the liquor. It is said that 25 or 30 gallons of good table beer may be taken from each bushel of malt. For ale and porter of the superior kinds, only the produce of the first mashing, or six or eight gallons is to be employed. Brewers make use of an instrument called a sacchrometer, to ascertain the strength and goodness of the wort. This instrument is a kind of hydrometer, and shews the specific gravity of the wort, rather than the exact quantity of saccharine matter which it contains.

We now come to the boiling and hopping; and if only one kind of liquor is made, the produce of the three mashings, is to be mixed together; but if both ale and table-beer are required, the wort of the first, or of the first and second mashings is appropriated to the ale, and the remainder is set aside for the beer. All the wort destined for the same liquor, after it has run from the tun, is transferred to the large lower copper, and mixed with a certain proportion of hops. The better the wort, the more hops are required. In private families, a pound of hops is generally used to every bushel of malt: but in public breweries, a much smaller proportion is deemed sufficient. When both ale and table-beer are brewed from the same malt, the usual practice is to put the whole quantity of hops in the ale wort, which having been boiled some time, are to be transferred to the beer wort, and with it to be again boiled.

When the hops are mixed with the wort in the copper, the liquor is made to boil, and the best practice is to keep it boiling as fast as possible till upon taking a little of the liquor out, it is found to be full of small flakes like those of curdled soap. The boiling copper is in common breweries uncovered; but in many on a very large scale, it is fitted with a steam-tight cover, from the centre of which passes a pipe, that terminates by several branches in the upper or mashing copper: the steam, therefore, produced by the boiling, instead of being wasted, is let into the cold water, and thus raises it very nearly to the temperature required for mashing, besides impregnating it very sensibly with the essential oil of the hops, in which the flavour resides.

When the liquor is boiled, it is discharged into a number of coolers, or shallow tubs, in which it remains until it becomes sufficiently cool to be submitted to fermentation. It is necessary that the process of cooling should be carried on as expeditiously as possible, particularly in hot weather, and for this reason, the coolers in the great brewhouses are very shallow. Liquor made from pale malt, and which is intended for immediate drinking need not be cooled lower than 75 or 80 degrees, of course this kind of beer may be brewed almost in the hottest weather; but beer brewed from brown malt, and intended to be kept, must be cooled to 65 or 70 degrees, before it is put into a state of fermentation. Hence the spring and autumn have ever been deemed the most favourable for the manufacture of the best malt liquor.

We now come to the tunning and barrelling: from the coolers the liquor is to be transferred into the working tun, and with it is to be mixed a gallon of yeast to four barrels of beer. In four or five hours the fermentation begins, and it requires from 18 or 20 hours to 48, before the wort is fit to be put into barrels. In the barrels the fermentation again goes on, and during a few days, a copious discharge of yeast takes place from the bung-hole, care must be taken that the barrels are carefully filled up every day with fresh liquor: this discharge gradually becomes less, and in about a week it ceases; at which time the bung-hole is closed, and the liquor is fit for use after it has stood a certain time according to its strength, and the temperature at which it has been fermented.

BREWING, among distillers, denotes the method of extracting the more soluble parts of vegetables with hot water, and thus procuring a solution or decoction fitted for vinous fermentation. In this sense brewing is a necessary step towards distillation. A fermentable solution, fit for yielding a spirit, is obtainable from any vegetable, under proper management. Thus sugar, treacle, and other inspissated vegetable juices, which totally unite with water, are better adapted to fermentation, than roots, fruits, or herbs, in substance, the grains, or even the malt itself; all which dissolve, but very imperfectly, in hot water. Malt is, however, general-

ly used in England, and brewed for this purpose: the worst malt will serve for distillation; and the infusion or wort without the addition of hops, and the trouble of boiling, is here directly cooled and fermented. See DISTILLING.

BREYNIA, in botany, a genus of the polyandria dioecia class and order of plants. The essential character is, male cal. one-leaved, five-parted; cor. none; nect. five-glands; filaments five, very short; anthers roundish. Fem. cal. and cor. as in the male; pist. germ globose; style none; stigmas five; per. caps. five-celled; seeds solitary. There is one species, a native of New Caledonia.

BRIBERY, the receiving, or offering, any undue reward, by or to any person whatsoever, whose ordinary profession or business relates to the administration of public justice, in order to incline him to do a thing against the known rules of honesty and integrity; it also signifies the taking or giving a reward for offices of a public nature.

As to the punishment of bribery, by the common law, bribery in a judge, was looked upon as an offence of so heinous a nature, that it was sometimes punished as high treason. 3 Inst. 148. And all other kinds of bribery are punishable by fine and imprisonment; which may also be inflicted on those who offer a bribe though not taken. Black. 143. 2 Inst. 147.

BRICIANI, a military order, instituted by St. Bridget, queen of Sweden.

BRICK, a reddish earth, of the aluminous or argillaceous kind, formed into long squares, by means of a wooden mould, and then baked or burnt. In the east they baked their bricks in the sun; the Romans used them unburnt, only leaving them to dry for four or five years in the air.

BRICKS, among us, are various, according to their various forms, dimensions, uses, method of making, &c. the principal of which are, compass bricks, of a circular form, used in steyning of walls: concave, or hollow bricks, on one side flat like a common brick, on the other hollowed, and used for conveyance of water; feather-edged bricks, which are like common statute bricks, only thinner on one edge than the other, and used for penning up the brick-pannels in timber buildings: cogging bricks are used for making the indented works under the coping of walls built with great bricks: coping bricks, formed on purpose for coping of walls: Dutch or Flemish bricks, used to pave yards, or stables, and for soap boilers' vaults, and cisterns: clinkers, such bricks as are glazed by the heat of the fire in making: sandal or samel-bricks, are such as lie outmost in a kiln, or clamp, and consequently are soft and useless, as not being thoroughly burnt: great bricks are those twelve inches long, six broad, and three thick, used to build fence walls: plaister or buttress bricks, have a notch at one end, half the breadth of the brick; their use is to bind the work which is built of great bricks: statute bricks, or small common bricks, ought, when burnt, to be nine inches long, four broad, and two and a half thick.

The art of brickmaking is, in almost all its branches, regulated by different acts of parliament. Bricks may be made of pure clay, or of clay mixed with sand or ashes, or with both. The clay is first moistened and tempered with water, to render it fit for moulding into bricks. Then several persons are usually employed in making a single brick: these are called a gang, and they consist of one or two men, a woman, and two children, to each of which is assigned a different department in the occupation. A gang in full work will make many thousand bricks in the course of a week. When the bricks are made and sufficiently dried, they are burnt in a kiln. The great art in this part of the process, is required in piling the bricks, so that the fire may circulate through every course, and in all directions. Bricks when finished are of different colours, according to the clay of which they are made; the most beautiful are the white bricks manufactured at Woolpit in Suffolk.

BRICKLAYER, one who lays bricks in the building of edifices of any kind. Tilers and bricklayers were incorporated 10 Eliz. under the name of master and wardens of the society of freemen of the mystery and art of tilers and bricklayers.

BRIDEWELL, in Bridge-street, Blackfriars, is a foundation of a singular nature, partaking partly of the hospital, the prison, and the workhouse. It was founded by Edward VI. who presented the place, which had formerly been the palace of king John, to the city of London, with 700 marks of land, bedding and other furniture. Several youths are sent to this hospital as apprentices to manufacturers who reside there, and when they have faithfully served their time of seven years, they are presented with their freedom, and ten pounds each for carrying on their respective trades.

BRIDGE, a work of masonry or timber, consisting of one or more arches, built over a river, canal, or piece of water, for the conveniency of crossing the same.

Bridges are a sort of edifices very difficult to execute, on account of the inconvenience of laying foundations and walling under water. The parts of a bridge are the piers, the arches, the pavement, or way over for cattle and carriages, the foot way on each side, for foot passengers, the rail or parapet, which incloses the whole, and the buttments or ends of the bridge on the bank.

The conditions required in a bridge are, that it shall be well designed, and suitably decorated. The piers of stone bridges should be equal in number, that there may be one arch in the middle, where commonly the current is strongest; their thickness is not to be less than a sixth part of the span of the arch, nor more than a fourth; they are commonly guarded in the front with angular starlings, to break the force of the current. As the piers of bridges always diminish the bed of a river in case of inundations, the bed must be sunk or hollowed in proportion to the space taken up by the piers (as the waters gain in depth what they lose in breadth) which otherwise conduce to wash away the foundation and endanger the piers: to prevent this, they sometimes diminish the current, either by lengthening its course, or making it more winding; or by stopping the bottom with rows of planks, stakes, or piles, which break the current. It is also required that the foundation of bridges be laid at that season of the year, when the waters are lowest; and if the ground is rocky, hard gravel, or stony, the first stones of the foundation may be laid on the surface; but if the soil is soft sand, it will be necessary to dig till a firm bottom is found.

Bridges should rather be of few and large arches, than of many smaller ones, if the height and situation will possibly allow of it; for this will leave more free passage for the water and navigation, and be a great saving in materials and labour; as there will be fewer piers and centres, and the arches, &c. will require less materials; a remarkable instance of which appears in the difference between the bridges of Westminster and Blackfriars, the expence of the former being more than double the latter.

For the proper execution of a bridge, and making an estimate of the expence, &c. it is necessary to have three plans, three sections, and an elevation. The three plans are so many horizontal sections, viz. first a plan of the foundation under the piers, with the particular circumstances attending it, whether of gratings, planks, piles, &c.; the 2d is the plan of the piers and arches; and the 3d is the plan of the superstructure, with the paved road and banquet. The three sections are vertical ones; the first of them a longitudinal section from end to end of the bridge, and through the middle of the breadth; the 2d, a transverse one, or across it, and through the summit of an arch; and the 3d also across, but taken upon a pier. The elevation is an orthographic projection of one side or face of the bridge, or its appearance as viewed at a distance, shewing the exterior aspect of the materials, with the manner in which they are disposed, &c.

For the figure of the arches, some prefer the semicircle, though perhaps without knowing any good reason why; others the elliptical form, as having many advantages over the semi-circular; and some talk of the catenarian arch, though its pretended advantages are only chimerical; but the arch of equilibration is the only perfect one, so as to be equally strong in every part. See ARCH of EQUILIBRATION. The piers are of different thickness, according to the figure, span, and height of the arches.

With the Romans, the repairing and building of bridges were committed to the priests, thence named pontifices; next to the censors, or curators of the roads; but at last the emperors took the care of the bridges into their own hands. Thus, the Pons Janiculensis was built of marble by Antoninus Pius; the Pons Cestius was restored by Gordian; and Arian built a new one which was called after his own name. In the middle age, bridge-building was counted among the acts of religion; and, toward the end of the 12th century, St. Benezet founded a regular order of hospitallers, under the name of pontifices, or bridge-builders, whose office was to assist travellers, by making bridges, settling ferries, and receiving strangers into hospitals, or houses, built on the banks of rivers.

Among the bridges of antiquity, that built by Trajan over the Danube, it is allowed, is the most magnificent. It was demolished by his next successor Adrian, and the ruins are still to be seen in the middle of the Danube, near the city Warhel, in Hungary. It had 20 piers, of square stone, each of which was 150 feet high above the foundation, 60 feet in breadth, and 170 feet distant from one

another, which is the span or width of the arches; so that the whole length of the bridge was more than 1530 yards, or nearly one mile.

In France, the Pont de Garde is a very bold structure; the piers being only 13 feet thick, yet serving to support an immense weight of a triplicate arcade, and joining two mountains. It consists of three bridges, one over another; the uppermost of which is an aqueduct.

The bridge of Avignon, which was finished in the year 1188, consists of 18 arches, and measures 1340 paces, or about one thousand yards in length.

The famous bridge at Venice, called the Rialto, passes for a masterpiece of art, consisting of only one very flat and bold arch, near a hundred feet span, and only 23 feet high above the water: it was built in 1591. Poulet also mentions a bridge of a single arch, in the city of Munster in Bothnia, much bolder than that of the Rialto at Venice. Yet these are nothing to a bridge in China, built from one mountain to another, consisting of a single arch, 400 cubits long, and 500 cubits high, whence it is called the flying bridge; and a figure of it is given in the Philosophical Transactions. Kircher also speaks of a bridge in the same country three hundred and sixty perches long without any arch, but supported by three hundred pillars.

There are many bridges of considerable note in our own country. The triangular bridge at Crowland in Lincolnshire, it is said, is the most ancient Gothic structure remaining intire in the kingdom; and was erected about the year 860.

London-bridge is on the old Gothic structure, with twenty small locks or arches, each of only twenty feet wide; but there are now only eighteen open, two having been thrown into one in the centre, and another next one side is concealed or covered up. It is nine hundred feet long, sixty high, and seventy-four wide; the piers are from twenty-five to thirty-four feet broad, with starlings projecting at the ends; so that the great water-way, when the tide is above the starlings, was 450 feet, scarcely half the breadth of the river; and below the starlings, the water-way was reduced to one hundred and ninety-four feet, before the opening of the centre.

London-bridge was first built with timber, between the years 993 and 1016; and it was repaired, or rather new-built with timber, 1163. The stone bridge was begun in 1176, and finished in 1209. It is probable there were no houses on this bridge for upwards of 200 years; since we read of a tilt and tournament held on it in 1395. Houses it seems were erected on it afterwards; but being found of great inconvenience and nuisance, they were removed in 1758, and the avenues to it enlarged, and the whole made more commodious; the two middle arches were then thrown into one, by removing the pier from between them; the whole repairs amounting to above 80,000*l*.

The longest bridge in England is that over the Trent at Burton, built in the 12th century, of squared free-stone, and is strong and lofty; it contains thirty-four arches, and the whole length is 1545 feet. But this falls far short of the wooden bridge over the Drave, which according to Dr. Brown, is at least five miles long.

But one of the most singular bridges in Europe, is that built over the Taaf in Glamorganshire, by William Edward, a poor country mason, in the year 1756. This remarkable bridge consists of only one stupendous arch, which, though only eight feet broad, and thirty-five feet high, is no less than one hundred and forty feet span, being part of a circle of one hundred and seventy-five feet diameter.

Of modern bridges, perhaps the two finest in Europe, are the Westminster and Blackfriars bridges over the river Thames at London. The former is 1220 feet long, and 44 feet wide, having a commodious broad foot-path on each side for passengers. It consists of thirteen large and two small arches, all semicircular, with fourteen intermediate piers. The arches all spring from about two feet above low-water mark; the middle arch is seventy-six feet wide, and the others on each side decrease always by four feet at a time. The two middle piers are each seventeen feet thick at the springing of the arches; and the others decrease equally on each side by one foot at a time; every pier terminating with a saliant right angle against either stream. This bridge is built of the best materials, and in a neat and elegant taste, but the arches are too small for the quantity of masonry contained in it. This bridge was begun in 1738, and opened in 1750; and the whole sum of money granted and paid for the erection of this bridge, with the purchase of houses to take down, and widening the avenues, &c. amounted to 389,500*l*.

Blackfriars bridge, nearly opposite the centre of the city of London, was begun in 1760, and was completed in ten years and three quarters; and is an exceeding light and elegant structure; but the materials unfortunately do not seem to be the best, as many of the arch stones are decaying. It consists of nine large, elegant, elliptical arches; the centre arch being one hundred feet wide, and those on each side decreasing in a regular gradation, to the smallest, at each extremity, which is seventy feet wide. The breadth of the bridge is forty-two feet, and the length from wharf to wharf nine hundred and ninety-five. The upper surface is a portion of a very large circle, which forms an elegant figure, and is of convenient passage over it. The whole expence was 150,840*l*.

Bridges, *iron*, are the exclusive invention of British artists. The first that has been erected on a large scale is that over the river Severn, at Coalbrook Dale, in Shropshire. This bridge is composed of five ribs, and each rib of three concentric arcs connected together by radiating pieces. The interior arc forms a complete semicircle; but the others extend only to the cills under the road-way. These arcs pass through an upright frame of iron at each end, which serves as a guide; and the small space in the haunches between the frames and the outer arc is filled with a ring of about seven feet diameter. Upon the top of the ribs are laid cast-iron plates, which sustain the road-way. The arch of this bridge is one hundred feet six inches in span; the interior ring is cast in two pieces, each piece being about seventy feet in length. It was constructed in the year 1779, by Mr. Abraham Darby, ironmaster at Coalbrook Dale, and must be considered as a very bold effort in the first instance of adopting a new material. The total weight of the metal is 378½ tons.

The second iron bridge, of which the particulars have come to our knowledge, was that designed by Mr. Thomas Paine, author of many political works. It was constructed by Messrs. Walkers at Rotherham, and was brought to London, and set up in a bowling-green at Paddington, where it was exhibited for some time. After which it was intended to have been sent to America; but Mr. Paine not being able to defray the expence, the manufacturers took it back, and the malleable iron was afterwards worked up in the construction of the bridge at Wearmouth.

The third iron bridge of importance erected in Great Britain, was that over the river Wear, at Bishop Wearmouth, near Sunderland, the chief projector of which was Rowland Burdon, esq. M. P. This bridge consists of a single arch, whose span is 236 feet: and as the springing stones at each side project two feet, the whole opening is 240 feet. The arch is a segment of a circle of about 444 feet diameter; its versed sine is thirty-four feet, and the whole height from low-water about one hundred feet, admitting vessels of from two to three hnndred tons burthen to pass under, without striking their masts. A series of one hundred and five blocks form a rib, and six of these ribs compose the breadth of the bridge. The spandrels, or the spaces between the arch and the road-way, are filled up by cast-iron circles, which touch the outer circumference of the arch, and at the same time support the road-way, thus gradually diminishing from the abutments towards the centre of the bridge. There are also diagonal iron bars, which are laid on the tops of the ribs, and extended to the abutments to keep the ribs from twisting. The superstructure is a strong frame of timber planked over to support the carriage-road, which is composed of marl, lime-stone, and gravel, with a cement of tar and chalk immediately upon the planks to preserve them. The whole width of the bridge is thirty-two feet. The abutments are masses of almost solid masonry, twenty-four feet in thickness, forty-two in breadth at bottom, and thirty-seven at top. The south pier is founded on the solid rock, and rises from about twenty-two feet above the bed of the river. On the north side the ground was not so favourable, so that it was necessary to carry the foundation ten feet below the bed. The weight of the iron in this extraordinary fabric amounts to 260 tons; 46 of these are malleable, and 214 cast. The entire expence was 27,000*l*.

The splendid example of the bridge at Wearmouth gave an impulse to public taste, and caused an emulation among artists, which has produced many examples and more projects of iron bridges. The Coalbrook Dale Company have constructed several, among which is a very neat one over the river Parrot at Bridgewater. Mr. Wilson, the engineer employed by Mr. Burdon, has also built several: and has lately finished a very elegant one over the river Thames, at Staines, which is by far the most complete in design, as well as the best executed, of any that has hitherto been erected. This bridge consists of a single arch, 181 feet in span, and 16

feet six inches in rise, being a segment of a circle of 480 feet. The blocks of which the ribs are composed, are similar to those in the Wearmouth-bridge, except that these have only two concentric arcs instead of three, as at the latter. The arcs are cast hollow, and the blocks connected by means of dowels and keys; thus obviating the great defect observed at Wearmouth, of having so much hammered iron exposed to the action of the air. Four ribs form the width of the arch, which are connected together by cross frames. The spandrels are filled with circles which support a covering of iron plates an inch thick: on this is laid the road-way twenty-seven feet wide. Two hundred and seventy tons are the weight of the iron employed in the bridge, and three hundred and thirty of the road-way. See Plate.

BRIEF, any writ in writing issued out of any of the king's courts of record at Westminster, whereby any thing is commanded to be done in order to justice.

Briefs for collecting charity are to be read in all churches and chapels within two months after receipt thereof, and the sums thereby collected shall be paid over to the undertaker of briefs, within six months after the delivery of the briefs under penalty of 20*l*.

Brief also signifies an abridgment of the client's case made out for the instruction of counsel, on a trial at law, which is to be fully but briefly stated.

Briefs *apostolical*, letters which the pope dispatches to princes, or other magistrates, relating to any public affair. These briefs are distinguished from bulls, the latter being more ample and always written on parchment and sealed with lead or green wax, whereas briefs are very concise, written on paper, sealed with red wax, and with the seal of the fisherman, or St. Peter in a boat.

BRIGADE, in the military art, a party or division of a body of soldiers, whether horse or foot, under the command of a brigadier. An army is divided into brigades of horse and brigades of foot: a brigade of horse is a body of eight or ten squadrons; a brigade of foot consists of four, five, or six battalions.

Brigade-major is an officer appointed by the brigadier, to assist him in the management and ordering of his brigade.

BRIGADIER is the general officer who has the command of a brigade. The eldest colonels are generally advanced to this post. He that is upon duty is brigadier of the day. They march at the head of their own brigades, and are allowed a serjeant and ten men of their own brigade for their guard.

BRIGANTINE, a coat of mail, a kind of antient defensive armour, consisting of thin jointed scales of plate, pliant and easy to the body.

BRIMSTONE. See Sulphur. Brimstone medals, figures, &c. may be cast from a composition consisting of equal weights of sulphur and vermilion melted together, and when cleared it may be cast in a mould smeared with oil. If it should change to a yellowish hue, wet it with aquafortis and it will have the appearance of fine coral.

BRINE-PANS, the pits in which salt-water is retained, and suffered to stand, to bear the action of the sun, by which it is converted into salt.

Brine-pit, the salt spring from which the water to be boiled into salt is taken. There are many of these springs in this country; that at Nantwich, in Cheshire, is said to be sufficient to yield salt for the whole kingdom.

BRING-TO, in naval affairs, to check or retard the velocity, or rate of sailing of a ship, by arranging the sails in such a manner, that they shall counteract each other, and thus prevent her either from advancing ahead, or getting stern-way.

BRINING of grain; the practice of immersing it in some sort of liquor or pickle to prevent the smut, or other diseases, and also to guard it from the ravages of insects. Mr. Arthur Young, in his Farmer's Calendar, says, that from various experiments it appears that steeping wheat from twelve to twenty-four hours in a lye of wood-ashes, in lime-water, and in a solution of arsenic, gave clean crops from extremely smutty seed.

Brining of hay, the blending of salt with hay in the operation of stacking, to preserve and render it palatable. This practice is useful in rainy seasons, and it prevails chiefly in America.

BRISTLE, a thick glossy kind of hair, with which the swine kind are more especially covered. They are hard, transparent, horny substances, of a prismatical figure, without any appearance of cavities or pores in them. Cat's bristles, or whiskers, have a solid pith in the middle. Hog's bristles constitute an important article of exportation in Russia; those imported into this country pay a heavy duty.

Bristle-dice, a sort of false dice, furnished with a piece of hog's-bristle stuck in the corners, to prevent them from falling on certain sides, and to make them run high or low at pleasure.

BRISTOL-WATER. See Mineral Waters.

BRIZA, in botany, quaking grass: a genus of the digynia order, and triandria class of plants; and in the natural method ranking under the 4th order, gramina. The calyx is two-valved, and multiflorous; the spicula bifarious, with the small valves heart-shaped and blunt, and the inner one small in proportion to the rest. There are six species of briza: two of which are natives of Britain, viz.

1. Briza media, the middle quaking-grass, and

2. Briza minor, the small quaking-grass. Both grow in pasture grounds. The briza maxima is a native of the south of Europe, and is a very ornamental plant in gardens.

BROCADE, a stuff of gold, silver, or silk, raised and enriched with flowers, foliages, and other ornaments, according to the fancy of the merchants or manufacturers. Formerly the word signified only a stuff, woven all of gold, both in the warp and in the woof, or all of silver, or of both mixed together; thence it passed to those of stuffs in which there was silk mixed, to raise and terminate the gold or silver flowers: but now all stuffs, even those of silk alone, whether they are grograms of Tours or of Naples, satins, and even taffeties or lutestrings, if they are but adorned and worked with some flowers, or other figures, are called brocades.

BROKER, a name given to persons of several and very different professions, the chief of which are exchange-brokers, stock-brokers, pawn-brokers, and brokers simply so called, who sell household furniture, and second-hand apparel.

Brokers, exchange, are a kind of agents, or negociators, who contrive, propose, and conclude bargains between merchants, and between merchants and tradesmen, in matters of bills of exchange, or merchandise, for which they have so much commission. These, by the statute of 8 and 9 William III. are to be licensed in London by the lord-mayor, who administers to them an oath, and takes bond for the faithful execution of their offices. If any person shall act as broker, without being thus licensed and admitted, he shall forfeit the sum of 500*l*. and persons employing him 5*l*. and brokers are to register contracts, &c. under the like penalty: also brokers shall not deal for themselves, on pain of forfeiting 200*l*. They are to carry about with them a silver medal, having the king's arms, and the arms of the city, and pay 40*s*. a year to the chamber of the city.

The exchange-brokers make it their business to know the alteration of the course of exchange, to inform merchants how it goes, and to give notice to those who have money to receive, or pay, beyond sea; they are the proper persons for negotiating the exchange, and when the matter is accomplished, that is, when the money for the bill is paid, and the bill delivered, they have for brokerage 2*s*. for 100*l*. sterling.

Brokers, stock, are those employed to buy and sell shares in the joint stock of a company, or in the public funds. The negotiations of these brokers are regulated by certain acts of parliament, which among other things enact, that contracts in the nature of wagers, incur a penalty of 500*l*. and by the sale of stock, of which the seller is not possessed, and which he does not transfer, a forfeit of 100*l*.; and contracts for the sale of any stock, of which the contractors are not actually possessed, or to which they are not entitled, are void, and the parties agreeing to sell, &c. incur a penalty of 500*l*.; and that brokers keep a book in which all contracts, &c. shall be regularly entered.

Brokers, *pawn*, are persons who keep shops, and let out money, to necessitous people, upon pledges, on interest. This trade is regulated by statutes, which prevent the demand of exorbitant interest; which prohibit pawnbrokers from purchasing goods in their custody, and from lending money to any person appearing to be under twelve years of age, or intoxicated. Pawnbrokers are to place in their shops, a table of rates allowed by act of parliament; they are subject also to divers other restrictions, evidently intended as a security to the poor, whose exigencies or misfortunes oblige them to part with their property, to satisfy their most pressing wants.

BROMELIA, the pine-apple: See Plate Nat. Hist. fig. 64. a genus of the monogynia order, and hexandria class of plants; and in the natural method ranking under the tenth order, coronariæ. The essential character is calyx, trifid, superior: corolla with nectareous scales at the base of each berry, three-celled. There are nine species of which the following are the most remarkable:

1. Bromelia ananas, with leaves very like some sorts of aloes, but not so thick and succulent, which are strongly armed with black spines. From the centre of the plant arises

Pl. XXII

C. Varley del.

S. Porter sc.

The Iron Bridge at Colebrook Dale.

Printed Apr 1 1806. for Richard Phillips. 6. New Bridge St. Blackfriars.

the flower-stalk, which is near three feet high; the lower part is garnished with entire leaves, placed alternately at every joint. The upper part is garnished with flowers set in a loose spike or thyrse quite round: these are succeeded by oval seed-vessels, having a longitudinal partition, in the centre of which are fastened smooth cylindrical seeds. Of this there are six varieties.

2. Bromelia lingulata, with obtuse, sawed, and prickly leaves.

3. Bromelia nudicaulis, with the lower leaves indented and prickly. The leaves of this species are shorter than those of the ananas. They are sharply sawed on their edges, and of a deep green colour. The flower stem arises from the centre of the plant, which divides upward into several branches; the upper part of these are garnished with spikes of flowers, which come out alternately from the sides of the branches, each having a narrow entire leaf just below it, which are longer than the spike. The flowers are placed very close on the spikes: and when they decay, the empalement turns to an oval-pointed seed-vessel, inclosing seeds of the same shape with the other.

The plants of the pine-apple are propagated by planting the crowns which grow on the fruit, or the suckers which are produced either from the sides of the plants or under the fruit The suckers and crowns must be laid to dry in a warm place for four or five days, or more; for if they are immediately planted, they will rot. The certain rule of judging when they are fit to plant, is by observing if the bottom is healed over and become hard. In summer, they must be frequently watered; but not with large quantities at a time; and the moisture should not be detained in the pots by the holes being stopped, for that will soon destroy the plants. If the season is warm, they should be watered twice a week; but in a cool season, once a week will be sufficient; and in summer they should once a week be watered gently all over the leaves; which will greatly promote their growth. During the winter, they will not require to be watered oftener than once a week, according as the earth in the pots seems to dry. Plants beginning to show their fruit should never be shifted; for if they are removed after the fruit appears, it stops the growth, and thereby causes the fruit to be smaller, and retards its ripening, so that it will be October or November before the fruit is ripe; therefore the plants should be kept in a vigorous growing state from the first appearance of the fruit, as upon this depend the goodness and the size of it. After cutting off the fruit from the plant intended to be propagated, the leaves should be trimmed, and the pots plunged again into a moderate hot-bed, observing to refresh them frequently with water, which will make them put out suckers in plenty; so that one may be soon supplied with plants enough of any of the kinds, who will but observe to keep the plants in health. The most dangerous thing that can happen to these plants is their being attacked by small white insects, which appear at first like a white mildew, but soon after have the appearance of lice: these attack both root and leaves at the same time; and if they are not soon destroyed, will spread over a whole stove in a short time, and in a few weeks entirely stop the growth of the plants by sucking out the nutritious juice, so that the leaves will appear yellow and sickly, and have a number of yellow transparent spots all over them. These insects, after they are fully grown, appear like bugs, adhering so closely to the leaves as not to be easily washed off, and seem to have no local motion. They were originally brought from America upon the plants imported from thence. The only method yet discovered of destroying them, is by frequently washing the leaves, branches, and stems, of such plants as they attack, with water in which there has been a strong infusion of tobacco-stalks. But this method cannot be practised on the ananas plants, because the insects fasten themselves so low between the leaves, that it is impossible to come at them with a sponge to wash them off; so that although they seem to be all cleared off, they are soon succeeded by a fresh supply from below, and the roots are also equally infected at the same time. Therefore, whenever they appear on the plants, the safest method is to take the plants out of the pots, and clear the earth from the roots; then put them into a tub, filled with water in which there has been a strong infusion of tobacco-stalks; and lay some sticks across to keep them immersed in the water, wherein they should remain twenty-four hours; then take them out, and with a sponge wash off all the insects from the leaves and roots, and wash the plants in a tub of fresh water. This is the most effectual way to clear them from the insects. After this, you should put them in fresh earth; and, having stirred up the bark-bed, and added some new tan to give a fresh heat to the bed, the pots should be plunged again, observing to water them all over the leaves, and this should be repeated once a week during summer; for these insects always multiply much faster where the plants are kept dry, than when they are sometimes sprinkled over with water, and kept in a growing state.

Of late, some very considerable improvements have been made in this article. The leaves of the oak have been substituted for the more expensive bark; and the pines treated with them are found to thrive as well, and to produce as good fruit as the others. But the most considerable improvement is that mentioned in the 67th volume of the Philosophical Transactions, where the following method is shown by William Bastard, Esq. of Devonshire, of raising these fruits in water. "The way in which I treat them," says he "is as follows: I place a shelf near the highest part of the back wall, that the pine plants may stand without absolutely touching the glass, but as near as it can be: on this shelf I place pans full of water, about seven or eight inches deep; and in these pans I put the pine-apple plants, growing in the same pots of earth as they are generally planted in, to be plunged into the bark-bed in the common way; that is, I put the pot of earth, with the pine plant in it, in the pan full of water, and as the water decreases I constantly fill up the pan. I place either plants in fruit, or young plants as soon as they are well rooted, in these pans of water, and find they thrive equally well: the fruit reared this way is always much larger as well as better flavoured, than when ripened in the bark-bed. I have more than once put only the plants themselves without any earth, I mean after they had roots, into these pans of water, with only water sufficient to keep the roots always covered, and found them flourish beyond expectation. In my house, the shelf I mention is supported by irons from the top, and there is an intervening space of about ten inches between the back wall and the shelf. A neighbour of mine has placed a leaden cistern upon the top of the back flue, (in which, as it is in contact with the flue, the water is always warm when there is fire in the house,) and finds his fruit excellent and large. My shelf does not touch the back flue, but is about a foot above it; and consequently only warmed by the air in the house. Both these methods do well. The way I account for this success is, that the warm air always ascending to the part where this shelf is placed, as being the highest part of the house, keeps it much hotter than in any other part. The temperature at that place is, I believe, seldom less than what is indicated by 73° of Fahrenheit's thermometer, and when the sun shines it is often above 100°: the water the plants grow in, seems to enable them to bear the greatest heat, if sufficient air is allowed; and I often see the roots of the plants growing out of the holes in the bottom of the pot of earth, and shooting vigorously in the water."

BROMUS, BROOM-GRASS, in botany: a genus of the digynia order, and triandria class of plants; and, in the natural method, ranking under the 4th order, gramina. The calyx is bivalved, having a partial spike, oblong and round, opposite grains, with an awn below the point of each outer valve. There are 25 species, of which seven are natives of Britain, viz.

1. Bromus arvensis, common broom-grass:
2. Bromus ciliatus, wall broom-grass:
3. Bromus giganteus, tall broom-grass:
4. Bromus pinnatus, spiked broom-grass:
5. Bromus ramosus, wood broom-grass:
6. Bromus secalinus, field broom-grass:
7. Bromus sterilis, barren broom-grass.

BRONCHIA. See ANATOMY.

BRONCHOCELE, in surgery, a tumour rising in the forepart of the neck. This disorder with us is frequently called a Derbyshire neck, on account of the inhabitants of that county being much subject to it; probably for the same reasons that the inhabitants about the valleys of the Alps, and other mountainous countries, are so much affected with it. The most common situation of this swelling is the sides of the thyroid gland, and in many cases it seems to consist of a general enlargement of that organ. This disease is known to predominate most in countries affected by the humidity of the atmosphere, joined with excessive heat: it increases in the spring time, and diminishes in the autumn; it is less prevalent in cold and dry seasons, than in those that are damp, and moderately warm; it has been asserted that its progress, wherever it is endemial, is in exact proportion to the degree of moisture indicated by the hydrometer.

BRONCHOTOMY, in surgery, an incision made in the aspera arteria, or windpipe, which is necessary in many cases, and especially in a violent quinsey, to prevent suffocation from the great inflammation or tumour of the parts. It is also called laryngotomy and tracheotomy. See SURGERY.

BRONCHUS, in anatomy, the lower part of the aspera arteria, dividing in bronchiæ, or branches. In this sense it stands contradistinguished from the larynx. The name is frequently extended to the whole aspera arteria or trachea.

BRONTIÆ, thunder-stones, a kind of hemispherical stones divided by zones. The word is Greek, signifying thunder, in reference to the popular tradition, that this species of stones fall in thunder-showers.

BRONZE, a compound metal, composed of from 6 to 12 parts of tin combined with 100 parts of copper. This alloy is heavier than copper, and possesses more tenacity; it is more fusible, and less liable to be altered by exposure to the air. This composition is used for cannon as well as for medals.

BRONZES, a name given by antiquarians to figures either of men or beasts, to urns, and, in general, to every piece of sculpture which the antients made of that metal. We likewise give the name of bronzes to statues and busts cast of bronze, whether these pieces are copies of antiques, or original subjects.

The method of casting bronzes is as follows: The figure to be cast, must have a mould made on it with a mixture of one part of plaister of Paris, and two parts of brick-dust. In the joints little channels should be cut from different parts of the internal hollow, tending upwards, to give vent to the air which the metal will force out, as it runs into the mould. When the mould is made, a thin layer of clay should be spread over the inside, the same thickness the bronze is intended to be: then the mould must be closed, and the hollow within the layer of clay filled with two thirds of brick-dust, and one third of plaister mixed with water. This will make the core; and if the figure to be cast should be large, strong bars of iron forming a skeleton of support for the metal figure must be laid in the mould, and round this the core must be cast; when this is done, the mould must be opened again, and round this the core of clay taken out; the mould and core must be thoroughly dried, to prevent any accident with the cast. The core is then to be laid in the mould, and supported by short bars of bronze which run through the mould into the core. The mould is now to be laid in a situation for casting; a channel must be continued sufficiently sloping from the reservoir of metal to the mouth of the mould for the liquid bronze to run easily. The form of the furnace, and the manner of running the metal are the same as those employed in the bell foundry.

BRONZING, the art of varnishing wood, plaister, ivory, &c. so as to give them the colour of bronze. There are two sorts of composition used for this purpose, the red and the yellow; the latter is made of the finest copper dust, and to the former is added a small quantity of red ochre, well pulverized. Both are applied with varnish, and the work is dried over a chafing-dish as soon as bronzed.

BROOM, in botany. See SPARTIUM, and GENISTA.

BROOM-FLOWER, *ordre de la geniste*, an order instituted by St. Louis, king of France, to shew the esteem which he had for the queen his wife; and who, the evening before his queen's coronation, received this order himself.

The collar of this order was a gold chain of broom-flowers, interlaced with fleur-de-lis: the inscription, "exaltat humiles," the founder accounting the broom the symbol of humility.

BROSÆA, in botany, a genus of plants, of the order monogynia, and pentandria class. The characters are these: the cup is a one-leaved perianthium, five segments; the flower is monopetalous, of the shape of a truncated cone. The fruit is a roundish capsule, divided into five cells, and opening at the sides, discharges a great number of seeds. There is one species, a native of South America.

BROTHERHOOD *of God*, a Christian denomination associated together for restraining and abolishing the right and exercise of private war. This sect was founded in the 12th century by a carpenter at Guienne, who pretended to have had divine communication with Jesus Christ and the Virgin Mary. He was received as an inspired messenger of God. Many prelates and barons assembled at Puy, and took an oath, not only to make peace with all their own enemies, but to attack such as refused to lay down their arms, and to be reconciled to their enemies.

BROWALLIA, in botany, a genus of the angiospermia order, in the didynamia class of plants. The essential character is, calyx five-toothed: corolla five cleft, equal spreading with the navel closed: anthers, two larger: capsule, one-celled. There are two species, both annuals, viz.

1. Browallia demissa, with a single flower upon each footstalk. The seeds were sent to Mr. Miller, from Panama. The flowers are of a light blue colour, sometimes inclining to a purple or red; and there are often three colours of flowers on the same plant. They flower in July, August, and September.

2. Browallia elata, with one or many flowers on each footstalk, is a native of Peru. The stalk appears somewhat shrubby; the footstalks have sometimes one flower, others with three, and others with five, of a deep violet colour. As both species of browallia are annual plants, they must be raised from seeds, which are to be sown on a hot-bed; but they may be transplanted in June, into the borders of the flower garden; where, if the weather proves warm, they will flower and perfect seeds; but lest these should fail, there should be a plant or two kept in the greenhouse to secure seeds.

BROWN, among dyers, painters, &c. a dusky colour, inclining towards redness. Of this colour there are various shades or degrees, distinguished by different appellations; for instance, Spanish-brown, a sad-brown, a tawny-brown, the London-brown, a clove-brown, &c.

Spanish-brown is a dark dull red, of a horse-flesh colour. It is an earth, and is of great use among painters, being generally used as the first and priming colour that they lay upon any kind of timber-work in house-painting. That which is of the deepest colour, and freest from stones, is the best. Though this is of a dirty brown colour, yet it is not much used to colour any garment, unless it be an old man's gown; but to shadow vermilion, or to lay upon any dark ground behind a picture, or to shadow yellow berries in the darkest places, when lake is wanted, &c. It is best and brightest when burnt in the fire till it is red-hot, although, to colour a hare, horse, dog, or the like, it should not be burnt; but, for other uses, it is best when it is burnt, as for instance, for colouring wood, posts, bodies of trees, or any thing else of wood, or any dark ground of a picture.

The method of dying browns is by plunging the cloth in a boiling bath of red wood ground and nut-galls bruised; and when it has boiled for two hours and a half, and has been cooled and aired, it is plunged again in the same bath, to which a proportionable quantity of copperas must first be added. The more dull you would have the brown, the more copperas must be put in.

BROWNISTS, in church history, a religious sect, which sprung up in England towards the end of the 16th century. Their leader was one Robert Brown, born at Northampton. They separated from the established church, on account of its discipline and form of government. They equally disliked episcopacy and presbyterianism. They condemned the solemn celebration of marriages in churches, maintaining, that matrimony being a political contract, the confirmation of it ought to proceed from the civil magistrate. They rejected all forms of prayer, and held that the Lord's prayer was not to be recited as a prayer; being given only as a model, upon which to form our prayers.

BRUCEA, in botany, a genus of the tetrandria order, and dicœcia class of plants. The essential character is, calyx four-leaved: corolla, four-petalled: fem. perri. four one-seeded. There is one species, a shrub of Abyssinia. It is a simple bitter, leaving in the throat something of roughness resembling ipecacuanha.

BRUCHUS, a genus of coleopterous insects, with filiform antennæ, equal filiform feelers, and acuminated lip. The species of this genus are in all twenty-five.

BRUISER, the name of a concave tool used for grinding and polishing the specula of telescopes. It is made of brass about a quarter of an inch thick, and hammered as near the gauge as possible. It is tinned on the convex side, and made equally broad at bottom and top. By this instrument the speculum is prepared for the hands of the polisher.

BRUNSFELIA, in botany: a genus of the monogynia order, and pentandria class of plants. The corolla is funnel-shaped, and very long; and the fruit an unilocular polyspermous berry. There are two species.

Brunsfelia Americana, rises six or eight feet high, has a woody branching rough stem, with oblong entire leaves on footstalks, and large whitish flowers by threes or fours at the ends of the branches, succeeded by round saffron-coloured soft fruit. It may be raised from seeds sown in pots in the spring, and plunged in a bark-bed. It may also be propagated by cuttings planted in pots in the same season, plunging them also in a bark-bed or other hot-bed under glasses. The plants must always remain in the stove. 2d, B. undulate. Both natives of Jamaica.

BRUNIA, in botany; a genus of the monogynia order, and pentandria class of plants. The flowers are aggregate or clustered; the filaments inserted into the heels of the petals; the stigma is bifid; the seeds are solitary,

and the capsule is bilocular. There are eight species natives, of the Cape.

BRUNONIAN *system*, the system of medicine discovered by the late Dr. Brown, and explained at large in his Elements of Medicine. It might appear proper to give an account of this doctrine under the general article MEDICINE; but the new system differs so widely from all former systems of that science, that we think it more consistent with propriety to delineate it under its own proper title. The following will give a sufficient view of the outlines of this doctrine to such as are unacquainted with it; and for its minutiæ we must refer to the doctor's own works, and those of Dr. Beddoes, Dr. Jones, &c.

BRUNONIAN *system, account of*.—The human body, particularly the system of solids it consists of, is a form of living matter, whose characteristics are sensation and motion. The capability of being affected by external powers is termed *excitability*; the agents *stimuli*, or exciting powers; the result *excitement*. Without this property (excitability), the body would be dead inert matter: by this property it becomes living matter; by this property, called into action by the exciting powers, it becomes a living system. While the *stimuli* act on the *excitability* with a sufficient degree of power, then is the pleasant sensation of health: when they raise the excitement above this point, or depress it below it, disease takes place: when the stimuli cease to act, or the system to feel their power, death ensues. *Excitability* is a property of living matter, peculiar and inherent, but it is a property which Dr. Brown did not pretend to explain. He left it as sir Isaac Newton did his *attraction*, as a property not to be investigated. Of this energy or power there is assigned to every living system, at the commencement of life, a certain quantity or proportion; but its quantity differs in each, and in the same body it is found to change; for the excitability, according to circumstances, may be "abundant, increased, accumulated, superfluous, exhausted, consumed," &c. The *stimuli*, or exciting powers, are of two classes, external and internal. The external stimuli are heat, light, sound, air, and motion; food, drink, medicines, and whatever else is taken into the body, not excepting poisons and contagions. The internal are the functions of the body, the blood, the secretions, muscular exertion, and finally the powers of the mind; as sensation, passion, and thought. *Excitement* is life; the natural movements of the machine, and the functions resulting from these, as sensation, reflection, and voluntary motion, as they immediately flow from the exciting powers, are vigorous when they are strong, languid when they are weak, and cease when they are taken away entirely. Thus our body is continually moved by external agents, and life is a *forced state*. Our weak frame has an unceasing tendency to dissolution, which is opposed only by the incessant application of *exciting powers*, which are the sources of life, and which, being partially or completely withdrawn, are immediately followed by disease or death. It is also a principle of this doctrine, that "all stimuli by acting on the excitability exhaust it." Thus the stimuli of food, air, motion, passion, and thought, have supported the body through the labours of the day: they have supported the functions by acting on the excitability; in the evening it is exhausted by their continued operation; they have no longer the same power; the functions fail; we sink into rest, and continue in sleep, unaffected by the stimuli, renewing by sleep that excitability which had been exhausted by the labours or by the pleasures of the day; we rise with restored excitability: we feel a new power of excitement in every object around us; we are refreshed in the morning, and languid at night, and our whole life is an alternation of motion and rest, of action and sleep, of apathy and pleasure, of wasting our excitability by day in labour or enjoyment, and of recruiting it by night by the abstraction of all stimulant powers. The same philosophy extends to the duration of life: in childhood excitability is abundant in *quantity*, as being little exhausted; but it is low in power, because the tender stamina and accumulated excitability of children can neither suffer nor support high excitement. Their excitability is so abundant, that they are easily supported by weak diet and low exciting powers, and therefore most of their diseases are diseases of weakness. In youth and manhood the excitability is yet entire, the stamina are strong, the powerful stimuli are applied, and high passions prevail: these are the periods of vigour, and the æra of inflammatory disease. In old age the stamina are worn, the excitability is exhausted, the common stimuli have lost their power, and the system begins to decline; we have weakness of body, imbecility of mind, and asthenic diseases. We may last of all have recourse to more generous diet, and raise the stimulant powers by substituting wine to water or brandy to wine; thus perhaps excitement may be awhile supported, and life prolonged; but in a few years these also fail. This doctrine farther teaches, that our body is never moved but by exciting powers. None but stimuli affect our system. That there are direct sedatives in nature, is esteemed an unphilosophical and vulgar error. In stimuli there is a gradation which, being relative to the system, deceives our sense; for, as some stimuli are powerful and others weak, a low stimulus applied after a more powerful one, will stimulate less than the former, will allay the motions which the former had excited, and will, therefore, be named a sedative. Take heat as an example of this: cold is but an abstraction of heat, yet it is thought a positive existence; and cold is named a sedative and heat a stimulant power. To detect this deception of sense, plunge the right hand into water at the heat of 150°, the left into melting snow; withdraw both, and plunge them at once into water at 100°, it will prove at once stimulant and sedative; cold or sedative to the right hand, and hot or stimulant to the left. So is fasting an abstraction of the wonted stimulus of food, bleeding of the usual stimulus of blood, and so on. Health, then, is the due operation of stimuli on a well regulated excitability, producing a moderate excitement, and a pleasant sensation, moving the whole system with a just degree of power, and giving all the functions their due energy and tone. Asthenic disease, disease of debiliry or of weakness, is the result of stimuli applied in a low degree, or of the system less easily excited. Sthenic disease, or disease of strength, is the result of stimuli applied in too great a degree, or of a system too susceptible of excitement. The first is depression of excitement below the healthy state: it produces languid motions and functions, and requires excitement for its cure. The second is a strong state of the system, wound up to too high a degree of excitement. It is an exuberance of health and strength. It is marked by violent movements, and is cured by extraction of stimuli. Thus are all our maladies either diseases of weakness or of excessive strength; and this is the foundation of the Brunonian scale, which has for its middle point health; below that are arranged the diseases of weakness; above it the diseases of excessive strength; and in both divisions of the scale, diseases are so arranged, that the worst forms are set off at the greatest distance from the middle point, to mark them as the widest deviations from the healthy state. To illustrate still further the nature of these two forms of disease, we must observe their respective causes. Sthenia, or excessive strength, is simply the effect of many or powerful stimuli acting on the system. Asthenia is the immediate effect of withdrawing these; but asthenia is not so simple as its opposite state, for debility varies in its nature according to its various causes. 1. By abstraction of exciting powers is produced a species of debility named *direct*. 2. By long or violent application of strong exciting powers, the excitability is exhausted; both the excitement and the strength fail: this species of debility is named *indirect*. 3. When the exciting powers are withdrawn, and the direct debility produced, it is at the same time combined with a new species. By merely withdrawing the stimuli, such weakness would be produced as should be temporary only, and might be done away by restoring the usual exciting powers; but where the stimuli are withdrawn, excitability is accumulated, and when it is accumulated in an undue degree, it cannot bear the usual stimuli, and will not give out the healthy degree of excitement. Thus, direct debility caused by the absence of exciting powers, is attended with accumulation of excitability. Indirect debility, caused by superabundant stimuli, is attended with exhausted excitability. The former is most easily cured, as we have but to apply stimuli, and raise the excitement: the latter is difficultly cured; for the excitability being in some degree exhausted, the system is less susceptible, and has less excitability to operate upon for the restoration of health. The abstraction of stimuli is an immediate cause of weakness; high excitement is a state of the system which the excitability cannot long endure without being exhausted, so that stimuli themselves produce ultimate weakness. Since, therefore, high excitement is temporary only, and has but one cause, while weakness is a permanent state, and has many causes, the diseases of debility must in a very great proportion exceed in number the diseases of excessive strength; and diseases of excessive strength must ultimately end there. If 97 of 100 diseases arise from weakness, the conclusion must be of the first importance in practice. Hence it is a general principle in this system, that though there are many individual diseases, there are but two states of the system, and two general methods of cure;

and though it admits the difference between local and general diseases, yet it does not allow that a local sthenic disease can exist for any time along with a general asthenic diathesis, or *vice versa*. For the cure of all those diseases which stand above the point of health, nothing more is required than withdrawing the stimuli of food, drink, heat, &c. or by evacuation, as bleeding, vomiting, and purging. For all those diseases which stand below the point of health, we use the natural stimuli of diet, beef-tea, wine, heat, &c., or the less natural stimuli of the pharmacopœia, the chief of which are opium, æther, volatile alkali, musk, camphor, brandy, and other spirits. The cause of the one form of disease is the cure of the other; in the one we raise the excitement till it arrives at the point of health; in the other we depress it to the same point: having effected this by the powers of medicine, we keep it there by attention to regimen; and the great object in the Brunonian practice is to hit the point of health, neither to stop short of this object, nor to pass beyond it; for by either imprudence we may do much harm. By profusion of stimuli we may convert a disease of weakness into a disease of inflammation: by too severe an abstraction of stimuli we may run into the opposite excess, converting into a disease of weakness what was originally a disease of violent inflammation. The use of stimuli in asthenic diseases is to be regulated by the cause and state of the disease. In all diseases of indirect weakness, where excitability has been exhausted, the strength must be raised by the immediate application of the most powerful stimuli, which are to be slowly reduced in quantity or strength, till moderate or ordinary stimuli suffice for supporting the excitement of health. In all cases of direct weakness, where excitability is accumulated, the immediate application of powerful stimuli would destroy. Weak stimuli must be first used, the superabundant excitability must be gradually wasted, and the doses very slowly increased, till we rise to the point of health.

Dr. Brown's frequent prescriptions of wine, spirits, and opium, to his patients in asthenic diseases, with his repeated recommendations of these stimuli in his lectures and writings, raised a very general prejudice against his system and practice, among those who knew nothing of either but from vague report. They alleged that, though he might cure the diseases of his patients, he would infallibly corrupt their morals, by habituating them to such dangerous medicines. From these charges Dr. Beddoes vindicates the doctrine, in the following words: (p. clix.) "The Brunonian system has been frequently charged with intemperance; the objection is serious, but the view already given of its principles shews it to be groundless. No writer has insisted so much upon the dependance of life upon external causes, or so strongly stated the inevitable consequences of excess: and there are no means of promoting morality upon which we can rely, except the knowledge of the true relations between man and other beings or bodies. For by this knowledge we are directly led to shun what is hurtful, and pursue what is salutary." And what stronger motive of temperance can philosophy itself inculcate than the Brunonian doctrine does, when it teaches, that every act of intemperance and excess tends to exhaust the very principle of life?

Dr. Beddoes, though he seems to be a decided Brunonian, has nevertheless, with great candour as well as judgment, pointed out a few of the imperfections of the new doctrine. 1. He observes, that, as Dr. Brown "assumes that a certain portion of excitability is originally assigned to every living system, by his very assumption he denies its continual production, subsequent diffusion, and expenditure." 2. He next objects against the doctor's "uniformity of operation in stimulants." "Heat and wine (he justly observes) can never act in the same manner; for no person is intoxicated by heat." He adds, "Had it been once allowed by Brown that the different constituent parts of the body bear a different relation to the same agents, he must have admitted the operation of specific stimulants to an unlimited extent." On the subject of *predisposition to disease*, he observes, "that though facts have been noted, the principle lies involved in total obscurity. Brown does not purposely elude the difficulty, but his principles lead him beside it; and we may doubt whether the term *predisposition* ought in strict propriety to have appeared in his Elements; for predisposition is with him a slight disease, differing only in degree from that into which the person predisposed falls." 4. "There are several other opinions (he adds) which, in a complete revisal of the Brunonian system, would require particular examination; such as his doctrine concerning hereditary diseases," (of which Brown denies the existence) "the peculiar state of sthenic inflammation, and the nature of the passions." 5. And in a note upon Brown's preface, he styles the doctor's opinion, that 'nearly all the diseases of children depend on debility,' "a gross and dangerous error," though he admits that "thousands of them are cut off at an early period of life, and tens of thousands kept languishing in misery, by asthenic diseases, for want of the necessaries of life."

The following are among the principal objections that have been urged by the opponents of this doctrine. 1. Medicines and the other exciting powers do not act as mere stimuli only. If they did, they must have all one common nature, and differ only in degree; whereas they differ widely in their effects: one produces hilarity, as wine, &c. another coma, as opium; one poison produces phrenzy, another palsy, a third convulsions, &c. If ipecacuanha operates on the stomach, jalap on the bowels, cream of tartar on the kidneys, and mercury on the salivary glands, they must have some peculiar or specific qualities superadded to their stimulant power, and the latter must be but a subordinate effect. If bark cures an intermittent fever, or mercury the venereal disease, which brandy, opium, and even æther cannot, then it is the duty of the physician to discover these secret, peculiar, and inexplicable powers, and to operate by them, without regard to their stimulant effects. 2. In opposition to the Brunonian doctrine, that there is not a direct sedative in nature, it is argued, that fixed air, and the contagion of fever, dysentery, the plague, &c. are direct sedatives, which do not stimulate in the smallest degree. 3. It has been urged, that if the new doctrine is true, there ought to be no such thing as an incurable disease. All diseases, whether above or below the point of health, ought to yield to the abstraction or application of the stimuli, as long as the excitability is not totally exhausted. 4. In short, it has been argued, that if the Brunonian system is true, there is no use for nosology or physiology; very little for chemistry or botany, as a few stimuli, with an emetic and cathartic or two, are sufficient to supply a Brunonian laboratory; and not much even for anatomy itself, that grand foundation of medical knowledge. But whatever deficiencies, imperfections, or inexplicable mysteries, may still adhere to this system, it is allowed, even by its opponents, to have contributed greatly to the improvement of medical practice; to have considerably diminished the former too frequent prescriptions of copious bleeding on almost every occasion; and to have lessened the number of evacuant doses, and increased that of corroborant medicines, in many diseases of weakness, where the opposite practice was manifestly injurious. And it is allowed to be the duty of every medical practitioner to examine it without prejudice or partiality.

BRUNSWICK-GREEN, a colour used in paper-hangings, and other coarse kinds of painting in water-colours. It is prepared in any close vessel of wood or earthenware, filled half-full of copper filings or clippings, on which is poured a saturated solution of sal-ammoniac, which together will form the muriate of copper, the ammonia being at the same time disengaged. In a few weeks almost the whole of the copper may be converted into oxyde; this being well washed, and slowly dried in the shade, is pure Brunswick-green. Three parts of muriate of ammonia, or sal-ammoniac, and two of copper, yield six parts of green.

BRUSH, a well-known domestic utensil. The wooden part of brushes is generally of oak, which is cut to its proper size by an instrument like a large knife, fastened down to the block with a staple at one end, in such a manner that it is movable up and down; to the other end is a handle. The wood to be cut is held in the left hand, while the knife is worked with the right. The knife is always kept very sharp; and, by its make and mode of using, hard wood is very readily reduced to any shape and size. This wood, when cut into the proper sizes, is drilled with as many holes as is necessary, and into these the hair or bristle is put.

There are brushes of various sorts, shapes, and sizes; but the structure of them all is the same, or nearly so. When the bristles are sorted, combed, and picked, a certain portion of them is taken and tied together in the middle with string, or with fine copper or iron wire: in this double state they are fastened into the wooden stock with glue or with pitch. The ends of the hair are now to be cut off, and the surface to be made even or uniform.

Common hearth-brushes and hair-brooms are made in a slighter way. As soon as the stock is brought to its proper shape it is drilled, the hairs doubled, and each bundle is put into the hole with some hot cement made with pitch and rosin.

In some brushes, the wires are visible on the back; in others the backs are smooth,

there being thin slices of wood glued over the wires.

A patent was obtained in 1804, by Mr. Thomason, for making hearth-brushes, the object of which was to conceal the hair in a neat metal case, into which the hair is drawn by means of rack-work.

BRYGMUS, among physicians, a grating noise made by the gnashing of teeth, a symptom common in epilepsy, and some convulsive disorders. See MEDICINE.

BRYONIA, bryony, a genus of the syngenesia order, and monœcia class of plants; in the natural method ranking under the 34th order, cucurbitaceæ. The calyx of the male is five-toothed, with a quinquefid corolla, and three filaments. In the female the calyx is dentated, the corolla quadrifid, the style trifid, with a roundish many-seeded berry. There are 19 species, of which the most remarkable are:

1. Bryonia Africana, African tuberous-rooted bryony.

2. Bryonia alba, rough or white bryony with red flowers, a native of dry banks under hedges in many parts of Britain. The roots of this plant have by impostors been wrought into a human shape, and shown for mandrakes. Their method was to find a young thriving plant of bryony; then they opened the earth all round, being careful not to disturb the lower fibres; and being provided with such a mould as is used for making plaister figures, they fixed the mould close to the root, fastening it with wire to keep it in its proper situation; then they filled the earth about the root, leaving it to grow to the shape of the mould, which in one summer it will do; so that if done in March, by September it will have the shape. The leaves of the plant are also imposed on people for mandrake leaves, although there is no resemblance between them, nor any agreement in quality. The roots of this species are used in medicine. These are very large, sometimes as thick as a man's thigh; their smell, when fresh, is strong and disagreeable; the taste nauseously bitter, acrid, and biting; the juice is so sharp, as in a little time to excoriate the skin; in drying, they lose a great part of their acrimony, and almost their whole scent. Bryony root is a strong irritating cathartic, and applied externally is said to be a powerful discutient.

3. Bryonia Bonariensis, bryony with hairy palmated leaves, divided into five parts, and obtuse segments. It is a native of warm countries; but merits cultivation on account of the pretty appearance it makes when full of fruit.

4. Bryonia Cretica, spotted bryony of Crete.

5. Bryonia racemosa, bryony with a red olive-shaped fruit. It is a native of warm climates, and perennial; but the branches decay every winter.

6. Bryonia variegata, the American bryony with variegated fruit.

BRYUM, in botany, a genus of the 56th natural order, viz. musci, belonging to the cryptogamia class of plants. The anthera is operculated or covered with a lid, the calyptra polished, and there is a filament arising from the terminal tubercle. There are 41 species, most of them natives of England.

BUBO, or BUBOE. See SURGERY.

BUBON, Macedonian parsley: a genus of the digynia order, and pentandria class of plants; and in the natural method ranking under the 46th order, umbellatæ. The fruit is ovated, striated, and villous. There are five species, which are propagated by seeds, and require the common culture of other exotic vegetables, viz.

1. Bubon Galbanum or African ferula, rises with an upright stalk to the height of eight or ten feet, which at bottom is woody, having a purplish bark covered with a whitish powder that comes off when handled. The top of the stalk is terminated by an umbel of yellow flowers; which are succeeded by oblong channelled seeds, which have a thin membrane or wing on their border. When any part of the plant is broken, there issues out a little thin milk of a cream colour, which has a strong scent of galbanum.

2. Bubon gummiferum, with a mock chervil leaf, rises with a ligneous stalk about the same height, with leaves at each joint; the small leaves or lobes narrow and indented like those of bastard hemlock. The stalk is terminated by an umbel of small yellow flowers, which are succeeded by seeds like those of the former sort. The galbanum of the shops is supposed to be procured from these two species.

3. Bubon Macedonicum, sends out many leaves from the root: the lowest grow almost horizontally, spreading near the surface of the ground. In the centre of the plant arises the flower-stem, which is little more than a foot high, dividing into many branches, each terminated by an umbel of white flowers, which are succeeded by oblong hairy seeds. This plant, in warm countries, is biennial; but in Britain seldom flowers till the third or fourth year; but whenever the plant flowers, it always dies.

4. Bubon rigidius, hard or rigid ferula, is a native of Sicily. It is a low perennial plant, having short, stiff, and very narrow leaves: the flower-stalk rises a foot high, which is terminated by an umbel of small white flowers. 5. B. cavigattum.

BUBONOCELE, or HERNIA INGUINALIS. See SURGERY.

BUBROMA, a genus of the class and order polyadelphia dodecandria. The essential character is, calyx three-leaved: petals, five-arched, semibifid: anthers, on each filament, three: stigma, simple: capsule, muriate, ending in a five-rayed star.

There is one species, a large tree of the West Indies, resembling the elm.

BUCCINATOR. See ANATOMY.

BUCCINUM, the TRUMPET-SHELL, a genus of univalve shells, shaped, in some degree, like a horn, or other wind-instrument: the belly of the shell is distended, the aperture of the mouth is large, wide, and elongated, the tail is more or less long, and the clavicle more or less exerted.

This is a very numerous genus, the principal species of which are the pomum, (Plate Nat. Hist. fig. 65.) spindle-shell, the mitre-shell, the midas-ear-shell, the great triton-shell, the tower of Babel-shell, &c.

The shells of the buccinum kind are commonly furnished with an operculum; the animal, a limax or snail, subject to some slight difference in its form in various species. They are oviparous, and the males are said to be smaller and higher in colour than the females.

BUCCO, the Barbet, in ornithology, the name of a genus in the picæ order, distinguished by having the bill sharp-edged, compressed on the sides, notched on each side near the apex, bent inwards, with a long slit beneath the eyes. Nostrils covered with incumbent feathers: feet formed for climbing. There are seventeen species, and some varieties. They occur in Africa, but chiefly inhabit Asia, and the hotter parts of America. They are in general dull and stupid birds; their bill is stout, and remarkably covered with projecting bristles. Those of the antient hemisphere are very much distinguished by the thickness and shortness of the bill; and, far from affecting the stupid gravity of the American species, they attack the smaller tribes with the boldness and intrepidity of the hawk. The principal species are as follows, viz.

1. The tamatia, or spotted barbet, a native of Brazil. Its length is six inches and a half, of which the tail occupies two inches; the bill is hooked, and divided into two points; the bristles or beard which covers it extends more than half its length. They feed chiefly on insects; and their flesh, though not good, is eaten by the natives.

2. The Cayanensis, or red-headed barbet. This is about seven inches in length; the bill is strong, of a dark ash colour, bending a little downward at the tip; at the basis of the upper mandible are a few black bristles pointing forward over the nostrils. They are inhabitants of Cayenne, and are also met with at Guiana and St. Domingo; and, no doubt, in other hot parts of America. They feed on caterpillars, locusts, and large beetles.

3. The capensis, or collared barbet. The plumage of this bird is agreeably variegated. It is found in Guiana, but is a rare species.

4. The bucco elegans (see Plate Nat. Hist. fig. 66.), or elegant barbet, the most beautiful of the genus.

5. The viridis, or green barbet is 6½ inches long; the back, the coverts of the wings, and of the tail, are of a very fine green; the head is brown grey; the neck is the same colour, but each feather is edged with yellow.

6. The grandis, or Chinese barbet, is nearly eleven inches long. The principal colour in its plumage is a fine green mixed with blue, which changes with the light. Pl. Nat. Hist. fig. 67.

BUCEROS, in ornithology, the name of a genus in the order of picæ, called in English the hornbill. Birds of this kind have the bill convex, curved, sharp at the edge, of a large size, and serrated outwardly; a horny protuberance on the upper mandible, near the front of the head, nostrils behind the base of the bill, tongue acute and short; feet formed for walking. Of this genus there are thirteen species; the principal of which are,

1. The buceros rhinoceros, distinguished above every other of this extraordinary family by the enormity of its bill. The upper mandible is red towards the base, and of a whitish yellow from thence to the tip; the lower one entirely of a whitish yellow except at the base, where it is black, and hid in the feathers; on the top of the upper mandible is an appendage, as large as the bill itself, and turning upwards, contrary to the direction of the bill, both mandibles of which bend downwards; this curved horn is variegated with

whitish-yellow, red, and black, and is as it were divided longitudinally by a line of black on each side. This bird, when full-grown, measures four feet from the point of the bill to the tip of the tail. The beak, far from being in proportion to the size of the bird, or useful from its structure, seems to be a cumbrous load to the animal destined to bear it; nature does not furnish another example of a weapon of such magnitude attended with so little effect; the point of it, like that of a lever too far removed from the fulcrum, takes but a feeble hold; it is of a substance so soft, that its edges are continually broken by the least resistance. This singular bird is found in Java, Sumatra, the Philippine islands, and other parts of the East Indies. They are said to feed on flesh and carrion, and that they follow the hunters for the purpose of feeding on the entrails of the beasts which they kill: that they chase rats and mice, and, after pressing them flat, toss them up and catch them in their descent, swallowing them whole.

2. The galeatus, or helmeted hornbill. The prevailing colour of the bird is black; and of the helmet the tops of snuff-boxes are sometimes made.

3. The Malabaricus, or pied hornbill. This species is two feet ten inches from the point of the bill to the extremity of the tail. Its bill is eight inches long and two broad, and bent from the straight position; a false bill sits like a horn close on the first, and follows its curvature, and is extended from the case to within two inches of the point. This bird has been called the Indian raven, the horned crow, the horned pie of Ethiopia, &c. When at rest, its head seems to recline on its shoulders; and when disturbed by surprise, it assumes an air of boldness and importance. This bird will eat vegetables and raw flesh; will catch rats, and devour small birds alive. It often repeats a cry like the clocking of a turkey-hen when she leads her brood.

4. The bicornis, or Philippine hornbill, according to Brisson is of the size of the turkey-hen; but its head is much larger, which indeed is requisite, to support a bill nine inches long, and two inches eight lines thick, and which carries, above the upper mandible, a horny excrescence six inches long, and three inches broad. It inhabits the Philippine islands and the East Indies, and has a cry more like that of a hog or a calf than of a bird; the Gentoos rank it among their gods, and pay adoration to it; it lives chiefly in woods, feeding on wild figs, almonds, and the pistachio nut, which it swallows whole, and, after the external parts of it have been digested, it brings up the nuts again whole, without the kernels being anywise damaged or unfit for vegetation.

BUCHNERA, in botany, a genus of the angiospermia order, in the didynamia class of plants; ranking, in the natural method, under the 40th order, personatæ. The characters are: the calyx is obscurely 5-toothed: corolla, border, 5-cleft, equal: lobes, cordate: capsule, 2-celled. There are eleven species, natives of the Cape, South America, and the West Indies.

BUCIDA, in botany, a genus of the order monogynia, in the decandria class of plants; ranked, in the natural method, under the 12th order, holeraceæ. The calyx is indented in five segments: it has no corolla; and the fruit is a single-seeded berry. There is only one species.

BUCKLER, a piece of defensive armour used by the antients. It was worn on the left arm, and composed of wickers woven together, or wood of the lightest sort, but most commonly of hides, fortified with plates of brass or other metal.

BUCKRAM, in commerce, a sort of coarse cloth made of hemp, gummed, calendered, and dyed several colours. It is put into those places of the lining of a garment, which are to be stiff and to keep their forms. Sometimes they use new pieces of linen cloth to make buckrams, but most commonly old sheets and pieces of old sails.

BUCK-WHEAT. See POLYGONUM.

BUCKTHORN. See RHAMNUS.

BUDDING, a method of propagating various sorts of trees, particularly those of the wall-fruit kinds. See GARDENING.

BUDDLEIA, in botany, a genus of the monogynia order, in the tetrandria class of plants. The calyx and corolla are quadrifid; the stamina placed at the incisures of the corolla. The capsule is bisulcated, bilocular, and polyspermous. There are eight species, of which three deserve notice.

1. Buddleia Americana, a native of Jamaica and most of the other American islands. It rises to the height of ten or twelve feet, with a thick woody stem covered with grey bark; and sends out many branches towards the top, which come out opposite: at the ends of the branches the flowers are produced in long close spikes branching out in clusters, which are yellow, consisting of one leaf cut into four segments: these are succeeded by oblong capsules filled with small seeds.

2. Buddleia occidentalis, a native of Carthagena. It rises much higher than the other, dividing into a great number of slender branches covered with a russet hairy bark, with long spear-shaped leaves ending in sharp points: at the end of the branches are produced branching spikes of white flowers growing in whorls round the stalks, with small spaces between each. All these plants grow in low sheltered spots; their branches being too tender to resist the force of strong winds.

3. Buddleia globosa, a native of Chili, but hardy enough to stand the winter in this climate. It is a beautiful shrub. The flowers are of an orange colour, in close peduncled heads, two together on opposite sides of the branches.

BUDGE-BARRELS, among engineers, small barrels well hooped, with only one head; on the other end is nailed a piece of leather, to draw together upon strings like a purse. Their use is for carrying powder along with a gun or mortar, being less dangerous, and easier carried, than whole barrels. They are likewise used upon a battery of mortars, for holding meal-powder.

BUFF, in commerce, a sort of leather prepared from the skin of the buffalo, dressed with oil, after the manner of shammy. This makes a very considerable article in the French, English, and Dutch commerce at Constantinople, Smyrna, and all along the coast of Africa. The skins of elks, oxen, and other like animals, when prepared after the same manner as that of the buffalo, are likewise called buffs.

Of buff-skin, or buff-leather are, made a sort of coats for the horse or gens-d'armes of France, bandaliers, belts, pouches, and gloves.

BUFFALO. See Bos.

BUFONIA, TOAD GRASS: a genus of the digynia order, belonging to the tetrandria class of plants; and in the natural method ranking under the 22d order, caryophylleæ. The calyx is 4-leaved: the corolla, 4-petaled: the capsula is monospermous. There is but one species, a native of Britain.

BUG. See CIMEX.

BUGGASINS, in commerce, a name given to buckrams made of calico.

BUGLOSS. See ANCHUSA.

BUILDING. See ARCHITECTURE.

BUILDINGS, *laws concerning*. The buildings of London are regulated by what is denominated the building-act, which repeals and amends several former acts for the same purpose. It was passed in the year 1774, and begins by dividing all buildings into seven rates or classes, for the purpose of subjecting them to various regulations respecting the thickness of the walls, &c. Surveyors of districts are appointed to see the rules and regulations of this act properly complied with. Before any building is begun to be erected, the master workman is bound to give twenty-four hours notice to the surveyor, who is to attend and view the building, and enforce the observance of the act. The fees to be paid by the builder to the surveyor are, for a building of the first rate, 3*l.* 10s. and for an alteration or addition, 1l. 15s.: for a building of the second rate, 3l. 3s. and for an alteration 1l. 10s.: for the third rate, 2l. 10s. and 1l. 5s.; and for the fourth rate, 1l. 1s. and 15s.

BULBOCODIUM, mountain-saffron: a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the ninth order, spathaceæ. The corolla is funnel-shaped, and hexapetalous, with the heels narrow, supporting the stamina. There is one species,

Bulbocodium vernum, which is a native of Spain, and has a bulbous root shaped like those of the snow-drop, which sends out three or four spear-shaped concave leaves, between which comes out the flower, standing on a very short footstalk. The flowers appear about the same time with the last; at first they are of a pale colour, but afterwards change to a whitish purple.

BULIMY, a disease in which the patient is affected with an insatiable and perpetual desire of eating; and, unless he is indulged, he often falls into fainting fits. It is also called *fames canina*, canine appetite. See MEDICINE.

BULK-HEADS are partitions made athwart the ship, with boards, by which one part is divided from the other; as the great cabin, gun-room, bread-room, and several other divisions. The bulk-head before is the partition between the forecastle and grating in the head.

BULL. See Bos.

BULL'S-EYE, among seamen, a small, obscure, sublime cloud, ruddy in the middle, that sometimes appears to mariners, and is the immediate forerunner of a great storm at sea. It is also used for a small oval block of hard wood, without sheaves. It is turned in a lathe, has a groove round the outside, and an oval hole gouged through the middle.

BULL, among ecclesiastics, a written letter, dispatched, by order of the pope, from the

Roman chancery, and sealed with lead, being written on parchment, by which it is partly distinguished from a brief. It is a kind of apostolical rescript, or edict, and is chiefly in use in matters of justice or grace. If the former is the intention of the bull, the lead is hung by a hempen cord; if the latter, by a silken thread. It is this pendant lead, or seal, which is, properly speaking, the bull; and which is impressed, on one side, with the heads of St. Peter and St. Paul, and on the other with the name of the pope, and the year of his pontificate. The bull is written in an old, round, Gothic letter, and is divided into five parts; the narrative of the fact, the conception, the clause, the date, and the salutation, in which the pope styles himself servus servorum, *i.e.* the servant of servants. These instruments, besides the lead hanging to them, have a cross, with some text of scripture, or religious motto, about it. Bulls are granted for the consecration of bishops, the promotion to benefices, and the celebration of jubilees, &c.

Bull *in cæna Domini*, a particular bull read every year, on the day of the Lord's supper, or Maundy Thursday, in the pope's presence, containing excommunications and anathemas against heretics, and all who disturb or oppose the jurisdiction of the holy see. After the reading of the bull, the pope throws a burning torch into the public place, to denote the thunder of this anathema.

Bull, golden, an edict, or imperial constitution, made by the emperor Charles IV. reputed to be the magna charta, or the fundamental law, of the German empire. It is called golden, because it has a golden seal, in the form of a pope's bull, tied with yellow and red cords of silk; upon one side is the emperor represented sitting on his throne, and on the other the capitol of Rome. It is also called Caroline, on Charles IV's. account. Till the publication of the golden bull, the form and ceremony of the election of an emperor were dubious and undetermined, and the number of the electors not fixed. This solemn edict regulated the functions, rights, privileges, and pre-eminences of the electors. The original, which is in Latin, on vellum, is preserved at Frankfort: this ordonnance, containing thirty articles, or chapters, was approved of by all the princes of the empire, and remains still in force.

BULLA, in conchology, the name of a genus of shells, the character of which is thus defined: animal a limax; shell univalve, convoluted, and unarmed; mouth or aperture somewhat straightened, oblong, longitudinal, and at the base very entire; pillar lip oblique, and smooth. There are many species.

BULLÆ, in Roman antiquity, ornaments at first given only to the sons of noblemen; though afterwards they became of more common use. This ornament was first given by Tarquinius with the prætexta to his son, who had, with his own hand, at fourteen years of age, killed an enemy.

BULLION, uncoined gold or silver in the mass.

Those metals are called so, either when smelted from the native ore, and not perfectly refined, or when they are perfectly refined but melted down in bars or ingots, or in any unwrought body of any degree of fineness.

When gold and silver are in their purity, they are so soft and flexible that they cannot well be brought into any fashion for use, without being first reduced and hardened with an alloy of some other baser metal. To prevent abuses, according to the laws of England, all sorts of wrought plate in general ought to be made to the legal standard; and the price of our standard gold and silver, the common rule whereby to set a value on their bullion, whether the same is in ingots, bars, dust, or in foreign specie; whence it is easy to conceive that the value of bullion cannot be exactly known without being first assayed, that the exact quantity of pure metal therein contained may be determined, and consequently whether it is above or below the standard.

BUMALDA, in botany, a genus of the digynia order, belonging to the pentandria class of plants. The corolla is five-petalled, styles villose, capsule two-celled, two-beaked. There is one species, a native of Japan.

BUMELIA, a genus of the class and order pentandria monogynia. The essential character is, corolla five-cleft, with five-leaved nectary, drupe one-seeded. There are seven species, all trees and shrubs, natives of the West Indies, called there bastard bully-tree.

BUMICILLI, a religious sect of Mahometans in Egypt and Barbary, who pretend to fight with devils, and commonly appear in a fright and covered with wounds and bruises.

BUNIAS, in botany, a genus of the order siliquosa, and tetradynamia class of plants, and ranking under the thirty-ninth natural order, siliquosæ. The siliqua is deciduous, four-sided, muricated, or shagreened with unequal pointed angles. There are nine species, all annual plants, but none of them possessed of any remarkable property.

BUNIUM, pig-nut, or earth-nut, in botany, a genus of the digynia order and pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The corolla is uniform, the umbel thick, and the fruit ovate. There is but one known species, viz.

Bunium bulbocastanum, with a globular root. It grows naturally in moist pastures in Britain, and has a tuberous solid root, which lies deep in the ground. The leaves are finely cut, and lie near the ground. The stalk rises a foot and a half high, is round, channelled, and solid. The flowers are white, and shaped like those of other umbelliferous plants; the seeds are small, oblong, and when ripe are channelled. The roots of this sort are frequently dug up, and by some people eaten raw. They have much resemblance in taste to a chesnut, whence the specific name.

BUNT *of a sail*, the middle part of it, formed designedly into a bag or cavity, that the sail may gather more wind. It is used mostly in top-sails, because courses are generally cut square, or with but small allowance for bunt or compass. The bunt holds much leeward wind, that is, it hangs much to leeward.

Seamen all agree that a bellying or bunting sail carries a vessel faster to the windward than a straight or fast sail.

Bunt-lines are small lines made fast to the bottom of the sails, in the middle part of the bolt-rope, to a cringle, and so are reeved through a small block, seized to the yard. Their use is to trice up the bunt of the sail, for the better furling it up.

BUOY, at sea, a short piece of wood, or a close-hooped barrel, fastened so as to float directly over the anchor, that the men who go in the boat to weigh the anchor, may know where it lies.

Buoy is also a piece of wood or cork, sometimes an empty cask, well closed, swimming on the surface of the water, and fastened by a chain or cord to a large stone, piece of broken cannon, or the like, serving to mark the dangerous places near a coast, as rocks, shoals, wrecks of vessels, anchors, &c.

Stream the buoy, is to let the anchor fall while the ship has way.

To buoy up the cable is to fasten some pieces of wood, barrels, &c. to the cable, near the anchor, that the cable may not touch the ground in case it be foul or rocky, lest it should be fretted and cut off.

BUPHAGA, in ornithology, a genus of the order of picæ, of which only a single species, Africana (see Plate, Nat. Hist. fig. 68.) has been discovered. Its character is, the bill straight and somewhat quadrangular; mandibles gibbous, entire, and more gibbous on the outside; legs formed for walking. It is found in Africa, and is called in English the beef-eater from this peculiarity; that it sometimes alights upon the backs of cattle, and picks holes in them in order to get at the larvæ of the œstri, or gad-flies, deposited by those creatures in the flesh directly below the skin

BUPHTHALMUM, *ox-eye*, a genus of the polygamia superflua order, and syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is paleaceous; the pappus an indifferent rim; the seeds, especially those of the radius, emarginated on the sides; the stigmata of the hermaphrodite florets undivided. There are twelve species, all of which may be propagated by seeds; and those which do not, by parting their roots, or cutting off their branches. Some of the species are tender, and require to be raised on a hotbed. The following are the most remarkable:

1. Buphthalmum arborescens, rises with several woody stems to the height of eight or ten feet. The flowers are produced at the ends of the branches; they are of a pale yellow colour, and have scaly empalements.

2. Buphthalmum helianthoides, a native of North America. It has a perennial root and an annual stalk, which rises six or eight feet high. The flowers come out at the extremities of the branches, and are of a bright yellow colour, resembling a small sunflower.

BUPLEURUM, *hare's ear*, or thoroughwax, a genus of the digynia order, and pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The involucra of the partial umbels are large in proportion, and pentaphyllous; the petals involuted or rolled inwards; the fruit roundish, compressed and striated. There are 14 species, the principal of which is,

Bupleurum fruticosum, or shrubby Ethiopian hartwort. It rises with a shrubby stem, dividing into numerous branches, forming a bushy head five or six feet high, adorned with oblong, oval, entire leaves of a sea-green colour, placed alternate, with yellow flowers in umbels at the ends of the branches, which appear in July and August, and are some-

times succeeded by ripe seeds. It may be propagated by cuttings.

BUPRESTIS, a genus of coleopterous insects, distinguished in a peculiar manner by the uncommon brilliancy and highly metallic splendour of their colours, which emulate the finest and most beautifully polished metals. The insects of this genus, which are very numerous, have the antennæ serrated, and as long as the thorax; feelers four, which are all filiform, with the last joint obtuse or truncated; head partly retracted within the thorax. The larvæ of the buprestes are said to live in the solid wood, or in the trunks of decayed trees; but this is doubted by some naturalists, since they do not appear to be exactly known in that state. The conjecture is, however, plausible, as the perfect insects are almost constantly found upon trees, or plants and flowers. Few species of this beautiful tribe of insects are found in Europe; the largest and most brilliant of those discovered are from the Brazils, and other hot countries, among which is the buprestis vittata. See Plate Nat. Hist. fig. 69. There are in all 27 species.

BURBAS, in commerce, a small coin at Algiers, with the arms of the dey struck on both sides. It is worth half an asper.

BURBER, an Egyptian piece of copper-money, twelve of which make a medine.

BURCARDIA, a genus of the class and order pentandria pentagynia. The essential character is, calyx five-leaved; corolla five-petalled; capsule angular, one-celled, three-valved, seven or eight seeded. There is one species, a native of Guiana, annual.

BURDEN *of a ship* is its contents or number of tons it will carry. The burden of a ship may be determined thus: multiply the length of the keel, taken within board, by the breadth of the ship, within board, taken from the midship-beam; from plank to plank and multiply the product by the depth of the hold, taken from the plank below the keelson, to the under part of the upper-deck plank, and divide the last product by 94, then the quotient is the content of the tonnage required.

BURGAGE, an antient tenure in boroughs, whereby the inhabitants, by custom, hold their lands, &c. of the king, or other superior lord of the borough, at a certain yearly rent; also a dwelling-house in a borough was antiently called a burgage.

BURGLARY, the breaking and entering the mansion-house of another in the night, with intent to commit some felony within the same, whether the felonious intent be executed or not. Hale's Pl. 79. But there must be a breaking and entry to complete this offence. 1 Haw. c. 38. s. 3. If there be day-light enough, begun or left, to discern a man's face, it is no burglary. This however does not extend to moonlight, for then many burglaries would go unpunished. 4 Black. 224.

Every entrance into a house by trespass is not a breaking in this case; for there must be an actual breaking. If the door of a mansion should stand open, and the thief enter, this is not a breaking; or if the window of an house be open, and a thief with a hook or other instrument should draw out some of the goods of the owner, this is no burglary, because there is no actual breaking. But if the thief should break the glass of the window, and with a hook or other instrument draw out some of the goods of the owner, this is a burglary, for there is an actual breaking of the house. 3 Inst. 64.

The mansion-house does not only include the dwelling-house, but also the outhouses that are parcel thereof, though not under the same roof, or joining contiguous to it; but if they be far remote from the dwelling-house, and not so near it as to be reasonably esteemed parcel thereof, then the breaking is not burglary. H. H. 553. To break and enter a shop, not parcel of the mansion-house, in which the shopkeeper never lodges, but only works or trades there in the day-time, is not a burglary, but only larceny; but if he or his servant, usually or often lodge in the shop at night, it is then a mansion-house, in which a burglary may be committed. Id. Where the owner leaves his house and disfurnishes it, without a settled resolution of returning, it cannot under these circumstances be deemed a dwelling-house; but where the owner quits the house in order to return occasionally, though no person be left in it, it may still be considered as his mansion-house. Fost. 76. A chamber in an inn of court, &c. where one usually lodges, is a mansion-house, for every one has a several property there; but a chamber where any person lodges as an inmate cannot be called his mansion, though if a burglary be committed in his lodgings, the indictment may lay the offence to be in the mansion-house of him that let them. 3 Inst. 65. If the owner live under the same roof with the inmates, there must be a separate outer door, or the whole is the mansion of the owner; but if the owner inhabit no part of the house, or even if he occupies a shop or cellar in it, but do not sleep therein, it is the mansion of each lodger, though there be but one outer door. Leach's Haw. c. 38, s. 15.

By the 18 Eliz. c. 7, s. 1. it is enacted, that if any person shall commit any felonious rape, ravishment, or burglary, and be found guilty by verdict, or shall be outlawed, or shall confess such rape or burglary, every person so found guilty shall suffer death, and forfeit as in cases of felony without benefit of clergy. But in all cases of burglary, accessaries after must have their clergy. 1 Haw. 557.

The court may allow a prosecutor who has bona fide prosecuted, such sum as they shall think reasonable, not exceeding the expences he was bona fide put to; making also, if he shall appear to be in poor circumstances, a reasonable allowance for his trouble and loss of time. 18 Geo. III. c. 19.

And further, any person who shall apprehend any one guilty of burglary, and prosecute him to conviction, shall have a certificate without fee, to be made out and delivered before the end of the assizes, under the hand of the judge, certifying the conviction, and in what parish the burglary was committed, and that the burglar was taken by the person or persons claiming the reward; and if any dispute should arise between the parties claiming, the judge shall by such certificate, direct the same to be paid and distributed among them as to him shall seem just and reasonable; and on tendering such certificate to the sheriff, and demand made, he shall pay to the person or persons so entitled the sum of 40*l.* without any deduction. 5 Anne, c. 31. 6 Geo. 23. s. 10. Such certificate shall be inrolled by the clerk of the peace of the county in which it shall be granted, for which he shall have 1*s.* And the said certificate may be once assigned over, and the original proprietor or assignee of the same shall, by virtue thereof, be discharged from all manner of parish and ward offices, within the parish and ward where the felony was committed. 10 and 11 Wm. c. 23.

BURGOMASTER, the chief magistrate of the great towns in Flanders, Holland, and Germany. The power and jurisdiction of the burgomaster are not the same in all places, every town having its particular customs and regulations. At Amsterdam there are four, chosen by the voices of all those people in the senate, who have either been burgomasters or echevins. Their authority resembles that of our lord-mayor and aldermen; they dispose of all under-offices that fall in their time, keep the key of the bank, and enjoy a salary but of five hundred guilders; all feasts, public entertainments, &c. being defrayed out of the common treasury.

BURIAL. Among the Jews, the privilege of burial was denied only to self-murderers, who were thrown out to rot upon the ground. In the Christian church, though good men always desired the privilege of interment, yet they were not, like the Heathens, so concerned for their bodies as to think it any detriment to them, if either the barbarity of an enemy, or some other accident, deprived them of this privilege. The primitive Christian church denied the more solemn rites of burial only to unbaptized persons, self-murderers, and excommunicated persons who continued obstinate and impenitent, in manifest contempt of the church's censures.

The place of burial among the Jews was never particularly determined. We find they had graves in the town and country, upon the highways, in gardens, and upon mountains. Among the Greeks, the temples were made repositories for the dead in the primitive ages; yet the general custom in later ages with them, as well as with the Romans and other heathen nations, was to bury their dead without their cities, and chiefly by the highways. Among the primitive Christians, burying in cities was not allowed for the first three hundred years, nor in churches for many ages after; the dead bodies being first deposited in the atrium or church-yard, and porches and porticoes of the church: hereditary burying-places were forbidden till the twelfth century.

By the laws of England, persons dying are to be buried in woollen, or their representatives shall sorfeit 5*l.* and affidavit is to be made thereof before a justice under a like penalty. The minister is to keep a register at the parish expence.

BURMANNIA, a genus of the monogynia order, in the hexandria class of plants; ranked in the natural method under the 10th order, coronariæ. The flower is small, and consists of three minute, ovated, oblong petals, situated at the mouth of the cup; the fruit is an involuted capsule, formed of three valves, with three cells, containing many small seeds. There are two species, of no note.

BURN. See SURGERY.

BURNING-GLASS, a convex or concave glass, commonly spherical, which being ex-

posed directly to the sun, collects all the rays falling on it into a very small space, called the focus, where wood, or any other combustible matter being put, will be set on fire. The convex burning-glasses transmit the rays of light, and in their passage refract or incline them towards the axis, having the property of lenses, and acting according to the laws of refraction. The concave burning-glasses, or rather mirrors, being usually made of metal, reflect the rays of light, and in that reflection incline them to a point in the axis, having the property of mirrors, and acting according to the laws of reflection. See Optics.

BURNISHER, a round polished piece of steel, serving to smooth and give a lustre to metals. Of these there are different kinds, of different figures, straight, crooked, &c. Half burnishers are used to solder silver, as well as to give a lustre.

Book-binders burnish the edges of their books by rubbing them with a dog's tooth. Gold and silver are burnished by rubbing them with a wolf's tooth, or by the bloody stone, or by tripoli, a piece of white wood, emery, &c. Deer are said to burnish their heads by rubbing off a downy white skin from their horns against a tree.

BURR-PUMP, or Bilge-pump, differs from the common pump in having a staff 6, 7, or 8 feet long, with a bar of wood to which the leather is nailed, and this serves instead of a box. Two men, standing over the pump, thrust down this staff, to the middle whereof is fastened a rope, for 6, 8, or 10 to hale by, thus pulling it up and down.

BURTON, in the sea-language, a small tackle consisting of two single blocks: it may be made fast any where at pleasure, for hoisting small things in and out, and will purchase more than a single tackle with two blocks.

BURSERA, in botany, a genus of the dicœcia polygamia class and order. The hermaphrodite calyx is triphyllous; the corolla tripetalous; the male capsule carnous, trivalved, and monospermous. The male is, corolla five-petalled, stamina ten. There is but one species, viz.

Bursera gummifera, or gum elemi, (see Plate Nat. Hist. fig 70.) It is frequent in w ods in most of the Bahama islands, and grows speedily to a great height and thickness. The bark is brown and very like the birch. The wood is soft and useless, except when pieces of the limbs are put into the ground as fences, when it grows readily, and becomes a durable barrier. The leaves are pinnate: the middle rib 3 or 6 inches long, with the pinnæ set opposite on footstalks half an inch long. It has yellow flowers, male and female on different trees. These are succeeded by purple-coloured berries bigger than large peas, hanging in clusters on a stalk of about 5 inches long, to which each berry is joined by a footstalk half an inch long. The seed is hard, white, and of a triangular figure, inclosed within a thin capsule, which divides in 3 parts and discharges the seed. The fruit when cut, discharges a clear balsam, esteemed a good vulnerary, particularly for horses. On wounding the bark, a thick milky liquor is obtained, which soon concretes into a resin no way different from the gum elemi of the shops.

BUSHEL, a measure or capacity for dry goods, as grain, fruits, dry pulse, &c. containing four pecks or eight gallons, or one-eighth of a quarter. A bushel, by 12 Henry VIII. c. 5, is to contain eight gallons of wheat: the gallon eight pounds of troy-weight; the ounce twenty sterlings, and the sterling thirty-two grains, or corns of wheat, growing in the midst of the ear.

This standard bushel is kept in the exchequer, and it is found to contain 2145.6 solid inches, and the water with which it has been filled weighed 1131 ounces and fourteen pennyweights troy. By act of parliament made in 1697, it is determined that every round bushel with a plain and even bottom, being 18½ inches in diameter, and 8 inches deep, should be esteemed a legal Winchester bushel according to the standard in his majesty's exchequer. A vessel thus made will contain 2150.42 cubic inches, of course the corn gallon contains 268.8 cubic inches. Besides the standard or legal bushel, there are several local bushels of different dimensions in different places.

BUSKIN, a kind of shoe, somewhat in the manner of a boot, and adapted to either foot, and worn by either sex. This part of dress, covering both the foot and mid-leg, was tied underneath the knee; it was very rich and fine, and principally used on the stage by actors in tragedy. It was of a quadrangular form, and the sole was so thick, as that by means of it, men of the ordinary stature might be raised to the pitch and elevation of the heroes they personated. The colour was generally purple on the stage: herein it was distinguished from the sock, worn in comedy, that being only a low common shoe. The buskin seems to have been worn not only by actors, but by girls, to raise their height: travellers and hunters also made use of it to defend themselves from the mire.

BUSS, in maritime affairs, a small sea-vessel, used by us and the Dutch in the herring-fishery, commonly from 48 to 60 tons burden, and sometimes more. A buss has two small sheds or cabins, one at the prow, and the other at the stern; that at the prow serves for a kitchen.

BUTCHER-*bird*, in ornithology. See Lanius.

BUTEA, in botany, in honour of the late marquis of Bute. Class and order diadelphia decandria; nat. ord. papilionaceæ; calyx sublabiate; corolla standard very long, lanceolate; legume compressed, membranaceous, with one seed at the summit. There are two species; one an evergreen tree, about 15 feet high, from which, when cut, exudes a gummy blood-red juice, of a sweetish taste. The second differs but little from the preceding. They are both natives of the East Indies, on the coasts of Malabar and Coromandel.

BUTNERIA, a genus of the pentandria monogynia class and order. The essential character is; cor. five-petalled, filaments at top, connate with the petals; caps. five-grained, muricate. There are three species, shrubs of America and the West Indies.

BUTOMUS, the *flowering rush*, or *water gladiole*; a genus of the hexagynia order, in the enneandria class of plants, ranking, in the natural method, under the 5th order, tripetaloideæ. There is no calyx, but it has six petals, and as many monospermous capsules. There is but one species, viz.

Butomus umbellatus, of which there are two varieties, the one with a white, the other with a rose-coloured, flower. Though common plants, they are very pretty, and are worth propagating in a garden where there is conveniency for an artificial bog, or where there are ponds of standing water, as is many times the case. Where these conveniences are wanting, they may be planted in cisterns, which should be kept filled with water, with about a foot thickness of earth in the bottom; and into this earth the roots should be planted, or the seeds sown as soon as they are ripe.

BUTT, in commerce, a vessel or measure of wine containing two hogsheads, or 126 gallons.

Butt, or *butt-ends*, in the sea-language, are the fore-ends of all planks under water, as they rise, and are joined one end to another. Butt-ends in great ships are most carefully bolted; for if any one of them should spring or give way, the leak would be very dangerous, and difficult to stop.

BUTTER, a fat unctuous substance, prepared from milk by the process of churning. It was late before the Greeks appear to have had any notion of butter; their poets make no mention of it, and yet frequently speak of milk and cheese. The Romans used butter no otherwise than as a medicine, never as a food. The antient christians of Egypt burnt butter in their lamps instead of oil; and in the Roman churches, it was antiently allowed, during Christmas time, to burn butter instead of oil, on account of the great consumption of it otherwise.

BUTTOCK *of a ship*, is that part of her which is her breadth right astern, from the tack upwards; and a ship is said to have a broad or a narrow buttock, according as she is built broad or narrow at the transum.

BUTTON, an article of dress, serving to fasten clothes tight about the body, made of metal, silk, mohair, &c. in various forms. Metal buttons are formed two different ways; the blanks, or bases of the button, are either pierced out of a large sheet of metal, or cast. In the latter case, the shanks are previously fixed in the sand, exactly in the centre of the impression formed by each pattern, so as to have their extremities immersed in the melted metal, by which means they are firmly fixed in the button when cooled. The former process is generally used for yellow buttons, and the latter for those of white metal.

The metal used for gilt buttons is an alloy of copper and zinc, containing more copper than goes to the composition of brass. This metal is rolled into sheets, and the blanks pierced out; these are then planished, if for plain buttons; but when ornamented buttons are wanted the die is now struck, unless great nicety is required, when they are wrought by the hand. The shanks, made with great expedition by a curious engine, are then attached to the bottom of each button by a wire clamp, like a pair of sugar-tongs, and a small quantity of solder and resin applied to each. They are then exposed to heat on an iron plate, containing about a gross, till the solder runs, and the shank becomes fixed to the button, after which they are singly put into a lathe, and their edges turned off smoothly. The surface of the metal, which has become in a small degree oxidated by

the action of the heat, is to be cleaned by means of diluted nitric acid. The next step in the business is the rough burnishing, which is done in a lathe with a hard black stone, from Derbyshire. After this comes the gilding; which is done by first covering the surface uniformly with a thin stratum of mercury, and upon this is to be laid an amalgam, made of mercury and gold; five grains of gold will cover 144 buttons, each one inch in diameter. The mercury is now to be volatilized by means of heat.

Glass buttons are composed of glass of various colours, in imitation of opal, lapis lazuli, and other stones. The glass is kept in fusion, and the button nipped out of it whilst in its plastic state, by a pair of iron moulds, like those for casting pistol-shot, adapted to the intended form of the button; the shank having been inserted in the mould so that it may become imbedded in the glass when cool.

Shell buttons are those which consist of a back, generally made of bone, without any shank, but corded with catgut, and covered in front with a thin plate of metal struck with a die. The backs are cut out with a brace, the bit of which is a circular saw, and the four holes through which the catgut passes are drilled by four drills moving parallel to each other, and acting at once. They are then corded by children, who tie the catgut on the inside; the cavity is filled with melted resin, and the metal shell applied warm. The button is then pressed between two centres in a lathe, which are forced together by a weight acting on a lever, and the edge of the shell turned down during its revolution with a small burnisher.

Button *stone*, in natural history, a figured stone, so named from its resembling the button of a garment. There are three sorts, which Dr. Hook supposes to have been nothing but the filling up of three several sorts of shells. They are very hard flints, and consist of two bodies. This name is also given to a peculiar species of slate, found in some parts of Germany, that runs with ease into glass, in the course of a few hours, without the addition of any salt, or other foreign substance, to promote its vitrification. It, in fact, contains in itself all the principles of glass, and from it the Swedes and Germans make glass buttons, the handles of knives, and other articles.

BUTTS, or Backs, a name given to that sort of tanned leather which is prepared from the stoutest and heaviest ox hides, and is chiefly used for the soles of shoes.

BUXBAUMIA, in botany, a genus of the order musci, belonging to the cryptogamia class of plants; ranking under the same order, musci, or mosses, in the natural method.

BUXUS, the *box-tree*; a genus of the tetrandria order, and monœcia class of plants; and in the natural method ranking under the 38th order, tricoccæ. The male calyx is triphyllous; the germen an embryo, or imperfect rudiment. The female calyx is tetraphyllous: there are three petals, and as many styles: the capsule is three-beaked and trilocular, with two seeds. There is one species, with three varieties.

1. Buxus angustifolia, the narrow-leaved box. 2. Buxus arborescens, with oval leaves. These two varieties grow in great plenty upon Boxhill, near Dorking, in Surry. Here were formerly large trees of that kind, but now they are few in number. There are two or three varieties of the 2d sort, which are propagated in gardens; one with yellow, and the other with white-striped leaves. Another has the tips of the leaves only marked with yellow, and is called tipped box. Both these may be raised from seeds, or propagated by cuttings, planted in autumn in a shady border. The best season for removing these trees is in October; though if care is used to take them up with a ball of earth, they may be transplanted almost at any time, except the middle of summer. Box wood is extremely hard and smooth, and therefore well adapted to the use of the turner. Combs, mathematical instruments, knife-handles, and button-moulds, are made of it. It may properly enough be substituted in default of ebony, the yellow alburnum of which it perfectly resembles. Neither the wood nor the leaves of the box-tree at present are used for any other medicinal purpose than the distillation of an empyreumatic oil; and an oil of nearly the same quality is obtained from almost every other wood.

3. Buxus suffruticosa, dwarf or Dutch box, commonly used for bordering flower-beds. It is increased by parting the roots, or planting the slips; but as it makes a great increase of itself, and easily parts, it is hardly worth while to plant the slips that have no roots. For borders to flower-plots, it far excels any other plant. It is of long duration; is easily kept handsome; and by the firmness of its rooting, keeps the mould in the borders from washing into the gravel walks more effectually than any plant whatever.

BUZZARD. See Falco.

BUYING and selling, a transferring of property from one person to another, in consideration of some price or recompence. On an agreement for goods, the vendee cannot carry them away without payment, unless the vendor agrees to trust him. But if any part of the price is laid down, or any portion of the goods delivered by way of earnest, the vendee may recover the goods by action, as well as the vendor may the price of them. By 29 C. II. c. 3. no contract for the sale of goods, to the value of 10*l.* or upwards, shall be valid, unless the payment or delivery be performed, or unless some note in writing be made and signed by the party, or his agent. But if a vendee, after a bargain is struck, tenders the money, and the vendor refuses it, the property is absolutely vested in the vendee.

BY-LAW, is a private law made by those who are duly authorised so to do by charter, prescription, or custom, for the preservation of order and good government, within some particular place or jurisdiction. Moor, 583.

Every corporation, lawfully erected, has power to make by-laws, or private statutes, for the better government of the corporation; which are binding upon themselves, unless contrary to the laws of the land, and then they are void. 11 Black. 475.

BYSSUS, in botany, a genus of mosses, belonging to the order algæ, in the cryptogamia class of plants: the characters are; that the mosses of it are composed of simple and uniform parts, and always appear in form of excrescences, either of a woolly or of a dusty matter. It seems properly a genus of a middle kind, between the mushrooms and the mosses, but most approaching to the latter; as the several species of it are of longer duration, and want that fleshy texture which distinguishes the fungus class; and as they never produce heads, nor have any thing of the figure or texture of fungi. There are 19 species, natives of Britain, which grow upon old walls, rotten wood, &c. They are also found in many parts of Europe, covering the ground like a carpet.

Byssus asbestinus, a species of asbestus or combustible flax, composed of flexible parallel fibres. It is found plentifully in Sweden, either white, or of different shades of green. At a copper-mine in Westmannland, it forms the greatest part of the vein out of which the ore is dug; and by the heat of the furnace which melts the metal, is changed into a pure semitransparent glass.

Byssus, in antiquity, that fine Egyptian linen of which the tunics of the Jewish priests were made.

BYSTROPOGON, a genus of the didynamia gymnospermia class and order. The essential character is; cal. five-subulated, bearded at the opening; cor. upper lip bifid, lower trifid; stam. distant. There are seven species, but none deserving particular notice.

C.

C, the third letter of the alphabet. C, in music, is the highest part in the thorough-base: again, a simple C, or rather a semicircle, placed after the cliff, intimates that the music is in common time, which is either quick or slow, as it is joined with allegro or adagio; if alone, it is usually adagio. If the C is crossed or turned, the first requires the air to be played quick, and the last very quick.

CAABA, or Caabah, properly signifies a square building, but is particularly applied by the Mohammedans to the temple of Mecca, built, as they pretend, by Abraham, and Ismael his son. It is towards this temple they always turn their faces when they pray, in whatever part of the world they happen to be. This temple enjoys the privilege of an asylum for all sorts of criminals; but it is most remarkable for the pilgrimages made to it by the devout Musselmen, who pay so great a veneration to it, that they believe a single sight of its sacred walls, without any particular act of devotion, is as meritorious,

in the sight of God, as the most careful discharge of their duty, for the space of a whole year, in any other temple.

CAB, an Hebrew dry measure, containing two five-sixths pints of our corn-measure.

CABALLEROS, or CAVALLEROS, are Spanish wools, of which there is a considerable trade at Bayonne, in France.

CABBAGE. See BRASSICA.

Any person who shall steal, or take away, or maliciously pull up and destroy, any turnips, potatoes, cabbages, parsnips, peas, or carrots, growing in any lands, &c. shall, on conviction before one justice, by confession, or oath of one witness, forfeit, over and above the value of the goods stolen, a sum not exceeding 20*s*. one half to the owner of the goods, and one half to the poor.

CABBALA, according to the Hebrew style, has a very different signification from that wherein we understand it in our language. The Hebrew cabbala signifies tradition; and the rabbis, who are called cabbalists, study principally the combination of particular words, letters, and numbers, and by this means pretend to discover what is to come, and to see clearly into the sense of many difficult passages in scripture: there are no sure principles of this knowledge, but it depends upon some particular traditions of the antients; for which reason it is termed cabbala.

The cabbalists have abundance of names, which they call sacred; these they make use of in invoking of spirits, and imagine that they receive great light from them. They tell us that the secrets of the cabbala were discovered to Moses on mount Sinai, and that these have been delivered down to them from father to son, without interruption, and without any use of letters; for to write them down is what they are by no means permitted to do. This is likewise termed the oral law, because it passed from father to son, in order to distinguish it from the written laws.

There is another cabbala, called artificial, which consists in searching for abstruse and mysterious significations of a word in scripture, whence they borrow certain explanations, by combining the letters which compose it. This cabbala is divided into three kinds, the gematrie, the notaricon, and the temura or themurah: the first of which consists in taking the letters of a Hebrew word for cyphers or arithmetical numbers, and explaining every word by the arithmetical value of the letters whereof it is composed. The second sort of cabbala, called notaricon, consists in taking every particular letter of a word for an entire diction; and the third, called themurah, i. e. change, consists in making different transpositions or changes of letters, placing one for the other, or one before the other.

Among the Christians likewise, a certain sort of magic is by mistake called cabbala, which consists in using improperly certain passages of scripture for magic operations, or in forming magic characters or figures with stars and talismans.

Some visionaries among the Jews believe that Jesus Christ wrought his miracles by virtue of the mysteries of the cabbala.

CABECA, or CABESSE, a name given to the finest silks in the East Indies, as those from 15 to 20 per cent. inferior to them are called barina.

CABIDOS, or CAVIDOS, a long measure used at Goa, and in other places of the East Indies belonging to the Portuguese, to measure stuffs, linens, &c. and equal to four-sevenths of the Paris ell.

CABLE, a thick, large, strong rope, commonly of hemp, which serves to keep a ship at anchor. There is no merchant ship, however small, but has at least three cables; viz. the chief cable, or cable of the sheet anchor, a common cable, and a smaller one. Cable is also said of ropes which serve to raise heavy loads, by the help of cranes, pulleys, and other engines. The name of cable is usually given to such as have at least three inches in diameter; those that are less are only called ropes, of different names according to their use. Every cable, of what thickness soever it may be, is composed of three strands, every strand of three ropes, and every rope of three twists; the twist is made of more or less threads, according as the cable is to be thicker or thinner. In the manufacture of cables, after the ropes are made, they use sticks, which they pass first between the ropes of which they make the strands, and afterwards between the strands of which they make the cable, to the end that they may all twist the better, and be more regularly wound together; and also, to prevent them from twining or intangling, they hang at the end of each strand and of each rope, a weight of lead or of stone. The number of threads each cable is composed of is always proportioned to its length and thickness; and it is by this number of threads that its weight and value are ascertained. Thus a cable of three inches circumference, or one inch diameter, ought to consist of 48 ordinary threads, and weigh 192 pounds: and on this foundation is calculated the following table.

Circumf.	Threads.	Weight.
3 inches.	48	192 pounds.
4	77	308
5	121	484
6	174	696
7	238	952
8	311	1244
9	393	1572
10	485	1940
11	598	2392
12	699	2796
13	821	3284
14	952	3808
15	1093	4372
16	1244	4976
17	1404	5616
18	1574	6296
19	1754	7016
20	1943	7772.

A patent has been taken out within these few months by Mr. Haddart, for improvements in the manufacture of cables.

Pay more CABLE, is to let more out of the ship. Pay cheap the cable, is to hand it out apace. Veer more cable, is to let more out, &c.

CABLE's *length*, is 120 fathoms. This regulates the distance of ships of war when formed into a line of battle, which is ordered to be one or more cables length.

Slip the CABLE, is to let it run quite out when there is not time to weigh the anchor: this is preferable to cutting it. Before it is either cut or slipped, a spare buoy-rope should be passed through the hawse-hole, and fastened near the end, with a rolling-nitch, that it and the anchor may be easily regained.

CABLED, in heraldry, a term applied to a cross formed of the two ends of a ship's cable.

CABOCHED, in heraldry, is when the heads of beasts are borne without any part of the neck, full faced.

CABOLETTO, in commerce, a coin of the republic of Genoa, worth about three pence of our money.

CACALIA, in botany, Alpine colt's-foot, a genus of the polygamia æqualis order, and syngenesia class of plants. The receptacle is naked; the pappus hairy; the calyx cylindrical, oblong, and calyced, or having a small calyx of very short scales only at the base. There are 33 species: the most remarkable are:

1. Cacalia ficoides, a native of the Cape of Good Hope. It rises with strong round stalks to the height of seven or eight feet. The flowers are in small umbels; they are white, tubulous, and cut into five parts at the top. The leaves are pickled by the French, who esteem them much. They have a method of preserving the white farina upon them, which adds greatly to the beauty of the pickle when brought to table.

2. Cacalia kleinia, with a compound shrubby stalk. It grows naturally in the Canary islands, but has long been cultivated in the English gardens. There have been stones and fossils dug up at a very great depth in some parts of England having very perfect impressions of this plant upon them. This plant has been called the cabbage-tree, from the resemblance which the stalk of it has to the cabbage. Others have entitled it carnation-tree, from the shape of the leaves and the colour of the flowers.

CACHEXY, in medicine, such a disposition of the body as depraves the nourishment throughout its whole habit. See MEDICINE.

CACHRYS, a genus of the digynia order, and pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The fruit is subovate, angled, and cork or spongy rinded. There are five species, viz.

1. Cachrys hungarica, with a plain, fungous, channelled seed. 2. Cachrys libanotis, with smooth furrowed seeds. 3. Cachrys linearis, with plain channelled fruit. 4. Cachrys sicula, with double-winged leaves. 5. Cachrys trifida, with bipinnated leaves. All these are perennial plants, rising pretty high, and bearing large umbels of yellow flowers, and may be propagated by seeds.

CACTUS, melon thistle: a genus of the monogynia order, and icosandria class of plants; and in the natural method ranking under the 13th order, succulentæ. The calyx is monophyllous, superior, or above the receptacle of the fruit, imbricated; the corolla polypetalous; the fruit an unilocular polyspermous berry. To this genus Linnæus has added the cereus and opuntia. See Plate Nat. Hist. fig. 71. The cacti are plants of a singular structure. When the plants are cut through the middle, their inside is a soft, pale-green, fleshy substance, very full of moisture. The fruits of all the species are frequently eaten by the inhabitants of the West Indies. They are about three-fourths

of an inch in length, of a taper form, drawing to a point at the bottom toward the plant, but blunt at the top, somewhat like a pear. The taste is agreeably acid, which in a hot country must render them grateful. There are 27 species, all natives of the West Indies. The two following are the most remarkable, viz. 1. Cactus cochenillifer, the species which the cochineal animals inhabit. See COCCUS. 2. Cactus grandiflora, one of the creeping cereuses. The flower of this species, though very short-lived, is as grand and beautiful as any in the vegetable system: it begins to open in the evening about seven o'clock, is in perfection about eleven, and fades about four in the morning; so that the same flower only continues in perfection about six hours. The calyx when expanded is about a foot in diameter, of a splendid yellow within, and a dark brown without; the petals are many, and of a pure white; and the great number of recurved stamina, surrounding the style in the centre of the flower, make a grand appearance, to which may be added the fine scent which perfumes the air to a considerable distance. It flowers in July.

The cactus tribe are divided by gardeners into, 1. melon thistles or turks caps; 2. torch thistles; 3. creeping cereuses; 4. Indian figs or prickly pears. The cochineal plant is of this last description. They are easily distinguished from the euphorbia by the milky juice which exudes from the latter on puncture.

CADE, a cag, cask, or barrel. A cade of herrings is a vessel containing the quantity of 500 red herrings, or of sprats 1000.

CADENE, one of the sorts of carpets which the Europeans import from the Levant. They are the worst sort of all, and are sold by the piece from one to two piasters per carpet.

CADI, or CADHI, a judge of the civil affairs in the Turkish empire. It is generally taken for the judge of a town, judges of provinces being distinguished by the appellation of mouls.

In Biledulgerid in Africa, the cadi decides in spiritual affairs.

CADILESCHER, a principal officer of justice among the Turks, answering to a chief justice among us.

CADRITES, Mohammedan friars, who once a week spend great part of the night in turning round, holding each other's hands, and repeating incessantly the word *hai*, which signifies living, and is one of the attributes of God; during which one of them plays on a flute.

CÆCILIA, the name of a genus of serpents. The generic character is, that the body is without scales, is smooth, and moves by means of lateral rugæ or wrinkles; the upper lip is prominent, and furnished with two tentacula; it has no tail. There are three species, viz.

1. Cæcilia tentaculata. Eel-shaped cæcilia. The length of this species is about a foot, and its general appearance that of a small eel: its colour a livid brown, the abdomen paler or whitish: is a native of South America, and is said to be of an innoxious nature.

2. Cæcilia glutinosa. White-sided cæcilia. Is about the same length and diameter with the former, but has a large tumid head, and wider nostrils, without any appearance of tentacula: the colour of both head and body is deep brown, and along each side runs abroad whitish stripe; the wrinkles are extremely close and numerous, and disposed in such a manner as to form a slight carina along the sides on the white stripe. This is a native of South America.

3. Slender cæcilia. Length 13 inches and three-quarters: diameter, which is perfectly equal throughout, one fifth of an inch: skin smooth, but when closely examined appearing most minutely granulated. It is supposed to be a native of South America.

CÆCUM, or CŒCUM, in anatomy, the blind gut, or first of the thick intestines. See ANATOMY.

CÆRITES, or CÆRITUM TABULÆ, in Roman antiquity, tables or registers in which the names of the Cærites were registered. The people of Cære were accounted citizens of Rome, but had no privilege of voting. Hence when a Roman citizen was degraded, if a senator, he was expelled the senate; if a knight, he lost the public horse; and if a plebeian, his name was inserted in the register of the Cærites; that is, he was subject to all taxes, but incapable of voting or enjoying any public office.

CÆSALPINIA, BRASILETTO, or BRASILWOOD, a genus of the decandria class, and monogynia order of plants; and in the natural method ranking under the 33d order, lomentaceæ. The calyx is quinquefid, with the lowest segment larger in proportion. There are five petals, the lowest most beautiful. It is a leguminous plant. There are eight species, the most remarkable of which is:

Cæsalpinia brasiliensis, commonly called brasiletto. It grows naturally in the warmest parts of America, whence the wood is imported for the dyers. The demand has been so great, that none of the large trees are left in any of the British plantations; so that Mr. Catesby owns himself ignorant of the dimensions to which they grow. The largest remaining are not above two inches in thickness, and eight or nine feet in height. The branches are slender, and full of small prickles; the leaves are pinnated; the lobes growing opposite to one another, broad at their ends, with one notch. The flowers are white, papilionaceous, with many stamina and yellow apices, growing in a pyramidal spike at the end of a long slender stalk: the pods inclose several small round seeds. The colour produced from this wood is greatly improved by a solution of tin in aqua regia. There is another sort, a native of the same countries with the first, but of a larger size. It sends out many weak irregular branches, armed with short, strong, upright thorns. The flowers are produced in long spikes like those of the former, but are variegated with red. These plants may be propagated from seeds, and should be constantly kept in the stove.

CÆSARIAN SECTION. See MIDWIFERY.

CÆSTUS, in antiquity, a large gauntlet made of raw hide, which the wrestlers made use of when they fought at the public games. It was a kind of leathern strap, strengthened with lead, or plates of iron, which encompassed the hand, the wrist, and a part of the arm, as well to defend these parts as to enforce their blows.

CÆSURA, in the antient poetry, is when, in the scanning of a verse, a word is divided so that one part seems cut off, and goes to a different foot from the rest; as,

Menti|ri no|li, nun|quam men|dacia|prosunt:

where the syllables ri, li, quam, and men, are cæsuras.

CAFFA, in commerce, painted cotton-cloths manufactured in the East Indies, and sold at Bengal.

CAFFILA, a company of merchants or travellers, who join together in order to go with more security through the dominions of the great mogul, and through other countries on the continent of the East Indies. The caffila differs from a caravan, at least in Persia; for the caffila belongs properly to some sovereign, or to some powerful company, of Europe; whereas a caravan is a company of particular merchants, each trading upon his own account. The English and Dutch have each of them their caffila at Gambron.

CAG, or KEG, of sturgeon, &c. a cask or vessel that contains from four to five gallons.

CAHYS, a dry measure for corn, used in some parts of Spain, particularly at Seville and at Cadiz. It is nearly a bushel of our measure.

CAIC, or CAIQUE, a skiff, or sloop, belonging to a galley. The same name is given to a small kind of bark used in the navigation of the Black Sea, and carrying from 40 to 50 men. Those used on the sea of Marmora are generally manned by two or three rowers, and they are incessantly employed in crossing the harbour, and proceeding to the several neighbouring villages and islands. They carry one or more sails, which are set only in fair weather, and when the wind is not strong.

CAIMACAN, or CAIMACAM, in the Turkish affairs, a dignity in the Ottoman empire, answering to lieutenant, or rather deputy, among us.

CAINIANS, or CAINITES, in church-history, a christian sect that sprung up about the year 130, and took their name from Cain, whom they looked upon as their head and father. They said that he was formed by a celestial and almighty power, and that Abel was made but by a weak one.

CAISSON, in the military art, a wooden chest, into which several bombs are put, and sometimes only filled with gunpowder. This is buried under some work, of which the enemy intend to possess themselves; and when they are masters of it, is fired, in order to blow them up. It is also employed for a wooden frame, or chest, used in laying the foundations of the piers of a bridge.

Caissons were used in the building of Westminster-bridge, each of which contained 150 loads of fir timber, and was of more tonnage than a 40-gun frigate: their size was 80 feet long, and 30 feet broad, and their sides 10 feet in height. The caisson was provided with a sluice to admit the water. The method of working was as follows: a pit being dug, and levelled in the proper situation for the pier, of the same shape as the caisson, only larger, it was brought to its position, and a few of the lower courses of the pier built in it, and sunk once or twice, to prove the level of the foundation; then being finally fixed, the masons worked in the usual way of tide-work. About two hours before low water, the sluice was shut down, and the water pumped out, for the masons to set and cramp the stone-work of the succeeding courses. In this manner the work proceeded till the pier rose to the surface of the caisson, when the sides were floated away to serve the same purpose at another pier.

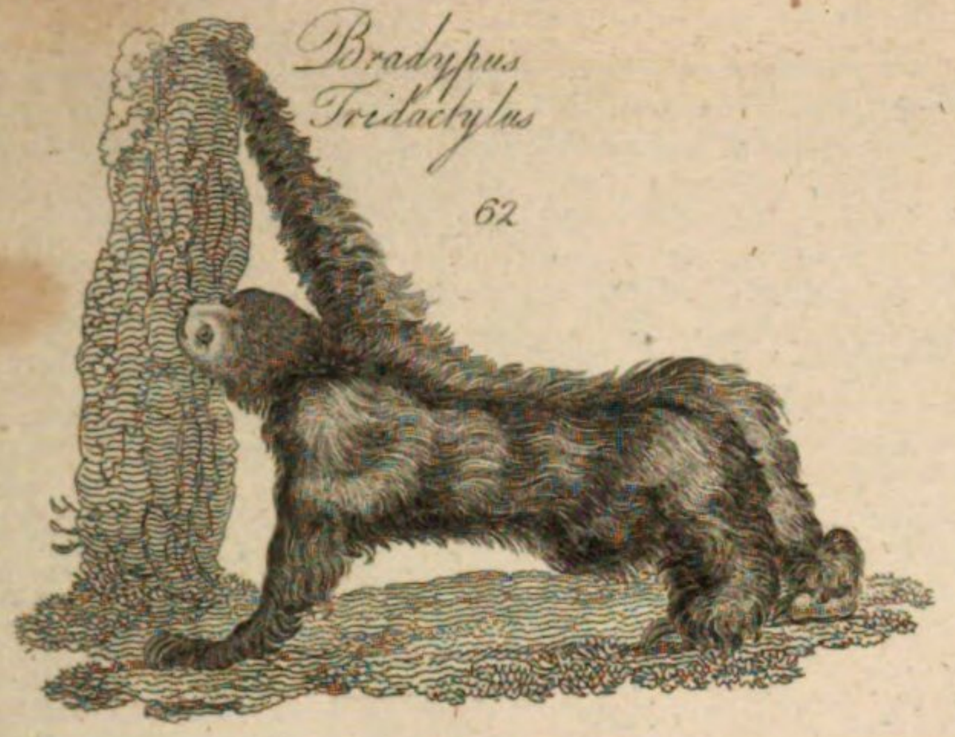
CALAMANCO, a sort of woollen stuff manufactured in England and in Brabant. It

Brentus anchorago

63

Bradypus Tridactylus

62



Bromelia Ananas

64

Buccinum

65

Bucco degans

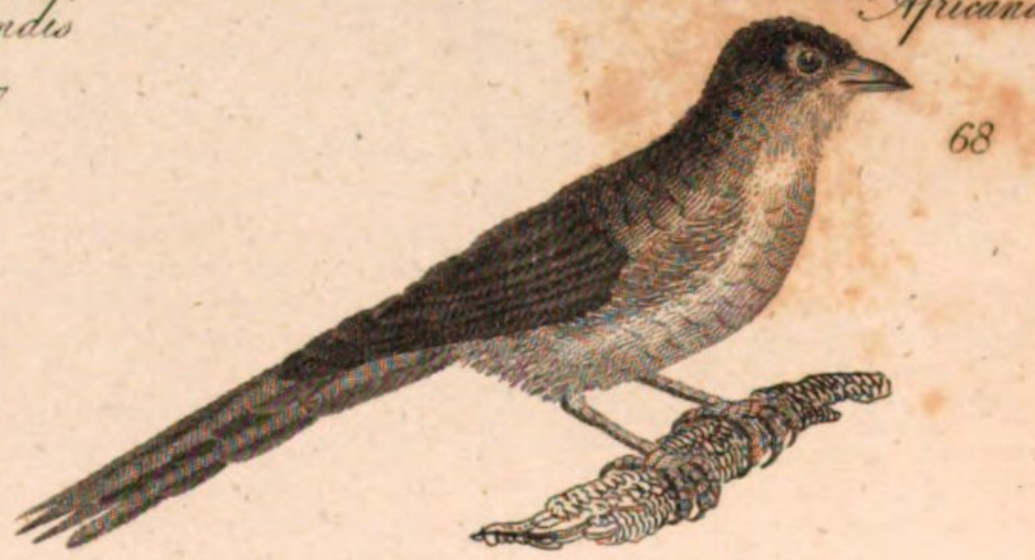
66

Bucco grandis

67

Buphagà Africana

68



Buprestis vittata

69

Busera Gummifera

70

Cactus Opuntia

71

Calamus rotang

72

Heath Sculp.

Printed 1806. for Richard Phillips, 6 New Bridge Street, Blackfriars.

has a fine gloss, and is chequered in the warp, whence the checks appear only on the right side. Some calamancos are quite plain, others have broad stripes adorned with flowers, some with plain broad stripes, some with narrow stripes, and others watered.

CALAMINARIS, or LAPIS CALAMINARIS, in natural history, an ore of zinc, of a spungy substance, and a lax and cavernous texture, yet considerably heavy. See ZINC.

CALAMUS, a genus of the monogynia order, and hexandria class of plants; and in the natural method ranking under the 5th order, tripetaloideæ. The calyx is hexaphyllous, there is no corolla, the fruit is a dry monospermous berry, imbricated backwards. There is but one species, viz.

Calamus rotang. The stem is without branches, has a crown at top, and is every where beset with straight spines. This is the true Indian cane, which is not apparently such on the outside; but the external bark being taken off discovers the smooth stick, which has no marks of spine on the inner bark; and is exactly like those which the Dutch sell to us, keeping this matter very secret, lest travellers going by should take as many canes out of the woods as they please. Sumatra is said to be the place where most of these sticks grow. Such are to be chosen as are of proper growth, between two joints, suitable to the fashionable length of canes as they were then used; but such are scarce. The calamus rotang is one of several plants from which the drug called dragon's blood is obtained. See Plate Nat. Hist. fig. 72.

Calamus aromaticus. See ACORUS.

CALATOR, in antiquity, was a public servant, and a freeman, such as a bailiff or crier, or summoner, to summon courts, synods, and other public assemblies.

CALATRAVA, *knights of*, a military order in Spain, instituted under Sancho III. king of Castile, upon the following occasion. When that prince took the strong fort of Calatrava from the Moors of Andalusia, he gave it to the Templars; who, wanting courage to defend it, returned it to him again. Then don Raymond, of the order of the Cistercians, accompanied with several persons of quality, made an offer to defend the place, which the king thereupon delivered up to them, and instituted that order.

CALCANEUM, or OS CALCIS. See ANATOMY.

CALCINATION, in chemistry, such a management of bodies by fire as renders them reducible to a calx or cinder.

As most metals were reducible to this form, the term calces of metals was long appropriated to them; but in science the term is supplanted by the characteristic appellation of oxide, which expresses the peculiar change that occurs in calcining metallic bodies by the absorption of oxygen. Calcination and oxidation are not strictly synonymous, even when applied to metals, since the true sense of the former implies the agency of fire, but the metals may be oxidated by the action of the acids as well as by heat and air.

CALCULI, BILIARY, are hard bodies sometimes formed in the gall-bladder, or in the duct through which the bile passes into the intestinal canal, and stop up the passage altogether. They naturally drew the attention of physicians, because it was soon ascertained that they occasioned the disease called jaundice. Accordingly they were examined and described by different chemists, and the facts ascertained before 1764 were collected by Haller in the sixth volume of his Physiology. Since that period, a treatise has been published on them by Vicq d'Azyr; and several new facts have been discovered by Poulletier de la Sale, Fourcroy, Gren, and Saunders.

Such of the biliary calculi as have been hitherto examined with attention may be arranged under four classes.

1. The first kind comprehends those which have a white colour, and a crystallized, shining, lamellated structure.

2. The second is brown-coloured, and has the appearance of inspissated bile.

3. The third class comprehends those calculi which are composed of a mixture of the substances which constitute the two last.

4. The fourth comprehends those gall-stones which do not flame, but gradually waste away at a red heat.

Let us take a view of each of these classes of biliary calculi.

1. The first species of biliary calculi was pointed out for the first time by Haller, in a dissertation published in 1749. Walther afterwards added several new facts; and at last it was accurately described by Vicq d'Azyr. It is almost always of an oval shape, sometimes as large as a pigeon's egg, but commonly about the size of a sparrow's; and for the most part only one calculus (when of this species) is found in the gall-bladder at a time. It has a white colour, and when broken presents crystalline plates or striæ, brilliant and white like mica, and having a soft greasy feel. Sometimes its colour is yellow or greenish; and it has constantly a nucleus of inspissated bile. Its specific gravity is inferior to that of water. Gren found the specific gravity of one 0.803.

When exposed to a heat considerably greater than that of boiling water, this crystallized calculus softens and melts, and crystallizes again when the temperature is lowered. It is altogether insoluble in water; but hot alcohol dissolves it with facility. Alcohol, of the temperature of 167°, dissolves $\frac{1}{20}$ of its weight of this substance; but alcohol, at the temperature of 60°, scarcely dissolves any of it. As the alcohol cools, the matter is deposited in brilliant plates resembling talc or boracic acid. It is soluble in oil of turpentine. When melted it has the appearance of oil, and exhales the odour of melted wax: when suddenly heated it evaporates altogether in a thick smoke. It is soluble in pure alkalies, and the solution has all the properties of a soap. Nitric acid also dissolves it; but it is precipitated unaltered by water.

This matter, which is evidently the same with the crystals which Cadet obtained from bile, and which he considered as analogous to sugar of milk, has a strong resemblance to spermaceti. Like that substance, it is of an oily nature, and inflammable; but it differs from it in a variety of particulars.

Since it is contained in bile, it is not difficult to see how it may crystallize in the gall-bladder if it happens to be more abundant than usual; and the consequence must be a gall-stone of this species. Fourcroy found a quantity of the same substance in the dried human liver.

2. The second species of biliary calculus is of a round or polygonal shape, often of a grey colour externally, and brown within. It is formed of concentric layers of a matter which seems to be inspissated bile; and there is usually a nucleus of the white crystalline matter at the centre. For the most part there are many of this species of calculus in the gall-bladder together; indeed it is frequently filled with them. The calculi belonging to this species are often light and friable, and of a brownish-red colour. The gall-stones of oxen, used by painters, belong to this species.

3. The third species of calculi are most numerous of all. Their colour is often deep brown or green; and when broken, a number of spermaceti crystals are observable, mixed with the inspissated bile.

The calculi belonging to these three species are soluble in alkalies, in soap leys, in alcohol, and in oils.

4. Concerning the fourth species of gall-stone, very little is known with accuracy. Dr. Saunders tells us that he has met with some gall-stones insoluble both in alcohol and oil of turpentine; some of which do not flame, but become red, and consume to an ash like a charcoal. Haller quotes several examples of similar calculi.

Gall-stones often occur in the inferior animals, particularly in cows and hogs; but the biliary concretions of these animals have not hitherto been examined with much attention.

CALCULI, *urinary*. It is well known that concretions not unfrequently form in the bladder, or the other urinary organs, and occasion one of the most dismal diseases to which the human species is liable.

These concretions were distinguished by the name of calculi, from a supposition that they are of a stony nature. They have long attracted the attention of chemists and physicians. Boyle extracted from calculi, by distillation, oil, and a quantity of volatile salts. Boerhaave supposed them compounds of oil and volatile salts. Slare attempted a chemical analysis of them. Hales extracted from them a prodigious quantity of air. He gave them the name of animal tartar, pointed out several circumstances in which they resemble common tartar, and made many experiments to find a solvent of them. Drs. Whytt and Alston pointed out alkalies as solvents of calculi. It was an attempt to discover a more perfect solvent that induced Dr. Black to make those experiments, which terminated in the discovery of the nature of the alkaline carbonates.

Such was the state of the chemical analysis of calculus, when, in 1776, Scheele published a dissertation on the subject in the Stockholm Transactions, which was succeeded by some remarks of Mr. Bergman. These illustrious chemists completely removed the uncertainty which had hitherto hung over the subject, and ascertained the nature of the calculi which they examined. Since that time considerable additional light has been thrown upon the nature of these concretions by the labours of Austin, Walther, Brugnatelli, Pearson, &c. But the most important additions to our knowledge of calculi were made by Dr. Wollaston. That ingenious chemist distinguished them into species, and ascertained the composition of each, pointing out several new constituents which had not been suspected before.

Urinary calculi are usually spheroidal or egg-shaped: sometimes they are polygonous, or resemble a cluster of mulberries; and in that case they are distinguished by the epithet mulberry. Their size is various; sometimes they are very small, and sometimes as large as a goose-egg, or even larger. The colour of some of them is a deep brown, resembling that of wood. In some cases they are white, and not unlike chalk; in others, of a dark grey, and hard. These different colours are often intermixed, and occur of various degrees of intensity. Their surface in some cases is polished like marble; in others, rough and unequal; sometimes they are covered with semitransparent crystals. Their specific gravity varies from 1.213 to 1.976.

The substances hitherto discovered in urinary calculi are the following:

1. Uric acid,
2. Urat of ammonia,
3. Phosphate of lime,
4. Phosphate of magnesia and ammonia,
5. Oxalate of lime,
6. Carbonate of lime,
7. Silica,
8. Animal matter.

It appears from a strict analysis of the different urinary calculi, that all their component parts exist in urine, except oxalat of lime and silica. But little satisfactory is known concerning the manner in which they are formed, or of the cause of their formation. Whenever any solid body makes its way into the bladder, it has been observed that it is soon encrusted with a coat of phosphate of lime; and this first nucleus soon occasions a calculus. Concretions of uric acid seldom or never form in the bladder, unless a primitive nucleus has originated in the kidneys. The gravel, which is so frequently emitted by persons threatened with the stone, consists always of this acid. As oxalic acid does not exist in urine, some morbid change must take place in the urine when calculi composed of oxalate of lime are deposited.

As our ignorance of the cause of urinary concretions puts it out of our power to prevent their formation, the ingenuity of physicians has been employed in attempting to discover substances capable of dissolving them after they have formed, and thus to relieve the human race from one of the most dreadful diseases to which it is subject. These attempts must have been vain, or their success must have entirely depended upon chance, till the properties of the concretions themselves had been discovered, and the substances capable of dissolving them ascertained by experiment. We shall therefore pass over the numerous lithanthriptics which have been recommended in all ages, and satisfy ourselves with giving an account of the experiments made by Fourcroy and Vauquelin to dissolve stones by injections through the urethra, made after their analysis of the urinary calculi.

The component parts of urinary calculi, as far as solvents are concerned, may be reduced under three heads: 1. Uric acid and urat of ammonia: 2. the phosphates: 3. oxalate of lime.

1. A solution of pure potass and soda, so weak that it may be kept in the mouth, and even swallowed without pain, soon dissolves calculi composed of uric acid, or urat of ammonia, provided they are kept plunged in it.

2. The phosphates are very quickly dissolved by nitric or muriatic acid, so weak that it may be swallowed without inconvenience, and possessed of no greater acridness than urine itself.

3. Oxalate of lime is much more difficult of solution than the preceding substances. Calculi composed of it are slowly dissolved by nitric acid, or by carbonate of potass or soda, weak enough not to irritate the bladder; but the action of these substances is slow, and scarcely complete.

These solvents, injected into the bladder repeatedly, and retained in it as long as the patient can bear their action without inconvenience, ought to act upon the stone, and gradually dissolve it. The difficulty, however, is to determine the composition of the calculus to be acted upon, in order to know which of the solvents to employ. But as no method of deciding this point with certainty is at present known, we must try some one of the solvents for once or twice, and examine it after it has been thrown out of the bladder. Let us begin, for instance, with injecting a weak solution of potass; after it has remained in the bladder half an hour, or longer if the patient can bear it, let the liquid, as soon as passed, be filtred and mixed with a little muriatic acid; if any uric acid has been dissolved, a white solution will make its appearance. This precipitate is a proof that the calculus is composed of uric acid. If it does not appear, after persevering in the alkaline solution for some days, then there is reason to expect the presence of the phosphates; of course a weak muriatic acid solution should be injected. After this solution is emitted, let it be mixed with ammonia, and the phosphate of lime will precipitate, if the calculus is composed of it. If neither of these solutions takes up any thing, and if the symptoms are not alleviated, we must have recourse to the action of nitric acid, on the supposition that the calculus is composed of oxalate of lime. These different solutions must be persisted in, and varied occasionally as they lose their efficacy, in order to dissolve the different coats of the calculus. Such are the methods pointed out by Fourcroy and Vauquelin. It is scarcely necessary to observe, that the bladder should be evacuated of urine previous to the injections, and that the injections should be previously heated to the temperature of the body.

CALCULUS, or *calculus humanus*, in medicine, the stone in the bladder or kidneys. See the preceding article.

CALCULUS *differentialis*, is a method of differencing quantities, that is, of finding an infinitely small quantity, which being taken an infinite number of times, shall be equal to a given quantity. An infinitely small quantity, or infinitesimal, is a portion of a quantity less than any assignable one; it is therefore accounted as nothing: and hence two quantities differing by an infinitesimal, are reputed equal. The word infinitesimal is merely respective, and implies a relation to another quantity: for example, in astronomy, the diameter of the earth is an infinitesimal in respect of the distance of the fixed stars. It must not, then, be confounded with any real being.

Infinitesimals are likewise called differentials, or differential quantities, when they are considered as the differences of two quantities. Sir Isaac Newton calls them momenta, considering them as momentary increments of quantities: for instance, of a line generated by the flux of a point, of a surface by the flux of a line, or of a solid by the flux of a surface. The calculus differentialis, therefore, and the doctrine of fluxions, are the same thing, under different names; the latter given by sir Isaac Newton, and the former by Mr. Leibnitz, who disputes with sir Isaac the honour of the discovery. There is, however, one difference between them, which consists in the manner of expressing the differentials of quantities: Mr. Leibnitz, and most foreigners, express them by the same letters as variable ones, prefixing only the letter d: thus the differential of x is called dx, and the differential of y, dy. And dx is a positive quantity if x continually increase, and a negative quantity if x decrease. We, on the other hand, following sir Isaac Newton, instead of dx, write $\dot{x}$ (with a dot over it), and instead of dy, $\dot{y}$. But foreigners reckon this method not so commodious as the former, because if differentials were to be differenced again, the dots would occasion great confusion; not to mention that printers are more apt to overlook a point than a letter.

Now as permanent quantities are always expressed by the first letters of the alphabet, $da = 0$, $db = 0$, $dc = 0$; wherefore $d(x + y - a) = dx + dy$, and $d(x - y + a) = dx - dy$. The difference of quantities then, is easily performed by the addition or subtraction of their compounds. To difference two quantities that multiply each other, as xy, multiply the differential of one factor into the other factor, and the sum of the two factors is the differential required. Thus the differentials of xy will be $x\,dy + y\,dx$, that is $d(xy) = x\,dy + y\,dx$. Again, if there be three quantities mutually multiplying each other, the factum of the two must be multiplied into the differential of the third; thus suppose vxy: let $vx = t$, and vxy will be $= ty$; consequently $d(vxy) = t\,dy + y\,dt$: but $dt = v\,dx + x\,dv$. If these values therefore are substituted in the antecedent differential $t\,dy + y\,dt$, it follows that $d(vxy) = vx\,dy + vy\,dx + xy\,dv$. In the same manner must we proceed when the quantities to be differenced are more than three. But if, while one variable quantity increases, the other, y, decreases, it is evident that $y\,dx - x\,dy$ will be the differential of xy.

The rule for differencing quantities that mutually divide each other, is first to multiply the differential of the divisor into the dividend; and, on the contrary, the differential of the dividend into the divisor. 2. To subtract the first product from the last. 3. To divide the remainder by the square of the divisor, and the quotient is the differential of the quantities mutually dividing each other. For instance, let $xy : vz$ be to be differenced: suppose $xy = t$, and $vz = w$; then $xy : vz$ will be equal to $t : w$. But $d(t : w) = (w\,dt - t\,dw) : w^2$; and $dt = x\,dy + y\,dx$, $dw = v\,dz + z\,dv$. Wherefore $d(t : w) = d(xy : vz) = (vz\,x\,dy + vz\,y\,dx - xyv\,dz - xyz\,dv) : v^2 z^2$. For a farther account of the doctrine of the differentials, see FLUXIONS.

CALCULUS *exponentialis*, among mathematicians, a method of differencing exponen-

tial quantities. By an exponential quantity is meant a power, the exponent of which is variable, as x^x, a^x. In order to difference an exponential quantity, nothing else is required than to reduce the exponential quantities to logarithmic ones, upon which the differencing is managed as in logarithmic ones. For instance, suppose the differential of the exponential quantity x^y were required.

Let $x^y = z$

then will $ylx = lz$

$$\frac{lxdy + ydx : x = dz : z}{zlxdy + zydx : x = dz.}$$

That is, $x^y\ lxdy + yx^{y-1}dx = dz$. If the exponential quantity to be differenced be of the second degree, as v^{x^y}, suppose as before

$$v^{x^y} = z$$

then will $x^y\ lv = lz$

$$\frac{(x^y lxdy + yx^{y-1}dx)\ lv + x^y dv : v = dz : z}{z\ (x^y lxdy + yx^{y-1}dx)\ lv + zx^y\ dv : v = dz}$$

that is,

$$v^{x^y}\ (x^y lxdy + yx^{y-1}dx)\ lv + v^{x^y}\ v^{-1}\ x^y\ dv + dz$$

or,

$$v^{x^y}\ x^y lxlvdy + v^{x^y}\ yx^{y-1}lvdx + v^{x^y}\ v^{-1}\ x^y\ dv = dz.$$

By the same method may be found the differential of exponential quantity of any power. This calculus was invented by Mr. John Bernouilli, and is used in investigating the properties of exponential curves. See *Exponential* CURVE.

CALCULUS *integralis*, or *summatorius*, is a method of summing up differential quantities; that is, from a differential quantity from whose differencing the given differential results.

It is the inverse of the calculus differentialis; whence the English, who usually call the differential method fluxions, give this calculus, which ascends from the fluxions to the flowing quantities, or, as Wolfius and other foreigners express it, from the differences to the sums, the name of the inverse method of fluxions.

Let s be the sign of the sum, or integral quantity, so that $sydx$ may denote the integral of the differential ydx. To integrate or sum up a differential quantity, 1. It is demonstrated that $sdx = x$. 2°. $s\ (dx \mp dy) = x \mp y$. 3°. $s\ (xdy + ydx) = xy$. 4°. $smx^{m-1}\ dx = x^m$. 5°. $s\ (n : m)\ (n - m) : m\ x^{(n-m):m}\ dx = x^{n:m}$. 6°. $s\ (ydx - xdy) : y^2 = x : y$. Of these the fourth and fifth cases occur most frequently, in which the differential quantity is integrated, if a variable unity is added to the exponent, and the sum divided by the new exponent, multiplied into the differential of the root, as in the fourth case by $(m - 1 + 1)\ dx$, that is, by mdx.

If the differential quantity to be integrated, do not come under any of these formulas, it must either be reduced to an integrable finite, or an infinite series each of whose terms may be summed.

This calculus is applied to geometry, in the quadrature and rectification of curves, in cubing solids and measuring their surfaces, in the inverse method of tangents, and in the doctrine of logarithms.

It may be remarked, that as in the analysis of finites, any quantity may be raised to any given power; but, *vice versa*, the root cannot be extracted out of any number required: so in the analysis of infinites, any variable or flowing quantity may be differenced; but, *vice versa*, any differential cannot be integrated. And as in the analysis of finites, we are not yet arrived at a method of extracting roots of all equations, so neither has the integral calculus arrived at perfection: and as in the former we are obliged to have recourse to approximation, so in the latter we have recourse to a perfect integration. See SERIES.

CALCULUS, *antecedental*. A geometrical method of reasoning without any consideration of motion or velocity, applicable to every purpose to which fluxions have been or can be applied. It was invented by Mr. Glenie, who derived it from an examination of the antecedents of ratios, having given consequents, and a given standard of comparison in the several degrees of augmentation and diminution, which they undergo by composition and decomposition.

CALEA, in botany, a genus of the polygamia æqualis order and syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is paleaceous, the pappus hairy, and the calyx imbricated. There are seven species.

CALENDAR. See ALMANAC.

The first calendar was made by Romulus, who divided the year into ten months only, beginning on the first day of March, and containing 304 days, in which time he imagined the sun performed his course through all the seasons. This calendar was reformed by Numa Pompilius, who added two months more, viz. January and February, placing them before March: his year began on the first of January, and consisted of 355 days. This was afterwards improved by Julius Cæsar, and was by him called the Julian account, which reduced the year to 365 days, 6 hours; and was retained in most protestant countries, and in our nation till the year 1752. This year is disposed into quadriennial periods, whereof the first three years, which were called common, consisted of 365 days, and the fourth, bissextile, of 366. The Julian account was afterwards corrected by pope Gregory XIII. which on that account obtained the name of the Gregorian calendar, or new style, the Julian being called the old style; and though the Gregorian calendar is preferable to the Julian, yet it is not without its defects.

When pope Gregory had reformed the calendar, he ordered all the ecclesiastics under his jurisdiction to conform to this new mode of reckoning; and he exhorted the christian princes, within the pale of his authority, to adopt it in their dominions. It was accordingly introduced without delay into all catholic countries. In Spain, Portugal, and part of Italy, it was received on the same day as at Rome; but in France not till some months after. The catholic states in Germany adopted the Gregorian calendar in 1583; but the protestant states refused it. Hence arose a difference of 10, and afterwards 11, days, between the methods of reckoning used in catholic and protestant countries. The protestant states in Germany reformed their calendar in 1700. But in this country the new style was not introduced till September, 1752; on the 2d of that month the old style ceased, and the next day was called the 14th, instead of the 3d. The act of parliament which altered the style, changed also the beginning of the year from the 25th of March to the 1st of January.

Dr. Playfair, in his Chronology, has taken some pains to shew that the method of intercalation used in the Gregorian calendar is not quite accurate. It supposes the tropical year to consist of 365 d. 5 h. 49′ 12″, whereas recent observations have shewn it to be 365 d. 5 h. 48′ 45½″. The following intercalations ought to be made instead of those determined on by pope Gregory.

$+\frac{4}{1}, -\frac{17}{4}, +\frac{33}{8}, -\frac{128}{31}, +\frac{545}{132}, +\frac{673}{163}, +\frac{801}{199}, +\frac{929}{225}, +\frac{1057}{256}$, &c. &c. so that one day is to be intercalated in the space of four years; or, more accurately, four days in 17 years; or still more accurately, eight days in 33 years; or 31 days in 128 years, and so on. The signs + and — indicate, that the number of intercalary days above which they are placed is too great or too small.

Julian christian CALENDAR, that in which the days of the week are determined by the letters A, B, C, D, E, F, G; by means of the solar cycle, and the new and full moons, especially the paschal full moon, with the feast of Easter, and the other moveable feasts depending thereon, by means of golden numbers rightly disposed through the Julian year.

Gregorian CALENDAR, that which, by means of epacts rightly disposed, through the several months, determines the new and full moons, and the time of Easter, with the moveable feasts depending thereon, in the Gregorian year. Therefore the Gregorian calendar differs from the Julian, both in the form of the year, and in that epacts are substituted instead of golden numbers.

Reformed, or *corrected* CALENDAR, that which, setting aside golden numbers, epacts, and dominical letters, determines the equinox, with the paschal full moon, and the moveable feasts depending thereon, by astronomical computations, according to the Rudolphine tables.

CALENDER, a machine used in manufactories, to press certain woollen and silken stuffs, and linens, to make them smooth, even, and glossy, or to give them waves, or water them, as may be seen in mohairs and tabbies. This instrument is composed of two thick cylinders, or rollers, of very hard and polished wood, round which the stuffs to be calendered are wound: these rollers are placed crossways between two very thick boards, the lower serving as a fixed base, and the upper moveable, by means of a thick screw, with a rope fastened to a spindle, which makes its axis: the uppermost board is loaded with large stones cemented together, weighing 20,000 lb. or more. It is this weight that gives the polish, and makes the waves on the stuffs about the rollers, by

means of a shallow indenture or engraving cut in it.

CALENDS, in Roman antiquity, the first day in each month, so called from the Greek καλειν, to proclaim: it being customary on those days to proclaim the number of holidays in each month. The Roman method of reckoning the days of their months has something extremely singular in it: instead of computing forwards, in the natural order of the numbers 1, 2, 3, &c. they reckoned backwards, in the manner expressed in the following verses:

Prima dies mensis cujusque est dicta *calendæ*:
Sex Maius, *nonas*, Julius, October, et Mars;
Quatuor at reliqui: habet *idus* quilibet octo;
Inde dies reliquos omnes dic esse *calendas*;
Quas retro numerans, dices a mense sequente.

Hence, to find the day of our month answering to that of the calends, to the number of days in the preceding month add two, and from this sum subtracting the number of calends given, the remainder will be the day of our month: thus the fourth of the calends of June is found to answer to the 29th of May; and so on in other cases.

CALENDULA, in botany, the *marigold*, a genus of the polygamia necessaria order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked, there is no pappus, the calyx is polyphyllous and equal, the seeds of the disk membranaceous. There are 14 species, none of them natives of Europe. The common kind is so well known as to need no description; and none of the others merit any, except

CALENDULA *fruticosa*, which in 1759 was introduced from the Cape of Good Hope. It has a slender shrubby perennial stalk, which rises to the height of seven or eight feet, but requires support. It may be propagated by cuttings.

CALIBER *compasses*, the name of a particular instrument used by gunners for measuring the diameters of shot, shells, &c. as also the cylinder of cannon, mortars, and howitzers. They resemble other compasses, except in their legs, which are arched, in order that the points may touch the extremities of the arch. To find the true diameter of a circle, they have a quadrant fastened to one leg, and passing through the other, marked with inches and parts, to express the diameter required: the length of each ruler or plate is usually between the limits of six inches and a foot. On these rulers are a variety of scales, tables, proportions, &c. such as are esteemed useful to be known by gunners. The following articles are on the completest gunner's-callipers, viz. 1. The measure of convex diameters in inches. 2. Of concave ditto. 3. The weight of iron shot from given diameters. 4. The weight of iron shot from given gun-bores. 5. The degrees of a semicircle. 6. The proportion of troy and avoirdupois weight. 7. The proportion of English and French feet and pounds. 8. Factors used in circular and spherical figures. 9. Tables of the specific gravity and weights of bodies. 10. Tables of the quantity of powder necessary for proof and service of brass and iron guns. 11. Rules for computing the number of shot or shells in a finished pile. 12. Rule concerning the fall of heavy bodies. 13. Rules for raising of water. 14. Rules for firing artillery and mortars. 15. A line of inches. 16. Logarithmetic scales of numbers, sines, versed sines, and tangents. 17. A sectoral line of equal parts, or the line of lines. 18. A sectoral line of plans and superficies. 19. A sectoral line of solids. See Plate.

CALIDUCT, in antiquity, a kind of pipes, or canals, disposed along the walls of houses and apartments, used by the antients for conveying heat to several remote parts of the house from one common furnace.

CALIPH, the supreme ecclesiastical dignity among the Saracens; or, as it is otherwise defined, a sovereign dignity among the Mahometans, vested with absolute authority in all matters relating both to religion and policy. It signifies in the Arabic, successor or vicar: the Saracen princes assumed this title as descendants from Mahomet; the caliphs bearing the same relation to Mahomet that the popes pretend they do to Jesus Christ, or St. Peter. It is at this day one of the grand signior's titles, as successor of Mahomet; and of the sophi of Persia, as successor of Ali.

CALIXTINS, in church history, a sect of Christians, in Bohemia and Moravia: the principal point in which they differed from the church, was the use of the chalice, or communicating in both kinds. It is also a name given to those, among the Lutherans, who follow the sentiments of George Calixtus, a celebrated divine, who opposed the opinion of St. Augustine on predestination, grace, and free-will.

CALLA, *African*, or *Ethiopian arum*, a genus of the polyandria order, in the gynandria class of plants, and in the natural method ranking under the second order, piperitæ. The spatha is plain; the spadix covered with florets; there is no calyx; no petals; and the berries are monospermous.

There are four species, the most beautiful of which is the calla Æthiopica. It is a native of the Cape, and requires the shelter of a greenhouse. It propagates very easily by offsets. It resembles the arum, but the flower, or rather the spathe, is white.

CALLICARPA, a genus of the class and order tetrandria monogynia. The essential character is, calyx four-cleft; corolla four-cleft; berry four-seeded.

There are seven species, trees and shrubs, of North America and the West Indies.

CALLICO, a kind of manufacture made of cotton. It takes its name from Callicut, a city on the coast of Malabar, where it was first manufactured. In the East Indies the callicoes are all painted by the hand, which is performed with great expedition. From these we derive our

CALLICO-*printing*, which is the art of communicating different colours to particular spots or figures on the surface of the cloth, while the other parts retain its original whiteness. This art, or rather that to which we have just referred, has been practised in India for more than 2000 years. But in London callico-printing was not introduced till about the year 1676, since which it has been encouraged by several acts of parliament.

This art consists in impregnating those parts of the cloth which are to receive a colour, with a mordant, and then dyeing it as usual with some dye-stuff or other. The dye-stuff attaches itself firmly only to that part of the cloth which has received the mordant. The whole surface of the cotton is indeed more or less tinged, but by washing, and bleaching it for some days on the grass with the wrong side uppermost, all the unmordanted parts resume their original colour, while those which have received the mordant retain it. Suppose that a piece of white cotton cloth is to receive red stripes; all the parts on which the stripes are to appear are pencilled over with a solution of acetite of alumina; after this, the cloth is dyed in the usual manner with madder. When taken out of the dyeing vessel, it is all of a red colour, but by washing and bleaching, the madder leaves every part of the cloth white, except the stripes impregnated with the acetite of alumina, which remain red. In the same manner may yellow stripes, or any other wished-for figure, be given to cloth, by substituting quercitron bark, weld, &c. for madder.

When different colours are to be given to different parts of the cloth at the same time, it is done by impregnating it with various mordants. Thus, if stripes are drawn upon a cotton cloth with acetite of alumina, and other stripes with acetite of iron, and the cloth afterwards dyed in the usual way with madder, and then washed and bleached, it will be striped *red* and *brown*. The same mordants with quercitron bark, give *yellow* and *olive*, or *drab*.

The mordants chiefly employed in callico-printing, are acetite of alumina, and acetite of iron. These mordants are applied to the cloth, either with a pencil, or by means of blocks, on which the pattern, according to which the cotton is to be printed, is cut. As they are applied only to particular parts of the cloth, care must be taken that none of them spread to the part of the cloth which is to be left white, and that they do not interfere with one another when several are applied. If these precautions are not attended to, all the elegance and beauty of the print must be destroyed. It is necessary, therefore, that the mordants should be of such a degree of consistence, that they will not spread beyond those parts of the cloth on which they are applied. This is done by thickening them with flour or starch, when they are to be applied by the block: and with gum-arabic, when they are to be put on by a pencil. The thickening should never be greater than is sufficient to prevent the spreading of the mordants; when carried too far, the cotton is apt not to be sufficiently saturated with the mordants; of course the dye takes but imperfectly.

In order that the parts of the cloth impregnated with mordants may be distinguished by their colour, it is usual to tinge the mordants with some colouring matter or other. The printers commonly use the decoction of Brazil-wood for this purpose; but Dr. Bancroft has objected to this method, because he thinks that the Brazil-wood colouring matter impedes the subsequent process of dyeing. It is certain that the colouring matter of the Brazil-wood is displaced, during that operation, by the superior affinity of the dye-stuff of the mordants. Was it not for this superior affinity, the colour would not take at all. Dr. Bancroft advises to colour the mordant

with some of the dye stuff afterwards to be applied; and he cautions the using of more for that purpose, than is sufficient to make the mordant distinguishable when applied to the cloth. The reason of this precaution is obvious. If too much dye is mixed with the mordant, a great proportion of the mordant will be combined with colouring matter, which must weaken its affinity for the cloth, and of course prevent it from combining with it in sufficient quantity to ensure a permanent dye.

Sometimes these two mordants are mixed together in different proportions; and sometimes one or both is mixed with an infusion of sumach, or of nut-galls. By these contrivances, a great variety of colours are produced by the same dye-stuff.

After the mordants have been applied, the cloth must be completely dried. It is proper for this purpose to employ artificial heat, which will contribute something towards the separation of the acetous acid from its base, and towards its evaporation, by which the mordant will combine in a greater proportion, and more intimately with the cloth.

When the cloth is sufficiently dried, it is to be washed with warm water and cow-dung, till all the flour, or gum, employed to thicken the mordants, and all those parts of the mordants which are uncombined with the cloth, are removed. The cow-dung serves to entangle these loose parts of the mordants, and to prevent them from combining with those parts of the cloth which are to remain white. After this, the cloth is thoroughly rinsed in clean water.

Almost the only dye stuffs employed by callico-printers, are indigo, madder, and quercitron bark, or weld. This last substance, however, is but little used by the printers of this country, except for delicate greenish yellows. The quercitron bark has almost superseded it, because it gives colours equally good, and is much cheaper and more convenient, not requiring so great a heat to fix it. Indigo, not requiring any mordant, is commonly applied at once, either with a block or a pencil. It is prepared by boiling together indigo and potash made caustic by quick-lime, and orpiment; the solution is afterwards thickened with gum. It must be carefully secluded from the air, otherwise the indigo would soon be regenerated, which would render the solution useless. Dr. Bancroft has proposed to substitute coarse brown sugar for orpiments: it is equally efficacious in decomposing the indigo, and rendering it soluble; while it likewise serves all the purposes of gum.

Let us now give an example or two of the manner in which the printers give particular colours to callicoes. Some callicoes are only printed of one colour, others have two, others three or more, even to the number of eight, ten, or twelve. The smaller the number of colours, the fewer in general are the processes.

1. One of the most common colours on cotton prints, is a kind of nankeen yellow of various shades down to a deep yellowish brown, or drab. It is usually in stripes or spots. To produce it, the printers besmear a block, cut out into the figure of the print, with acetite of iron, thickened with gum or flour; and apply it to the cotton, which, after being dried and cleaned in the usual manner, is plunged into a potash ley. The quantity of acetite of iron is always proportioned to the depth of the shade. 2. For yellow the block is besmeared with acetite of alumina. The cloth, after receiving this mordant, is dyed with quercitron bark, and then bleached. 3. Red is communicated by the same process; only madder is substituted for the bark. 4. The fine light blues which appear so often on printed cottons, are produced by applying to the cloth, a block besmeared with a composition, consisting partly of wax, which covers all those parts of the cloth which are to remain white. The cloth is then dyed in a cold indigo vat; and after it is dry, the wax composition is removed by hot water. 5. Lilac, flea brown, and blackish brown, are given by means of acetite of iron; the quantity of which is always proportioned to the depth of the shade. For very deep colours, a little sumach is added. The cotton is afterwards dyed in the usual manner with madder, and then bleached. 6. Dove-colour and drab, by acetite of iron, and quercitron bark.

When different colours are to appear in the same print, a greater number of operations are necessary. Two or more blocks are employed, upon each of which, that part of the print only is cut, which is to be of some particular colour. These are besmeared with different mordants and applied to the cloth, which is afterwards dyed as usual. Let us suppose, for instance, that these blocks are applied to cotton, one with acetite of alumina, another with acetite of iron, a third with a mixture of those two mordants, and that the cotton is then dyed with quercitron bark, and bleached. The parts impregnated with the mordants would have the following colours.

Acetite of alumine,	Yellow.
——— iron,	Olive, drab, dove.
The mixture,	Olive green, olive.

If part of the yellow is covered over with the indigo liquor, applied with a pencil, it will be converted into *green*. By the same liquid, blue may be given to such parts of the print as require it.

If the cotton is dyed with madder, instead of quercitron bark, the print will exhibit the following colours.

Acetite of alumine,	Red.
———-iron,	Brown, black.
The mixture,	Purple.

When a great number of colours are to appear; for instance, when those communicated by bark, and those by madder, are wanted at the same time, mordants for part of the pattern are to be applied; the cotton is then to be dyed in the madder bath, and bleached: then the rest of the mordants, to fill up the pattern, are added, and the cloth is again dyed with quercitron bark, and bleached. The second dyeing does not much affect the madder colours; because the mordants, which render them permanent, are already saturated. The yellow tinge is easily removed by the subsequent bleaching. Sometimes a new mordant is also applied to some of the madder colours, in consequence of which, they receive a new permanent colour from the bark. After the last bleaching, new colours may be added by means of the indigo liquor. The following table will give an idea of the colours, which may be given to cotton by these complicated processes.

I. *Madder dye.*

	Colours.
Acetite of alumine,	Red.
———-iron,	Brown, black.
———-diluted,	Lilac.
Both, mixed,	Purple.

II. *Bark dye.*

Acetite of alumine,	Yellow.
———-iron,	Dove, drab.
Lilac and acetite of alumine,	Olive.
Red and acetite of alumine,	Orange.

III. *Indigo dye.*

Indigo,	Blue.
Indigo and yellow,	Green.

Thus no less than 12 colours may be made to appear together in the same print, by these different processes.

These instances will serve to give the reader an idea of the nature of callico-printing, and at the same time afford an excellent illustration of the importance of mordants in dyeing.

If it was possible to procure colours sufficiently permanent, by applying them at once to the cloth by the block or the pencil, as is the case with the mordants, the art of callico printing would be brought to the greatest possible simplicity; but at present, this can only be done in one case, that of indigo; every other colour requires dyeing. Compositions, indeed, may be made, by previously combining the dye stuff and the mordants. Thus *yellow* may be applied at once, by employing a mixture of the infusion of quercitron bark and acetite of alumine; *red*, by mixing the same mordant with the decoction of alumine, and so on. The colours applied in this way are, unfortunately, far inferior in permanency to those produced when the mordant is previously combined with the cloth, and the dye stuff afterwards applied separately. In this way are applied almost all the fugitive colours of callicoes, which washing, or even exposure to the air, destroys. As the application of colours in this way cannot always be avoided by callico-printers, every method of rendering them more permanent is an object of importance.

CALLIGONUM, in botany, a genus of the polyandria digynia class of plants, having no flower; the fruit is an oval, compressed, striated, hairy pericarpium, with bifid tops, turning backwards; the seed is single. There are three species.

CALLISIA, in botany, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking under the 6th order, ensatæ. The calyx is triphyllous; the petals are three; the antheræ are double; and the capsule is biocular. There is but one species, a native of America.

CALLITRICHE, or *star-grass*, in botany, a genus of the digynia order, in the monandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. It has no calyx, but two petals, and the capsule is bilocular and tetraspermous. There are two species.

CALLUS, or *callosity*, any cutaneous, corneous, or osseous hardness, whether natural or preternatural: but most frequently it means the callus generated about the edges of a fracture, provided by nature to preserve the fractured bones, or divided parts, in the

situation in which they are replaced by the surgeon. See SURGERY.

CALODENDRUM, a genus of the class and order pentandria monogynia. The essential character is, calyx spreading, five-petalled; nect. five-leaved; capsule five-celled. There is one species, a native of the Cape.

CALOGERI, in church history, monks of the Greek church, divided into three degrees: the novices, called archari; the ordinary professed, called microchemi; and the more perfect, called megalochemi: they are likewise divided into cœnobites, anchorets, and recluses. The cœnobites are employed in reciting their office from midnight to sunset. The anchorets retire from the conversation of the world, and live in hermitages, in the neighbourhood of the monasteries; they cultivate a little spot of ground, and never go out but on Sundays and holidays to perform their devotions at the next monastery. As for the recluse, they shut themselves up in grottoes and caverns, on the tops of mountains, from which they never go out, abandoning themselves entirely to Providence. They live on the alms sent them by the neighbouring monasteries.

CALOMEL. See MATERIA MEDICA.

CALOPHYLLUM, in botany, a genus of the polyandria monogynia class of plants, whose corolla consists of four roundish, hollow, patent petals, and is larger than the cup; the fruit is a large globose drupe. There are two species.

CALORIC, a word used to denote that substance by which the phenomena of heat are produced.

Philosophers formerly differed in opinion respecting the causes of those phenomena; and there were many who considered them merely as the effect of the mechanical changes of bodies, and some even admitted an active principle of cold. At present, however, it is almost unanimously agreed, that these effects are produced by a peculiar matter which has received the name of caloric; and which, in general, enables us to explain those appearances fully, and in a satisfactory manner. Caloric is an unconfinable fluid, highly elastic, and so very subtle that its gravity has not yet been ascertained. It is diffused through all natural bodies, with which it is more or less combined, according as their affinities for it are greater or less. We are not acquainted with any body that does not enter into combination with it; nor any from which the utmost endeavours could entirely separate it: and caloric, therefore, is not to be had in a pure state in nature: hence chemists, when mentioning the constituent parts of bodies, pay no regard to the presence of caloric, but consider it as understood of course. All bodies are combined in some way with a certain portion of caloric; or, to express it in other words, the particles of every substance are intermixed in a variable proportion with the particles of caloric, and kept probably apart by them. Hence the elementary particles of bodies do not, in fact, touch each other; and this is manifest from the property which all bodies possess, of being contracted into a lesser volume when deprived of heat. See PYROMETER.

Caloric, being a substance perfectly elastic, whose component particles would expand ad infinitum if not impeded, all bodies combined with them ought likewise to expand ad infinitum, if there existed no power which acted in direct opposition to its elasticity. This power is the mutual attraction of the particles, or cohesion. All material bodies, therefore, are continually acted upon by two powers, which tend more or less to equipoise each other; one causes the particles of bodies to recede from each other, and by the other they tend to approximate.

The proportion of each of these powers determines the exterior form of bodies. If cohesion predominates, then the bodies are solid; but if this power be overcome, then the particles are further removed, and their volume is proportionally increased. Finally, if caloric predominates to such a degree that the particles of bodies are placed out of the sphere of their reciprocal attraction, they lose their aggregation, and appear no longer in the form of solids, but become liquid or gaseous.

But if there existed no other power but the two already mentioned, bodies would not remain liquid; for, on increasing the heat, they would immediately pass from the solid to the aeriform, or gaseous state. But there is a third power, which, by acting at the same time, preserves them in an intermediate or liquid state. This power is the pressure of the atmosphere, without which there would be no liquid in nature, for all bodies would be either solid or aeriform. Hence all bodies, from their combination with caloric, may exist in three different states, which result from, 1. The power of attraction by which bodies cohere. 2. The quantity of caloric with which the substance is combined. 3. The greater or less pressure of the atmosphere.

The means by which a solid body may be changed into a liquid are, therefore: 1. A combination with a new and sufficient quantity of caloric, and 2. An union with another body already liquid. The operation by which a body is rendered liquid, according to the first method, is termed fusion, the theory of which is clear from what has been advanced. In the second case, a body becomes liquid, if the quantity of caloric, in the liquid body added, be sufficient to remove the elementary particles of the new compound, to such a distance as will enable them to move freely in all directions.

A liquid body is rendered solid, 1. By the loss of a portion of its caloric. 2. By combining it with another solid body. In the former case, a body parts with that portion of caloric whereby it overcame the repelling force of the molecules, which now approach nearer to each other; so that they are again acted upon by cohesion. This change of bodies is termed congelation. In the latter case, the compound body becomes solid, if the caloric, present in the liquid, be not sufficient to prevent the attraction of the constituent particles of the new body, so as to cause it to be acted upon by cohesion.

A liquid is changed into the state of gas, 1. By being combined with a quantity of caloric sufficient to equipoise the pressure of the atmosphere. 2. If the pressure of the atmosphere is either sufficiently diminished, or totally removed.

A gas becomes liquid, 1. By the loss of that superabundant portion of caloric which resisted the pressure of the atmosphere. 2. By sufficiently increasing that pressure. Hence, in every elastic fluid, two principal objects are to be considered: first, the caloric which gives its exterior form, viz. that of gas. Secondly, the body dissolved by the caloric, and by which the peculiar chemical properties of the gas are determined. This latter is generally termed the base, which we must be cautious not to confound with the gas itself.

Caloric continually tends to form an equilibrium. Hence it is, that, if two bodies of the same nature (for instance, two pieces of the same metal) be unequally heated, or imbued with different portions of caloric, and brought into contact with each other, the caloric equally diffuses itself throughout the two bodies; and the quantities of caloric, in each body, will bear the same proportion to each other as the masses themselves. But, supposing the two bodies to be of a different kind, in that case, though the caloric would also form an equilibrium, and each body would indicate the same temperature to the thermometer, yet the proportions of caloric in each body, will not be as the masses, but will vary according as the bodies differ. This property of bodies, to require different quantities of caloric to indicate the same temperature to the thermometer, was termed by Dr. Black, the capacity of a body for heat; but the quantity of caloric itself he called specific heat. The cause of this phenomenon arises from the different degrees of affinity which different bodies possess for caloric, and from which the capacities, and various points of saturation, of different bodies may be estimated.

When any body is in equilibrio with the bodies which surround it, with respect to its caloric, that quantity which it contains is not perceptible by any external sign or organ of sense, and is termed combined caloric, or, according to Black, latent heat. But, if the latent heat, from any cause, is forced, in some degree, to quit a body, and to combine with those that surround it, then such caloric is said to be free or sensible until the equilibrium is restored.

It is this caloric in a free state which acts upon our organs, and excites that sensation which we term warmth; and it is this alone which we can ascertain by the thermometer. The temperature of a body is, therefore, the termination of the rarefaction of the mercury, at the instant when its caloric has established an equilibrium with that of the body.

The equilibrium of caloric is destroyed by the following causes: 1. A change of the capacities in bodies by chemical analysis or synthesis. 2. External mechanical pressure. As to the former, the reason of the separation or addition of caloric is to be sought for from the general laws of chemical composition, viz. that a compound body possesses properties different from its constituent parts. Hence the capacity of the compound body is not always a mean between the sum of the capacities of its constituent parts, but is oftentimes greater or less; and, on account of this greater or less capacity of a compound body, caloric, at the moment the constituent parts unite, is either expelled or attracted from surrounding bodies. In the former case, the temperature of the surrounding bodies is increased, in the latter it is diminished. When a body, whose temperature has been

raised, comes into contact with several other bodies of lower temperatures, then the caloric endeavours to form an equilibrium; and that of the first body, because it is this especially, which causes a change in the equilibrium, diffuses itself throughout the second, and thence throughout the third, and so in succession till all their temperatures are equal. The intermediate bodies, through which caloric permeates, are called conductors of heat; and, as they convey it more or less quickly, they are said to be good or bad conductors. All bodies possess the property of communicating caloric, but according to different degrees, being hence termed good or bad conductors. Hitherto we know of but one exception, which is in congealed water or ice. This body imbibes all the caloric which it receives from other bodies; nor does it communicate the least quantity to such as lie contiguous to it, until the quantity of caloric it has absorbed has rendered it liquid. The water produced follows again the general law, and becomes a conductor of heat. Therefore, if a body of a certain temperature is brought into contact with ice, it will impart to the ice its own caloric, till it has descended to the temperature of the ice itself; and we shall see that only as much of the ice returns to the state of water as the caloric, which it had imbibed, could liquefy. This, however, is that portion of caloric, which had raised the body from the temperature of the ice to that which it possessed previously to the experiment, and which we have denominated specific heat. Moreover, since equal quantities of caloric ought to liquefy equal quantities of ice, it follows, that the specific heat of bodies, under like circumstances, is in a direct ratio of the quantities of ice which they can liquefy when brought into contact.

From the foregoing observations we may draw the following conclusions:

1. If equal quantities of the same body, at the same temperature, come severally into contact with ice, then equal quantities of ice will be changed into the liquid state of water, and such bodies will descend to the temperature of the ice.

2. If unequal quantities of the same body is treated in a similar manner, then the quantities of the ice liquefied will be in a direct ratio of the quantities of the body.

3. But, if equal quantities of different bodies are treated in this way, then the quantities of the ice liquefied will be in a direct ratio of the quantities of caloric which those bodies have lost; or, in other words, they will be in a direct ratio of the quantities of caloric which caused those bodies to ascend from the temperature of the ice to that which they possessed at the beginning of the experiment: and therefore, as the masses of the bodies were equal, they will be in a direct ratio of their specific heat, and in a direct ratio of their own capacities for caloric.

These experiments not only demonstrate, that different bodies, in reality, possess different capacities for caloric; but they likewise shew us the means by which we are enabled to measure the relative quantities which they contain.

Heat and cold, with respect to our senses, are distinguished by those perceptions which are the effect either of an augmentation, or diminution of caloric, in the animal body, whenever we approach an object whose temperature is either higher or lower than that which we ourselves possess. But the perception is always modified by the state of the organs, and the temperature they have been before exposed to. Hence not only one person shall feel cold, another warm, in the same atmosphere; but if we plunge our hands for some time, the one into hot, the other into cold water, and suddenly transfer them both into water of the heat of the blood, the same water will distinctly impress on our perceptions both heat and cold. It follows, that our perceptions are not a just criterion of the state of bodies as to their temperature.

Incandescence and flame are observed in the rapid disengagement of caloric and light. The first effect of this disengagement is inflammation; and these phenomena, taken collectively, excite in us that idea which is expressed by the word fire.

Among the various states of heat, it is necessary that we should consider caloric in two points of view. First, as it elevates bodies above the temperature of the surrounding medium, where it is known by the term sensible heat, and which we can measure either by a common thermometer or by Wedgewood's pyrometer. Secondly, the whole quantity of caloric existing in a body in chemical union, where it is known by the term absolute heat, the quantity of which is ascertained by the calorimeter of La Place. From the principal laws which caloric follows in its combination with other bodies, and from the properties already recited, many phenomena may be explained which occur in the chemical solution of bodies, and in which caloric is the principal agent. Thus: 1. Why two solid bodies cannot mutually dissolve each other; and why it is necessary, for that purpose, that one of them, at least, should be in a fluid state. 2. Why, in most combinations of solids with fluids, caloric promotes solution. 3. Why the contrary happens in solutions of aeriform bodies in liquids. 4. Why the combination of two solid or two fluid bodies, or the combination of one fluid with one solid, produces a body which is either solid or fluid. 5. What phenomena ought to be produced as to volume, specific gravity, and temperatures.

CALOTTE, in architecture, a round cavity or depressure, in form of a cap or cup, lathed and plaistered, used to diminish the rise or elevation of a moderate chapel, cabinet, alcove, &c. which, without such an expedient, would be too high for other pieces of the apartment.

CALTHA, *marsh-marygold*, in botany, a genus of the polyandria polygynia class of plants, and in the natural method ranking under the 26th order, multisiliquæ. There is no calyx; there are five petals; no nectaria; the capsules are many, and polyspermous. There is only one species known, which grows naturally in moist boggy lands in many parts of England. There is a variety with double flowers, which for its beauty is preserved in gardens. It is propagated by parting the roots in autumn. Upon May-day the country people strew the flowers upon the pavement before their doors. Goats and sheep eat this plant; horses, cows, and swine, refuse it.

CALVARY, in heraldry, a cross so called because it resembles the cross on which our Saviour suffered.

CALVINISTS, in church history, those who follow the opinions of John Calvin, one of the principal reformers of the church in the 16th century, a person of great parts and industry, and of considerable learning; whose doctrine still subsists in its greatest purity at Geneva, where it was first introduced, and whence it was propagated. The Calvinists are great advocates for the absoluteness of God's decrees; and hold that election and reprobation depend on the mere will of God, without any regard to the merit or demerit of mankind; that he affords to the elect an irresistible grace, a faith that they cannot lose, which takes away the freedom of will, and necessitates all their actions to virtue. The Calvinists believe that God foreknew a determinate number, in whom he would manifest his glory; and that having thus foreknown them, he predestinated them to be holy, in order to which he gives them an irresistible grace, which makes it impossible for them to be otherwise.

CALYCANTHUS, in botany, a genus of the polygynia order, in the icosandria class of plants, and in the natural method ranked among the plantæ dubii ordinis. The calyx is monophyllous, pitcher-form, squarrose, with small coloured leaves, the corolla consisting of the leaves on the calyx; the styles are numerous, each with a glandular stigma; the seeds are many, each with a train, within a succulent calyx. There are two species, viz.

1. Calycanthus floridus, or Carolina allspice tree, a native of Carolina. It seldom grows, at least with us, to more than five feet high. It divides into many branches irregularly near the ground. It is of a brown colour; and when bruised emits a most agreeable odour. The leaves that garnish this delightful aromatic are of an oval figure. At the end of these stand the flowers, of a kind of chocolate purple colour. The propagation of this shrub is not very difficult; though more than common care must be taken, after small plants are obtained, to preserve them till they are of a size to be ventured abroad. The last year's shoots, if laid in the ground, the bark being a little bruised, will strike root within a year, particularly if the layers are shaded, and watered in summer.

2. C. præcox is not yet inured to our climate.

CALYPTRA. Most of the mosses have calyptræ. See BOTANY.

CALYPTRANTHES, a genus of the icosandria monogynia class and order. The essential character is, calyx superior, truncate, covered with a veil-shaped rib; corolla none; berry one-celled, one to four seeded.

There are six species, trees and shrubs of the West Indies.

CALYX, among botanists, a general term expressing the cup of a flower, or that part of a plant which surrounds and supports the other parts of the flower. See BOTANY.

CAMÆA, in natural history, a genus of the semipellucid gems, approaching to the onyx structure, being composed of zones, and formed on a crystalline basis; but having the zones very broad and thick, and laid alternately on one another, with no common matter between; usually less transparent,

and more debased with earth, than the onyxes.

1. One species of the camæa is the dull-looking onyx, with broad black and white zones; and is the camæa of the moderns, and the Arabian onyx: this species is found in Egypt, Arabia, Persia, and the East Indies. 2. Another species of the camæa is the dull, broad-zoned, green and white camæa, or the jaspi-cameo of the Italians: it is found in the East Indies, and in some parts of America. 3. The third is the hard camæa, with broad white and chesnut-coloured veins. 4. The hard camæa, with bluish, white, and flesh-coloured broad veins, being the sardonyx of Pliny's time, only brought from the East Indies.

CAMALDULIANS, a religious order founded by St. Romuald, in a little plain, on the mount Apennine, called Camaldali, situated in the state of Florence.

The manner of life first enjoined this order was, that they dwelt in separate cells, and met together only at the time of prayer: some of them, during the two Lents of the year, observed an inviolable silence; and others for the space of a hundred days. On Sundays and Thursdays they fed on herbs, and the rest of the week only on bread and water. These constitutions were, however, a little moderated some time afterwards. This hermitage is now accounted very opulent.

CAMAX, in botany, a genus of the class and order pentandria monogynia. The essential character is, corolla wheel-shaped; filaments inserted between the segments of the corolla; berry four-celled, many-seeded.

There is one species, a native of Guiana.

CAMBER-BEAM, among builders, a piece of timber in an edifice, cut archwise, or with an obtuse angle in the middle, commonly used in platforms, as church-leads, and on other occasions where long and strong beams are required.

CAMBLET, or *camlet*, a plain stuff, composed of a warp and woof, which is manufactured on a loom, with two treadles, as linens are. There are camblets of several sorts: some of goat's hair, both in the warp and woof; others, in which the warp is of hair, and the woof half hair and half silk; others again, in which both the warp and the woof are of wool; and lastly, some of which the warp is of wool and the woof of thread; some are striped, some waved or watered, and some figured.

CAMBOGIA, in botany, a genus of the monogynia order in the polyandria class of plants, and in the natural method ranking under the 39th order, tricoccæ. The corolla is tetrapetalous; the calyx tetraphyllous; and the fruit is a pome with eight cells, and solitary seeds. There is but one species, viz.

Cambogia gutta, a native of India. It yields the gum-resin known by the name of gamboge.

CAMBRICS, a species of very fine white linen, made of flax at Cambray.

Of so much repute are French cambrics, that for many years more than 200,000*l.* per annum was expended in them by the inhabitants of this country. Parliament interfered, and the wearing and selling of foreign cambrics are prohibited under heavy penalties. The cambrics now allowed in this country are chiefly manufactured in Scotland and Ireland.

CAMELLIA, in botany, a genus of the monadelphia polyandria class, and in the natural method ranking under the 37th order, columniferæ. The calyx is imbricated and polyphyllous, with the interior leaves larger than the exterior. There are three species, natives of China and Japan. Thunberg, in his Flora Japonica, describes it as growing every where in the groves and gardens of Japan; where it becomes a prodigiously large and tall tree, highly esteemed by the natives for the elegance of its large and very variable blossoms, and its evergreen leaves. It is there found with single and double flowers, white, red, and purple, produced from April to October. Representations of this flower are frequently met with in Chinese paintings. With us the camellia is generally treated as a greenhouse plant, and propagated by layers. At some future time it may, perhaps, not be uncommon to treat it as a laurustinus or magnolia: the high price at which it has hitherto been sold, has probably prevented its being hazarded in this way. The blossoms are of a firm texture, but apt to fall off long before they have lost their brilliancy.

CAMELOPARDALIS, a genus of the order of pecora. The generic character is; horns permanent, bony, covered with a bristly skin; front teeth in the lower jaw eight; the exterior one on each side deeply bilobate. If height alone constituted precedency among quadrupeds, the giraffe, or camelopardalis, (see Plate Nat. Hist. fig. 77) would undoubtedly claim the first rank; measuring, when full-grown, near seventeen feet from the top of the head to the fore feet. The female, however, is lower than the male, and the measure abovementioned must be understood to relate to the animal when arrived at the utmost limits of its tallest growth, the generality of those described by travellers not exceeding fifteen or sixteen feet. Notwithstanding the unusual proportions of this animal, its general form is in the highest degree elegant and picturesque: the head being small, the aspect mild, the neck extremely long and tapering; the fore parts much higher than the hinder; and the disposition of the colours singular and pleasing. At first view, the fore legs seem nearly twice the length of the hind; but this difference, on accurate examination, appears to result chiefly from the extraordinary height of the shoulders, compared with that of the thighs.

The horns of the camelopardalis differ in texture from those of all other horned quadrupeds, forming a part of the skull, and consisting of a porous bony substance, covered externally with short coarse bristly hair: they terminate abruptly, in a flattish or slightly convex head, but little wider than the other part of the horn, and edged with stiff bristles all round the outline. On the middle of the forehead rises a considerable protuberance, owing to an elevation or bony rising on that part of the skull. From the head to the middle of the back runs a short stiffish mane. The tail is of moderate length, and of a cylindrical form, gradually tapering towards the end, and terminating in a tuft of long hair. The hoofs are moderately large and black. The fore part of the body is very thick and muscular, and the hind part thin and meagre. The ground colour of the animal is whitish, variegated on all parts with numerous, moderately large, and somewhat squarish spots; which in the male are brown, and in the female ferruginous. In the younger animals they are sometimes of a bright reddish yellow. These marks or spots are of a somewhat less regular shape on the sides than on the neck and shoulders.

The camelopardalis is a native of Ethiopia, and some other parts of Africa; where it is chiefly found in forests, living on herbage of various kinds, but principally on the foliage of trees, and particularly on some species of mimosa. When grazing on the surface of the ground, it is observed to spread its fore legs very considerably, in order to enable it to reach the ground with greater facility. It is an animal of a mild and harmless disposition, and when attacked, endeavours merely to save itself by flight; running with great swiftness, though in a somewhat peculiar and awkward style, on account of the length of its neck, and breadth of its fore parts compared with the hind.

The male and female camelopardalis resemble each other when young: but as the animal advances in age, the spots on the male become dark brown, while those of the female continue of a ferruginous cast. In both, however, some occasional differences of shade take place; and the female, when very old, is said to acquire the dusky shades of the male. The female has also a less conspicuous tubercle on the forehead, and has four teats, as in a cow.

These animals are sometimes seen in small groupes, to the number of six or seven together, and when disturbed run off with great celerity. When seen in front, at some little distance, the animal might be mistaken for a decayed tree, and thus be easily passed by without particular notice.

CAMELOPARDALIS, in astronomy, a new constellation of the northern hemisphere, formed by Hevelius, consisting of 32 stars, first observed by him, situated between Cepheus, Cassiopeia, Perseus, the two Bears, and Draco. It contains about 58 stars in the British catalogue.

CAMELUS, *camel*, a genus of quadrupeds of the order of pecora. The generic character is, horns none; front teeth in the lower jaw six, somewhat thin and broad; canine teeth distant, in the upper jaw three, in the lower two; upper lip divided. There are seven species.

1. C. dromedarius, Arabian camel, or dromedary, is found in the warmer parts of Asia, and in the upper regions of Africa. In Asia it is said not to be found farther north than Persia, and in Africa not farther south than Ethiopia. It is common in most parts of India. See Plate Nat. Hist. fig. 74.

The general height of the Arabian camel, measured from the top of the dorsal bunch to the ground, is about six feet and a half; but from the top of the head, when the animal elevates it, not much less than nine feet: the head, however, is generally so carried as to be nearly on a level with the bunch, or rather below it, the animal bending the neck extremely in its general posture: the head is small, the neck very long, the body of a long and meagre shape, the legs rather slender, and the tail, which is slightly tufted at the end, reaches to the joints of the hind legs; the feet are very large, and are hoofed in a peculiar style, being divided above into two

lobes not reaching through the whole length of the foot, and the extremity of each lobe is guarded by a small hoof; the under part of the foot is covered with an extremely strong, tough, and pliable skin, which, by yielding in all directions, enables the animal to travel with peculiar ease and security over dry, stony, and sandy regions. On each leg are six callosities. On the lower part of the breast is also a large callus or tough tubercle, which is gradually increased by the constant habit which the animal has of resting upon it in lying down. It is distinguished from the succeeding species by having a single large bunch on the back.

The general colour of the camel is an uniform dusky brown, more or less tinged with ferruginous. Its hair is fine and soft, and serves for the basis of several kinds of stuffs.

There are several varieties of this animal, differing in size, strength, &c. analogous to the different breeds of horses.

2. C. Bactrianus, Bactrian camel, in its general appearance so much resembles the Arabian, that it might rather seem a permanent variety of that animal than a distinct species; differing only in being somewhat larger, and in having two bunches on the back instead of one. It is said to be found wild in the northern parts of India, and in the deserts bordering on China, and is more esteemed for swiftness than the Arabian camel. See Plate Nat. Hist. fig. 73.

In Arabia it is kept chiefly for the use of the great, being not a native of that country, but imported from India, &c. Of this animal, as well as of the Arabian camel, there are several races or varieties, differing, like those of horses, in strength, size, swiftness, and elegance of form. A breed of peculiar swiftness is said to be reared in China, and to be distinguished by the expressive title of *fong kyo fo*, or camels with feet of wind. A white variety occurs in some parts of Siberia; and lastly, a hybrid or mixed breed is said to be occasionally obtained between the Bactrian and the Arabian camel.

3. Camelus glama. This animal, described by some of the old naturalists under the name of ovis Peruviana, or Peruvian sheep, is a native of South America, and is particularly plentiful in Peru, where it inhabits, in a wild state, the highest and coldest parts of mountains, feeding in numerous herds, and flying with great rapidity on the sight of mankind. It was, however, completely subdued and domesticated by the antient Peruvians, being the only beast of burthen known to that people, to whom it answered the same purposes as the camel and dromedary in the eastern regions of the old continent. The general size of the glama is nearly that of a stag; measuring about four feet and a half in height to the top of the shoulders, and about six feet in length from nose to tail. The neck is a great length; the head small; the back slightly elevated, and the whole animal bears some resemblance to a camel on a smaller scale. Its general colour is a light ferruginous brown, paler or whitish on the under parts; and sometimes it is said to be varied or patched with darker and lighter shades on different parts, and to have a black stripe running down the back to the beginning of the tail. See Plate Nat. Hist. fig. 75.

The voice of the glama resembles the shrill neighing of a horse. When angry or attacked, it strikes with its feet, and endeavours to bite. The glama is said to be able to carry a burthen of about a hundred and fifty pounds weight, and to travel at the rate of three German miles a day for three or four days together. When resting, it leans on its breast in the manner of the camel, which it also resembles in the faculty of abstaining long from drink, sometimes four or five days; and, like that animal, may be supported by very coarse and trifling food. Its flesh is said to resemble mutton in flavour.

4. Camelus vicuna. The vicuna bears a general resemblance to the glama; but is of a lighter and more delicate aspect, and of smaller size; the head is smaller and shorter in proportion; the eyes remarkably large and full; the ears somewhat sharper, and the limbs more slender. The hair of this animal is of a very soft, wavy, and woolly nature; that on the breast is nearly three inches long, on the other parts not more than one inch; the end of the tail is furnished, like the breast, with long woolly hair. See Plate Nat. Hist. fig. 76.

The vicuna affords the finest wool of any, and it is wrought into cloths of most exquisite silky softness and beauty, which are said to be too warm for common wear, unless made peculiarly thin.

The vicuna, as well as the paco or next species, is sometimes taken by the Peruvians by the simple artifice of tying cords, with bits of wool or cloth fixed to them at certain distances, at three or four feet from the ground, across the narrow passes of the mountains; and when the animals have been hunted or driven that way, they are so terrified by the fluttering of the rags, that, instead of attempting to pass, they huddle together in heaps, and thus afford their pursuers an opportunity of killing with their slings as many as they please.

5. Camelus paco. This species is said to be entirely confined to Peru, where the natives keep vast flocks of them for the sake of the wool, of which they prepare cloth of silky lustre and softness. Like the vicuna, it is found in mountainous districts in large herds, but is never observed to associate with those animals. It is of a more robust make than the vicuna, and is covered with very long wool; which is, in the wild animal, of a dull purple colour, resembling that of dried rose-leaves, but in the domesticated kind is often varied with black, white, and rufous; the belly is white. Like the two preceding species, it has sometimes been named the Peruvian sheep. Those concretions, known by the name of bezoars, are often found in the stomach of this as well as of other species.

6. Camelus huanacus, or the guanaco, is a native of Peru, and is found in similar situations with the glama and the paco. It is the largest of all the Peruvian animals of this kind, and is said sometimes to grow to the size of a horse. Its back is pretty much arched; and it is covered not with wool like the other smaller species, but with long smooth hair; the head is round, the nose somewhat pointed, the ears straight like those of a horse, and the tail short and turning upwards. It appears to be more nearly allied to the glama than to any other species, but is said never to associate with that animal. Its general colour is tawny above and white below.

7. Camelus arucanus. This species, which inhabits Peru and Chili, is described as measuring about six feet in length, and about four in height. It is covered with woolly hair, and in its general appearance is not unlike a ram. The ears are flaccid or pendulous, the neck and legs long; the tail like that of a sheep, but shorter in proportion: the wool is very soft, and the colour of the animal is said to vary in different individuals, being either brown, black, ash-coloured, or white. This animal was employed by the antient inhabitants of Chili as a beast of burthen, as well as in ploughing. Its wool was also used in the manufacture of a fine silky cloth or stuff; but this is now said to have given place to the introduction of European wool, as being stronger and more serviceable.

CAMEO. See CAMEA.

CAMERA OBSCURA. See OPTICS.

CAMERARIA, in botany, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 30th order, contortæ. There are two horizontal follicles at the base of the seed-case. The seeds are inserted into a proper membrane. There are two species, viz.

1. Cameraria angustifolia, has an irregular shrubby stalk, which rises about eight feet. The flowers are produced scatteringly at the end of the branches, which are shaped like those of the latifolia, but smaller. It is a native of Jamaica.

2. Cameraria latifolia, a native of the island of Cuba. It rises with a shrubby stalk to 10 or 12 feet, dividing into several branches, with roundish-pointed leaves placed opposite. The flowers are produced at the end of the branches in loose clusters, which have long tubes enlarging gradually upward; and at the top are cut into five segments, broad at their base, but ending in sharp points: the flower is of a yellowish white colour.

CAMERLINGO, according to Ducange, signified formerly the pope's or emperor's treasurer: at present, camerlingo is no where used but at Rome, where it denotes the cardinal who governs the ecclesiastical state, and administers justice.

CAMERONIANS, a party of presbyterians, which sprung up in Scotland in the reign of king Charles II. They affirmed that the king had forfeited his right to the crown, by breaking the solemn league and covenant, which were the terms on which he received it. They pretended both to dethrone and excommunicate him, and broke out into open rebellion. Upon the Revolution they were reconciled to the kirk, and their preachers submitted to the general assembly of the church of Scotland in 1690.

CAMP, in military affairs, is the whole extent of ground, in general, occupied by an army pitching its tents when in the field, and upon which all its baggage and apparatus are lodged. It is marked out by the quarter-master-general, who allots every regiment its ground. The extent of the front of a regiment of infantry is 200 yards, including the two battalion guns, and depth 320, when the regiment contains 9 companies, each of 100 private men, and the companies' tents in two rows; but when the companies' tents stand in one row, and but 70 private men to each row, the front is then but 155 yards. A squadron

of horse has 120 yards in front, and 100 for an interval between each regiment.

The nature of the ground must also be consulted, both for defence against the enemy, and for supplies to the army. It should have a communication with the army's garrisons; and have plenty of water, forage, fuel; and either rivers, marshes, hills, or woods, to cover it. An army always encamps fronting the enemy, and generally in two parallel lines, besides a corps de reserve, about 500 yards distant from each other; the horse and dragoons on the wings, and the foot in the centre. Each regiment posts a subaltern's guard at 80 yards from the colours to the officer's tent, called the quarter-guard, besides a corporal's guard in the rear; and each regiment of horse or dragoons, a small guard on foot, called the standard-guard, at the same distance. The grand guard of the army consists of horse, and is posted about a mile distant towards the enemy.

In a siege, the camp is placed all along the line of circumvallation, or rather in the rear of the approaches, out of cannon-shot: the army faces the circumvallation, if there is any; that is, the soldiers have the town in their rear. One thing very essential in the establishing a camp, and which should be particularly attended to if the enemy is near, is, that there should not only be a commodious spot of ground at the head of the camp, where the army, in case of surprize, may in a moment be under arms, and in condition to repulse the enemy; but also a convenient field of battle at a small distance, and of a sufficient extent for them to form advantageously, and to move with facility.

The arrangement of the tents in camp, is nearly the same all over Europe; which is, to dispose them in such a manner, that the troops may form with safety and expedition. To answer this end, the troops are encamped in the same order as that in which they are to engage, which is by battalions and squadrons; hence, the post of each battalion and squadron in the line of battle, must necessarily be at the head of its own encampment. Gustavus Adolphus, king of Sweden, was the first who formed encampments according to the order of battle. By this disposition, the extent of the camp from right to left, of each battalion and squadron, will be equal to the front of each in line of battle; and consequently, the extent from right to left of the whole camp, should be equal to the front of the whole army when drawn up in line of battle, with the same intervals between the several encampments of the battalions and squadrons, as are in the line. There is no fixed rule for the intervals. The most general method is, an interval of 60 feet between each battalion, and of 36 feet between each squadron.

Hence it follows, 1st, That the front line of the camp must be in a direction to face the enemy; 2dly, That at the head of the encampment of each battalion and squadron, there must be a clear space of ground, on which they may form in line of battle; and, 3dly, That when the space taken up by the army is embarrased with woods, ditches, and other obstructions, a communication must be opened for the troops to move with ease to the assistance of each other.

The tents for the cavalry, as well as for the infantry, are placed in rows perpendicular to the principal front of the camp; and their number is conformable to the number of troops. The horses of each troop are placed in a line parallel to the tents, with their heads towards them. The number of tents in each row, is regulated by the strength of the troops, and the number of troopers allotted to each tent is 5; it follows, that a troop of 30 men will require six tents, a troop of 60 men 12 tents, and a troop of 100 men 20 tents. The tents of the cavalry are of the same form as those of the infantry; but more spacious, the better to contain the fire-arms, accoutrements, saddles, bridles, boots, &c.

CAMPAIGN, in the art of war, denotes the space of time that an army keeps the field, or is encamped, in opposition to quarters.

CAMPANIFORM, or *campanulated*, an appellation given to flowers resembling a bell; a characteristic whereon Tournefort establishes one of his classes of plants. See BOTANY.

CAMPANINI, a name given to a marble of Italy, dug out of the mountains of Carrara; because, when it is worked, it resounds like a bell.

CAMPANULA, the *bell-flower*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 29th order, campanaceæ. The corolla is campanulated, with its fundus closed up by the valves that support the stamina; the stigma is trifid; the capsule inferior, or below the receptacle of the flower, opening and emitting the seeds by lateral pores. Of this genus there are no fewer than 78 species, but the following are the most worthy of attention:

1. Campanula canariensis, with an orach leaf and tuberous root, is a native of the Canary islands. It has a thick fleshy root of an irregular form; the leaves are of a sea-green, and when they first come out are covered slightly with an ash-coloured pounce; the flowers are the perfect bell-shape, and hang downwards; they are of a flame-colour, marked with stripes of a brownish red.

2. Campanula decurrens, the peach-leaved bell-flower, is a native of the northern parts of Europe: of this there are some with white, and some with blue flowers, and some with double flowers of both colours.

3. Campanula hybrida, or Venus's looking-glass, seldom rises more than six inches; the branches are produced, which are terminated by flowers very like the speculum. This was formerly cultivated in the gardens; but since the speculum has been introduced, it has almost supplanted this.

4. Campanula latifolia, or greatest bell-flower, has a perennial root, and several strong, round, single stalks. The flowers come out singly upon short footstalks; their colours are blue, purple, and white.

5. Campanula medium, the Canterbury bell-flower, is a biennial plant, which perishes soon after it has ripened its seeds. It is well known.

6. Campanula pyramidalis, has thick tuberous roots; it sends out strong, smooth, upright stalks, which rise to the height of 4 feet. The flowers are produced from the sides of the stalks, and are regularly set on for more than half their length, forming a sort of pyramid. The most common colour of the flowers is blue, though some are white.

7. Campanula rapunculus, the rampion, has roundish fleshy roots, which are eatable, and much cultivated in France for sallads; some years past, it was cultivated in the English gardens for the same purpose, but is now generally neglected.

8. Campanula speculum, with yellow eye-bright leaves, is an annual plant with slender stalks rising a foot; from the wings of the leaves come out the flowers sitting close to the stalks, which are of a beautiful purple inclining to a violet colour.

9. Campanula trachelium, with nettle leaves, has a perennial root, and stiff hairy stalks: the flowers are blue and white; some have double flowers.

CAMPHOR. The laurus camphoratus is a tree which grows in China, Japan, and several parts of India.

The wood and roots being boiled with water, the camphor rises with the steam, and is condensed (in straw placed in the capital, &c. of the still) in small granular crystals, together with another sort, apparently scraped from the cavities of the wood, and mixed with sand, ashes, &c. and purified by a second sublimation by the English and Dutch chemists. This operation is performed in shallow matrasses, technically termed *bumbelois*, on a sand heat. The camphor melts at 360 degrees, boils and sublimes solid and transparent. Its vapour is so heavy, that very little escapes, though the mouth is open. It is volatile at all temperatures, and exhales in toto when exposed. It is crystallisable either by cooling when melted, by sublimation at a low heat, or from its solvents, at an angle of 60 degrees: hence it forms figures like those of ice.

Its solvents are alcohol, acids (especially the mineral), essential and fat oils. From all solvents but the two latter it is separable, unchanged by water. Its specific gravity is 0.9887. Hence it just floats on water, but sinks readily in spirits. Small thin cuttings thrown on clean warm water are affected with a strong rotatory motion till an oily film has overspread the surface, when it ceases.

It is transparent as glass when pure and newly sublimed, and is highly refractive. It catches flame very readily, and emits a great deal of flame as it burns, but it leaves no residuum. It is so inflammable that it continues to burn even on the surface of water. When camphor is set on fire in a large glass globe filled with oxygen gas, and containing a little water, it burns with a very bright flame, and produces a great deal of heat. The inner surface of the glass is soon covered with a black powder, which has all the properties of charcoal, a quantity of carbonic acid gas is evolved, the water in the globe acquires a strong smell, and is impregnated with carbonic acid and camphoric acid.

From an useful analysis, M. Bouillon Lagrange concludes that camphor is composed of volatile oil and charcoal or carbon combined. From his experiments we learn that the ultimate ingredients of camphor are carbon and hydrogen, and that the proportion of carbon is much greater than in oils.

Camphoric acid is the result of the change produced on camphor by distilling nitric acid several times from it. It crystallises in parallelopipeds, is efflorescent, soluble in water, and volatile in a strong heat.

CAMPHOROSMA, in botany, stinking ground pine; a genus of the tetrandria order, in the monogynia class of plants, ranking in the natural method under the 12th order, holeraceæ. The calyx is pitcher-shaped and indented; there is no corolla; and the capsule contains a single seed. It is reputed cephalic and nervine; though little used in modern practice. It takes the name from its smell, which bears some resemblance to that of camphor. There are five species. Of these the principal is,

Camphorosma monspeliensis, which grows by the road-side in Languedoc, and especially about Montpelier. It has been produced as a specific for the dropsy, and asthma.

CANAL, a kind of artificial river, made for the convenience of water-carriage.

The Dutch, or if we can believe the relations of travellers, the Chinese, who inhabit a country vastly more extensive than that of the Dutch, have shewn the great advantages resulting from canals to a trading people.

There are several large canals in France; that of Briere begun under Henry IV. and finished under Lewis XIII. establishes a communication between the Loire and the Seine by the Loing. There are forty-two sluices upon it. But the greatest and most wonderful work of that kind, and at the same time one of the most useful, is the junction of the two seas, by the canal of Languedoc, proposed under Francis I. but not finished till the time of Lewis XIV.

The operations necessary for making artificial navigations or canals, depend on the situation of the ground, the connection with rivers, and the ease with which water can be obtained. When the ground is naturally level, and unconnected with rivers, the execution is easy, and the navigation is not liable to be disturbed with floods: but when the ground rises and falls, and cannot be reduced to a level, artificial methods of raising and lowering vessels must be employed. Temporary sluices are sometimes used for raising boats over falls or shoals in rivers by a very simple operation. Two pillars of masonry-work with grooves, are fixed, one on each bank of the river, at some distance below the shoal. The boat having passed these posts, planks are let down across the river by pulleys into the grooves, by which the water is dammed up to a proper height for allowing the boat to pass up the river over the shoal.

The Dutch frequently make use of inclined planes or rolling-bridges upon dry land, along which their vessels are drawn from the river below into the river above; this was the method employed by the ancients, and is still used by the Chinese, who are said to be ignorant of the nature and utility of locks. These rolling-bridges consist of a number of cylindrical rollers which turn easily on pivots; and a mill is commonly built near at hand, so that the same machinery may serve a double purpose of working the mill and drawing up vessels.

Before a canal is undertaken, the following circumstances require consideration.

1st. *Places to be benefited in point of trade.* Trade being the grand source from which adventurers in canal schemes expect to derive their great profits, such towns, places &c. must be included in the line of a canal, to which the safe, expeditious, and easy conveyance of merchandise, and consequent enlargement of commerce, will be of moment. These can be fixed upon only by an accurate survey and knowledge of the country through which the canal is intended to pass.

2dly. *The supply of water, &c.* It is almost needless to mention the absolute necessity of a supply of water for a canal, which must be in requisite quantities in the summit, or reservoirs, which may be supplied by the neighbouring springs; or if these fail, water must be thrown up by engines from a lower level.

Reservoirs are large bodies of water collected together for the use of such parts of the canal as are likely to be deficient; into which it is let by sluices, when and where wanted.

The quantity of water requisite for the use of a canal depends in a great measure upon the quantity of trade carried on. A lock-ful of water must be lost every time a boat passes through, which, in a lock whose length in the chamber is seventy-five feet, breadth seven feet, and lift six feet, will be 125 cubic yards of water; which quantity, multiplied by the number of boats likely to pass through the summit lock, will give an idea of the waste of water. Allowance also must be made for exhalation and accidents.

The most eligible level is certainly that which has the least fall and the fewest obstructions, and is best adapted to the face of the country.

The soil most favourable for a canal is clay; the most unfavourable, sand. As soils approach more or less to the quality of clay or sand, in such proportion are they to be preferred for holding water.

Of the expence of execution little can be said, as it entirely depends on the extent, the several works, &c. which can be accurately known only by an actual survey and estimate, the total of which will of course be considered previous to undertaking works of such magnitude. It may be proper to observe generally, that many locks, bridges, or aqueducts, much tunneling, unfavourable soil, &c. will of necessity incur great expences.

Lastly. *The mode of execution.* The foregoing particulars having been attended to, it becomes necessary to enumerate the several works, useful and necessary, in the execution of a canal.

For the passing and repassing of boats, there are various expedients, some of which have been noticed; but experience confirms the use of locks, when it becomes necessary, by artificial means, to raise or let down boats from one level to another.

A lock is a large basin, or, more properly, a long square cistern, placed lengthways in a river or canal, inclosed by upper and lower gates. The lock should be lined with walls of strong masonry on each side, and at the bottom; or if wood, stout oak piles should be used, shod with iron, and lined with two inch and a half or three inch oak plank, with a floor of the same materials, laid on oak-sleepers, dove-tailed and spiked into the upright piles.

The use, or locking down, is thus managed: the lock being full to the level of the upper water, the gates are then shut, including the boat to be lowered. The water in the lock is drawn off; in part first, by means of the paddles in the gates, and completely by the gates being opened; when the boat, being upon a level with the lower water, is able to proceed upon its passage. For ascending, or locking up, the boat being in the lock, the lower gates are shut: the lock is then filled with the upper water, first by the sluices, and finally by the gates being opened: thus the vessel is on a level with the upper water, and may immediately proceed.

In the first figure (see Plate) we have a perspective view of part of a canal, with a vessel within a lock, on the upper level of the water. The second figure shews a section of an open lock, with a vessel about to enter. A, B, in the former figure, are floodgates; each of which consists of two leaves resting upon one another, so as to form an obtuse angle, in order to resist the pressure of the water. A, when shut, prevents the water of the superior canal from falling into the lock, and B sustains the water in the lock. D, in the second figure, is the subterraneous passage by which the water passes from the upper level into the lock when the sluice *d* is opened; and C is the passage by which the water in the lock is let out when the sluice *c* is raised; and thus the vessel in the lock is brought on a level with the lower part of the canal.

CANARINA, in botany, a genus of the order monogynia, belonging to the hexandria class of plants. The calyx is six-leaved; corolla six-cleft, bill-form. There are 2 species.

CANARIUM, in botany, a genus of the diœcia order, in the pentandria class of plants. Its characters are, that it has male and female flowers; that, in both, the calyx has two leaves, and the corolla consists of three petals: the fruit is a drupa with a three-cornered nut. There is but one species.

CANCER, in astronomy, one of the 12 signs, represented on the globe in the form of a crab, and thus marked (♋) in books. It is the fourth constellation in the starry zodiac. The reason generally assigned for its name as well as figure, is a supposed resemblance which the sun's motion in this sign bears to the crab's. As the latter is said to walk backwards, so the former, in this part of his course, begins to go backwards, or recede from us. By others, the disposition of stars in this sign is supposed to have given the first hint to the representation of a crab. It gives name to a quadrant of the ecliptic, viz.

Cancer, tropic of, in astronomy, a lesser circle of the sphere parallel to the equator, and passing through the beginning of the sign Cancer.

Cancer, in medicine, a roundish, unequal, hard, and livid tumour, generally seated in the glandulous part of the body, supposed to be so called because it appears at length with turgid veins shooting out from it, so as to resemble, as it is thought, the figure of a crab-fish; or, others say, because, like that fish, where it has once got, it is scarcely possible to drive it away. See MEDICINE.

CANCER, in zoology, a genus of insects belonging to the order of insecta aptera. The generic characters are these: they have eight legs, (seldom ten or six) besides two large claws which answer the purpose of hands. They have two eyes at a considerable distance from each other, and for the most part they are supported by pedunculi or footstalks: the eyes are elongated and moveable. They have two clawed palpi,

and the tail is jointed. There are eighty-seven species of the cancer, distinguished principally by the length of their tails, and the margin of their breasts. The following are the most remarkable:

1. Cancer astacus, or the craw-fish, with a projecting snout slightly serrated on the sides; a smooth thorax; back smooth, with two small spines on each side; claws large, beset with small tubercles; two first pair of legs clawed, the two next subulated; tail consisting of five joints; the caudal fins rounded. It inhabits many of the rivers in England, lodging in holes which they form in the clayey banks.

2. Cancer atomos, atom lobster, with a slender body; filiform antennæ; three pair of legs near the head; beyond are three pair of legs, and a slender tail between the last pair. It is very minute, and the help of the microscope is often necessary for its inspection.

3. Cancer crangon, the shrimp, with long slender feelers, and between them two projecting laminæ; claws with a single, hooked, moveable fang. It inhabits the shores of Britain in vast quantities.

4. Cancer stagnalis, is found generally in small shallow pools of rain water, and is very transparent. The head of the male is armed with fangs; the tail of the female is furnished with a bag of eggs at the base. See Plate Nat. Hist. fig. 78.

5. Cancer diogenes, soldier crab, or hermit crab, with rough claws; the left claw is the longest. This species is parasitic, and inhabits the empty cavities of turbinated shells, changing its habitation according to its increase of growth from the small nerite to the large whelk. They crawl very fast with the shell on their back, and at the approach of danger draw themselves within the shell, and, thrusting out the larger claw, will pinch very hard whatever molests them. When it wants to change its shell, it travels along that line of pebbles and shells which is formed by the extremest wave; still, however, dragging its old incommodious habitation at its tail, unwilling to part with one shell, even though a troublesome appendage, till it can find another more convenient. It is seen stopping at one shell, turning it, and passing it by; going on to another, contemplating that for a while, and then slipping its tail from its old habitation to try on the new: if this also is found to be inconvenient, it quickly returns to its old shell again. It is not till after many trials, and many combats also, that the soldier is completely equipped; for there is often a contest between two of them for some well-looking favourite shell for which they are rivals. When this animal is taken, it sends forth a feeble cry, endeavouring to seize the enemy with its nippers; which if it fastens upon, it will sooner die than quit the grasp. See Plate Nat. Hist. fig. 110.

6. The strigosus, or plated lobster, with a pyramidal spiny snout; thorax elegantly plated, each plate marked near its junction with short striæ; only three legs spiny on their sides; tail broad. The largest of this species is about six inches long. It inhabits the coasts of Anglesea. See Plate Nat. Hist. fig. 109.

7. Cancer gammarus, the common lobster, inhabits the rocky shores of our island, but chiefly where there is a depth of water. In Llyn in Caernarvonshire a certain small lobster, nothing different except in size, burrows in the sand. Lobsters fear thunder, and are apt to cast their claws on a great clap: it is said that they will do the same on the firing of a great gun; and that, when men of war meet a lobster-boat, a jocular threat is used, that if the master does not sell them good lobsters, they will salute him. This species inhabits the clearest water, at the foot of rocks that impend over the sea; which has given opportunity of examining more closely into the natural history of the animal, than of many others who live in an element, that in a great measure limits the inquiries of the most inquisitive. Some lobsters are taken by hand; but the greater quantity in pots, a sort of trap formed of twigs, and baited with garbage. They are formed like a wire mouse-trap, so that when the lobster gets in, it cannot return. Lobsters begin to breed in spring, and continue breeding most part of the summer. Dr. Baster says he counted 12,444 eggs under the tail, besides those that remained in the body unprotruded. They deposit those eggs in the sand, where they are soon hatched. Lobsters change their shells annually. They acquire an entire new coat in a few days; but during the time that they remain defenceless, they seek some very lonely place, for fear of being devoured by such of their brethren as are not in the same situation. It is remarkable, that lobsters and crabs renew their claws, when accidentally torn off; and they grow again in a few weeks, though they never attain to the size of the first. They are very voracious animals, and feed on sea-weeds, garbage, and all sorts of dead bodies. Though the ova are cast at all seasons, they seem only to come to life in July and August. Great numbers of them may then be found, in the form of tadpoles, swimming about the little pools left by the tides among the rocks, and many also under their proper form from half an inch to four inches in length. In casting their shells, it is hard to conceive how the lobster is able to draw the flesh of their large claws out, leaving the shells entire and attached to the shell of their body, in which state they are constantly found. The fishermen say, the lobster pines before casting, till the flesh of its large claw is no thicker than the quill of a goose, which enables it to draw its parts through the joints and narrow passage near the trunk. The new shell is quite membranaceous at first, but hardens by degrees. Lobsters only grow in size while their shells are in their soft state. They are chosen for the table, by their being heavy in proportion to their size; and by the hardness of their shells on their sides, which, when in perfection, will not yield to moderate pressure.

8. Cancer granulatus, or rough-shelled crab: these crabs are pretty large, and are commonly taken from the bottom of the sea in shallow water; the legs are small in proportion to the body; the two claws are remarkably large and flat. The whole shell is covered over with innumerable little tubercles like shagreen: the colour is brown variously stained with purple.

9. Cancer grapsus, or the red mottled crab, has a round body, the legs longer and larger than in other kinds; the claws are red, and the rest of the animal is mottled in a beautiful manner with red and white. These crabs inhabit the rocks hanging over the sea; they are the nimblest of all crabs, and run with surprising agility along the upright side of a rock, and even under the rocks that hang horizontally below the water. This they are often obliged to do for escaping the assaults of rapacious birds that pursue them.

10. Cancer horridus, the horrid crab, with a projecting bifurcated snout, the end diverging; with the claws and legs covered with long and very sharp spines. It is a large species, and inhabits the rocks on the eastern coasts. See Plate Nat. Hist. fig. 111.

11. Cancer locusta, the locust lobster, with four antennæ; two pair of imperfect claws; the first joint ovated; the body consists of fourteen joints. It abounds, in summer, on the shores, beneath stones and algæ, and leaps about with vast agility.

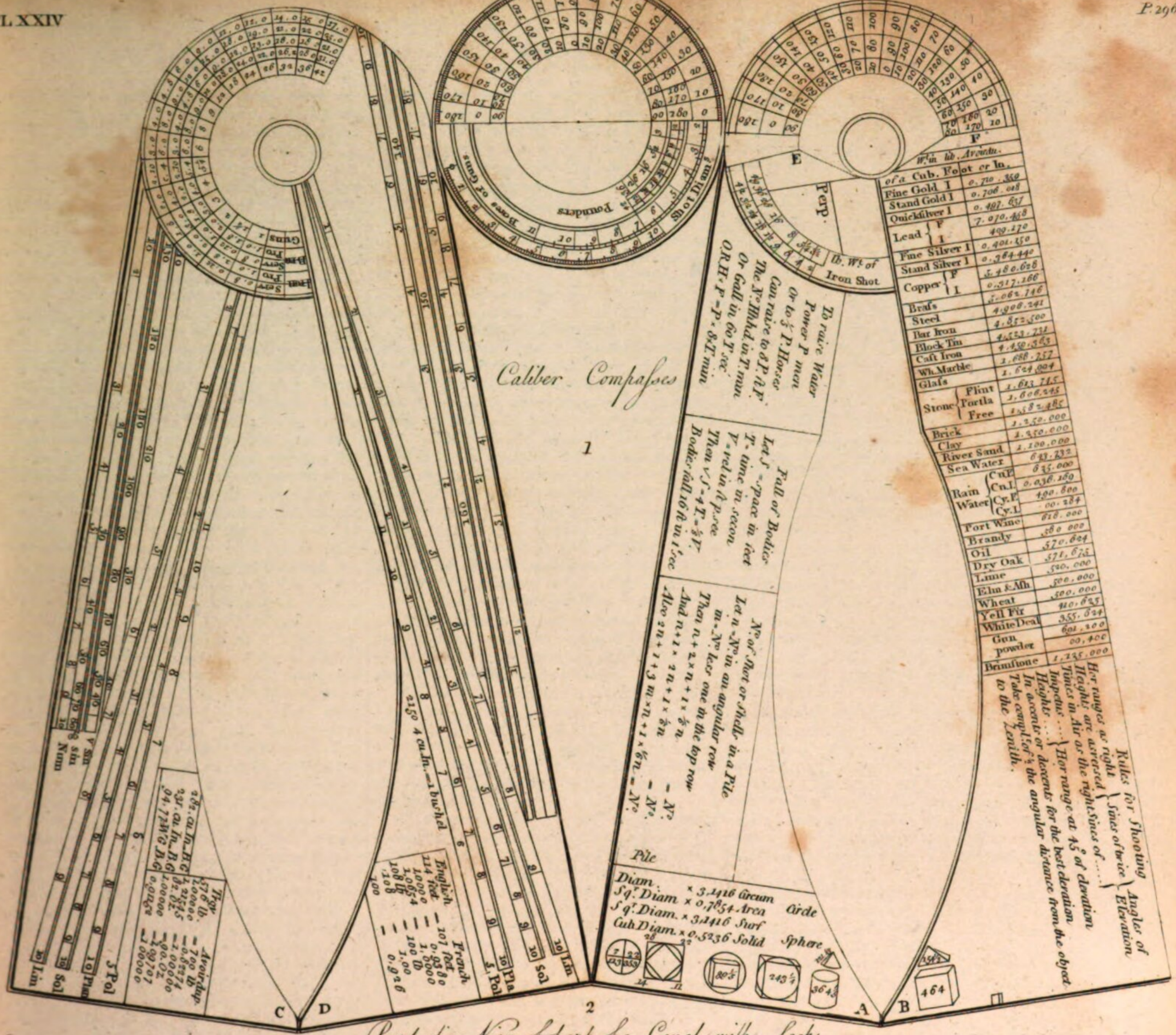
12. Cancer mænas, the common crab, with three notches on the front; five serrated teeth on each side; claws ovated; next joint toothed; hind feet subulated. It inhabits all our shores; lurks under the algæ, or burrows under the sand.

13. Cancer pagurus, or the black-clawed crab, with a crenated thorax; smooth body; smooth claws and black tips; hind feet subulated. It inhabits the rocky coasts; is very delicious meat, and casts its shell between Christmas and Easter.

14. Cancer pisum, the pea crab, with rounded and smooth thorax, entire and blunt; with a tail of the size of the body, which commonly is the bulk of a pea. It inhabits the muscle, and on that account has been deemed poisonous; but the swelling after eating is wholly constitutional.

15. Cancer pulex, the flea lobster, with five pair of legs, and two claws, imperfect; and twelve joints in the body. It is very common in fountains and rivulets; swims very swiftly in an incurvated posture on its back; embraces and protects its young between the legs; does not leap.

16. Cancer ruricola, the land crab, or violet crab, with a smooth entire thorax, and the two last joints of the feet armed with spines. It inhabits the Bahama islands, as well as most lands between the tropics. (See Pl. Nat. Hist. fig. 112.) These animals live not only in a kind of orderly society in the retreats in the mountains, but regularly once a year march down to the sea-side in a body of some millions at a time. As they multiply in great numbers, they choose the month of April or May to begin their expedition; and then sally out by thousands from the stumps of hollow trees, from the clefts of rocks, and from the holes which they dig for themselves under the surface of the earth. At that time the whole ground is covered with this band of adventurers; there is no setting down one's foot without treading upon them. The sea is their place of destination, and to that they direct their march with right-lined precision. No geometrician could send them to their destined station by a shorter course; they neither turn to the right nor left, whatever obstacles intervene; and even if they meet with a house, they will attempt to scale the walls to keep the unbroken tenor of their way. But though this is the general order of their route, they, upon other occasions,


Caliber Compasses
Pounders
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Fall of Bodies
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Sphere
Rules for Shooting
Angles of Elevation
Sines of twice
Heights
Ranges
Sines of
Weights and Specific Gravities
Of a Cub. Foot
Fine Gold
Stand Gold
Quicksilver
Lead
Fine Silver
Stand Silver
Copper
Brass
Steel
Bar Iron
Block Tin
Cast Iron
Wh. Marble
Glass
Stone
Flint
Portla
Free
Brick
Clay
River Sand
Sea Water
Rain Water
Port Wine
Brandy
Oil
Dry Oak
Lime
Elm & Ash
Wheat
Yell Fir
White Deal
Gun powder
Brimstone
Averdup
Troy
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English
French
Perspective View of part of a Canal with Locks
Section of a Lock.
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are obliged to conform to the face of the country; and if it is intersected with rivers, they are then seen to wind along the course of the stream. They are often obliged to halt for want of rain, and to go into the most convenient encampment till the weather changes. The main body of the army is composed of females, which never leave the mountains till the rain is set in for some time. The night is their chief time of proceeding; but if it rains by day, they do not fail to profit by the occasion; and they continue to move forward in their slow uniform manner. When the sun shines and is hot upon the surface of the ground, they make an universal halt, and wait till the cool of the evening. When they are terrified, they march back in a confused disorderly manner, holding up their nippers, with which they sometimes tear off a piece of the skin, and then leave the weapon where they inflicted the wound. They even try to intimidate their enemies; for they often clatter their nippers together, as if to threaten those that disturb them. But though they thus strive to be formidable to man, they are much more so to each other; for they are possessed of one most unsocial property, which is, that if any of them by accident is maimed in such a manner as to be incapable of proceeding, the rest fall upon and devour it on the spot, and then pursue their journey. When, after a fatiguing march, and escaping a thousand dangers, (for they are sometimes three months in getting to the shore,) they have arrived at their destined port, they prepare to cast their spawn, which shaking off into the water, they leave accident to bring it to maturity. At this time shoals of hungry fish are at the shore in expectation of this annual supply; the sea to a great distance seems black with them; and about two thirds of the crabs' eggs are immediately devoured by these rapacious invaders. The eggs that escape are hatched under the sand; and, soon after, millions at a time of these little crabs are seen quitting the shore, and slowly travelling up to the mountains. This animal, when possessed of its retreats in the mountains, is impregnable: for, only subsisting upon vegetables, it seldom ventures out: and its habitation being in the most inaccessible places, it remains for a great part of the season in perfect security. It is only when impelled by the desire of bringing forth its young, and when compelled to descend into the flat country, that it is taken. At that time, the natives wait for its descent in eager expectation, and destroy thousands; but, disregarding their bodies, they only seek for that small spawn which lies on each side of the stomach within the shell, of about the thickness of a man's thumb. They are much more valuable upon their return after they have cast their shell; for, being covered with a skin resembling soft parchment, almost every part except the stomach may be eaten. They are taken in the holes by feeling for them with an instrument; they are sought after by night, when on their journey, by flambeaux. The instant the animal perceives itself attacked, it throws itself on its back, and with its claws pinches most terribly whatever it happens to fasten on. But the dextrous crab-catcher takes them by the hinder legs in such a manner that the nippers cannot touch him, and thus he throws them into his bag. Sometimes also they are caught when they take refuge in the bottoms of holes in rocks by the sea-side, by covering the mouth of the hole, to prevent their getting out; and then soon after, the tide coming, enters the hole, and the animal is found, upon its ebbing, drowned in its retreat. These crabs are of various sizes, the largest about six inches wide; they walk sideways like the sea-crab, and are shaped like them: some are black, some yellow, some red, and others variegated with red, white, and yellow, mixed.

The light-coloured are reckoned best; and when full in flesh, are very well tasted.

16. Cancer serratus, or the prawn, with a long serrated snout bending upwards; three pair of very long filiform feelers; claws small, furnished with two fangs; five joints to the tail; middle caudal fin subulated, two outmost flat and rounded. It is frequent in several shores among loose stones; sometimes found at sea, and taken on the surface over 30 fathoms depth of water; cinereous when fresh; of a fine red when boiled.

17. Cancer squilla, with a snout like a prawn, but deeper and thinner; the feelers longer in proportion to the bulk; the subcaudal fins rather larger; is, at full growth, not above half the bulk of the former.—It inhabits the coasts of Kent; and is sold in London under the name of the white shrimp, as it assumes that colour when boiled.

19. Cancer velutinus, or velvet crab, with the thorax quinquedentated; body covered with short, brown, velvet-like pile; claws covered with minute tubercles; small spines round the top of the 2d joint; hind legs broadly ovated. It inhabits the western coast of Anglesea.

20. Cancer volans, or sand crab, is but of a small size; its colour light brown, or dusky white. It has eight legs, and two claws, one of which is double the size of the other; these claws serve both to defend and feed them. The head has two square holes, which are receptacles for its eyes; out of which it thrusts them, and draws them in again at pleasure. Their abode is only on the sandy shores of Hathera, and others of the Bahama islands. They run very fast, and retreat from danger into little holes they make in the sand.

CANCROMA, or BOAT-BILL, in ornithology, a genus of birds belonging to the order of grallæ; the characters of which are: The bill is broad, with a keel along the middle; the nostrils are small, and lodged in a furrow; the tongue is small; and the toes are divided. There are two species:

1. Cancroma cancrophaga, or the brown boat-bill, resembles the cochlearia so much in size, head, crest, and every thing almost, except the colour, that Mr. Latham considers them both as only varieties of the same species. Linnæus however ranks them as distinct. In this species the under parts, instead of ash colour, are of a pale rufous brown; the tail rufous ash; and the upper parts wholly of a cream colour; the bill and legs of a yellow brown. It inhabits Cayenne, Guiana, and Brasil, and chiefly frequents such parts as are near the water: in these places it perches on the trees which hang over the streams, and, like the king's-fisher, drops down on the fish which swim beneath. It has been thought to live on crabs likewise, whence the Linnæan name.

2. Cancroma cochlearia, the crested boat-bill, as well as the cancrophaga, is of the size of a domestic fowl; the length 22 inches. The bill is four inches long, and of singular form, not unlike a boat with the keel uppermost, or, as some think, like the bowls of two spoons, placed with the hollow parts together; from the hind head springs a long black crest; the feathers which compose it are narrow, and end in a point; the middle ones are six inches in length, the others lessen by degrees; the plumage on the forehead white; the rest of the bird of a pale bluish ash colour; across the lower part of the neck behind is a transverse band of brownish black, which passes forwards on each side towards the breast. Its place and manners are the same with those of the cancrophaga.

CANDIDATI MILITES, an order of soldiers among the Romans who served as the emperor's body guards to defend him in battle.

CANDLE, a taper of tallow, wax, or spermaceti, the wick of which is commonly of several threads of cotton, spun and twisted together.

The machine for cutting the cotton is a smooth board made to be fixed on the knees; on the upper surface are the blade of a razor, and a round piece of cane, placed at a certain distance from one another, according to the length of the cotton wanted: the cotton is carried round the cane, and being brought to the razor, is instantly separated from the several balls.

A tallow-candle, to be good, must be half sheep's and half bullock's tallow, for hog's tallow makes the candle gutter, and always gives an offensive smell, with a thick black smoke. The wick ought to be pure, sufficiently dry, and properly twisted, otherwise the candle will emit an unconstant vibratory flame, which is both prejudicial to the eyes and insufficient for the distinct illumination of objects.

There are two sorts of tallow-candles; the one dipped, the other moulded: the former are the common candles. The tallow is prepared by chopping the fat, and then boiling it for some time in a large copper; and when the tallow is extracted by the process of fire, the remainder is subjected to the operation of a strong iron press, and the cake that is left after the tallow is expressed from it is called greaves: with this dogs are fed, and the greater part of the ducks that supply the London markets. It is also sometimes given to pigs, but certainly without benefiting the flavour of the meat.

When the tallow is in proper order, the workman holds three of the broaches, with the cottons properly spread, between his fingers, and immerses the cotton into the vat containing the tallow: they are then hung on a frame and suffered to cool; and when cold they are dipped again, and so the process is continued till the candles are of the proper size. During the operation the vat is supplied from time to time with fresh tallow, which is kept to the proper heat by means of a gentle fire under it.

The mould in which the moulded candles are cast, consists of a frame of wood, and several hollow metal cylinders, generally made of pewter, of the diameter and length of the candle wanted: at the extremity of these is the neck, which is a little cavity in form of a dome, having a moulding withinside, and

pierced in the middle, with a hole big enough for the cotton to pass through. The cotton is introduced into the shaft of the mould by a piece of wire being thrust through the aperture of the hook till it comes out of the neck: the other end of the cotton is so fastened as to keep it in a perpendicular situation, and in the middle of the candle; the moulds are then filled with warm tallow, and left to be very cold before they can be drawn out of the pipes.

Besides these, there are other candles made by tallow-chandlers, intended to burn during the night without the necessity of snuffing: the wick has been usually made of split rushes; but lately very small cotton wicks have been substituted for the rush: these are lighted much easier, are less liable to go out, and, owing to the smallness of the cotton, they do not require the aid of snuffers.

To make wax-candles with the ladle.—The wicks being prepared, a dozen of them are tied by the neck, at equal distances, round an iron circle, suspended directly over a large bason of copper tinned, and full of melted wax: a large ladleful of this wax is poured gently on the tops of the wicks one after another, and the operation continued till the candle arrives at its destined bigness, with this precaution, that the first three ladles be poured on at the top of the wick; the fourth at the height of $\frac{3}{4}$, the fifth at $\frac{1}{2}$, and the sixth at $\frac{1}{4}$, in order to give the candle its pyramidal form. Then the candles are taken down, kept warm, and rolled and smoothed upon a walnut-tree table, with a long square instrument of box, smooth at the bottom.

As to the manner of making wax-candles by the hand, they begin to soften the wax by working it several times in hot water, contained in a narrow but deep cauldron. A piece of the wax is then taken out, and disposed by little and little around the wick, which is hung on a hook in the wall, by the extremity opposite to the neck; so that they begin with the large end, diminishing still as they descend towards the neck. In other respects the method is nearly the same as in the former case. However, it must be observed, that in the former case water is always used to moisten the several instruments, to prevent the wax from sticking; and in the latter, oil of olives, or lard, for the hands, &c. The cylindrical wax-candles are either made as the former, with a ladle, or drawn. Wax-candles, or tapers drawn, are so called because they are actually drawn in the manner of wire, by means of two large rollers of wood turned by a handle, which turning backwards and forwards several times, pass the wick through melted wax contained in a brass bason, and at the same time through the holes of an instrument like that used for drawing wire, fastened on one side of the bason.

A patent has very lately been obtained for making candles with hollow cylindrical wicks upon the principle of the Argand lamp. See LAMP.

Tallow-chandlers and wax-chandlers are by 24 Geo. III. s. 2. c. 41. to take out annual licences. They shall not use melting-houses without making a true entry, on pain of 100*l.* and are to give notice of making candles to the excise-officer for the duties, and of the number, &c. or forfeit 50*l.*

CANDLE. Sale or auction by inch of candle, is when a small piece of candle being lighted, the bystanders are allowed to bid for the merchandize that is selling: but the moment the candle is out, the commodity is adjudged to the last bidder.

CANELLA, in botany, a genus of the monogynia order, in the dodecandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. The calyx is three-lobed; the petals are five; the antheræ sixteen, growing to an urceolated or bladder-shaped nectarium; and the fruit is a trilocular berry, with two seeds. There is but one species, viz.

Canella alba. It grows usually about 20 feet high, and 8 or 10 inches in thickness, in most of the Bahama islands. The bark is a warm stomachic.

CANDY, or SUGAR-CANDY, a preparation of sugar, made by melting and crystallizing it six or seven times over, to render it hard and transparent. See SUGAR.

CANE, *canna*. See ARUNDO. It is also the name of a long measure, which differs according to the several countries where it is used.

At Naples, the cane is equal to 7 feet $3\frac{1}{2}$ inches English measure; the cane of Thoulouse, and the upper Languedoc, is equal to the varre of Arragon, and contains 5 feet $8\frac{2}{3}$ inches; at Montpelier, Provence, Dauphiné, and the lower Languedoc, to 6 English feet $5\frac{1}{2}$ inches.

CANES *venatici*, in astronomy, the greyhounds, two new constellations first established by Hevelius, between the tail of the Great Bear and Bootes's arms, above the Coma Berenices. The first, viz. that nearest the Bear's tail, is called asterion; the other chara. They comprehend 23 stars, two only of which were observed by Tycho. In the British catalogue they are 25.

CANINE *teeth*, in anatomy, are two sharp-edged teeth in each jaw, one on each side, placed between the incisores and molares.

CANIS, *dog*, in zoology, the name of a comprehensive genus of quadrupeds, of the order of the feræ. The generic character is, cutting teeth in the upper jaw six; the lateral ones longer, distant; the intermediate ones lobated. In the lower jaw six; the lateral ones lobated. Canine teeth solitary, incurvated. Grinders six or seven (or more than in other genera of this order). There are 24 species.

1st. Canis familiaris, or common dog. The real origin of this species is in a state of uncertainty: wild dogs appear to be found in great troops in Congo, lower Æthiopia, and towards the Cape of Good Hope. They are said to be red-haired, with slender bodies and turned-up tails, like greyhounds. It is also added that they vary in colour, have upright ears, and are of the general size of a large foxhound. They destroy cattle, and hunt down antelopes and many other animals, and commit great ravages among the sheep of the Hottentots. They are very seldom to be taken, being extremely swift as well as fierce. The young are said to be sometimes obtained, but grow so fierce as to be rendered domestic with great difficulty.

It is not, however, allowed by modern naturalists that these wild dogs constitute the true or real species in a state of nature, but that they are rather the descendants of dogs once domesticated, and which have relapsed into a state resembling that of primitive wildness; and a theory has for some time prevailed, that the wolf is in reality the stock or original from which the dog has proceeded. If, however, the origin of the dog must be traced to some other animal, the jackall seems a more probable origin than the wolf. It is generally believed that the dog was unknown in America on the arrival of the Europeans.

That which is supposed by Buffon to approach most nearly to the original animal, is known by the name of the shepherd's dog. This is distinguished by its upright ears, and tail remarkably villose beneath. In the Alpine regions, as well as in some other parts of Europe, this dog is much larger and stronger than in England. Its principal use is as a guard to the flock, which it prevents from straggling, and defends from all attacks.

The dingo, or New Holland dog, approaches in appearance to the largest kind of shepherd's dog. The ears are short and erect; the tail rather bushy; the hair, which is of a reddish dun-colour, is long, thick, and straight. This dog is capable of barking, though not so readily as the European dogs: it is extremely fierce, and has the same sort of snarling and howling voice as the larger dogs in general. By some it has been erroneously said neither to bark nor growl. Those which have been brought over to Europe were of a savage and untractable disposition.

The Pomeranian dog is distinguished by upright ears, long hair on the head, and an extremely curved tail, so as to form almost a circle. This dog is generally of a white colour.

The Siberian dog is nearly allied to the preceding, and may be subdivided into several races, differing as to strength and size. The Siberian dogs are principally used in that country and in Kamtschatka for drawing sledges over the frozen snow in winter. When yoking to the sledge, they set up a dismal yell, which ceases on beginning the journey, and then gives place to silent subtlety, and a perpetual endeavour to weary out the patience of the driver by wayward tricks and contrivances.

The Iceland dog seems to differ but slightly from the preceding kind. It has a shortish muzzle, upright ears, with flaccid tips, and is covered with long roughish hair. Its general colour is blackish: the breast, legs, and tip of the tail often white.

The water dog is distinguished by its curly hair, like wool. It is remarkable for its great attachment to the water, swims with great ease, and is used in hunting ducks, and other aquatic birds. Its feet are commonly said to approach more to a webbed form than those of most other dogs.

The great water spaniel is also distinguished in a similar manner by its curled hair, and its propensity to the water. There is a smaller variety of the water dog, called the little barbet, which, in general appearance, extremely resembles the larger.

The Newfoundland dog is of a very large size, and from its strength and docility, is one of those which are best calculated for the security of a house. This animal is remarkably fond of plunging into the water. See Plate Nat. Hist. fig. 85.

King Charles's dog is one of the most elegant varieties of the dog, and it is recorded

that king Charles the Second hardly ever walked out without being attended by some of this breed. It is in some degree allied to the small water spaniel, and is generally black, with the roof of the mouth of the same colour.

The Maltese dog is also a very small kind of spaniel, generally of a white colour.

The hound admits of some varieties. The old English hound is distinguished by its great size and strength. Its power of smelling is exquisite, and it is said to be able to distinguish the scent an hour after the lighter beagles have given it up. These dogs are said to have been once very common in every part of England, and to have been much larger than at present, the breed having, as it should seem, been gradually suffered to decline.

The blood hound is a very large dog, taller and more beautifully formed than the old English hound, and superior to most others in speed, strength, and sagacity. The blood hound was in much esteem with our ancestors for the pursuit of robbers, &c. It was mostly of a reddish or brown colour. "A person of quality (says Mr. Boyle), to make a trial whether a young blood hound was well instructed, caused one of his servants to walk to a town four miles off, and then to a market-town three miles from thence. The dog, without seeing whom he was to pursue, followed him by the scent to the abovementioned places, notwithstanding the multitude of market-people that went along the same way, and of travellers that had occasion to cross it; and when the blood hound came to the chief market-town, he passed through the streets without taking notice of any of the people there, nor did he stop till he had gone to the house where the man he sought rested himself, and found him in an upper room, to the wonder of those that followed him."

The pointer is employed principally in finding partridges and other game. The large pointer, commonly termed the Spanish pointer, is supposed to distinguish itself by a greater degree of docility than the English pointer, but is not able to undergo the fatigues of the field so well.

The Dalmatian, or coach dog, is an animal of great beauty. Its native country seems uncertain. Mr. Pennant, however, informs us that Dalmatia is the country of this elegant dog. It is white, and beautifully marked with numerous black spots. See Plate Nat. Hist. fig. 88.

The Irish greyhound is supposed to be the largest of all the dog kind, as well as the most beautiful and majestic in its appearance. It is only to be found in Ireland, and even there is become extremely rare.

The common greyhound is remarkable for the slenderness of its shape, the length of its snout, and the extreme swiftness of its course. The greyhound wants the faculty of quick scent, and follows his prey merely by the eye. The Italian greyhound is a small and beautiful variety of the former. See Plate Nat. Hist. fig. 89.

The naked dog is naturally divested of hair, and is supposed to have originated in some very warm climate.

The mastiff is of a very strong and thick form, with a large head, a bold countenance, and large lips hanging down on each side. Dr. Caius, who lived in the reign of Elizabeth, and who described the several varieties of English dogs, tells us that three mastiffs were reckoned a match for a bear, and four for a lion; but from an experiment made in the Tower in the reign of James the First, a lion was found an unequal match to only three. Two of the dogs were disabled by the combat, but the third forced the lion to seek for safety by flight. See Plate Nat. Hist. fig. 86.

The bull dog is a kind of mastiff on a smaller scale, with a somewhat flatter snout, and a greater ferocity of aspect. The bull dog is remarkable for the undaunted and savage pertinacity with which it provokes and continues the fight, and when it has fixed its bite, is with extreme difficulty disengaged from its antagonist. The pug dog is a small and innocent resemblance of the former, and is in some countries considered as a kind of lap-dog. See Plate Nat. Hist. fig. 87.

The terrier is generally an attendant on every pack of hounds, and is very expert in forcing foxes or other game out of their coverts. It is the determined enemy of all the vermin kind; such as weasels, foumarts, badgers, rats, mice, &c.

The turnspit is a breed very much on the decline in England, though still used in some other countries. It is a long-bodied, short-legged dog, with crooked or bowed knees, and is commonly of a dusky grey, spotted with black. To these we may add the alco, or Peruvian dog, and several mixed breeds from the above.

2d. Canis lupus, or wolf, is distinguished from the dog by his superior size, stronger limbs, more muscular body, and greater breadth of the upper part of the face, while the whole form of it is longer: the tail also, which in the dog is pretty uniformly turned a little towards one side (generally the left), in the wolf has an inward direction; it is rather long and bushy. The wolf is a native of almost all the temperate and cold regions of the globe. It is found in most countries of Europe, but has been totally extirpated from our own island, as well as from Ireland.

The general colour of the wolf is a pale grey, with a cast of yellowish, but it varies much as to the shades or gradations of colour in different parts of the world.

The wolf is sometimes affected with madness, attended with similar appearances to those exhibited in that state by the dog, and productive of the same symptoms in consequence of its bite: this disease is said to happen to them in the depth of winter, and therefore, as Mr. Pennant observes, can never be attributed to the rage of the dog-days. Wolves in the northern parts of the world sometimes, during the spring, get on the ice of the sea, in order to prey on young seals, which they catch asleep; but this repast sometimes proves fatal to them, for the ice, detached from the shore, carries them to a great distance from the land before they are sensible of it. It is said that in some years a large district is by this means delivered from these pernicious beasts, which are heard howling in a most dreadful manner far in the sea.

The time of gestation in the wolf is (according to Buffon) about three months and a half; and the young whelps are found from April to July; and this difference in the time of gestation, which in the wolf is 100 days, and in the dog only 60, he considers justly as a proof of the real difference between the two species. See Plate Nat. Hist. fig. 84.

3d. Canis Mexicanus, or Mexican wolf, appears to have been first described by Hernandez, in his account of Mexico. In its general appearance it resembles the common wolf, but has a head twice as large, a thicker neck, and a less bushy tail: the colour of the body is cinereous, marked with some yellow spots. Above the mouth are situated several bristles as large, but not so stiff, as those of the hedgehog; the ears are grey, like the head and body; there is a long yellow spot on the neck, another on the breast, and a third on the belly; on the flanks are transverse bands from the back to the belly; the tail is grey, with a yellow spot in the middle; the legs are barred with grey and brown.

4th. Canis lycaon, or black wolf. Like the common wolf, it is found both in Europe and America, as well as in some parts of Asia. It bears a great general resemblance to the common species, but is smaller, entirely black, with a somewhat thinner or less bushy tail hanging nearly straight; the ears are larger in proportion than those of the common wolf, and the eyes smaller, and situated at a greater distance from each other. In America the black wolf is chiefly found in Canada, and in Europe occurs only in the more northern regions.

5th. Canis hyæna, is a native of many parts of Asia and Africa, being found in Syria, Persia, Barbary, Senegal, &c. &c. Its general size is that of a large dog, but it is distinguished by great strength of limbs, and by a remarkable fullness or thickness of the snout. Its colour is a pale greyish-brown accompanied by a tawny cast, and the whole body is marked by several distant blackish transverse bands running from the back downwards. On all the feet are four toes. Hyænas generally inhabit caverns and rocky places: they prowl about chiefly by night, and feed on the remains of dead animals as well as on living prey. They are even said to devour the bodies which they occasionally find in cemeteries. They attack cattle, and frequently commit great devastation among the flocks. Though not gregarious from any social principle, they sometimes assemble in troops, and follow with dreadful assiduity the movements of an army, through the hope of feasting on the slaughtered bodies. See Plate Nat. Hist. fig. 79.

There is something in the aspect of the hyæna which seems to indicate a peculiar gloominess and malignity of disposition; and its manners in a state of captivity seem in general to correspond with its appearance, being savage and untractable. It has even been supposed that the hyæna cannot be tamed; but this opinion is proved to be erroneous from two instances at least; one of which is recorded by Mr. Pennant, who declares that he saw a hyæna which had been rendered as tame as a dog; the other by the Count de Buffon, who assures us that in an exhibition of animals at Paris, in the year 1773, there was a hyæna which had been tamed very early, and was apparently divested of all its natural malevolence of disposition.

6th. Canis crocuta, or spotted hyæna, resembles the former, but is superior in size, and is readily distinguished by being marked all over the body and legs with numerous

roundish black spots. It is an African animal, and is found in Guinea, Æthiopia, and about the Cape of Good Hope.

7th. Canis aureus, or jackal, is a native of the warmer regions of Asia and Africa, and appears to be no where more common than in Barbary. It is about the size of a middling dog, and is of a pale or light orange-yellow, with darker or blackish shades about the back and legs: the tail hangs straight, is rather bushy, and is commonly black at the tip. The jackal resides in rocky places, and in woods, and makes its principal excursions during the night, preying indiscriminately on all the weaker animals. It also occasionally devours various vegetables. The voice of the jackal is described as peculiarly hideous, consisting of a kind of mixture of howling and indistinct barking. These animals frequently go in great troops to hunt their prey, and by their dreadful yellings alarm and put to flight deer, antelopes, and other timid quadrupeds; while the lion, instinctively attending to the clamour, is said to follow till the jackals have hunted down the prey, and, having satiated himself, leaves only the mangled remains to be devoured by the jackals.

When taken young the jackal is easily tamed, attaches itself to mankind, distinguishes its master, comes on being called by its name, shews an attachment to dogs, instead of flying from them, and has all the other particularities of character by which the dog is distinguished. See Plate Nat. Hist. fig. 82.

8th. Canis mesomelas, or cape jackal, is said to be not uncommon about the Cape of Good Hope, and is by some confounded with the jackal, to which, indeed, it seems to be very nearly allied. The head is yellowish-brown, with a mixture of black and white hairs: the nape of the neck and the whole length of the back black, with a mixture of white. The general colour of the animal is bright foxy or ferruginous: the tail is not unlike that of a fox, but rather less bushy. The length of this animal is two feet and three quarters, exclusive of the tail, which measures one foot.

9th. Canis Barbarus, Barbary jackal, has a long slender nose, sharp upright ears, and a long bushy tail. Its colour is a very pale brown: from behind each ear runs a black line, which soon divides into two, running downwards along the neck. It is of the size of the common fox, but the limbs seemingly shorter, and the nose more slender.

10th. Canis Ceilonicus, Ceylonese dog, is a native of Ceylon, but no particulars relative to its manners or history are known. It is a little larger than a common domestic cat, measuring about twenty-two inches from nose to tail; the tail itself sixteen inches, gradually tapering to the point. The claws of this animal resemble those of a cat more than of a dog, though not so long and slight in proportion. Both fore and hind feet have five toes.

11th. Canis vulpes, or fox, like the wolf, appears to be pretty generally diffused throughout all the northern and temperate parts of the globe; occurring with numerous varieties, as to shades of colour and gradations of size, in most parts of Europe, the north of Asia, and America. See Plate Nat. Hist. fig. 83.

In the northern climates are foxes of all colours, black, blue, grey, iron colour, silver-grey, white with yellow feet, white with black heads, white with the extremity of the tail black, reddish, with the throat and belly entirely white, and, lastly, some have a black line along the back, and crossed with another over the shoulders: the latter are larger than the other kinds, and have black throats.

The fox prepares for himself a convenient den or receptacle in which he lies concealed during the greater part of the day. This den is sometimes said to be obtained by dispossessing the badger of its hole, and appropriating it to his own purposes. It is so contrived as to afford the best security to the inhabitant, by being situated under hard ground, the roots of trees, &c. and is besides furnished with proper outlets through which he may escape in case of necessity.

The fox attempts his prey by cunning rather than by force: his scent is exquisite, so that he can perceive his prey or his enemies at the distance of 2 or 300 paces: he has the habit of killing more than he eats, and hiding the remainder under grass, the roots of trees, &c. His voice is a sharp, quick yell, often ending in a higher, stronger, and screaming kind of note, not unlike that of the peacock.

The fox produces five or six young at a time; and if they are discovered or disturbed, the female will carry them in her mouth, one at a time, to some more secret retreat; in this respect imitating the conduct of the cat and dog, which are known to do the same.

12th. Canis alopex, brant fox, is less than the common fox, and has a thicker and darker fur, though sometimes, on the contrary, it is much brighter and redder than that species, as mentioned by Linnæus in his Fauna Suecica: the tail is tipped with black.

13th. Canis corsac, or corsac fox. The colour of this species is, in summer, a clear yellow-ferruginous; in winter mixed or shaded with grey, deeper on the back, white on the belly, and reddish on the feet: the eyes are surrounded with a border of white; and a brownish stripe runs from them down the nose. The size of this animal is less than that of the common fox.

14th. Canis Karagan, or Karagan fox. This is a small species, which, according to Dr. Pallas, is very common in almost all parts of the Kirghisian deserts and Great Tartary. Its general colour is a wolf-grey; the head yellowish, and above the eyes reddish: the throat and breast are of a deep or blackish grey, the belly white.

15th. Canis cinereo-argenteus, or fulvous-necked fox, inhabits North America, and the skins are often sent over to Europe. The crown of the head, neck, and back, are grey, mixed with black and white: the finer hairs being white-grey, the coarser varied with black and white like a porcupine's quill. In size this species is inferior to the common fox.

16th. Canis Virginianus, or Virginian fox, resembles the common fox in shape: has a sharp nose, long, sharp, upright ears, long legs, and a bushy tail: its colour is a whitish grey, with a cast of red about the ears. It inhabits the warmer parts of North America, particularly Carolina and Virginia. It is said never to burrow under ground like the common fox, but to inhabit hollow trees: it is destitute of the strong smell of the common fox, is easily tamed, and is said to prey chiefly on poultry, birds, &c.

17. Canis argentatus, silvery fox, resembles the common fox. It is of a deep brown-colour, with the longer or exterior hairs of a silvery white, giving a highly elegant appearance to the animal. It is an inhabitant of the forests of Louisiana, and preys on game.

18th. Canis lagopus, arctic fox, is inferior in size to the common fox. Its colour is a bluish-grey, which sometimes changes to perfect white: when young it is said to be of a dusky colour. They inhabit Spitzbergen, Greenland, and Iceland; and are only migratory in Hudson's Bay, once in four or five years. They are the hardiest of animals, and even in Spitzbergen and Nova Zembla prowl for prey during the severity of winter. They live on the young wild geese, and all kinds of water-fowl, or on their eggs; on hares or any lesser animals; and in Greenland (through necessity) on berries, shell-fish, or whatsoever the sea throws up. They swim well, and often cross from island to island in search of prey. The Greenlanders take them either in pitfalls dug in the snow, and baited with the capelin fish, or in springs made with whalebone laid over a hole made in the snow, strewed over at bottom with the same kind of fish; or in traps made like little huts, with flat stones, with a broad one by way of door, which falls down (by means of a string baited on the inside with a piece of flesh) whenever the fox enters and pulls at it. The Greenlanders preserve the skin for traffic; and, in cases of necessity, eat the flesh. They also make buttons of the skins; and split the tendons, which they use instead of thread. The blue furs are much more esteemed than the white. See Plate Nat. Hist. fig. 80.

19th. Canis culpæus, Chili fox, is supposed to be a variety of the antarctic fox. Its length from nose to tail is two feet and a half; its colour a deep brown. It inhabits the open countries of Chili, in which it forms its burrows.

20th. Canis thous, or Surinam dog, seems to have been unknown to other naturalists. Linnæus states only that the body is grey, entirely white beneath; that it is of the size of a large cat, and has upright ears of the same colour with the body; a verruca or wart above the eyes, on each cheek, and beneath the throat; and that the tongue is ciliated at the edges.

21st. Canis Bengalensis, Bengal fox, is scarcely half the size of the European fox. The face is cinereous, the body pale-brown, the legs fulvous, the tail tipped with black, and down the middle of the face runs a black stripe. The spaces round the eyes and the middle of the jaws are white. It is said to feed chiefly on roots and berries.

22d. Canis fuliginosus, sooty fox, in size and habit resembles the arctic fox, but is a distinct species. It is said to be numerous in Iceland.

23d. Canis antarcticus, antarctic fox, is about a third part superior in size to the arctic fox, and has pretty much the habit of a wolf in its ears, tail, and strength of limbs. It is a native of the Falkland isles, and is said to be almost the only land quadruped of those distant spots. It resides near the shores; kennels like a fox, and forms regular paths from bay to bay, probably for the convenience of surprising water-fowl, on which it principally lives. It is a tame, fetid animal, and barks in the manner of a dog.

24th. Canis zerda, the Fennec, or zerda, is a beautiful African and Asiatic animal, and is principally found in Arabia. Its general

Camelus vicuna

Camelus Bactrianus
Bactrian Camel

Camelus Glama

Camelus Dromedarius
Dromedary

Caprimulgus
Goat-sucker

Canis Hyæna

Camelopardalis Giraffe

Cancer Stagnalis

Canis lagopus
Arctic fox

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length is about ten inches, and its colour yellowish-white. The ears, which are uncommonly large, are internally of a bright rose-colour, edged with a broad margin of white hair, and the tip of the tail is black. It inhabits the vast deserts of Zaara, which extend beyond mount Atlas; it burrows in sandy ground, which shews the use of valves to the ears. It is so exceedingly swift that it is very rarely taken alive; feeds on insects, especially locusts; sits on its rump; is very vigilant, and barks like a dog, but much shriller.

CANIS *major*, in astronomy, a constellation of the southern hemisphere, consisting of 28 stars, according to Ptolemy; of 13, according to Tycho; and 32 in the Britannic catalogue.

CANIS *minor*, CANICULUS, or CANICULA, in astronomy, a constellation of the northern hemisphere. In Ptolemy's catalogue, the canis minor comprehends two stars; in that of Tycho, five; and in the Britannic catalogue, 15.

CANNA, Indian flowering reed; a genus of the monogynia order, in the monandria class of plants; and in the natural method ranking under the 8th order, scitaminæ. The corolla is erect, and divided into six parts, with a distinct lip, bipartite, and rolled back; the style lanceolate, and growing to the corolla; the calyx is triphyllous. There are five species, viz.

1. Canna coccinea, has larger leaves than any of the other four species, and the stalks rise much higher. The flowers are produced in large spikes, and are of a bright crimson or rather scarlet colour.

2. Canna glauca, with a very large yellow flower, is a native of South America.

3. Canna Indica, or common broad-leaved flowering cane.

4. Canna latifolia, with a pale red flower, is a native of Carolina, and some other northern provinces of America.

5. Canna lutea, with obtuse oval leaves, is less common in America than the other sorts. All these plants must always be kept in pots of rich earth, to be moved to shelter in winter.

CANNABIS, hemp, in botany, a genus of the dioecia pentandria class of plants, and in the natural method ranking under the 53d order, scabridæ. The calyx of the male is quinquepartite, with no corolla. In the female the calyx is monophyllous, entire, and gaping at the side; there is no corolla, but two styles; the fruit is a nut, bivalved, within the closed calyx. Of this there is but one species, viz.

Cannabis sativa. It is propagated in the rich fenny parts of Lincolnshire in great quantities for its bark, which is useful for cordage, cloth, &c. and the seeds abound with oil. Hemp is always sown on a deep, moist, rich soil, such as is found in Holland, Lincolnshire, and the fens of the island of Ely, where it is cultivated to great advantage, as it might be in many other parts of England where there is a soil of the same kind; but it will not thrive on clayey or stiff cold land. The ground on which hemp is to be sown should be well ploughed, and made very fine by harrowing. About the middle of April the seed may be sown; three bushels are the usual allowance for an acre, but two are sufficient. In the choice of the seed, the heaviest and brightest, coloured should be preferred; and particular care should be had to the kernel of the seed. For the greater certainty in this matter, some of the seeds should be cracked to see whether they have the germ or future plant perfect; for, in some places, the male plants are drawn out too soon from the female, i. e. before they have impregnated the female plants with the farina; in which case, though the seeds produced by these females may seem good to the eye, yet they will not grow. When the plants are come up, they should be hoed out in the same manner as turneps, leaving them two feet apart; observe also to cut down all the weeds, which, if well performed, and in dry weather, will destroy them. This crop, however, will require a second hoeing, in about six weeks after the first; and, if this is well performed, the crop will require no further care. The first season for pulling hemp is usually about the middle of August, when they begin to pull what they call the *simple hemp*, being that which is composed of the male plants; but it would be much better to defer this for a fortnight or three weeks longer, until those male plants have fully shed their farina or dust, without which the seeds will prove only empty husks. These male plants decay soon after they have shed their farina. The second pulling is a little after Michaelmas, when the seeds are ripe. This is usually called *karle hemp*, and consists of the female plants which were left. This karle hemp is bound in bundles of a yard compass, according to the statute measure, which are laid in the sun for a few days to dry; and then it is stacked up or housed to keep it dry till the seed can be threshed out. An acre of hemp, on a rich soil, will produce nearly three quarters of seed, which, together with the unwrought hemp, are worth from 6*l*. to 8*l*. Hemp is esteemed very effectual for destroying weeds; but this it accomplishes by impoverishing the ground, and thus robbing them of their nourishment; so that a crop of it must not be repeated on the same spot.

CANNEL-COAL. See AMPELITES.

CANNON, in the military art, an engine or kind of fire-arms for throwing iron, lead, or stone bullets, by the force of gunpowder.

Cannons at first were called bombardæ, from the noise they made. They had likewise the name of culverin, basilisk, &c. from the beasts that were represented upon them; and the Spaniards, from devotion, gave them the name of saints; witness the twelve apostles which Charles V. ordered to be cast at Malaga, for his expedition to Tunis.

The most remarkable parts about a cannon are the cascabel, mouldings, base-ring, touch-hole, vent-ring, reinforced ring, trunnions, dolphins, trunnion-ring, cornish-ring, neck, muzzle, face, and chace or cylinder.

The metal of which brass cannon is made is in a manner kept a secret by the founders; yet, with all their art and secrecy, they have not hitherto found out a composition that will stand a hot engagement without melting, or being rendered useless. Those cast at Woolwich bid fairest towards this amendment. The respective quantities which should enter into this composition, is a point not decided; every founder has his own proportions, which are peculiar to himself. The most common proportions of the ingredients are the following, viz. To 240 lb. of metal fit for casting, they put 68 lb. of copper, 52lb. of brass, and 12 lb. of tin. To 4200 lb. of metal fit for casting, the Germans put $368\frac{33}{41}$lb. of copper, $204\frac{13}{41}$lb. of brass, and $307\frac{6}{41}$lb. of tin. Others again use 100 lb. of copper, 6lb. of brass, and 9lb. of tin; and lastly, others 100lb. of copper, 10lb. of brass, and 15lb. of tin. With respect to iron guns, their structure is the same as that of the others, and they generally stand the most severe engagements, being frequently used on ship-board. Several experiments have taught us that the Swedish iron guns are preferable to all others.

Cannons are distinguished by the diameters of the balls they carry. The rule for their length is, that it be such as that the whole charge of powder be on fire before the ball quits the piece. If it be too long, the quantity of air to be driven out before the ball, will give too much resistance to the impulse; and that impulse ceasing, the friction of the ball against the surface of the piece will take off from the motion.

In former days, cannon were made much longer than they are now; but experience has taught us, that a ball moves with a greater impetus through a less space than a greater: and accordingly it is found that an iron ball of 48 pound weight goes farther from a short cannon than another ball of 96 pound out of a longer piece; whereas, in other respects, it is certain, the larger the bore and ball, the greater the range. But for the range of a cannon, see PROJECTILE. It is found, too, by experience, that of two cannons of equal bore, but different lengths, the longer requires a greater charge of powder than the shorter. The ordinary charge of a cannon is, for the weight of its gunpowder to be half that of its ball. See FOUNDING.

CANON, in an ecclesiastical sense, a law, rule, or regulation, of the policy and discipline of a church, made by councils, either general, national, or provincial.

CANONS *of the apostles*, a collection of ecclesiastical laws, which, though very antient, were not left us by the apostles. It is true, they were sometimes called apostolic canons; but this means no more than that they were made by bishops who lived soon after the apostles, and were called apostolical men. They consist of regulations, which agree with the discipline of the second and third centuries. The Greeks generally count eighty-five, but the Latins receive only fifty, nor do they observe all these.

CANON *of mass*, in the Romish church, the name of a prayer which the priest reads low to himself, the people kneeling.

CANON, in arithmetic, algebra, &c. is a rule to solve all things of the same nature with the present inquiry; thus, every last step of an equation in algebra, is such a canon; and, if turned into words, is a rule to solve all questions of the same nature with that proposed.

The tables of logarithms, artificial sines and tangents, are called likewise by the name of canon.

CANON-*law*, a collection of ecclesiastical laws, serving as the rule and measure of church government. The power of making laws was exercised by the church before the Roman empire became christian. The ca-

non-law that obtained throughout the west, till the twelfth century, was the collection of canons made by Dionysius Exiguus in 520, the capitularies of Charlemagne, and the decrees of the popes, from Sircius to Anastasius.

The canon-law, even when papal authority was at its height in England, was of no force when it was found to contradict the prerogative of the king, the laws, statutes, and customs of the realm, or the doctrine of the established church. The ecclesiastical jurisdiction of the see of Rome in England, was founded on the canon-law; and this created quarrels between kings and several archbishops and prelates, who adhered to the papal usurpation. Besides the foreign canons, there were several laws and constitutions made here for the government of the church; but all these received their force from the royal assent: and if, at any time, the ecclesiastical courts did, by their sentence, endeavour to enforce obedience to such canons, the courts at common law, upon complaints made, would grant prohibitions. The authority vested in the church of England of making canons was ascertained by a statute of Henry VIII., commonly called the act of the clergy's submission; by which they acknowledged that the convocation had been always assembled by the king's writ; so that though the power of making canons resided in the clergy met in convocation, their force was derived from the authority of the king's assenting to, and confirming them. The old canons continued in force till the reign of James I., when the clergy being assembled in convocation, the king gave them leave to treat and consult upon canons, which they did, and presented them to the king, who gave them the royal assent. These were a collection out of the several preceding canons and injunctions. Some of these canons are now obsolete. In the reign of Charles I. several canons were passed by the clergy in convocation.

CANOPUS, in astronomy, a star of the first magnitude in the rudder of Argo, a constellation of the southern hemisphere.

CANTAR, or CANTARO, in commerce, a weight used in Italy, particularly at Leghorn. There are three sorts: one weighs 150 pounds, the other 151, and the third 160. The first serves to weigh alum and cheese; the second is for sugar; and the third for wool and cod-fish. The word is used also as a measure of capacity used at Cochin, and containing four rubis.

CANTATA, in music, a song or composition, intermixed with recitatives, airs, and different movements, chiefly intended for a single voice.

CANTEENS, tin or wooden vessels used by soldiers on a march, &c. to carry water or other liquor in; each holds about two quarts. Wooden canteens are in general use with the British army: they are made cylindrical, like barrels, 7½ inches in diameter, and about four inches in length. They are chiefly manufactured by Mr. George Smart, of Camden Town.

CANTHARIS, in zoology, a genus of coleopterous insects, with setaceous antennæ, the exterior wings of which are flexile, the thorax somewhat flatted, and the sides of the abdomen plicated. Linnæus enumerates 27 species of the cantharis, most of them to be found in different parts of Europe.

For the cantharis, usually called Spanish flies with us, see MELOE.

CANTHI, see ANATOMY.

CANTO, in music, the treble or at least the higher part of a piece.

CANTONED, in architecture, is when the corner of a building is adorned with a pilaster, an angular column, rustic quoins, or any thing that projects beyond the naked of a wall.

CANTONED, or CANTONIZED, *cantonée*, in heraldry, the position of such things as are borne with a cross, &c. between. He bears gules, a cross argent cantoned with four scallop-shells.

CANTRED, or CANTREF, signifies an hundred villages; being a British word, compounded of the adjective *cant*, i. e. hundred, and *tref*, a town or village. In Wales, some of the counties are divided into cantreds, as in England into hundreds.

CANVASS, in commerce, a very clear unbleached cloth of hemp or flax, woven very regularly in little squares. It is used for working tapestry with the needle, by passing the threads of gold, silver, silk, or wool, through the intervals or squares. It is also a coarse cloth of hemp, unbleached, somewhat clear, which serves to cover women's stays, also to stiffen men's clothes, and to make some other of their wearing apparel, &c. It is also used to make sails for shipping, &c.

CANZONE, in music, signifies in general a song where some little figures are introduced; and

CANZONETTA is a diminutive of the same.

CAOUTCHOUC. About the beginning of the 18th century, a substance called caoutchouc was brought as a curiosity from America. It was soft, very elastic, and combustible. The pieces of it that came to Europe were usually in the shape of bottles, birds, &c. This substance is very much used in rubbing out the marks made upon paper by a black-lead pencil; and therefore in this country it is often called Indian rubber. Nothing was known of its production, except that it was obtained from a tree, until the French academicians went to South America in 1735, to measure a degree of the meridian. Mr. de la Condamine sent an account of it to the French academy, in the year 1736. He told them, that there grew in the province of Esmeraldas, in Brazil, a tree, called by the natives *hhevé*; that from this tree there flowed a milky juice, which, when inspissated, was caoutchouc.

It is now known that there are at least two trees in South America, from which caoutchouc may be obtained; the hævea caoutchouc and the jatropha elastica: and it is exceedingly probable that it is extracted also from other species of hævea and jatropha. Several trees, likewise, which grow in the East Indies, yield caoutchouc. When any of these plants is punctured, there exudes from it a milky juice, which, when exposed to the air, gradually lets fall a concrete substance, which is caoutchouc.

If oxymuriatic acid is poured into the milky juice, the caoutchouc precipitates immediately, and, at the same time, the acid loses its peculiar odour. This renders it probable that the formation of the caoutchouc is owing to its basis absorbing oxygen. If the milky juice is confined in a glass vessel containing common air, it gradually absorbs oxygen, and a pellicle of caoutchouc appears on its surface.

Caoutchouc, when pure, is of a white colour, and without either taste or smell. The blackish colour of the caoutchouc of commerce, is owing to the method employed in drying it after it has been spread upon moulds. The usual way is to spread a thin coat of the milky juice upon the mould, and then to dry it by exposing it to smoke; afterwards another coat is spread on, which is dried in the same way. Thus the caoutchouc of commerce consists of numerous layers of pure caoutchouc alternating with as many layers of soot. It is soft and pliable: it is exceedingly elastic and adhesive; so that it may be forcibly stretched out much beyond its usual length, and instantly recover its former bulk when the force is withdrawn. It cannot be broken without very considerable force. Its specific gravity is 0.9335. It is not altered by exposure to the air; it is perfectly insoluble in water; but if boiled for some time, its edges become somewhat transparent, owing undoubtedly to the water carrying off the soot; and so soft, that when two of them are pressed and kept together for some time, they adhere as closely as if they formed one piece. By this contrivance pieces of caoutchouc may be soldered together, and thus made to assume whatever shape we please. Caoutchouc dissolved in ether may be employed to make instruments of different kinds, just as the milky juice of the hævea; but this method would be a great deal too expensive for common use.

Caoutchouc is soluble in volatile oils; but, in general, when these oils are evaporated, it remains somewhat glutinous; and therefore is scarcely proper for those uses to which, before its solution, it was so admirably adapted. It is also soluble in alkalies. When exposed to heat, it readily melts; but it never afterwards recovers its properties, but continues always of the consistence of tar. It burns very readily with a bright white flame, and diffuses a fetid odour. In the countries where it is found, it is frequently used by way of candle. When distilled, it gives out ammonia: from this, and from the effect of sulphuric and nitric acid upon it, there is no doubt that it is composed of carbon, hydrogen, azote, and oxygen; but the modes of their combination are unknown.

CAP *of maintenance*, one of the regalia or ornaments of state belonging to the kings of England, before whom it was carried at the coronation, and other great solemnities. Caps of maintenance are also carried before the mayors of the several cities in England.

CAP, in a ship, a square piece of timber put over the head or upper end of any mast, having a round hole to receive the mast. By means of these caps, the top-masts and top-gallant-masts are kept steady and firm in the tressel-trees where their feet stand.

CAP *of a gun*, a piece of lead which is put over the touch-hole of a gun, to keep the priming from being wasted or spoiled.

CAPE, in law, a judicial writ concerning plea of lands or tenements, and divided into cape magnum and cape parvum, both of which affect things immoveable; and besides these there is a cape *ad valenciam*.

CAPE *magnum*, is designed to lie where a

person has brought a *præcipe quod reddat* of a thing that touches a plea of land, and the tenant makes default at the day given to him in the original writ; then this writ shall go for the king, to take the land into his hands: and if he comes not at the day given him, he loses his land, &c.

CAPE *parvum*, called petit-cape, is defined thus: When the tenant is summoned in plea of land, and cometh at the summons, and his appearance is recorded; and after he maketh default at the day that is given to him, then this writ shall go for the king.

CAPE *ad valenciam*, is a species of cape *magnum*, where one being impleaded, and on a summons to warrant lands, a vouchee does not come at the day; whereupon if the demandant recovers of the tenant, he shall have this writ against the vouchee, and recover so much in value of his lands, in case he has so much; and if not, there shall be an execution of such lands and tenements as shall after descend to him in fee; or if he purchases afterwards, there may be a regular summons, &c. against him.

CAPELLA, in astronomy, a bright fixed star in the left shoulder of the constellation Auriga. It is, in the Britannic catalogue, the fourteenth in order of that constellation. *Its longitude* is 17° 31′ 41″; its latitude 22° 51′ 47″.

CAPER, see CÁPPARIS.

CAPHAR, a duty which the Turks raise on the Christians who carry or send merchandizes from Aleppo to Jerusalem and other places in Syria.

CAPI-AGA, or CAPOU-AGASSI, a Turkish officer, who is grand-master of the seraglio.

CAPIAS, in law, is a writ of two sorts, one whereof is called *capias ad respondendum, before* judgment; where an original is sued out, &c. to take the defendant and make him answer the plaintiff: and the other a writ of execution, *after* judgment, being of divers kinds.

CAPIAS *ad respondendum*, is a writ commanding the sheriff to take the body of the defendant, if he may be found in his bailiwic, or county, and him safely to keep, so that he may have him in court on the day of the return, to answer to the plaintiff of a plea of debt or trespass, or the like, as the case may be. And if the sheriff return that he cannot be found, then there issues another writ, called an *alias capias;* and after that another, called a *pluries capias;* and if upon none of these he can be found, then he may be proceeded against to outlawry. But all this being only to compel an appearance, after the defendant has appeared the effect of these writs is taken off, and the defendant shall be put to answer, unless in cases where special bail is required, and there the defendant is actually to be taken into custody. 3 *Blacks.* 212.

CAPIAS *ad satisfaciendum*, is a writ directed to the sheriff, commanding him to take the body of the defendant, and him safely to keep, so that he may have his body in court at the return of the writ, to make the plaintiff satisfaction for his demand: otherwise he is to remain in custody till he does. When a man is once taken in execution upon this writ, no other process can be sued out against his lands or goods. But if a defendant dies whilst charged in execution upon this writ, the plaintiff may, after his death, sue out new executions against his lands, goods, or chattels. 3 *Blacks.* 415.

CAPIAS *utlegatum*, is a writ that lies against a person that is outlawed in any action, whereby the sheriff is commanded to apprehend the body of the party outlawed, and keep him in safe custody till the day of the return of the writ, and then present him to the court, there to be dealt with for his contempt. But this being only for want of appearance, if he shall afterwards appear, the outlawry is most commonly reversed. 3 *Blacks.* 284.

CAPIAS *in withernam*, is a writ directed to the sheriff, in case where a distress is carried out of the county, or concealed by the distrainer, so that the sheriff cannot make deliverance of the goods upon a replevin; commanding him to take so many of the distrainer's own goods, by way of reprisal, instead of the other that are so concealed.

CAPILLARY *tubes*, in physics, little pipes, whose canals are extremely narrow, their diameter being only a half, third, or fourth of a line. See ATTRACTION.

CAPILLARY *vessels*. See ANATOMY.

CAPISTRUM. See SURGERY.

CAPITAL, in architecture, the uppermost part of a column or pilaster, serving as the head or crowning, and placed immediately over the shaft, and under the entablature. See ARCHITECTURE.

CAPITATION, a tax or imposition raised on each person in consideration of his labour, industry, office, rank, &c. commonly called a poll-tax.

CAPITULATION, in the German polity, a contract which the emperor makes with the electors in the name of all the princes and states of the empire, before he is declared emperor, and which he ratifies before he is raised to that sovereign dignity. The principal points which the emperor undertakes to observe, are, 1. To defend the church and the empire. 2. To observe the fundamental laws of the empire. 3. To maintain and preserve the rights, privileges, and immunities, of the electors, princes, and other states of the empire, specified in the capitulation. These articles and capitulations are presented to the emperor by the electors only, without the concurrence of the other states, who have complained from time to time of such proceedings: and in the time of the Westphalian treaty, in 1648, it was proposed to deliberate in the following diet upon a way of making a perpetual capitulation; but the electors have always found means of eluding the execution of this article. In order, however, to give some satisfaction to their adversaries, they have inserted in the capitulations of the emperors, and in that of Francis I. in particular, a promise to use all their influence to bring the affair of a perpetual capitulation to a conclusion. Some German authors own that this capitulation limits the emperor's power; but maintain, that it does not weaken his sovereignty: though the most part maintain, that he is not absolute, because he receives the empire under conditions which sets bounds to an absolute authority.

CAPOC, a sort of cotton as soft as silk, so fine and so short that it cannot be spun. It is used in the East Indies, as well as in Europe, to line palanquins, to make beds, mattresses, cushions, pillows, &c.

CAPONIERE, or CAPONNIERE, a work sunk on the glacis of a place, about four or five feet deep. The earth that comes out of it serves to form a parapet of two or three feet high, made with loop-holes or small embrasures: it is covered overhead with strong planks, on which are laid clays or hurdles, which support the earth that covers all. It holds 15 or 20 men, who fire through these embrasures. They are also sometimes made in the bottom of a dry moat.

CAPPADINE, a sort of silk flock, taken from the upper part of the silkworm-cod, after the true silk has been wound off.

CAPPARIS, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking under the 25th order, putamineæ. The calyx is tetraphyllous and coriaceous; the petals are four, the stamina are long; the fruit is a berry, carnous, unilocular, and pedunculated, or furnished with a footstalk. There are 25 species, of which the principal is,

Capparis spinosa, or common caper, a low shrub, generally growing out of the joints of old walls or fissures of rocks in the warm parts of Europe. This plant is with great difficulty preserved in England. The pickle made from its berry is well known.

CAPRA, the GOAT-KIND, in zoology, constitutes a genus of quadrupeds, of the order of pecora. The generic character is, horns hollow, turning upwards and backwards, compressed, rough, almost close at their base. Front-teeth in the lower jaw eight. Canine-teeth, or tusks, none. Chin bearded in the male. There are nine species and varieties:

1. CAPRA IBEX. This, which is the common Ibex or Steinbock of authors, appears to have been sometimes confounded with the Caucasan Ibex, or next species, to which it is much allied. It is found in several parts of Europe and Asia. It inhabits the Carpathian and Pyrenæan mountains, and various parts of the Alps, more particularly the Rhætian Alps, in the midst of snow and glaciers. In Asia it occurs on the summits of the chain of mountains extended from Taurus, and continued between eastern Tartary and Siberia. It also inhabits the tract beyond the Lena, and in all probability may be a native of Kamtschatka. In Arabia, it inhabits the province of Hedsjaes, and is there known by the name of Baeden. Lastly, it is found in the high mountains of the island of Crete, where the Caucasan ibex has also been discovered.

It is an animal of great strength and agility, and is considerably larger than a common domestic goat. Its colour is a deep hoary or greyish brown; much paler or whitish beneath, and on the insides of the limbs; the body is of a thick, strong form; the head rather small, the eyes large, and the horns extremely large and long, so as sometimes to measure three feet in length, and to extend the whole length of the body.

In its general habits or manners the ibex resembles the common goat; but possesses every attribute of strength and activity in a degree proportioned to its natural state of wildness. It is even said, that, when hard-pressed, this animal will fling itself down a steep precipice, and falling on its horns, escape unhurt from its pursuers; nor will this appear in the least incredible, if we may rely on the faith of Monardes, who assures us that he saw a Caucasan ibex leap from

the top of a high tower, and fall ing on is horns, immediately spring up on its limbs and leap about without having received the least apparent injury. See Plate Nat. Hist. fig. 90.

The flesh of the young ibex is said to be in good esteem as an article of food. Its period of gestation is said to be the same as in the common goat, viz. five months.

2. CAPRA ÆGAGRUS, or CAUCASAN IBEX, supposed to be the stock or origin of the domestic goat, is considerably superior to that animal in size, and its form in some degree resembles that of a stag. Its general colour is a brownish or subferruginous grey above, and white beneath; the forehead is nearly black, which colour is continued down the back in the form of a list or stripe: the chin is furnished with a large brownish beard, and the horns, which are very large, and bend considerably backwards, are smooth, black, and sharply ridged on their upper part. The female is destitute both of horns and beard.

In point of strength and agility this species is at least equal, if not superior, to the common ibex; it inhabits the loftiest rocky points of mount Caucasus, and particularly the parts about the rivers Kuban and Terek; almost all Asia Minor, and may probably extend even to India. It is said to abound on the hills of Laar and Chorazan, in Persia.

3. CAPRA HIRCUS, or COMMON GOAT, in its domestic state, is found in almost every part of the globe, bearing the extremes of heat and cold, and differing in size and form according to various circumstances. It may be observed, that the horns have generally a curvature outwards towards the tips; and it may be added, that the animal was entirely unknown to the Americans on the discovery of that continent, having been introduced by the Europeans.

The colour of the domestic goat is various, being either black, brown, white, or spotted. The flesh is of great use to the inhabitants of Wales, and affords them a cheap and plentiful provision in the winter months, when the kids are brought to market: the haunches are often dried and salted, and used as a substitute for bacon. The skin of the goat is peculiarly well adapted for the glove-manufactory, especially that of the kid; and as it takes a dye better than any other skin, it was formerly much used for hangings in the houses of people of fortune; being susceptible of the richest colours. The goat goes with young four months and a half. The skin of the Chamois goat is also in high esteem for fine leather. See Plate Nat. Hist. fig. 91.

The following are the most remarkable varieties of the domestic goat.

1. Capra mambrica, or Syrian goat, is distinguished by the great length of the ears, which are pendulous, like those of a hound, and sometimes reach so low as to be troublesome to the animal while feeding. 2. Capra Angorensis, Angora goat, is generally of a beautiful milk-white colour, short-legged, with black, spreading, spirally twisted horns, and with the hair on the whole body disposed in long pendant spiral ringlets. It is from the hair of this animal that the finest camlets, &c. are prepared. 3. Capra depressa, or African goat, is a very small or dwarf variety, found in some parts of Africa. 4. Cepra reversa, or Whidaw goat. This is also a dwarf variety, found in Africa, where its flesh is considered as an excellent food. 5. Long-horned Whidaw goat. 6. Capricorn goat.

CAPRARIA, SWEET-WEED, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The calyx is quinquepartite; the corolla is campanulated, quinquefid, with acute segments; the capsule bivalved, bilocular, and polyspermous. There are five species.

CAPRICORN, in astronomy, one of the twelve signs of the zodiac, represented in globes in the form of a goat, and characterised in books by this mark ♑.

It is the tenth sign in order, and contains twenty-eight stars according to Ptolemy and Tycho Brahe; twenty-nine, according to Hevelius; and fifty-one according to Flamsteed.

Tropic of CAPRICORN, a lesser circle of the sphere, which is parallel to the equinoctial, and at 23° 30′ distance from it southwards.

CAPRIMULGUS, goat-sucker, a genus of birds belonging to the order of passeres. The beak is incurvated, small tapering, and depressed at the base: the mouth opens wide. There are two species: 1. The Europæus, with the tubes of the nostrils hardly visible, which feeds on moths, gnats, &c. It appears in May, and leaves us in August. 2. The Americanus, a night bird, found in America. See Plate Nat. Hist. fig. 81.

CAPSICUM, in botany, GUINEA PEPPER, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 28th order, luridæ. The corolla is verticillated, and the fruit is a sapless berry. There are five species, the principal are:

1. Capsicum annuum, the common long-podded capsicum, commonly cultivated in the gardens. Of this there is one variety with red and another with yellow fruit; and of these there are several sub-varieties, differing only in the size and figure of their fruit.

2. Capsicum baccatum, bird pepper, rises with a shrubby stalk four or five feet high; the leaves are of a lucid green; the fruit grows at the division of the branches, standing erect: these are small, oval, and of a bright red; they are much more sharp and biting than those of the other sorts. This is the Cayenne pepper.

3. Capsicum grossum, the bell pepper. The fruit of this is red, and is the only kind proper for pickling, the skin being tender, whereas those of the other sorts are thin and tough.

CAP-SQUARES, in gunnery, strong plates of iron which come over the trunnions of a gun, and keep it in the carriage.

CAPSTAN, or MAIN-CAPSTAN, in a ship, a large piece of timber in the nature of a windlass, placed next behind the main-mast, its foot standing in a step on the lower deck, and its head between the upper decks, formed into several squares with holes in them. Its use is to weigh the anchors, to hoist up or strike down top-masts, to heave any weighty matter, or to strain any rope that requires a main force.

CAPSTAN *Jear* is placed between the main-mast and the mizen, and serves to strain any rope, heave upon the jear-rope or upon the viol, or hold off by at the weighing of an anchor.

CAPSULE, among botanists, a species of pericarpium or seed-vessel.

CAPSULÆ ATRABILIARIÆ, called also glandulæ renales, and renes succenturiati, are two yellowish glands of a compressed figure, lying on each side of the upper part of the kidneys. See ANATOMY.

CAPTION, in law, is where a commission is executed, and the commissioners subscribe their names to a certificate, declaring when and where the commission was executed. It relates chiefly to commissions to take answers in chancery and depositions of witnesses, and take fines of lands, &c.

CAPTION and HORNING, in the law of Scotland. When a decrete or sentence is obtained against any person, the obtainer takes out a writ, whereby the party decerned is charged to pay or fulfil the will of the decrete, under the pain of rebellion: this writ is called letters of horning. If he refuses to comply, then the writ or letters of caption may be raised, whereby all the inferior judges and magistrates are commanded to assist in apprehending the rebel, and putting him in prison.

CAPURA, a genus of the class and order hexandria monogynia. The essential character is, cal. none; cor. six-cleft; stam. within the tube; germ. superior; stigma globular; per. berry. There is one species, a native of the East Indies.

CAPUT DRACONIS, the DRAGON'S HEAD, in astronomy, the ascending node of the moon. It is also a star of the first magnitude, in the head of the constellation Draco.

CAPUT MORTUUM, in chemistry, that thick dry matter, which remains after distillation of any thing, but of minerals especially. See CHEMISTRY.

CARABINE, a fire-arm, shorter than a musket, carrying a ball of twenty-four in the pound, borne by the light horse, hanging at a belt over the left shoulder.

CARABUS, in zoology, a genus of insects belonging to the order of coleoptera, or the beetle kind. The feelers are bristly; the breast is shaped like a heart, and marginated, and the elytra are likewise marginated. There are 34 species of this genus, mostly distinguished by their colour. The most remarkable is the crepitans, or bombardier, with the breast, head, and legs ferruginous, or iron-coloured, and the elytra black. It keeps itself concealed among stones, and makes but little use of its wings; when it moves it is by a sort of jump; and whenever it is touched, it makes a noise resembling the discharge of a musket in miniature, during which a blue smoke may be perceived proceeding from it. The insect may be made to play off its artillery, by scratching its back with a needle. A bladder placed near the anus, is the arsenal whence it derives its store, and this is its chief defence against an enemy; but the smoke emitted seems altogether inoffensive, except by causing a fright, though it is useful to the insect by concealing its course. Its chief enemy is another species of the same genus, but four times larger. When pursued and fatigued, the bombardier has recourse to stratagem, by lying down in the path of the large carabus, which advances with open mouth and claws to seize it; but, on the discharge of the artillery, suddenly draws back, and remains a while confused, during which the bombar

82

Canis aureus.
Jackall

83

Canis vulpes.
Fox

84

Canis lupus.
Wolf

85

Newfoundland Dog

86

Mastiff

87

Bull Dog

88

Coach Dog

89

Greyhound

91

Chamois Goat

90

Ibex

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Heath Sc

dier conceals himself, in some crevice if there is one; but if not, the larger carabus renews the attack, takes his prisoner by the head and tears it off.

CARACOL, in architecture, denotes a stair-case in a helix or spiral form.

CARACT, CARAT, or CARRAT, the name of that weight which expresses the degree of fineness that gold is of. The mint-master, or custom, has fixed the purity of gold at 24 caracts; though it is not possible so to purify and refine that metal, but it will want still about one fourth part of a caract in absolute purity and perfection. The caract is divided into $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$. These degrees serve to distinguish the greater or lesser quantity of alloy therein contained: for instance, gold of 22 caracts, is that which has two parts of silver, or of any other metal, and 22 of fine gold.

It is also a certain weight which goldsmiths and jewellers use with which to weigh precious stones and pearls. This caract weighs four grains, but something lighter than the grains of other weights. Each of these grains is subdivided into $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, &c.

CARAGROUTH, in commerce, a silver coin of the empire, weighing nine drachms. It goes at Constantinople for 120 aspers.

CARBON, or the radical of carbonic acid, has not, unless the diamond is admitted as such, been yet obtained in a separate state: charcoal, which was once so esteemed, appearing to be a compound substance. Nor is it ever found united with caloric, in a gaseous state, unaccompanied by some third principle. Its taste, smell, and colour are unknown. It is infusible and indissoluble by caloric, and is hence esteemed the most refractory substance in nature. It has no evident attraction for nitrogen alone, but combines with it by the intervention of other principles. With hydrogen it has a strong affinity, uniting and forming a gas termed carbonated hydrogen; hydrogen gas having the power of holding it in solution.

The diamond, which exceeds all other gems in hardness, density, and refraction of the rays of light, crystallizes in two tetrahedral and trihedral pyramids, united base to base, or in hexahedral prisms terminating in trihedral summits, or in irregular polyhedral grains. At a very high temperature it burns, becomes black and opaque, and is converted into gas. Sp. gr. about 3,5.

Newton conjectured the diamond to be a combustible body. Guyton, in 1785, inferred its similarity to charcoal, from its leaving an effervescent alkali, after combustion in fused nitre. Lavoisier found that on burning it in closed vessels, it yielded carbonic acid. This has also been proved by Mr. Tennant, who performed the combustion in a crucible of gold. Berthollet considered it as crystallized charcoal.

Since this, Guyton, having burnt the diamond in oxygen gas, by the solar rays, and thereby having obtained carbonic acid without residue, presumed that he had ascertained the diamond to be pure carbon, or the pure combustible matter of the carbonic genus, yielding the pure acidifiable basis of the carbonic acid. He found its combustion required a much higher temperature than charcoal; but this, he observes, takes place with other acidifiable bases, their first degrees of oxydation being difficultly produced, although their subsequent acidification is easy. It also required more oxygen for its complete combustion than charcoal; one part of diamond absorbing four of oxygen, and producing five of carbonic acid; this he remarks is not to be wondered at, since being pure carbon, it contains none of the oxygen principle, and therefore demands more. In proportion therefore as substances contain pure combustible matter, will, in fact, be the difficulty of their combustion, their first degrees of oxygenation proceeding so slowly. Thus he accounts for plumbago, or black lead, which is a carbonic combustible, richer in combustible matter than charcoal itself, not burning, but at a very high degree of temperature: and thus he accounts for the incombustibility of anthracolite, Kilkenny coal, the brilliant charcoal of certain vegetables, &c. The diamond is therefore to be considered as pure carbon; plumbago, carbon oxygenized in the first degree; charcoal, an oxyd of the second, obtained from various substances in the animal, vegetable, and mineral kingdoms, generally by volatilizing their other constituent parts. When obtained in a state of purity, it resists the strongest heat in closed vessels. It decomposes sulphuric acid, from its affinity with oxygen exceeding that of sulphur. It decomposes nitric acid with great rapidity; and if the charcoal is first powdered, and the acid strong, and allowed to run down the side of the vessel, to mix with the charcoal, it burns with rapidity, with a beautiful flame, throwing up the powder so as to resemble a beautiful fire-work. With nitrate of pot-ash, it detonates in a hot crucible, leaving a fixed alkali behind. It is dissolved by the alkalies, and by the sulphurets of alkali, both in the dry and moist way. It does not unite with metals, but restores their oxyds to a metallic state.

Charcoal possesses the power of absorbing several gases, which thus condensed retain their properties, and even exert them in some instances more powerfully. It decomposes water at the common temperature, carbonic acid and carbonated hydrogen being separated. If burnt in contact with common air, its acidifiable base attracts oxygen, and this peculiar acid is formed, which, with a certain proportion of caloric, assumes a gaseous form. If burnt in oxygen gas, its peculiar acid is plentifully formed, the charcoal burning with considerably increased rapidity, and if the lighter charcoal made from bark is used, a very brilliant effect is produced from the numerous vivid corruscating sparks.

CARBONATES, are neutral salts, composed of the carbonic acid, and certain bases: thus carbonate of ammonia, or mild volatile alkali, consists of carbonic acid and pure or caustic ammonia. Owing to the weakness of this acid, the characters of their bases are generally most predominant.

The carbonates are not acted on by light, oxygen, or nitrogen; nor do they deliquesce with the moisture of the atmosphere. Although charcoal decomposes the phosphoric acid alone, the carbonates are decomposed by phosphorus; this difference arises from the attraction which the phosphoric acid exercises on the base of the carbonate; from similar causes the effects of different combustible bodies on them vary much. All the other acids have a greater attraction for the earthy and alkaline bases than the carbonic; that acid being disengaged from the carbonates by their addition. So feeble is this acid, that it is separated from most of its bases by heat only.

CARBUNCLE, in natural history, a very elegant gem, the colour of which is deep red, with an admixture of scarlet. See GARNET.

CARBUNCLE, or ANTHRAX, in surgery, an inflammation which arises, with a vesicle or blister, almost like those produced by burning. This inflammation, for the most part, terminates in a sphacelus, and putrifies the subjacent parts down to the bone, they becoming as black as a coal. A carbuncle always breaks out very speedily, even in the space of an hour or two, attended with heat and pain: as soon as it is opened, it discharges a livid sanies, or sometimes a limpid water: it is black within, which is a sign that the sphacelus has seized the subjacent parts, and is making its progress: but the putrid flesh in those who recover, suppurates, and parts from the sound. The size of these pestilential blisters is various, more or less; as is also their number in the patient; for there is no part of the body which they do not infest, and they generally appear in company with buboes.

Those carbuncles which arise in the face, neck, breast, or armpits, are observed to be of the worst kind, for they generally kill the patient.

In the external treatment, some of the modern physicians use only scarification in this case, with very good success; others open the eruptions with a pair of scissars, and having discharged the matter, frequently wash the carbuncle with sp. vin. camph., or sp. vin. in which has been digested a little theriaca: they afterwards apply a maturating cataplasm, which is to be continued till the carbuncle separates from the sound parts; then they cut it out all at once.

CARBUNCLE, in heraldry, a charge or bearing consisting of eight radii, four whereof make a common cross, and the other four a saltier.

CARCASS, a composition of combustibles. Carcasses are of two sorts, oblong and round: the uncertain weight of the first sort has almost rendered them useless. They are prepared in the following manner: Boil 12 or 15lb. of pitch in a glazed earthen pot; mix with that 3lb. of tallow, 30lb. of powder, 6lb. of saltpetre, and as many stopins as can be put in. Before the composition is cold, the carcass must be filled; to do which, smear your hands with oil or tallow, and fill the carcass one-third full with the above composition; then put in loaded pieces of gun or pistol barrels, loaded grenades, and fill the intervals with composition; cover the whole over with coarse cloth, well sewed together, keeping it in a round form. Then put it into the carcass, having a hollow top and bottom, with bars running between them to hold them together, and composed of four slips of iron jointed at top, and fixed at the bottom, at equal distances, to a piece

of iron, which, together with the hoops, when filled, form a complete globular body. When quite finished and cold, the carcass must be steeped in melted pitch, and then instantly immerged in cold water. Lastly, bore three or four holes at top, and fill the same with fuse composition, covering the holes with pitch until used. Carcasses are thrown out of mortars, and weigh from 50 to 230lb. according to the size of the mortars they are to be thrown out of. There are other carcasses for the sea-service, which differ from a shell only in the composition, and in the four holes from which they burn when fired.

CARCASSES were first used by the bishop of Munster, at the siege of Groll in 1672, where the duke of Luxemburg commanded.

CARCERES, in the antient circensian games, were inclosures in the circus, in which the horses were restrained till the signal was given for starting, when, by an admirable contrivance, they all at once flew open.

CARD, among artificers, an instrument consisting of a block of wood, beset with sharp teeth, serving to arrange the hairs of wool, flax, hemp, and the like: there are different kinds of them, as hand-cards, stock-cards, &c.

CARDS, among gamesters, little pieces of fine thin pasteboard of an oblong figure, of several sizes, but most commonly in England $3\frac{1}{2}$ inches long, and $2\frac{1}{2}$ broad, on which are painted several points and figures. The moulds and blocks for making cards, are exactly like those that were used for the first books: they lay a sheet of wet or moist paper on the block, which is first slightly done over with a sort of ink made with lamp-black diluted in water, and mixed with some starch to give it a body. They afterwards rub it off with a round list. The court-cards are coloured by means of several patterns, stiled stane-files. These consist of papers cut through with a pen-knife, and in these apertures, they apply severally the various colours, as red, black, &c. These patterns are painted wi h oil-colours, that the brushes may not wear them out; and when the pattern is laid on the pasteboard, they slightly pass over it a brushful of colour, which, leaving it within the openings, forms the face or figure of the card.

CARDAMINE, lady's smock; a genus of the siliquosa order, in the tetradynamia class of plants; and in the natural method ranking under the 39th order, siliquosa. The siliqua parts asunder with a spring, and the valves roll spirally backward; the stigma is entire, and the calyx a little gaping. Of this there are 18 species; but the most remarkable is the

Cardamine pratensis, with a large purplish flower. It grows naturally in many parts of Britain, and is also called cuckow-flower. There are four varieties, viz. the single, with purple and white flowers, which are frequently intermixed in the meadows; and the double of both colours. The single sorts are not admitted into gardens; but the double deserve a place, as making a pretty appearance during the time they are in flower.

CARDAMOM, see AMOMUM and MATERIA MEDICA.

CARDIA, or CARDIUM, in natural history, a genus of the vermes testaceæ, or shell-fish, the shell of which is formed of two ovals, and resembles the figure of a heart at cards: the valves are equal and gibbose.

Of this genus there are 21 species, some nearly globose, others of a triangular figure, and others irregularly oblong. Under this genus are comprehended the cockles, ark-shells, &c. together with the pectini inauriti, or scallops without ears, as they are called.

CARDIAC, an appellation given to such medicines as preserve or increase the strength of the heart, and by that means the vital forces, though they do not immediately operate upon the heart, nor are particularly appropriated to the corroboration of that part. See MATERIA MEDICA.

CARDIALGIA, the heartburn, in medicine, a disorder of the stomach attended with anxiety, a nausea, and often a reaching or actual vomiting. See MEDICINE.

CARDINAL, an ecclesiastical prince in the Romish church, being one who has a voice in the conclave at the election of a pope. The cardinals were originally nothing more than deacons, to whom was entrusted the care of distributing the alms to the poor of the several quarters of Rome; and as they held assemblies of the poor in certain churches of their several districts, they took the title of these churches. They began to be called cardinals in the year 300, during the pontificate of St. Sylvester, by which appellation were meant the chief priests of a parish, and next in dignity to a bishop. This office grew more considerable afterwards, and by small degrees arrived at its present state.

The cardinals compose the pope's council, and till the time of Urban VIII. were styled most illustrious; but by a decree of that pope in 1630, they had the title of eminence conferred upon them. At the creation of a new cardinal, the pope performs the ceremony of shutting and opening his mouth, which is done in a private consistory. The shutting his mouth, implies the depriving him of the liberty of giving his opinion in congregations; and the opening his mouth, which is performed fifteen days after, signifies the taking off this restraint. However, if the pope happens to die during the time a cardinal's mouth is shut, he can neither give his voice in the election of a new pope, nor be himself advanced to that dignity.

The cardinals are divided into six classes or orders, consisting of six bishops, fifty priests, and fourteen deacons, making in all seventy; which constitute the sacred college. The number of cardinal bishops has very seldom been changed, but that of priests and deacons has varied at different times. The privileges of the cardinals are very great: they have an absolute power in the church during the vacancy of the holy see: they have a right to elect the new pope, and are the only persons on whom the choice can fall: most of the grand offices in the court of Rome, are filled by cardinals. The dress of a cardinal is a red soutanne, a rochet, a short purple mantle, and the red hat. When they are sent to the courts of princes, it is in quality of legates a latere; and when they are appointed governors of towns, their government is called by the name of legation.

CARDIOID, in the higher geometry, an algebraical curve so called from its resemblance to a heart.

The Cardioid is thus generated. APB, Plate Miscell. fig. 11. is a circle and AB its diameter. Through one extremity A of the diameter draw a number of lines APQ, cutting the circle in P; upon these set off always PQ equal to the diameter AB; so shall the points Q be always in the curve of the cardioid.

From this generation of the curve its chief properties are evident, viz. that,

every where $PQ = AB$,

CQ, or QQ is $= A\,a$ or $2\,AB$,

$AQ = AB \pm AP$.

P always bisects QQ.

The cardioid is an algebraical curve, and the equation expressing its nature is thus:

Put $a = AB$ the diameter,

$z = aD$ perp. AB,

$y = DQ$ perp. AD; then is

$$y^4 - 6ay^3 + 2z^2y^2 - 6az^2y + z^4 + 12a^2y^2 - 8a^3y + 3a^2z^2 \Big\} = 0,$$

which is the equation of the curve.

Many properties of the cardioid may be seen in the Philosphical Transactions, 1741.

CARDIOSPERMUM, heart pea, a genus of the trigynia order, in the octandria class of plants, and in the natural method ranking under the 39th order, trihilatæ. The calyx is tetraphyllous; the petals four; the nectarium tetraphyllous and unequal; the capsules three, grown together, and inflated. There are three species, natives of the East and West Indies.

CARDUUS, the thistle, a genus of the polygamia æqualis order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The calyx is ovate, imbricated with prickly scales, and the receptacle hairy. Of this genus there are 51 species, ten of which are natives of Britain; and being troublesome weeds, they require no description. Some of the exotics are propagated in gardens for the sake of variety.

CARDUUS *benedictus*. See CENTAURIA and MATERIA MEDICA.

CAREENING, in the sea language, the bringing a ship to lie down on one side, in order to trim and caulk the other side. A ship is said to be brought to the careen when the most of her lading being taken out, she is hauled down on one side by a small vessel as low as necessary; and there kept by the weight of the ballast, ordnance, &c. as well as by ropes, lest her masts should be strained too much; in order that her sides and bottom may be trimmed, seams caulked, or any thing that is faulty under water mended. Hence when a ship lies on one side when she sails, she is said to sail on the careen.

CAREX, the sedge, a genus of the monœcia triandria class and order of plants, and in the natural method ranking under the 3d order, calamariæ. The characters are: the male flowers are digested into a long spike; the calyx is an oblong and imbricated amentum, consisting of acute, hollow, and lanceolated scales, each containing one flower: there is no corolla; the stamina are three erect setaceous filaments of the length of the calyx; the antheræ are oblong and erect. In the female flowers the calyx is the same as in the male; there are no petals, but there is an inflated oblong nectarium; the germen is triangular, and is placed within the nec-

tarium; the style is very short; the stigmata are two or three; long, crooked, pointed, and hoary. The nectarium grows larger when the flower is fallen, and contains the seed; which is single, of an acute ovated form, triangular, and has one of its angles usually much smaller than the others. There are 97 species. The common sedge may serve as an example for all.

CARICA, the papaw, a genus of the decandria order, belonging to the diœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ. The calyx of the male, almost none; the corolla is quinquefid and funnel-shaped; the filaments in the tube of the corolla, a longer and a shorter one alternately. The calyx of the female quinquedentated; the corolla is pentapetalous, with five stigmata; the fruit an unilocular and polyspermous berry.

1. Carica papaya rises with a thick, soft, herbaceous stem, to the height of 18 or 20 feet, naked till within two or three feet of the top. The leaves come out on every side, upon very long footstalks; in full-grown plants they are very large, and divided into many lobes deeply sinuated. The flowers of the male plant are of a pure white, and have an agreeable odour. The flowers of the female papaya are large, bell-shaped, composed of six petals, and commonly yellow: when these fall away, the germen swells to a fleshy fruit, of the size of a small melon. These fruits are of different forms: some angular, and compressed at both ends; others oval or globular, and some pyramidal. The fruit, and all the other parts of the tree, abound with a milky acrid juice, which is applied for killing of ringworms. When the roundish fruit are nearly ripe, the inhabitants of India boil and eat them with their meat as we do turnips. They have somewhat the flavour of a pompion. But they mostly pickle the long fruit, and thus they make no bad succedaneum for mango. The buds of the female flowers are gathered, and made into a sweetmeat; and the inhabitants are such good managers of the produce of the tree, that they boil the shells of the ripe fruit into a repast, and the insides are eaten with sugar and pepper, like melons. The stem being hollow, has given birth to a proverb in the West India islands, where, in speaking of a dissembling person, they say he is as hollow as a papaw.

2. Carica prosoposa, differs from the other in having a branching stalk, the lobes of the leaves entire, the flower of a rose colour, and the fruit shaped like a pear, and of a sweeter flavour than the papaya. Both species being natives of hot countries, they cannot be preserved in Britain unless constantly kept in a warm stove. They are easily propagated by seeds, which are annually brought in plenty from the West Indies, though the seeds of the European plants ripen well.

CARINA, in architecture, a name given by the Romans to all buildings in the form of a ship (from carina, the keel of a ship); as we still apply the word nave from navis, a ship, to the middle or principal vault of our churches, because it has that figure.

CARINA, in anatomy, a term used for the fibrous rudiments, or embryo of a chick, appearing in an incubated egg.

The carina consists of the intire vertebræ, as they appear after ten or twelve days incubation.

CARISSA, in botany; a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 30th order, contortæ. It has two berries, many-seeded. There are two species, trees of Africa.

CARLINA, the carline thistle: a genus of the polygamia æqualis order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The calyx is radiated with long coloured marginal scales. There are nine species; but the carlina vulgaris is the only one that is a native of Britain. All the others are natives of the south of France or Italy, and are very easily propagated in this country by seeds. The roots are used in medicine, and for that purpose are imported. As we receive them they are about an inch thick, externally of a rusty brown colour, corroded as it were on the surface, and perforated with numerous small holes, appearing as if worm-eaten. They have a strong smell, and a subacrid, bitterish, weakly aromatic taste. They are reckoned warm alexipharmics and diaphoretics.

CARLINE, or CAROLINE, a silver coin current in the Neapolitan dominions, and worth about fourpence of our money.

CARLINGS, or CARLINES, in a ship, two pieces of timber lying fore and aft, along from beam to beam, whereon the ledges rest on which the planks of the ship are fastened.

CARLOCK, in commerce, a sort of isinglass made with the sturgeon's bladder, imported from Archangel. The chief use of it is for clarifying wine; but it is also used by dyers.

CARMELITES, or WHITE-FRIARS, are an order of Our Lady of mount Carmel, making one of the four orders of mendicants. They pretend to derive their origin from the prophets Elijah and Elisha. Their original rules contained sixteen articles, one of which confined them to their cells, and enjoined them to employ themselves day and night in prayer; another prohibited the brethren having any property; another enjoined fasting, from the feast of the exaltation of the holy cross till Easter, excepting on Sundays; abstinence at all times from flesh was enjoined by another article: one obliged them to manual labour; another imposed a strict silence on them from vespers till the tierce the next day. However, these constitutions have been in some respects altered.

CARMINATIVES, in pharmacy, medicines used in colics, or other flatulent disorders, to dispel the wind. See MATERIA MEDICA.

CARMINE, a powder of a very beautiful red colour, bordering upon purple, and used by painters in miniature, though but rarely because of its great price. The mode of preparing this colour is kept from the public. The receipts which have been from time to time published concerning the preparation of this and other colours, have been rarely found to succeed in practice. It is said to be extracted from cochineal by means of water, wherein chouan and antour have been infused; some add rocou, but this gives it too much of the opal cast. Others make carmine with brasil-wood, fernambouc, and leaf-gold, beaten in a mortar, and steeped in white-wine vinegar; the scum arising from this mixture, upon boiling, when dried, makes carmine; but this kind is vastly inferior to the former. There is another carmine, made of Brasil-wood and fernambouc, by a different preparation.

CARNEDDE, in British antiquity, denotes heaps of stones supposed to be druidical remains, and thrown together on some important occasions. They are very common in the isle of Anglesey, and were also used as sepulchral monuments, in the manner of tumuli. Hence it is inferred, that the antient Britons had the custom of throwing stones on the deceased. From this custom is derived the Welsh proverb, *karn ardyben*; "Ill betide thee."

CARNEL, among ship-carpenters. The building of ships, first with their timbers and beams, and after bringing on their planks, is called carnel-work, to distinguish it from clinch-work.

CARNELIAN, *sarda*, in natural history, a precious stone, of which there are three kinds, distinguished by three colours, a red, a yellow, and a white. Authors have attributed medicinal virtues to this stone, meaning the red carnelian; this, therefore, is to be understood as the sarda, or carnelian of the shops. It is very well known among us; and is found in roundish or oval masses, much like our common pebbles; and is generally met with between an inch and two or three inches in diameter. It is of a fine, compact, and close texture, of a glossy surface; and in the several specimens is of all the degrees of red, from the palest flesh-colour to the deepest blood-red. It is generally free from spots, clouds, or variegations: but sometimes it is veined very beautifully with an extremely pale red, or with white; the veins forming concentric circles, or other less regular figures, about a nucleus, in the manner of those of agates. The pieces of carnelian which are all of one colour, and perfectly free from veins, are those which our jewellers generally make use of for seals, though the variegated ones are much more beautiful. The carnelian is tolerably hard, and capable of a very good polish: it is not at all affected by acid menstruums; the fire divests it of a part of its colour, and leaves it of a pale red; and a strong and long-continued heat will reduce it to a pale dirty grey. The finest carnelians are those of the East Indies; but there are very beautiful ones found in the rivers of Silesia and Bohemia; and we have some not despicable in England.

Though the antients have recommended the carnelian as an astringent, and attributed a number of fanciful virtues to it, we know no other use of the stone than the cutting seals on it, to which purpose it is excellently adapted, as being not too hard for cutting, and yet hard enough not to be liable to accidents, to take a good polish, and to separate easily from the wax.

According to the new arrangement in natural history, the carnelian is a variety of the chalcedony of færo, and is composed of 84 parts of silica, and 16 of alumine, mixed with iron. The name has been given to different hard stones, capable of a fine polish, but chalcedony forms the basis of the greater number. The varieties in their colours, trans-

parency, &c. have given occasion to their being known under a great variety of names.

CARNIVAL, or CARNAVAL, a time of rejoicing, a season of mirth, observed with great solemnity by the Italians, particularly at Venice, lasting from Twelfth-day till Lent. Feasts, balls, operas, concerts of music, intrigues, marriages, &c. are chiefly held in carnival time. The carnival begins at Venice the second holiday in Christmas; then it is they begin to wear masks, and open their playhouses and gaming-houses; the Place of St. Mark is filled with mountebanks, pedlars, and such-like mob, who flock thither from all parts. There have been no less than seven sovereign princes, and thirty thousand foreigners here, to partake of these diversions.

CARNIVOROUS, an appellation given to animals which naturally feed on flesh, and thence called beasts or birds of prey. Some will have it, that no quadrupeds are naturally carnivorous but those furnished with canine or dog-teeth: on which principle mankind are excluded out of the number of naturally carnivorous animals; and, in fact, animal food must undergo various preparations before it is fit for the use of man.

CAROLINE-BOOKS, the name of four books, composed by order of Charlemagne, to refute the second council of Nice. These books are couched in very harsh and severe terms, containing one hundred and twenty heads of accusation against the council of Nice, and condemning the worship of images.

CAROLINEA, a genus of the monadelphia polyandria class and order. The essential character is; monogyneous, calyx simple, tubular, truncate; petal ensiform; pome five-grooved, two-celled. There are two species, natives of Guiana and Tobago.

CAROLOSTADIANS, in church-history, an antient branch of Lutherans, who denied the real presence in the eucharist.

CAROLUS, an antient English broad piece of gold, struck under Charles I. Its value has of late been at twenty-three shillings sterling, though at the time it was coined, it is said to have been rated at twenty shillings.

CAROLUS, a small copper coin, with a little silver mixed with it, struck under Charles VIII. of France. The carolus was worth twelve deniers when it ceased to be current.

CAROTEEL, in commerce, an uncertain weight or quantity of goods. Thus a caroteel of cloves is from four to five hundredweight, of currants from five to nine, of mace about three hundred, of nutmegs from six to seven hundred and a half.

CAROTIDS, in anatomy, two arteries of the neck, which convey the blood from the aorta to the brain. See ANATOMY.

CAROXYLON, a genus of the pentandria monogynia class and order: the essential character is; corolla five-petalled; nect. five-leaved, converging, inserted into the corolla; seed clothed. There is one species.

CARPESIUM, a genus of the syngenesia polygamia superflua class and order: the essential character is; calyx imbricate; down none; recept. naked. There are two species.

CARP. See CYPRINUS.

CARPÆA, a kind of dance antiently practised in Athens and other Grecian states, by two persons, the one acting as a labourer, the other as a robber. The labourer, laying by his arms, goes to ploughing and sowing: the robber appears, and the other betakes himself to his arms, and fights in defence of his oxen. The whole was performed to the sound of flutes. Sometimes the one was victor and sometimes the other, and the reward was the oxen and plough. The great object of this national exercise was to teach and accustom the peasants to defend themselves against the attacks of ruffians.

CARPET, a sort of stuff wrought with the needle or on a loom, which is part of the furniture of a house, and commonly spread over tables, or laid upon the floor. Persian and Turkey carpets are most esteemed; though at Paris there is a manufactory after the manner of Persia, where they make them little inferior, not to say finer, than the true Persian carpets. They are velvety, and perfectly imitate the carpets which come from the Levant. There are also carpets of Germany, some of which are made of woollen stuffs, as serges, &c. and called square carpets; others are made of wool also, but wrought with the needle, and pretty often embellished with silk; and lastly there are carpets made of dog's hair. We have likewise carpets made in England, which are used either as floor-carpets, or to make chairs and other household-furniture.

In weaving carpets the design or pattern is traced in its proper colours on cartons, tied before the workman, who looks at them every moment, because every stitch is marked upon them, as it is to be in his work. By this means he always knows what colours and shades he is to use, and how many stitches of the same colour. In this he is assisted by squares, into which the whole design is divided; each square is subdivided into ten vertical lines, corresponding with the parcels of ten threads of the warp; and besides, each square is ruled with ten horizontal lines, crossing the vertical lines at right angles. The workman, having placed his spindles of thread near him, begins to work on the first horizontal line of one of the squares.

The lines marked on the carton are not traced on the warp, because an iron wire, which is longer than the width of a parcel of ten threads, supplies the place of a cross line. This wire is managed by a crook at one end, at the workman's right hand; towards the other end it is flatted into a sort of knife, with a back and edge, and grows wider to the point. The weaver fixes his iron wire horizontally on the warp, by twisting some turns of a suitable thread of the woof round it, which he passes forward and backward, behind a fore thread of the warp, and then behind the opposite thread, drawing them in their turn by their leishes. Afterwards he brings the woof-thread round the wire, in order to begin again to thrust it into the warp. He continues in this manner to cover the iron rod or wire, and to fill up a line to the tenth thread of the warp. He is at liberty either to stop here or to go on with the same cross line in the next division, according as he passes the thread of the woof round the iron wire, and into the warp, the threads of which he causes to cross one another at every instant: when he comes to the end of the line, he takes care to strike in, or close again all the stitches with an iron reed, the teeth of which freely enter between the empty threads of the warp, and which is heavy enough to strike in the woof he has used. This row of stitches is again closed and levelled, and in the same manner the weaver proceeds; then with his left hand he lays a srong pair of shears along the finished line, cuts off the loose hairs, and thus forms a row of tufts perfectly even, which, together with those before and after it, form the shag. Thus the workman follows stitch for stitch, and colour for colour, the plan of his pattern, which he is attempting to imitate; and he paints magnificently, without having the least notion of painting or drawing.

CARPINUS, the hornbeam, a genus of the polyandria order, in the monœcia class of plants; and in the natural method ranking under the 50th order, amentaceæ. The calyx of the male is monophyllous and ciliated; there is no corolla, but 20 stamina. The calyx of the female is monophyllous and ciliated; no corolla; two germens, with two styles on each. The fruit is an egg-shaped nut. There are four species, viz.

1. Carpinus betulus, or common hornbeam; a deciduous tree, native of Europe and America. Its leaves are of a darkish green, and about the size of those of the beech, but more pointed and deeply serrated. Its branches are long, flexible, and crooked; yet in their general appearance resemble those of the beech. Indeed there is so great a likeness between these two trees, especially in their shrubby and underwood state, that it would be difficult to distinguish them, were it not for the glossy varnish with which the leaves of the beech are strongly marked. As an underwood, it affords stakes and edders, fuel and charcoal. Its timber ranks with that of the beech and the sycamore; and the inner bark is said to be much used in Scandinavia to dye yellow.

2. Carpinus ostrya, the hop hornbeam, a native of Italy and Virginia.

3. Carpinus Virginiana, or flowering hornbeam.

4. Carpinus duinensis.

CARPOCRATIANS, heretics, who sprung up towards the middle of the second century, being a branch of the antient Gnostics. They are said to have held a community of wives, and maintained that a man cannot arrive at perfection without having passed through all criminal actions; laying down as a maxim, that there is no action bad in itself, but only from the opinion of men.

CARPODETUS, a genus of the pentandria monogynia class and order: the essential character is, calyx five-notched, corolla five-petalled; stigma flat-headed; berry globular, five-celled. There is one species, a native of New Zealand.

CARPUS, the wrist. See ANATOMY.

CARRARA *marble*, among artificers, the name of a species of white marble, distinguished from the Parian called the statuary marble, by being harder and less bright.

CARRIER. Every person carrying goods for hire is deemed a carrier, and as such is liable in law for any loss or damage that may happen to them whilst in his custody. Waggoners, captains of ships, lightermen, &c. are therefore carriers; but a stage-coachman is not within the custom as a carrier: neither are hackney-coachmen carriers within the custom of the realm, so as to be chargeable for the loss of goods, unless they are expressly

paid for that purpose, for their undertaking is only to carry the person.

If a person takes hire for carrying goods, although he be not a common carrier, he may nevertheless be charged upon a special assumpsit; for where hire is taken a promise is implied; and where goods are delivered to a carrier, and he is robbed of them, he shall be charged and answer for them on account of the hire, and the carrier can be no loser, as he may recover against the hundred. Goods sent by a carrier cannot be distrained for rent; and any person carrying goods for all persons indifferently, is to be deemed a common carrier as far as relates to this privilege. A delivery to a servant is a delivery to the master; and if goods are delivered to a carrier's porter and lost, an action will lie against the carrier. 1 Salk. 282.

Where a carrier gives notice by printed proposals that he will not be responsible for certain valuable goods if lost, if more than the value of a sum specified, unless entered and paid for as such; and valuable goods of that description are delivered to him, by a person who knows the conditions, but concealing the value, pays no more than the ordinary price of carriage and booking; the carrier is, under such circumstances, neither responsible to the sum specified, nor liable to repay the sum paid for carriage and booking. M. 30. Geo. III. 1. H. B. 298.

A carrier who undertakes for hire to carry goods, is bound to deliver them at all events, unless damaged and destroyed by the act of God, or the king's enemies; and if any accident, however inevitable, happen through the intervention of human means, a carrier becomes responsible. 1 T. R. 27.

CARRONADE, a short kind of ordnance, capable of carrying a large ball, and useful in close engagements at sea. It has its name from Carron, the place where this kind of ordnance was first made.

CARROT, *daucus*, in botany. See DAUCUS.

CARRUCA, in antiquity, a splendid kind of car, or chariot, highly decorated with gold, silver, ivory, &c. in which the emperors, senators, and people of high rank, were carried. The word was used also in the middle ages to signify a plough. Hence

CARRUCAGE denoted the ploughing of ground: either ordinary, as for grain, hemp, flax; or extraordinary, as for wood, dyers' weed, rape, and the like: and

CARRUCATE, in our antient history denotes as much arable land as can be tilled in one year with one plough. In the Doomsday inquisition, the arable land is estimated in carrucates, the pasture in hides, and the meadow land in acres. In the reign of Richard I. the carracate was estimated at 60 acres; in the time of Edward I. at 180, and in the 23d of Edward III. it contained 112 acres.

CARTHAMUS, a genus of the order of polygamia æqualis, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The calyx is ovate, imbricated with scales, close below, and augmented with subovate foliaceous appendices at top. Of this genus there are 10 species; but the only remarkable one is

Carthamus tinctorius, with a saffron-coloured flower, a native of Egypt and some of the warm parts of Asia. It is cultivated in many parts of Europe, and in the Levant, whence great quantities of it are annually imported into Britain for dyeing and painting. It is an annual plant, and rises with a stiff ligneous stalk, about 2½ or 3 feet in height, dividing upwards into many branches, with oval pointed leaves sitting close to the branches. The flowers grow single at the extremity of each branch; the heads of the flowers are large, of a fine saffron colour, and are the part used for the purposes abovementioned.

CARTHUSIANS, a religious order, founded in the year 1080, by one Bruno. Their rules are very severe. They are not to go out of their cells, except to church, without leave of their superior, nor speak to any person without leave. They must not keep any portion of their meat or drink till next day; their beds are of straw, covered with a felt; their clothing two hair-cloths, two cowls, two pair of hose, and a cloke, all coarse. In the refectory they are to keep their eyes on the dish, their hands on the table, their attention on the reader, and their hearts fixed on God. Women are not allowed to come into their churches.

CARTILAGE, in anatomy, a body approaching much to the nature of bones, but lubricous, flexible, and elastic. See ANATOMY.

CARTILAGINOUS *fishes*, or those with cartilaginous fins, constitute a class or order of fishes, called by Linnæus amphibia nantes. The term is applied to all those fish, the muscles of which are supported by cartilages, or gristles, instead of bones. They unite in their formation several leading properties of the other tribes. Like the cetaceous, they have lungs; and like the spinous, they have gills, and a heart without a partition. Thus they possess a twofold manner of breathing; sometimes by their lungs, and sometimes by their gills. This double capacity of breathing in cartilaginous fish is one of the most remarkable features in the history of nature, as they are thus enabled to unite all the advantages of which their situation is capable, and draw from both elements every aid to their necessities or their enjoyment. The apertures by which they breathe are variously placed. The gills are affixed to these apertures, but without any bone to open and shut them. From the gills are cylindrical ducts running to the lungs, and which are supposed to convey the air that gives play to the organs. This tribe can live longer out of the water than those whose gills are more simple; they can venture their heads above the deep, and continue for hours out of their native element. This order includes the shark, lamprey, sturgeon, ray, &c.

CARTON, or CARTOON, in painting, a design drawn on strong paper to be afterwards calked through, and transferred on the fresh plaister of a wall to be painted in fresco. Carton is also used for a design coloured for working in mosaic, tapestry, &c. The cartons at Hampton-court are designs of Raphael Urbino. They are seven in number, and form only a small part of the sacred historical designs executed by this artist, while engaged in the chambers of the Vatican, under the auspices of popes Julius II. and Leo X. When finished they were sent to Flanders to be copied in tapestry, for adorning the pontifical apartments; the work was not, however, sent to Rome till after the death of Raphael. The cartons themselves lay long neglected after the sacking of Rome in the time of Clement VII.; they were at length discovered and purchased by Rubens for Charles I. of England. They are held in the highest estimation by all those who have any pretensions to true taste, for their various and matchless merit, particularly with regard to the invention, and to the great and noble expression of such a variety of characters, countenances, and attitudes, as they are differently affected and properly engaged.

CARTOUCHE, in architecture and sculpture, an ornament representing a scroll of paper. It is usually a flat member, with wavings, to represent some inscription, device, cypher, or ornament of armoury. They are in architecture much the same as modillions; only these are set under the cornice in wainscoting, and those under the cornice at the eaves of a house.

CARTOUCHE, in the military art; a case of wood, about three inches thick at the bottom, girt with marlin, holding about 400 musket-balls, besides six or eight balls of iron, of a pound weight, to be fired out of a hobit, for the defence of a pass, &c. A cartouche is sometimes made of a globular form, and filled with a ball of a pound weight; and sometimes it is made for the guns, being of ball of half or quarter pound weight, according to the nature of the gun, tied in form of a bunch of grapes, on a tompion of wood, and coated over. These were made in the room of partridge-shot.

CARTRIDGE, in the military art, a case of pasteboard or parchment, holding the exact charge of a fire-arm. Those for muskets, carabines, and pistols, hold both the powder and ball for the charge; and those of cannon and mortars are usually in cases of pasteboard or tin, sometimes of wood, half a foot long, adapted to the caliber of the piece.

CARTS. Every cart, &c. for the carriage of any thing to and from any place where the streets are paved, within the bills of mortality, shall contain six inches in the felly; and no person shall drive any cart, &c. within the limits aforesaid, unless the name of the owner and number of such cart be placed in some conspicuous part thereof, and his name entered with the commissioners of the hackney-coaches, under the penalty of 40*s*. and any person may seize and detain such cart till the penalty be paid. 18. Geo. II. c. 33. And if the driver shall ride upon such cart without having a person on foot to guide it, he shall forfeit 10*s*. and the owner so guilty forfeits 20*s*. On changing property the name of the new owners shall be affixed, and entry shall be made with the commissioners of the hackney-coaches. The entry of all carts driven within five miles of Temple-bar, is strictly enjoined by the 24 Geo. III. s. 2. c. 27.

CARUM, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The fruit is ovate, oblong, and striated; the involucrum monophyllous; the petals are carinated or keel-shaped below, and emarginated by their inflection. There is one species,

Carum carui, the caraway of the shops, grows naturally in many places of Britain. It

is a biennial plant, which rises from seeds one year, flowers the next, and perishes soon after the seeds are ripe. It has a strong aromatic taste, and a taper root like a parsnip, but much smaller, which runs deep into the ground, sending out many small fibres. From the root arises one or two smooth, solid, channelled stalks, about two feet high, with winged leaves, having long naked footstalks. The seed of this plant is one of the greater hot seeds, stomachic, carminative, and good in the cholic. The officinal preparations of it are the seeds candied with sugar, and an oil distilled from the seed.

CARUNCULA. See ANATOMY.

CARUNCLES in the urethra. See SURGERY.

CARUS, in medicine, a sudden deprivation or sense and motion, affecting the whole body. See MEDICINE.

CARYATIDES, or CARIATES, in architecture, a kind or order of columns or pilasters under the figure of women dressed in long robes, after the manner of the Carian people, and serving instead of columns to support the entablement.

CARYOCAR, in botany, a genus of the tetragynia order, in the polyandria class of plants. The calyx is quinquepartite, the petals five, the styles most frequently four. The fruit is a drupe, with nucleuses, and four furrows netted. There is one species.

CARYOPHYLLUS, the clove-tree, a genus of the mongynia order, in the polyandria class of plants; and in the natural method ranking under the 19th order, hesperideæ. The corolla is tetrapetalous; the calyx tetraphyllous; the berry monospermous, below the receptacle of the flower. Of this there is but one species, viz.

Caryophyllus aromaticus, which is a native of the Molucca islands, particularly of Amboyna, where it is principally cultivated. The clove-tree resembles in its bark the olive; and is about the height of the laurel. No verdure is ever seen under it. It has a great number of branches, at the extremities of which are produced vast quantities of flowers, that are first white, then green, and at last pretty red and hard. When they arrive at this degree of maturity, they are, properly speaking, cloves. As they dry, they assume a dark yellowish cast, and when gathered become of a deep brown. The season for gathering the cloves is from October to February. The boughs of the trees are then strongly shaken, or the cloves beaten down with long reeds. Large cloths are spread to receive them, and they are afterwards either dried in the sun or in the smoke of the bamboo cane. The cloves which escape the notice of those who gather them, or are purposely left upon the tree, continue to grow till they are about an inch in thickness; and these falling off, produce new plants, which do not bear in less than eight or nine years. Those which are called mother cloves are inferior to the common sort, but are preserved in sugar by the Dutch, and in long voyages eaten after their meals, to promote digestion. The clove, to be in perfection, must be full-sized, heavy, oily, and easily broken, of a fine smell, and of a hot aromatic taste, so as almost to burn the throat. It should make the fingers smart when handled, and leave an oily moisture upon them when pressed. In the East Indies, and in some parts of Europe, it is so much admired as to be thought an indispensable ingredient in almost every dish Cloves are very hot, stimulating, aromatics; and possess in an eminent degree the general virtues of substances of this class. Their pungency resides in their resin, or rather in a combination of resin with essential oil; for the spirituous extract is very pungent: but if the oil and the resin contained in this extract are separated from each other hy distillation, the oil will be very mild; and any pungency which it does retain, proceeds from some small portion of adhering resin, and the remaining oil will be insipid. No plant, or part of any plant, contains such a quantity of oil as cloves do. From 16 ounces Newman obtained by distillation two ounces and two drams, and Hoffman obtained an ounce and a half of oil from two ounces of the spice. The oil is specifically heavier than water. Cloves acquire weight by imbibing water; and this they will do at some considerable distance. The Dutch, who trade in cloves, make a considerable advantage by knowing this secret. They sell them always by weight; and when a bag of cloves is ordered, they hang it for several hours before it is sent in, over a vessel of water, at about two feet distance from the surface. This will add many pounds to the weight, which the unwary purchaser pays for on the spot. This is sometimes practised in Europe, as well as in the spice islands: but the degree of moisture must be more carefully watched in the latter; for there a bag of cloves will, in one night's time, attract so much water, that it may be pressed out by squeezing them with the hand. At Amboyna the company have allotted the inhabitants 4000 parcels of land, on each of which they were at first allowed, and about the year 1720 compelled, to plant about 125 trees, amounting in all to 500,000. Each of these trees produces annua ly on an average more than two pounds of cloves, and consequently the collective produce must weigh more than a million. See Plate Nat. Hist. fig. 92.

CARYOTA, in botany, a genus of the monoecia polyandria plants, classed by Linnæus under palmæ: the male and female flowers of which are produced in separate parts of the same spadix; the corolla is divided into three hollow, lanceolated segments; the stamina are numerous filaments, longer than the corolla; the antheræ are linear; the corolla in the female flower is divided into two very small acuminated segments; the fruit is a round berry, containing a single cell; the seeds are two, large, oblong, rounded on one side, and flatted on the other. There are two species.

CASE, among grammarians, implies the different inflexions or terminations of nouns, serving to express the different relations they bear to each other, and to the things they represent.

CASE, among printers, denotes a sloping frame, divided into several compartments, each containing a number of types or letters of the same kind. From these compartments the compositor takes out each letter as he wants it, to compose a page or form.

CASE *of crown-glass* contains 12, 15, or 18 tables, according to the quality of the glass: in cases of the best glass there are the smallest number of tables, as the price is the same for each case.

CASE *of Newcastle green glass* contains 35 tables.

CASE-HARDENING, a method of preparing iron, so as to render its outer surface hard, and capable of resisting any edged tool.

CASE-SHOT, in the military art, musket-ball, stones, old iron, &c. put into cases, and shot out of great guns.

CASEMENT, or CASEMATE, in architecture, a hollow moulding, which some architects make one-sixth of a circle, and others one-fourth.

CASERN, in fortification, lodgings built in garrison towns, generally near the rampart, or in the waste places of the town, for lodging the soldiers of the garrison. There are usually two beds in each casern for six soldiers to lie, who mount the guard alternately, the third part being always on duty.

CASES, *reserved*, in the polity of the Romish church, atrocious crimes, the absolution of which is reserved by the superiors to themselves or their vicars. There are cases reserved by the pope, who formerly gave the absolution in person, but now delegates that power to certain bishops and priests: cases reserved by the bishops in convents, some by the chapters; but at the point of death all reserved cases are absolvable by the ordinary. The cases reserved by the pope, according to the ritual of Paris, are: 1. The wilful burning of churches, and also of other places, if the incendiary is publicly proclaimed. 2. Actual simony. 3. The murder or mutilation of a person in holy orders. 4. The striking a bishop or other prelate. 5. Furnishing arms to the infidels. 6. Falsifying the bulls or letters of the pope. 7. Invading or pillaging the lands of the church. 8. Violating an interdiction of the pope.

CASHEW-NUT. See ANACARDIUM.

CASING *of timber work*, among builders, is the plaistering a house all over on the outside with mortar, and then striking it while wet by a ruler with the corner of a trowel, to make it resemble the joints of free-stone. Some direct it to be done upon heart laths, because the mortar would in a little time decay the sap laths, and to lay on the mortar in two thicknesses, viz. a second before the first is dry.

CASKETS, on board a ship, small ropes made of sinnet, and fastened to gromets or little rings upon the yards. Their use is to make fast the sail to the yard when it is to be furled.

CASSATION, among civilians, the act of annulling any act or procedure. The reasons of cassation are; 1. When a decree is directly contrary to another decree, and both against the same party. 2. When the decrees are contrary to the express decision of statutes and customs. 3. When the formalities prescribed by the laws have not been observed.

Cassation is properly a term in the courts of France, the laws of which country require the party that sues for a cassation, to deposit 450 livres, which sum is forfeited if he fails in his suit.

CASSIA, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 33d order, lomentaceæ. The calyx is pentaphyllous; petals five; antheræ, upper, three barren; lower, three beaked: a leguminous plant.

There are 51 species, all natives of warm climates. The most remarkable are:

1. Cassia fistula, the purging cassia of Alexandria, is a native of Egypt and both Indies: it rises to the height of 40 or 50 feet, with a large trunk, dividing into many branches with winged leaves. The flowers are produced in long spikes at the end of the branches, each standing upon a long footstalk: these are composed of fine yellow concave petals, which are succeeded by cylindrical pods from one to two feet long, with a dark brown woody shell, having a longitudinal seam on one side, divided into many cells by transverse partitions, each containing one or two oval, smooth, compressed seeds, lodged in a blackish pulp, which is the cassia used in medicine. There are two sorts of this drug in the shops, one brought from the East Indies, the other from the West. The canes or pods of the latter are generally large, rough, thick-rinded, and the pulp nauseous; those of the former are less, smoother, the pulp blacker, and of a sweeter taste; this sort is preferred to the other. The pods should be chosen weighty, new, and not rattling (from the seeds being loose within them) when shaken. The pulp should be of a bright shining black colour, and a sweet taste; not harsh, which happens from the fruit being gathered before it has grown fully ripe, or sourish, which it is apt to turn upon keeping: it should neither be very dry nor very moist, nor at all mouldy; which, from its being kept in damp cellars or moistened, in order to increase its weight, it is very subject to be. The greatest part of the pulp dissolves both in water and rectified spirit; and may be extracted from the pod by either. This pulp is a gentle laxative medicine; and frequently given, in a dose of some drams, in costive habits. See Plate Nat. Hist. fig. 93.

2. Cassia senna, is a shrubby plant cultivated in Persia, Syria, and Arabia, for the leaves, which form a considerable article of commerce. They are of an oblong figure, sharp-pointed at the ends, about a quarter of an inch broad, and not a full inch in length; of a lively yellowish green colour, a faint, not very agreeable smell, and a subacrid, bitterish, nauseous taste. They are brought from the above places, dried and picked from the stalks, to Alexandria in Egypt, and thence imported into Europe. Some inferior sorts are brought from Tripoli and other places; these may easily be distinguished by their being either narrower, longer, and sharper-pointed; or larger, broader, and round-pointed, with small prominent veins; or large and obtuse, of a fresh green colour, without any yellow cast. Senna is a very useful cathartic, operating mildly, and yet effectually; and if judiciously dosed and managed, rarely occasioning the ill consequences which too frequently follow the exhibition of the stronger purges.

CASSIDA, in zoology, a genus of insects, of the order of the coleoptera, with filiform or thread-like antennæ, thickest towards the extremities. Add to this, that the thorax is plain and marginated. Of this genus there are many species, some green (as the viridis), some grey, but most black; but all have been confounded by authors with the beetles, and called in English tortoise-beetles. Foreign countries afford many beautiful species. Even in this climate there is something singular in them. Their larva, by the help of the two prongs which are found at its hinder extremity, makes itself, with its own excrements, a kind of umbrella, that shelters it from the sun and rain. When this umbrella becomes too dry, it parts with it for a new one. This larva casts its slough several times. Thistles and verticillated plants are inhabited by these insects. There is one species, of which the chrysalis resembles an armorial escutcheon. It is this which produces our variegated cassida. Numbers are found on the sides of ponds, upon the wild elecampane. See Plate Nat. Hist. fig. 94.

CASSINE, a genus of the trigynia order, in the pentandria class of plants, and in the natural method ranking under the 23d order, dumosæ. The calyx is quinquepartite; the petals are five; and the fruit is a trispermous berry. There are four species, all of them natives of warm climates.

CASSIOPEIA, in astronomy, a constellation in the northern hemisphere, situated opposite to the Great Bear, on the other side of the pole. The stars of this constellation, in Ptolemy's catalogue, are thirteen; in Tycho's twenty-eight; and in Mr. Flamsteed's fifty-six. In the year 1572 a remarkable new star appeared in this constellation, surpassing Sirius or Lyra in brightness and magnitude. It appeared even bigger than Jupiter, which, at that time, was near his perigee, and by some was thought equal to Venus when she is in her greatest lustre; but in a month it began to diminish in lustre, and in about eighteen months entirely disappeared.

CASSITERIA, in the history of fossils, a genus of crystals, the figures of which are influenced by an admixture of some particles of tin. The cassiteria are of two kinds; the whitish pellucid cassiterion, and the brown cassiterion: the first is a tolerably bright and pellucid crystal, and seldom subject to the common blemishes of crystal: it is of a perfect and regular form, in the figure of a quadrilateral pyramid, and is found in Devonshire and Cornwall principally. The brown cassiterion is like the former in figure: it is of a very smooth and glossy surface, and is also found in great plenty in Devonshire and Cornwall.

CASSOWARY. See STRUTHIO.

CAST, or *caste*, in the east, denotes a tribe or number of families of the same rank and profession. The division of a nation into casts obtains in the dominions of the great mogul, kingdom of Bengal, and the island of Ceylon. There are four principal casts, viz. that of the bramins, which is the most noble; that of the rajahs, or princes, who claim to be descended from the royal families; that of the choutres, which includes artificers; and that of the parias, the lowest of all. Every art and trade is confined to its proper cast, nor can it be exercised by any but those whose fathers have professed the same. The cast of parias is held infamous; and there are trades in the cast of choutres which debase the professors of them almost to the same rank; some of which are fishermen, shoemakers, and even shepherds.

CASSYTA, a genus of the monogynia order, in the enneandria class of plants. The corolla is in the form of a calyx, divided into six segments; the nectarium is composed of three truncated glands encompassing the germen; the interior filaments are glandular; and the drupe contains a single seed. There are two species.

CASTILLAN, or *Castillane*, a gold coin, current in Spain, and worth fourteen rials and sixteen deniers. Castillan is also a weight used in Spain for weighing gold. It is the hundredth part of a pound Spanish weight. What they commonly call a weight of gold in Spain, is always understood of the castillan.

CASTILLEIA, a genus of the didynamia angiospermia class and order. The essential character is, calyx tubular, compressed; upper lip bifid, lower none; corolla, lower lip trifid; capsule two-celled. There are two species, natives of South America.

CASTING, among sculptors, implies the taking of casts and impressions of figures, busts, medals, &c.

The art of taking casts or impressions from pieces of sculpture, medals, &c. is of very great importance in the fine arts. In order to procure a copy or cast from any figure, bust, medal, &c. it is necessary to obtain a mould, by pressing upon the thing to be moulded or copied some substance which, when soft, is capable of being forced into all the cavities or hollows of the sculpture. When this mould is dry and hard, some substance is poured into it, which will fill all the cavities of the mould, and represent the form of the original from which the mould was taken.

The particular manner of moulding depends upon the form of the subject to be worked upon. When there are no projecting parts, but such as form a right or a greater angle with the principal surface of the body, nothing more is required than to cover it over with the substance of which the mould is to be formed, taking care to press it well into all the cavities of the original, and to take it off clean, and without bending. The substances used for moulding are various, according to the nature and situation of the sculpture. If it may be laid horizontally, and will bear to be oiled without injury, plaister of Paris may be advantageously employed, which may be poured over it to a convenient thickness, after oiling it to prevent the plaister from sticking. A composition of bees-wax, resin, and pitch, may also be used, which will be a very desirable mould, if many casts are to be taken from it. But if the situation of the sculpture is perpendicular, so that nothing can be poured upon it, then clay, or some similar substance, must be used. The best kind of clay for this purpose is that used by the sculptors for making their models; it must be worked to a due consistence, and having spread it out to a size sufficient to cover all the surface, it must be sprinkled over with whiting, to prevent it from adhering to the original. Bees-wax and dough, or the crumb of new bread, may also be used for moulding some small subjects. When there are undercuttings in the bas relief, they must be first filled up before it can be moulded, otherwise the mould could not be got off. When the casts are taken afterwards, these places must be worked out with a proper tool.

When the model, or original subject, is of a round form, or projects so much that it cannot be moulded in this manner, the mould must be divided into several parts; and it is frequently necessary to cast several parts se-

parately, and afterwards to join them together. In this case, the plaister must be tempered with water to such a consistence, that it may be worked like soft paste, and must be laid on with some convenient instrument, compressing it so as to make it adapt itself to all parts of the surface. When the model is covered to a convenient thickness, the whole must be left at rest till the plaister is set and firm, so as to bear dividing without falling to pieces, or being liable to be put out of its form by any slight violence; and it must then be divided into pieces, in order to its being taken off from the model, by cutting it with a knife with a very thin blade; and being divided, must be cautiously taken off, and kept till dry: but it must be observed, before the separation of the parts is made, to notch them across the joints, or lines of division, at proper distances, that they may with ease and certainty be properly put together again. The art of properly dividing the moulds, in order to make them separate from the model, requires more dexterity and skill than any other thing in the art of casting, and does not admit of rules for the most advantageous conduct of it in every case. Where the subject is of a round or spheroidal form, it is best to divide the mould into three parts, which will then easily come off from the model; and the same will hold good of a cylinder, or any regular curve figure. The mould being thus formed, and dry, and the parts put together, it must be first oiled, and placed in such a position that the hollow may lie upwards, and then filled with plaister mixed with water; and when the cast is perfectly set and dry, it must be taken out of the mould and repaired when necessary, which finishes the operation.

In larger masses, where there would otherwise be a great thickness of the plaister, a core may be put within the mould, in order to produce a hollow in the cast, which both saves the expence of the plaister, and renders the cast lighter.

In the same manner, figures, busts, &c. may be cast of lead, or any other metal in the moulds of plaister or clay; taking care, however, that the moulds be perfectly dry; for, should there be the least moisture in them, the sudden heat of the metal would convert it into vapour, which would produce an explosion, and blow the melted metal about.

To take a cast in metal from any small animal, insect, or vegetable.—Prepare a box sufficiently large to hold the animal (which must be dead), in which it must be suspended by a string, and the legs, wings, &c. of the animal, or the tendrils, leaves, &c. of the vegetable, must be separated, and adjusted in their right position by a pair of small pincers. A due quantity of plaister of Paris mixed with talc, must be tempered to the proper consistence with water, and the sides of the box oiled. Also a straight piece of stick must be put to the principal part of the body, and pieces of wire to the extremities of the other parts, in order that they may form, when drawn out after the matter of the mould is set and firm, proper channels for pouring in the metal, and vents for the air, which otherwise, by the rarefaction it would undergo from the heat of the metals, would blow it out, or burst the mould. In a short time the plaister will set, and become hard; when the stick and wires may be drawn out, and the frame or coffin in which the mould was cast taken away; and the mould must then be put, first, into a moderate heat, and afterwards, when it is as dry as it can be rendered by that degree, removed into a greater, which may be gradually increased till the whole is red-hot. The animal or vegetable inclosed in the mould, will then be burnt to a coal: and may be totally calcined to ashes, by blowing for some time into the charcoal and passages made for pouring in the metal, and giving vent to the air; which will, at the same time that it destroys the remainder of the animal or vegetable matter, blow out the ashes. The mould must then be suffered to cool gently, and will be perfect; the destruction of the substance included in it, having produced a corresponding hollow; but it may nevertheless be proper to shake the mould, and turn it upside down, as also to blow with the bellows into each of the air vents, in order to free it wholly from any remainder of the ashes; or where there may be an opportunity of filling the hollow with quicksilver, it will be found a very effectual method of clearing the cavity; as all dust, ashes, or small detached bodies, will necessarily rise to the surface of the quicksilver, and be poured out with it. The mould being thus prepared, it must be heated very hot, when used, if the cast is to be made with copper or brass, but a less degree will serve for lead or tin. The metal being poured into the mould, must be gently struck, and then suffered to rest till it is cold; at which time it must be carefully taken from the cast, but without force; for such parts of the matter as appear to adhere more strongly, must be softened, by soaking in water till they are entirely loosened, that none of the more delicate parts of the cast may be broken off or bent.

When talc cannot be obtained, plaister alone may be used; but it is apt to be calcined, by the heat used in burning the animal or vegetable whence the cast is taken, and to become of too incoherent and friable a texture. Stourbridge, or any other good clay, washed perfectly fine, and mixed with an equal part of fine sand, may be employed. Pounded pumice-stone, and plaister of Paris, in equal quantities, mixed with washed clay in the same proportion, is said to make excellent moulds.

Method of taking a cast in plaister from a person's face.—The person whose likeness is required in plaister, must lie on his back, and the hair must be tied back, so that none of it covers the face. Into each nostril convey a conical piece of stiff paper, open at both ends, to allow of breathing. The face is then lightly oiled over in every part with salad-oil, to prevent the plaister from sticking to the skin. Procure some fresh-burnt plaister, and mix it with water to a proper consistence for pouring. Than pour it by spoonfuls quickly all over the face (taking care the eyes are shut), till it is entirely covered to the thickness of a quarter of an inch. This substance will grow sensibly hot, and in a few minutes it will be hard, and form a mould, in which a head of clay may be moulded; and therein the eyes may be opened, and such other additions and corrections may be made as are necessary. Then, this second face being anointed with oil, another mould of plaister must be made upon it, consisting of two parts joined lengthwise along the ridge of the nose; and in this a cast in plaister may be taken, which will be exactly like the original.

To take casts from medals.—In order to take copies of medals, a mould must first be made; this is generally either of plaister of Paris, or of melted sulphur.

After having oiled the surface of the medal with a little cotton, or a camel's-hair pencil dipped in oil of olives, put a hoop of paper round it, standing up above the surface of the thickness you wish the mould to be. Then take some plaister of Paris, mix it with water to the consistence of cream, and with a brush rub it over the surface of the medal, to prevent air-holes from appearing: then immediately afterwards make it to a sufficient thickness, by pouring on more plaister. Let it stand about half an hour, and it will in that time grow so hard, that you may safely take it off; then pare it smooth on the back and round the edges neatly. It should be dried, if in cold or damp weather, before a brisk fire. If you cover the face of the mould with fine plaister, a coarser sort will do for the back: but no more plaister should be mixed up at one time than can be used, as it will soon get hard, and cannot be softened without burning over again. Sulphur must not be poured upon silver medals, as this will tarnish them.

To prepare this mould for casting sulphur or plaister of Paris in, take half a pint of boiled linseed-oil, and oil of turpentine one ounce, and mix them together in a bottle; when wanted, pour the mixture into a plate or saucer, and dip the surface of the mould into it; take the mould out again; and when it has sucked in the oil, dip it again. Repeat this, till the oil begins to stagnate upon it; then take a little cotton wool, hard rolled up, to prevent the oil from sticking to it, and wipe it carefully off. Lay it in a dry place for a day or two (if longer the better), and the mould will acquire a very hard surface from the effect of the oil.

To cast plaister of Paris in this mould, proceed with it in the same manner as above directed for obtaining the mould itself, first oiling the mould with olive-oil. If sulphur casts are required, it must be melted in an iron ladle.

Another method with isinglass.—Dissolve isinglass in water over the fire; then, with a hair-pencil, lay the melted isinglass over the medal; and when you have covered it properly, let it dry. When it is hard, raise the isinglass up with the point of a pen-knife, and it will fly off like horn, having a sharp impression of the medal.

The isinglass may be made of any colour, by mixing the colour with it; or you may breathe on the concave side, and lay gold leaf on it, which, by shining through, will make it appear like a gold medal. But if you wish to imitate a copper medal, mix a little carmine with the isinglass, and lay gold-leaf on as before.

CASTLE, in the sea language, is a part of the ship, of which there are two; the forecastle, being the elevation at the prow, or the uppermost deck, towards the mizen, the place where the kitchens are; and the hindcastle, where the officers' cabins are.

CASTOR, the *beaver*, in zoology, a genus of the order of glires. The generic character is, front teeth in the upper jaw trun-

cated and excavated with a transverse angle; in the lower jaw transverse at the tips; grinders on each side four; tail long, depressed and scaly; collar-bones in the skeleton.

1. Castor fiber, or common beaver, is a native of the most northern parts of Europe and Asia, but is found most plentifully in North America. It is readily distinguished from every other quadruped (see Plate Natural Hist. fig. 95.) by the remarkable structure of its tail, which is of an oval form, nearly flat, but rising into a slight convexity on its upper surface, perfectly void of hair, except at the base, and marked out into scaly divisions like the skin of a fish. The general length of the beaver is about three feet, and of the tail nearly one foot. The colour of the animal is a deep chesnut, and the hair is very fine, smooth, and glossy. The beaver, like other quadrupeds, sometimes varies in colour, and is occasionally found perfectly black.

Of all quadrupeds the beaver is considered as possessing the greatest degree of natural or instinctive sagacity in constructing its habitation; preparing, in concert with others of its own species, a kind of arched caverns or domes, supported by a foundation of strong pillars, and lined or plaistered internally with a degree of neatness and accuracy unequalled by the art of any other quadruped.

The favourite resorts of the beaver are retired watery, and woody, situations. In such places the animals assemble, to the number of some hundreds; living in a kind of families, and building their arched mansions or receptacles.

They begin to assemble in the month of June or July, for the purpose of uniting into society. They arrive in numbers from all parts, and soon form a troop of two or three hundred. The place of rendezvous is generally the situation fixed for their establishment, and always on the banks of some water. If the waters are flat, and never rise above their ordinary level, as in lakes, the beavers make no bank or dam; but in rivers or brooks, where the waters are subject to risings and fallings, they construct a bank, and by this artifice form a pond or piece of water, which remains always at the same height. The bank traverses the river, from one side to the other, like a sluice, and is often from eighty to a hundred feet long, by ten or twelve broad at the base. This pile, for animals of so small a size, appears to be enormous, and supposes an incredible labour; but the solidity with which the work is constructed is still more astonishing than its magnitude. The part of the river where they erect this bank is generally shallow. If they find on the margin a large tree, which can be made to fall into the water, they begin with cutting it down, to form the principal part of their work. This tree is often thicker than the body of a man. By gnawing the foot of a tree with their four cutting teeth they accomplish their purpose in a very short time, and always make the tree fall across the river. They next cut the branches from the trunk, to make it lie level. These operations are performed by the whole community. Several beavers are employed in gnawing the foot of the tree, and others in lopping off the branches after it has fallen. Others, at the same time, traverse the banks of the river, and cut down smaller trees from the size of a man's leg to that of his thigh. These they dress and cut to a certain length, to make stakes of them, and first drag them by land to the margin of the river, and then by water to the place where the building is carrying on. These piles they sink down, and interweave the branches with the larger stakes. Whilst some are labouring in this manner, others bring earth, which they plash with their fore feet, and transport in such quantities, that they fill with it all the intervals between the piles. These piles consist of several rows of stakes, of equal height, all placed opposite to each other, and extend from one bank of the river to the other. The stakes facing the under part of the river are placed perpendicularly; but the rest of the work slopes upwards to sustain the pressure of the fluid, so that the bank, which is ten or twelve feet wide at the base, is reduced to two or three at the top.

The first great structure is made with a view to render their smaller habitations more commodious. These cabins or houses are built upon piles near the margin of the pond, and have two openings, the one for going on the land, and the other for throwing themselves into the water. The form of the edifices is either oval or round, some of them larger, and some less, varying from four to five, to eight or ten feet diameter. Some of them consist of three or four stories, and their walls are about two feet thick, raised perpendicularly upon planks, or plain stakes, which serve both for foundations and floors to their houses. They are built with amazing solidity, and neatly plaistered both without and within. They are impenetrable to rain, and resist the most impetuous winds. The partitions are covered with a kind of stucco, as nicely plastered as if it had been executed by the hand of man. In the application of this mortar their tails serve for trowels, and their feet for plaistering. They employ different materials, as wood, stone, and a kind of sandy earth, which is not subject to dissolution in water. They labour in a sitting posture; and besides the convenience of this situation, they enjoy the pleasure of gnawing perpetually the bark and wood, which are most agreeable to their taste; for they prefer fresh bark and tender wood to most of their ordinary aliment. Of these provisions they lay up ample stores to support them during the winter; but they are not fond of dry wood, and make occasional excursions during the winter season for fresh provisions in the forests. It is in the water, or near their habitations, that they establish their magazines. Each cabin has its own magazine, proportioned to the number of its inhabitants, who have all a common right to the store, and never pillage their neighbours. Some villages are composed of twenty or twenty-five cabins, but such establishments are rare; and the common republic seldom exceeds ten or twelve families, each of which has its own quarter of the village, its own magazine, and its separate habitation. The smallest cabins contain two, four, or six; and the largest eighteen, twenty, and, it is alleged, sometimes thirty, beavers. They are almost always equally paired, there being the same number of females as of males. When danger approaches, they warn one another by striking their tail on the surface of the water, the noise of which is heard at a great distance, and resounds through all the vaults of their habitations. Each takes his part; some plunge into the lake; others conceal themselves within their walls, which can only be penetrated by the fire of heaven or the steel of man, and which no animal will attempt either to open or overturn. They often swim a long way under the ice; and it is then that they are most easily taken, by attacking the cabin on one hand, and at the same time watching at a hole made at some distance, whither they are obliged to repair for the purpose of respiration. The continual habit of keeping their tail and posterior part in the water, appears to have changed the nature of their flesh. That of their anterior parts, as far as the reins, has the taste and consistence of the flesh of land animals; but that of the tail and hinder parts has the odour and all other qualities of fish.

Besides the associated beavers there are others that live solitary, and instead of constructing caverns, or vaulted and plaistered receptacles, content themselves with forming holes in the banks of rivers. The fur of these, which are commonly termed terrier beavers, is considered as far less valuable than that of the associated animals.

The beaver when taken young may readily be tamed; and in that state appears to be an animal of a gentle disposition, but does not exhibit any symptoms of superior sagacity.

2. Castor huidobrius, or Chili beaver. This is a species peculiar to South America, and is found in the very deep lakes and rivers of that country, and feeds principally on fish and crabs. Its length from nose to tail is about three feet: the head is of a squarish form, the eyes small, the ears rounded and short, and the snout obtuse; in each jaw are two sharp and strong cutting teeth, and the grinders are like those of the common beaver. The body is very broad, and covered, like the common beaver, with two sorts of hair; the shortest or softest of which is superior to that of most other quadrupeds, and is in high esteem with manufacturers, being wrought into a kind of cloth which has the softness of velvet, and is also used in the manufacture of hats. It is a bold and even fierce animal, and has the power of continuing a great while under water. It does not construct any regular habitation like the common beaver, nor does it afford any castor. The female is said to produce from two to three young at a birth. It is called in Chili by the name of guillino.

Castor, in astronomy. See Gemini.

CASTOREUM, *castor*, in the materia medica, is by many mistaken for the spermatic matter of the animal, though, in fact, it is a peculiar secreted matter, contained in bags destined to receive it, in the manner of the musk and civet, yet situated differently in the animal.

CASUARINA, a genus of the monandria order, in the monœcia class of plants. The male has the calyx of the amentum; the corolla a bipartite small scale. The female has a calyx of the amentum, no corolla; the style is bipartite. There are five species, natives of New South Wales.

CAT. See Felis.

Cat-harpings, in a ship, small ropes running in little blocks from one side of the shrouds to the other, near the deck. Their use is to force the shrouds, and make them tawt, for the more security and safety of the masts.

CAT, or *cat-head*, on shipboard, a short piece of timber in a ship, lying aloft right over the hawse, having at one end two shivers, wherein is reeved a rope, with a great iron hook fastened to it, called

CAT HOOK. Its use is to trice up the anchor, from the hawse to the top of the forecastle.

CAT-HOLES, in a ship, are over the parts as right with the capstan as they can be: their use is to heave the ship astern, upon occasion, by a cable, or a hawse, called stern-fast.

CAT-GUT, a small string for fiddles and other musical instruments, made from the intestines of sheep and lambs, dried and twisted either singly or several together. They are sometimes coloured, and are used by watch-makers, cutlers, turners, and other artificers. Great quantities are imported into England and other northern countries, from France and Italy.

CAT-SALT, a name given by our salt-workers to a very beautifully granulated kind of common salt. It is formed out of the bittern, or leach-brine, which runs from the salt when taken out of the pan. When the common salt is taken from the boiling-pans, it is put into long wooden troughs, with holes bored at the bottom for the brine to drain out: under these troughs vessels are placed to receive this brine, and across them small sticks, to which the cat-salt fixes itself in large and beautiful crystals. It contains some portion of the bitter purging salt, is sharp and pungent, and is white when powdered, though pellucid in the mass. Large quantities of this salt are used in the manufacture of hard soap.

CATACAUSTIC *curves*, in the higher geometry, that species of caustic curves which are formed by reflection.

These curves are generated after the following manner. If there be an infinite number of rays, as AB, AC, AD, &c. (see Plate, Miscel. fig. 12.) proceeding from the radiating point A, and reflected at any given curve BDH, so that the angles of incidence be still equal to those of reflection; then the curve BEG, to which the reflected rays BI, CE, DF, &c. are tangents continually, as in the points I, E, F, is thecatacaustic curve.

If the reflected IB be produced to K, so that AB = BK, and the curve KL be the evolute of the catacaustic BEG, beginning at the point K; then the portion of the catacaustic BE = AC — AB + CE — BI continually. Or if any two incident rays, as AB, AC be taken, that portion of the caustic that is evolved while the ray AB approaches to a coincidence with AC, is equal to the difference of those incident rays + the difference of the reflected rays. When the given curve is a geometrical one, the catacaustic will be so too, and always rectifiable.

The catacaustic of a circle is a cycloid, formed by the revolution of a circle along a circle. The caustic of the vulgar semi-cycloid, when the rays are parallel to the axis, is also a vulgar cycloid, described by the revolution of a circle upon the same base. The caustic of the logarithmic spiral is the same curve, only set in a different position.

CATACHRESIS, in rhetoric, a trope which borrows the name of one thing to express another.

CATACOMB, a grotto or subterraneous place for the burial of the dead. The term is particularly used in Italy for a vast assemblage of subterraneous sepulchres, three leagues from Rome, in the *via Appia*, supposed to be the sepulchres of the antients. Others imagine these catacombs to be the cells wherein the primitive Christians hid themselves. Each catacomb is three feet broad, and eight or ten high, running in form of an alley or gallery, and communicating with one another. Some authors suppose them to have been the *puticuli* mentioned by Festus Pompeius, into which the Romans threw the bodies of their slaves, to whom they denied the honours of burying; and Mr. Monro, in the Philosophical Transactions, gives it as his opinion, that the catacombs were the burial-places of the first Romans, before the practice of burning the dead was introduced; and that they were dug in consequence of these opinions, that Shades hate the light, and love to hover about the places where their bodies were laid.

The catacombs of Egypt seem to be of a different nature, though called by the same name. The bodies found in these catacombs are mummies. In searchingfor these labourers are frequently obliged to clear away the sand for weeks together, before they find the precious deposit. Upon coming to a square opening of about eighteen feet in depth, they descend into it by holes made for the feet, placed at proper distances, and there they are sure of finding a mummy. These caves, or wells, as they are usually called, are hollowed out of free-stone, which is found in Egypt a few feet below the covering of sand. At the bottom of these, which are about forty feet below the surface, there are several square openings on each side of the passages, of ten or fifteen feet wide, and these lead to chambers of fifteen or twenty feet square, hewn out of the rock; and in each of the catacombs are to be found several apartments communicating with one another. They are said to extend so far as to undermine the city of Memphis and its environs. In some of these chambers the walls are adorned with figures and hieroglyphics; in others the mummies are found in tombs, round the apartment, hollowed out in the rock.

CATALEPSY, in medicine, a kind of apoplexy, or drowsy disease, in which the patient is taken speechless, senseless, and fixed in the same posture in which the disease first seized him. See MEDICINE.

CATALOGUE *of the stars*. See ASTRONOMY.

CATANANCHE, *Candia lion's foot*, a genus of the polygamia æqualis order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is paleaceous; the calyx is imbricated; the pappus furnished with awns by a caliculas of five stiff hairs. There are three species, of which the most remarkable is the

Catananche cerulea, which is a hardy, herbaceous, and very ornamental plant for the flower-garden. There is a variety with double flowers.

CATAPHONICS, the science which considers the properties of reflected sounds. See PNEUMATICS.

CATAPHRACTA, in antiquity, a kind of coat of mail, which covered the soldier from head to foot. Hence cataphractati were horsemen armed with the cataphracta, whose horses, as Sallust says, were covered with linen full of iron plates disposed like feathers.

CATAPHRYGIANS, antient heretics, who took their name from the country of Phrygia. They supposed the Holy Spirit had abandoned the church, and therefore that Montanus, as a prophet, and Priscilla and Maximilla, as true prophetesses, were to be consulted in every thing relating to religion.

CATAPLASM, an external topical medicine, of a soft consistence, known by the common name of poultice, and prepared of ingredients of different virtues, according to the intention of the physician. See PHARMACY.

CATAPULTA, in antiquity, a military engine contrived for the throwing of arrows, darts, and stones, upon the enemy. Some of these engines were of such force, that they would throw stones of an hundredweight. Josephus takes notice of the surprising effects of these engines, and says, that the stones thrown out of them beat down the battlements, knocked off the angles of the towers, and would level a whole file of men, from one end to the other, were the phalanx ever so deep.

CATARACT, in hydrography, a precipice in the channel of a river, caused by rocks, or other obstacles, stopping the course of the stream, whence the water falls with a greater noise and impetuosity: such are the cataracts of the Nile, the Danube, the Rhine, and the famous one of Niagara in America.

CATARACT. See SURGERY.

CATARRH, in medicine, a defluxion from the head upon the mouth and aspera arteria, and through them upon the lungs. See MEDICINE.

CATECHU, in the materia medica, improperly called terra japonica in the shops, is a concreted vegetable juice, partly of the gummy, partly of the resinous kind. See ARECA, and MATERIA MEDICA.

CATEGORY, in logic, a series or order of all the predicates or attributes contained under any genus.

The school philosophers distribute all the objects of our thoughts and ideas into certain genera or classes; and these classes the Greeks called categories, and the Latins predicaments. Aristotle made ten categories, viz. quantity, quality, relation, action, passion, time, place, situation, and habit, which are usually expressed by the following technical distich.

Arbor, sex, servos, ardore, refrigerat, ustos,
Ruri cras stabo, nec tunicatus ero.

CATENARIA, in the higher geometry, the name of a curve line formed by a rope hanging freely from two points of suspension, whether the points be horizontal or not. The nature of this curve was sought after in Galileo's time, but not discovered till the year 1690, when James Bernouilli published it as a problem. Dr. Gregory, in 1697, published a method of investigation of the properties formerly discovered by John Bernouilli and Mr. Leibnitz, together with some new properties of this curve. From him we take the following method of finding the general property of the catenaria. 1. Suppose a line heavy and flexible, the two extremes of which

F and D (Plate Miscel. fig. 13.) are firmly fixed in these points; by its weight it is bent into a certain curve F A D, which is called the catenaria. 2. Let B D and *b c* be parallel to the horizon, A B perpendicular to B D, and D *c* parallel to A B, and the points B *b* infinitely near to each other. From the laws of mechanics, any three powers in equilibrio, are to one another as the lines parallel to the lines of their direction, (or inclined in any given angle) and terminated by their mutual concourses: hence if D *d* express the absolute gravity of the particle D *d* (as it will if we allow the chain to be every way uniform) then D *c* will express that part of the gravity that acts perpendicularly upon D *d*; and by the means of which this particle endeavours to reduce itself to a vertical position; so that if this little line *d c* be constant, the perpendicular action of gravity upon the parts of the chain, will be constant too, and may therefore be expressed by any given right line.

Further, the lineola D *c* will express the force which acts against that conatus of the particle D *d*, by which it endeavours to restore itself into a position perpendicular to the horizon, and hinders it from doing so. This force proceeds from the ponderous line D A drawing according to the direction D *d*; and is, cæteris paribus, proportional to the line D A which is the cause of it. Supposing the curve F A D, therefore, as before, whose vertex is A, axis A B, ordinate B D, fluxion of the axis D *c*=B *b*, fluxion of the ordinate *d c*, the relation of these two fluxions is thus, viz. *d c*: D *d*:: *a*: D A curve, which is the fundamental property of the curve, and may be thus expressed (putting A B=*x* and B D =*y* and A D=*c*) $y\frac{ax}{c}$.

CATERGI, the name of the public carriers in the grand signior's dominions. In Europe, the merchant or traveller gives earnest to the carrier, but the catergi in Turkey give earnest to the merchant and others, as a security that they will certainly carry their goods, or not set out with them.

CATERPILLAR, in zoology, the name of the butterfly-class of insects, in their reptile or worm state. See PAPILIO, &c.

CATESBÆA, the lily-thorn, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 28th order, luridæ. The corolla is monopetalous, funnel-shaped, very long above the receptacle of the fruit; the stamina are within its throat; the fruit a polyspermous berry. There are two species, viz. the

1. Catesbæa spinosa, a native of the island of Providence, discovered by Mr. Catesby, who gathered the seeds, and brought them to England. It rises to the height of 10 or 12 feet, and is covered with a pale russet bark, with small leaves resembling those of the box-tree; the flowers hang downward, are tubulous, and of a dull yellow colour. This plant is propagated by seeds, which must be procured from the country where it grows. 2. The Catesbæa parviflora.

CATHARINE, or knights of St. Catharine, a military order, instituted for the security of travellers who came to visit the tomb this saint on mount Sinai.

CATHARISTÆ, in church-history, a branch of Manichees, so called from certain purifications which they were obliged to practise: they are also said to have held it unlawful to eat flesh.

CATHARTICS. See MATERIA MEDICA.

CATHETER. See SURGERY.

CATHETUS, in geometry, a line or radius falling perpendicularly on another line or surface: thus the catheti of a right-angled triangle are the two sides that include the right angle.

CATHETUS, in architecture, a perpendicular line, supposed to pass through the middle of a cylindrical body, as a baluster, column, &c.

CATOPTRICS. See OPTICS.

CATTLE. By the 3 and 4 Edward VI. c. 19, no person shall buy any ox, steer, runt, or cow, &c. and sell the same again alive in the same market, or fair, on pain of forfeiting double the value thereof, half to the king, and half to him that shall sue. This is the only act in force against forestalling, engrossing, and regrating.

If any person shall feloniously drive away, or steal, or shall wilfully kill, any ox, bull, cow, calf, steer, bullock, heifer, sheep, or lamb, with a felonious intent to steal the whole carcase, or any part thereof, or shall assist in committing any such offence, he shall be guilty of felony without benefit of clergy. 14 and 15 George II. c. 6. and 34.

Any person, who shall unlawfully and maliciously kill, maim, or wound any cattle, shall be guilty of felony without benefit of clergy; and the hundred shall be answerable for the damages, not exceeding 200*l*. 9 George c. 22. And horses, mares, and colts, are included in the word cattle. Every person who shall apprehend and prosecute to conviction any offender, shall have ten pounds reward; to be paid by the sheriff within a month, on his producing a certificate from the judge. The 26 George III. c. 71. to prevent the stealing of horses, &c. for their skin, provides that all persons keeping a slaughter-house for cattle not killed for butcher's meat, shall take out licences, be subject to an inspector, and only slaughter at certain times.

CATURUS, a genus of the dicecia triandria class and order. There are two species, natives of the East Indies.

CAVA, or vena cava. See ANATOMY.

CAVALIER, in fortification, an elevation of earth, of different shapes, situated ordinarily in the gorge of a bastion, bordered with a parapet, and cut into more or less embrasures, according to the capacity of the cavalier.

Cavaliers are a double defence for the faces of the opposite bastion: they defend the ditch, break the besiegers' galleries, command the traverses in dry moats, scour the salient angle of the counterscarp where the besiegers have their counter-batteries, and enfilade the enemies' trenches, or oblige them to multiply their parallels: they are likewise very serviceable in defending the breach, and the retrenchments of the besieged, and can very much incommode the entrenchments which the enemy make, by their being lodged in the bastion.

CAVAZION, or cavasion, in architecture, denotes the hollow trench made for laying the foundation of a building, which, according to Palladio, ought to be one-sixth part of the height of the whole building.

CAUCALIS, in botany, a genus of the pentandria digynia class of plants, the universal flower of which is difform and radiated; the proper flower of the disk is male, small, composed of five inflexo-cordated equal petals; the fruit is of an oblato-oblong figure, striated longitudinally, with rigid scabrous bristles: the seeds are two, oblong, convex on one side and armed with prickles in order of the striæ, and plane on the other side. There are nine species.

CAUDA *draconis*, the dragon's-tail, in astronomy, the name of the moon's descending node.

CAUDA *leonis*, in astronomy, a star of the first magnitude in the tail of the constellation Leo. See LEO.

CAVEAR, *caveer*, or *caviar*, the spawn or hard roes of sturgeon, made into small cakes, an inch thick, and of a hand's breadth, salted, and dried in the sun. This sort of food is in great repute throughout Muscovy, because of their three Lents, which they keep with a superstitious exactness.

CAVEAT, is a caution, entered in the spiritual court, to stop probates, administrations, licences, dispensations, faculties, institutions, and such-like, from being granted without the knowledge of the party that enters it. A caveat stands in force for three months. 2 Rol. Rep. 6.

The entering a caveat, being at the instance of the party, is only for the benefit of the ordinary, that he may do no wrong; it is a cautionary act for his better information, to which the temporal courts have no manner of regard; therefore if after a caveat entered, the ordinary should grant administration, or probate of a will, it is not void by our law; it is true it is void by the canon law, but our law takes no notice of a caveat. Rol. Rep. 191.

CAVEDO, in commerce, a Portuguese long measure, equal to $27\frac{354}{1000}$ English inches.

CAVETTO, in architecture, a hollow member, or round concave moulding, containing a quadrant of a circle, and having a quite contrary effect to that of a quarter-round: it is used as an ornament in cornices

CAVIA, a genus of the order of glires. The generic character is, front-teeth two, wedge-shaped; grinders eight; toes on the fore feet from four to five, on the hind feet from three to five; tail very short, or none; clavicles, or collar bones, none. The animals of the genus cavia have generally a slow, and sometimes a leaping pace: they live, like the rest of the glires, on vegetable substances, and in their natural state inhabit excavations under ground, or beneath the roots of trees; or other recesses which they either find ready prepared, or form for themselves. The most familiar example of this genus is the well-known little animal, called the guinea-pig, or

1. Cavia cobaya, or variegated cavy. This little animal is very easily rendered tame, but is seldom observed to shew any very lively attachment to its benefactors; and is not distinguished by any remarkable degree of docility: it is, however, cleanly, harmless, and of a timid disposition. In a state of confinement it breeds almost every two months; and often produces a very numerous offspring at a birth. The young very soon acquire the necessary degree of strength and perfection of their species, though they continue to grow till seven or eight months. In their habits they are extremely neat, and

may be frequently observed in the act of smoothing and dressing their fur, somewhat in the manner of a cat. In their quarrels they not only bite but kick each other, like horses, with their hind feet. It is observed, that the male and female seldom sleep at the same time; but seem alternately to watch each other; the one sleeping while the other is feeding, &c. Their general voice is a sort of grunting squeak, and sometimes a shriller or sharper cry.

2. Cavia paca, or spotted cavy. This is a large species, (Plate Nat. Hist. fig. 98.) measuring near two feet in length. It is found in Guiana, Brasil, and other parts of South America; inhabiting holes, formed under ground, and principally near the banks of rivers. It is of a thick, clumsy form, somewhat resembling that of a pig; for which reason it has been sometimes called the the hog-rabbit. The spotted cavy is a nocturnal animal, residing in a solitary manner in his hole during almost the whole day. In a domestic state it readily feeds on almost any kind of vegetable diet, and is particularly fond of sugar and fruits. It is much esteemed as an article of food by the South Americans. It is subject to some variety in point of colour, and has been sometimes seen quite white. Its general length, when full-grown, is about two feet. The female is said to produce but one young at a birth.

3. Cavia Capybara. The characters of this animal (Plate Nat. Hist. fig. 97.) are somewhat ambiguous, and it was formerly considered by Linnæus as a species of hog, and was accordingly placed in that genus in the 12th edition of the Systema Naturæ, under the name of sus hydrochœris. It grows to the size of a hog of two years old, and is said to have been sometimes found of the weight of 100 pounds. It inhabits various parts of South America, though said to be more common in Brasil than in other regions. It feeds not only on various vegetables, and particularly on sugar-canes, but also (contrary to the nature of most of the glires) on fish; for which purpose, it frequents rivers, swimming with the same facility as the otter, and, like that animal, dragging its prey out of the water, and eating it on the bank.

4. Cavia caudata aguti. This species is peculiar to the warmer parts of South America, and is extremely common in Guiana. Its general size is that of a rabbit: the body is plump, and thicker behind than before: the head is rather small, and somewhat compressed laterally. This animal's manner of moving resembles that of a hare, and its voice is like the grunting of a young pig. It feeds on various roots, nuts, fruit, &c. &c. and resides in woods, where it forms subterraneous burrows, and sometimes lodges in the hollows of trees. They are taken in traps, or hunted with dogs. The Indians and negroes, who know how to allure them by whistling, or imitating their cries, kill as many as they please. When pursued, they conceal themselves, like rabbits, in the holes of old trees. They hold their food in their paws like squirrels.

5. C. Aguti Leporine. Leporine cavy, is probably a variety of the aguti, from which it differs in being of a reddish colour above, with the breast and belly white. It is of the size of a hare, and is a native of Surinam, and other parts of South America. It is altogether an American animal, and notwithstanding its common title of the Java hare, is not found either in that island or Sumatra, as erroneously supposed by some.

6. Cavia acuschy, (Plate Nat. Hist. fig. 96.) is by some regarded as a variety of the aguti, but differs in being somewhat smaller, rather thinner, and entirely of an olive colour, paler or more inclining to whitish beneath: the tail is also longer than in the aguti. It is a native of the same parts of South America with the auguti, is of similar manners, and is also tamed with equal readiness.

7. Cavia aperea, or rock cavy. This animal, which is a native of Brasil, is neither a rabbit nor a rat, but seems to partake of both. Its general colour is the same with that of our hares, and its belly is white: its upper lip is divided in the same manner, and it has the same large cutting teeth, and whiskers round the mouth and on the sides of the eyes, but its ears are rounded like those of a rat, and so short that they exceed not a finger's breadth in height.

CAUKING, or caulking of a ship, is driving oakum, or the like, into all the seams of the planks of a ship, to prevent leaking and keep out the water. After the seams are stopped with oakum, it is done over with a mixture of tallow, pitch, and tar, as low as the ship draws water.

CAULICOLES, or caulicoli, are eight lesser branches or stalks, in the Corinthian capital, springing out from four greater or principal cauls, or stalks. The eight volutes of this order are sustained by four cauls, or primary branches, of leaves, and from which these caulicoles or lesser foliages arise.

CAULIFEROUS, an appellation given to such plants as have a perfect caulis or stem. See Botany.

CAULIFLOWERS. See Brassica.

CAUSALTY, among the miners, denotes the lighter, sulphureous, earthy parts of ores, carried off in the operation of washing. This, in the mines, they throw in heaps upon banks, which, in six or seven years, they find it worth their while to work over again.

CAUSTICS. See Surgery.

Caustic-curve, in the higher geometry, a curve formed by the concourse or coincidence of the rays of light, reflected from some other curve.

CAUTERY, a medicine for burning, eating, or corroding, any solid part of the body. See Surgery.

CAUTION, in the civil and Scotch law, denotes much the same with what, in the law of England, is called bail.

CAXA, a little coin made of lead, mixed with some scoria of copper, struck in China, but current chiefly at Bantam in the island of Java, and some of the neighbouring islands. The caxas are of two kinds, great and small. Of the small 300,000 are equal to fifty-six livres five sols French money; and of the great 6000 are equal to four shillings and sixpence sterling.

CAZEMATE, or casemate, in fortification, a certain retired platform in the flank of a bastion, for the defence of the moat and face of the opposite bastion. Sometimes there are three such platforms, one behind another, the uppermost of which is on the terre-plein of the bastion, which makes the other two be called places-basses, or low places. They are covered from the enemies' batteries by a work of earth added to the angle of the shoulder, of a circular and sometimes of a square form, called shoulder, orillon, or epaulement.

Cazemate is also used for a well with several subterraneous branches dug in the passage of the bastion, till the miner is heard at work, and air given to the mine.

CEANOTHUS, New Jersey tea, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 43d order, dumosæ. There are five petals, pouched and arched. The fruit is a dry, trilocular, and trispermous berry. There are six species, of which the most remarkable is the

Ceanothus Americanus, a native of most parts of North America, whence the seeds have been imported into Europe. In England this plant seldom rises more than three feet high. The stem, which is of a pale brown colour, sends out branches from the bottom. The flowers grow at the ends of the twigs in clusters: they are of a white colour, and when in flower give the shrub a most beautiful appearance.

CECROPIA, a genus of the diandria order, in the diœcia class of plants; and in the natural method ranking under the 53d order, scabridæ. There is one species, a tree of South America.

CEDAR. See Juniperus, Pinus, Cedrela, &c.

Cedar, *bastard*. See Theobroma.

Cedar, *white*. See Cupressus.

CEDRELA, a genus of the monogynia order, in the pentandria class of plants; and ranking, according to the natural method, under the 54th order, miscellaneæ. There is only one species, called Barbadoes bastard cedar.

CELARENT, in logic, a mode of syllogism, wherein the major and conclusion are universal negative propositions, and the minor an universal affirmative. As

CE No man that is a hypocrite can be saved:
LA Every man who with his lips only cries, Lord, Lord, is a hypocrite:
RENT Therefore, no man, who with his lips only cries Lord, Lord, can be saved.

CELASTRUS, the staff tree, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 43d order, dumosæ. The corolla is pentapetalous and patent; the capsule quinquangular and trilocular; the seeds veiled. There are 22 species, two of which are inured to our climate, viz.

1. Celastrus bullatus, an uncertain deciduous shrub, a native of Virginia. It is about four feet high. The flowers are produced in July, at the ends of the branches, in loose spikes. They are of a white colour, and in their native countries are succeeded by beautiful scarlet fruit; but with us this seldom happens.

2. Celastrus scandens, the flowers of which are green, and appear in June. The berries are red, and make a fine appearance in autumn.

CELESTINS, in church-history, a religious order of christians, reformed from the Bernardins by pope Celestin V.

The celestins rise two hours after midnight to say matins: they eat no flesh any time, except when they are sick: they fast every Wednesday and Friday to the feast of the

exaltation of the holy cross; and from that feast to Easter, every day.

CELIAC, or cœliac passion. See MEDICINE.

CELLEPORÆ, a genus of marine plants, or rather animals; a class of worms in the Linnæan system. They are of the order of the lythophyta.

CELOSIA, cock's-comb, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 54th order, miscellaneæ. The calyx is triphyllous; the corolla is five-petalled in appearance; the stamina are conjoined at the base to the plated nectarium; the capsule gaping horizontally. There are 14 species, of which the most worthy of notice is the

Celosia cristata, or common cock's-comb. The principal colours of its flowers are red, purple, yellow, and white; but there are some whose heads are variegated with two or three colours. They are very tender exotics, and require a great deal of care to cultivate them in this country.

CELSIA, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 28th order, luridæ. The calyx is quinquepartite; the corolla wheel-shaped; the filaments bearded or woolly; the capsule bilocular. There are four species, natives of Armenia.

CELTIS, the lote, or nettle-tree, a genus of the monœcia order, in the polygamia class of plants; and in the natural method ranking under the 53d order, scabridæ. It is an hermaphrodite plant: the female calyx is quinquepartite; there is no corolla; there are five stamina, and two styles. The fruit is a monospermous plum. In the male, there is no calyx: the corolla is hexapetalous; there are six stamina, and an embryo of a pistillum. There are seven species, all of them deciduous. The most remarkable are

1. Celtis australis, the southern celtis, a deciduous tree, a native of Africa and the south of Europe.

2. Celtis occidentalis, the western celtis, a native of Virginia. These two species grow with large, fair, straight stems. The leaves are late in the spring before they show themselves; but they make amends for this, by retaining their verdure till near the close of autumn: and then do not resemble most deciduous trees, whose leaves show their approaching fall by the change of their colour; but continue to exhibit themselves of a pleasant green to the last. Hanbury speaks highly of the celtis as a timber tree: he says, "the wood of the lote-tree is extremely durable. In Italy they make their flutes, pipes, and other wind instruments of it. With us the coach-makers use it for the frames of their vehicles."

3. Celtis orientalis, the eastern celtis, a native of Armenia: it grows to about 12 feet, and its branches are numerous, smooth, and of a greenish colour. The leaves are smaller than those of the others, though they are of a thicker texture, and a lighter green. The flowers come out from the wings of the leaves, on slender footstalks: they are yellowish, appear early in spring, and are succeeded by large yellow fruit.

CEMENT, any glutinous substance capable of uniting and keeping things together by cohesion. We shall give an account of some of the best compositions used for the purpose of cementing together various articles.

Jeweller's cement.—for setting precious stones when pieces are broken off by accident. In such cases the artist can frequently join the pieces so correctly that an inexperienced eye cannot discover the stone to have been broken; for this purpose a small piece of gum mastich is applied between the fragments, which are previously heated sufficiently to melt the interposed gum. They are then pressed together, to force out the redundant quantity of gum.

Turkey cement, for joining metals, glass, &c.—Dissolve five or six bits of mastich, as large as peas, in as much spirit of wine as will suffice to render it liquid; in another vessel dissolve as much isinglass (which has been previously soaked in water till it is swollen and soft) in brandy or rum, as will make two ounces by measure of strong glue, and add two small bits of gum galbanum, or ammoniacum, which must be rubbed or ground till they are dissolved; then mix the whole with a sufficient heat; keep it in a phial stopt, and when it is to be used set it in hot water.

A cement for broken china, glass, &c.—Take quick-lime and white of eggs, or old thick varnish; grind and temper them well together, and it is ready for use. Drying oil and white lead are also frequently used for cementing china and earthenware; but this cement requires a long time to dry. Where it is not necessary the vessel should endure heat or moisture, isinglass glue, with a little tripoli, or chalk, is better.

A cement useful for turners.—Take resin one pound, pitch four ounces; melt these together, and, while boiling hot, add brick-dust, until by dropping a little upon a stone, you perceive it hard enough; then pour it into water, and immediately make it up in rolls, and it is fit for use. Or take resin one ounce, pitch two ounces; add red ochre, finely powdered, until you perceive it strong enough. Sometimes a small quantity of tallow is used, according to the heat of the weather, more being necessary in winter than in summer. Either of these cements is of excellent use for turners. By applying it to the side of a chuck, and making it warm before the fire, you may fasten any thin piece of wood, which will hold while you turn it; when you want it off again, strike it on the top with your tool, and it will drop off immediately.

A strong cement for electrical purposes.—Melt one pound of resin in a pot or pan, over a slow fire; add thereto as much plaister of Paris, in fine powder, as will make it hard enough, which you may soon know by trial; then add a spoonful of linseed-oil, stirring it all the while, and try if it be hard and tough enough for your purpose; if it is not sufficiently hard, add more plaister of Paris; and if not tough enough, a little more linseed oil. This is as good a cement as possible for fixing the necks of globes or cylinders, or any thing else that requires to be strongly fixed; for it is not easily melted again when cold. Or take resin one pound, bees-wax one ounce; add thereto as much red ochre as will make it of sufficient stiffness; pour it into water, and make it into rolls, and it is fit for use. This cement is useful for cementing hoops on glasses, or any other mounting of electrical apparatus.

A cement for glass-grinders.—Take pitch and boil it; add thereto, and keep stirring it all the while, fine sifted wood-ashes, until you have it of a proper temper: a little tallow may be added, as you find necessary. For small work: to four ounces of resin add one-fourth of an ounce of bees-wax melted together; and four ounces of whitening, made previously red hot. The whitening should be put in while hot, that it may not have time to imbibe moisture from the atmosphere.

Shell-lac is a very strong cement for holding metals, glass, or precious stones, while cutting, turning, or grinding them. The metal, &c. should be warmed, to melt it. For fastening ruby cylinders in watches, and similar delicate purposes, shell-lac is excellent.

To solder or cement broken glass.—Broken glass may be soldered or cemented in such a manner as to be as strong as ever, by interposing between the parts, glass ground up like a pigment, but of easier fusion than the pieces to be joined, and then exposing them to such a heat as will fuse the cementing ingredient, and make the pieces agglutinate without being themselves fused. A glass for the purpose of cementing broken pieces of flint glass, may be made by fusing some of the same kind of glass previously reduced to powder, along with a little red lead and borax, or with the borax only.

Cement for Derbyshire spar and other stones.—A cement for this purpose may be made with about seven or eight parts of resin and one of bees-wax, melted together with a small quantity of plaister of Paris. If it is wished to make the cement fill up the place of any small chips that may have been lost, the quantity of plaister must be increased a little. When the ingredients are well mixed, and the whole is nearly cold, the mass should be well kneaded together. The pieces of spar that are to be joined, must be heated until they will melt the cement, and then pressed together, some of the cement being previously interposed. Melted sulphur applied to fragments of stones previously heated (by placing them before a fire) to at least the melting point of sulphur, and then joined with the sulphur between, makes a pretty firm and durable joining. Little deficiencies in the stone, as chips out of corners, &c. may also be filled up with melted sulphur, in which some of the powder of the stone has been melted.

A cement that will stand against boiling water, and the pressure of steam.—In joining the flanches of iron cylinders, and other parts of hydraulic and steam engines, great inconvenience is often experienced from the want of a durable cement. Boiled linseed oil, litharge, and red and white lead, mixed together to a proper consistence, and applied on each side of a piece of flannel previously shaped to fit the joint, and then interposed between the pieces before they are brought home (as the workmen term it) to their place by the screws or other fastenings employed, make a close and durable joint.

The quantities of the ingredients may be varied without inconvenience, only taking care not to make the mass too thin with oil. It is difficult in many cases instantly to make

a good fitting of large pieces of iron-work, which renders it necessary sometimes to join and separate the pieces repeatedly, before a proper adjustment is obtained. When this is expected, the white lead ought to predominate in the mixture, as it dries much slower than the red. A workman, knowing this fact, can be at little loss in exercising his own discretion in regulating the quantities. It is safest to err on the side of the white lead, as the durability of the cement is no way injured by it, only a longer time is required for it to dry and harden. When the fittings will not admit easily of so thick a substance as flannel being interposed, linen may be substituted, or even paper or thin pasteboard.

This cement answers well also for joining broken stones, however large. Cisterns built of square stones put together with this cement, will never leak, or want any repairs. In this case the stones need not be entirely bedded in it: an inch, or even less, of the edges that are to lie next the water, need only be so treated; the rest of the joint may be filled with good lime.

Another cement that will stand the action of boiling water and steam.—This cement, which is preferable even to the former for steam-engines, is prepared as follows: Take two ounces of sal ammoniac, one ounce of flowers of sulphur, and 16 ounces of cast-iron filings or borings. Mix all well together by rubbing them in a mortar, and keep the powder dry.

When the cement is wanted for use, take one part of the above powder, and twenty parts of clean iron borings or filings, and blend them intimately by grinding them in a mortar. Wet the compound with water, and when brought to a convenient consistence, apply it to the joints with a wooden or blunt spatula. By a play of affinities, which those who are at all acquainted with chemistry will be at no loss to comprehend, a degree of action and re-action takes place among the ingredients, and between them and the iron surfaces, which at last causes the whole to unite as one mass. In fact, after a time, the mixture and the surfaces of the flanches become a species of pyrites (holding a very large proportion of iron), all the parts of which cohere strongly together.

Blood cement.—A cement often used by coppersmiths to lay over the rivets and edges of the sheets of copper in large boilers, to serve as an additional security to the joinings, and to secure cocks, &c. from leaking, is made by mixing pounded quicklime with ox's blood. It must be applied fresh made, as it soon gets hard. If the properties of this cement were duly investigated, it would probably be found useful for many purposes to which it has never yet been applied. It is extremely cheap, and very durable.

Flour paste.—Flour paste for cementing, is formed principally of wheaten flour, boiled in water till it is of a glutinous or viscid consistence. It may be prepared of these ingredients, simply for common purposes; but when it is used by bookbinders, or for paper-hangings, it is usual to mix with the flour a fifth or sixth of its weight of powdered resin or alum; and where it is wanted still more tenacious, gum arabic, or any kind of size, may be added.

Japanese cement, or *rice glue.*—This elegant cement is made by mixing rice-flour intimately with cold water, and then gently boiling it. It is beautifully white, and dries almost transparent. Papers pasted together by means of this cement will sooner separate in their own substance than at the joining, which makes it useful in the preparation of curious paper articles, as tea-trays, ladies' dressing-boxes, and other articles that require layers of paper to be cemented together.

CENCHRUS, in botany, a genus of the polygamia monoecia class of plants. There are two flowers, the one male, the other hermaphrodite; the proper flower is single, with two lanceolated, acuminated, concave valves: there is no pericarpium, and but one roundish seed. There are eleven species.

CENSOR, in Roman antiquity, a magistrate whose business it was to reform the manners and to value the estates of the people.

CENSUS, in Roman antiquity, an authentic declaration made before the censors, by the several subjects of the empire, of their respective names and places of abode. This declaration was registered by the censors, and contained an enumeration in writing of all the estates, lands, and inheritances, they possessed; their quantity, quality, place, wives, children, domestics, tenants, slaves.

CENT. in commerce, an abridgment of centum, is used to express the profit or loss arising from the sale of any commodity: thus we say, there is 10 *per cent.* profit, or 10 *per cent.* loss; which is $\frac{1}{10}$ profit, or $\frac{1}{10}$ loss, upon the sale of the whole. In the trade of money, it signifies the benefit or interest of any sum of money. Thus money is worth 4 or 5 *per cent.* upon exchange. But in brokerage, it must be observed, that cent. is applied in a different manner. For example, if a broker or exchange-agent takes $\frac{1}{8}$ *per cent.* for the contracts made by his interposition, it is to be understood that there is paid to him $\frac{1}{8}$ of a pound, viz. 2*s.* 6*d.* for every 100*l.* he negotiated.

CENTAUR, *centaurus*, in astronomy, a constellation of the southern hemisphere commonly joined with the wolf, and called *centaurus cum lupo*. In Ptolemy's catalogue, it consists of 37 stars; in Tycho's of 4; and of 35 in the Britannic catalogue, with Sharp's appendix.

CENTAUREA, a genus of the polygamia frustranea order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is bristly, the pappus simple, the corollulæ of the radius funnel-shaped, longer than those of the disk, and irregular. There are 77 species, of which we shall only mention two, viz.

1. Centaurea cyanus, the bluebottle, grows commonly among corn. The expressed juice of this flower stains linen of a beautiful blue colour, but it is not permanent. Mr. Boyle says, that the juice of the inner petals, with a little alum, makes a beautiful permanent colour, equal to ultramarine.

2. Centaurea glastifolia. The root of this species is an article in the materia medica. It has a rough, somewhat acrid taste, and abounds with a red viscid juice. Its rough taste had gained it some esteem as an astringent; its acrimony as an aperient; and its glutinous quality as a vulnerary: but the present practice takes very little notice of it.

CENTER *of a bastion*, a point in the middle of the gorge of a bastion, whence the capital line commences, and is generally at the angle of the inner polygon.

CENTER *of a conic section*, a point in which the diameters intersect each other. In the ellipsis, this point is within the figure, and in the hyperbola, without.

CENTER *of a curve of the higher kind*, the point where two diameters concur. When all the diameters concur in the same point, sir Isaac Newton calls it the general center.

CENTER *of a dial*, that point where the axis of the world intersects the plane of the dial; and therefore in dials that have centers, it is that point wherein all the hour-lines meet. All dials have centers, except such as have their planes parallel to the axis of the world.

CENTER *of gravity*, in mechanics, that point about which all the parts of a body, in any situation, balance each other. Hence, 1. If a body is suspended by this point as the center of motion, it will remain at rest in any position indifferently. 2. If a body is suspended in any other point, it can rest only in two positions, viz. when the center of gravity is exactly above or below the point of suspension. 3. When the center of gravity is supported, the whole body is kept from falling. 4. Because this point has a constant endeavour to descend to the center of the earth, therefore, 5. When the point is at liberty to descend, the whole body must also descend, either by sliding, rolling, or tumbling down. 6. The center of gravity in regular uniform and homogeneal bodies, as squares, circles, &c. is the middle point in a line connecting any two opposite points or angles. Wherefore, if such a line is bisected, the point of section will be the center of gravity. See MECHANICS.

CENTER *of oscillation*, that point in a pendulum in which, if the weight of the several parts was collected, each vibration would be performed in the same time as when those weights are separate. This is the point whence the length of a pendulum is measured, which, in our latitude, in a pendulum that swings seconds, is 39 inches and 2-10ths. The center of suspension is the point on which the pendulum hangs.

CENTER *of percussion*, in a moving body, that point wherein the percutient force is greatest, or that point with which if the body strikes against any obstacle, no shock shall be felt in the point of suspension. See MECHANICS.

CENTIPES, in zoology, see SCOLOPENDRA.

CENTNER, among metallurgists and assayers, denotes a weight divisible first into a hundred, and afterwards into other lesser parts. It is, however, to be observed, that the centner of metallurgists is the same with the common hundredweight; whereas that of assayers is no more than one dram, to which the other parts are proportional, and nevertheless pass by the names 100 lb. 64 lb. 32 lb. &c.

CENTRAL *forces*, the powers which cause a moving body to tend towards, or recede from, the center of motion. See MECHANICS.

CENTRIFUGAL *force*, that force by which all bodies that move round any other body, in a curve, endeavour to fly off from the axis of their motion in a tangent to the peri-

phery of the curve, and that in every point of it. See MECHANICS.

CENTRIPETAL *force*, that force by which a body is every where impelled, or any way tends, towards some point as a center; such are gravity, or that force whereby bodies tend towards the center of the earth (see MECHANICS); magnetical attraction, whereby the loadstone draws iron; and that force, whatever it be, whereby the planets are continually drawn back from right-lined motions, and made to move in curves.

CENTRISCUS, in ichthyology, a genus of fishes belonging to the order of amphibia nantes. The head gradually ends in a narrow snout, the aperture broad and flat; the belly is carinated, and the belly-fins united. There are two species, viz.

1. The scutatus, which has its back covered with a smooth bony shell, which ends in a sharp spine, under which is the tail, but the back fins are between the tail and the spine. It is a native of the East Indies.

2. The scolopax (see Plate Nat. Hist. fig. 105.) has a rough scabrous body, and a straight extended tail. It has two belly-fins, with four rays each, and has no teeth. It is found in the Mediterranean.

CENTRUM *tendinosum*, in anatomy, a point wherein the tendons of the muscles of the diaphragm meet. See ANATOMY.

CENTUMVIRI, in Roman antiquity, judges appointed to decide common causes among the people. They were chosen three out of each tribe; and though five more than a hundred, were nevertheless called centumviri, from the round number centum, a hundred.

CENTUNCULUS, in botany, a genus of plants called by some *anagallidiastrum*, and by others a species of *anagallis*, the characters of which are these: it belongs to the tetrandria monogynia class of plants; the flower is monopetalous, the tube being globose, and the limb divided into four oval segments: the fruit is an unilocular capsule, containing a great number of roundish seeds. There is one species, annual.

CENTURION, among the Romans, an officer in the infantry, who commanded a century or a hundred men. The centurions held the first rank in the first cohort of a legion, and two of them the place of the two first hastati, or pikemen: the first among the principes was also a centurion.

CENTUSSIS, in Roman antiquity, a coin containing a hundred asses.

CEPHALANTHUS, a genus of the tetrandria monogynia class of plants; the corolla consists of a single petal; the tube is slender; the limb is divided into four parts, acute, reflex, and of the length of the tube; the fruit is an oblong capsule, containing only one cell; several of these grow together, and form a roundish head: the seeds are numerous and oblong. There are five species, trees and shrubs of China.

CEPHALIC *medicines*, are remedies for disorders of the head. See MEDICINE.

CEPHALIC *vein*. See ANATOMY.

CEPHEUS, in astronomy, a constellation of the northern hemisphere, the stars of which, in Ptolemy's catalogue, are 13; in Tycho's, 11; in Hevelius's, 40; and in Mr. Flamsteed's, 35.

CEPI *corpus*, in law, a return made by the sheriff, that, upon a capias, or other like process, he has taken the defendant's body.

CERAMBYX, in zoology, a genus of beetles, or the coleoptera order, the characters of which are these: the antennæ are long and setaceous, and the thorax is oblong, rounded, and mucronated or pointed at each extremity. Under this genus is comprehended the capricorn-beetle.—There are 83 species of this genus enumerated by Linnæus, principally distinguished by the figure of the breast. See Plate Nat. Hist. figs. 99 and 100.

CERASTIUM, mouse-ear, a genus of the decandria pentagynia class of plants, the flower of which consists of five bifid petals; and its fruit is a very long unilocular pod, containing numerous roundish seeds. There are 18 species of this weed.

CERATE, in pharmacy, a medicine used externally in several diseases, especially those of the skin. It is generally of four sorts, the white cerate, the yellow cerate, the cicatrizing cerate, and the mercurial cerate. See PHARMACY.

CERATOCARPUS, a genus of the monœcia monandria class of plants, distinguished by having no petals, and a small, compressed, and bicornate seed, not unlike that of bidens.

CERATONIA, the carob tree, or St. John's bread, a genus of the triœcia order, in the polygamia class of plants, and in the natural method ranking under the 33d order, lomentaceæ. The calyx is hermaphrodite and quinquepartite; there is no corolla; the stamina are five; the style is filiform; the legumen coriaceous and polyspermous. It is also dioecious, or male and female distinct on different plants. There is but one species, viz.

Ceratonia siliqua, a native of Spain, of some parts of Italy, and the Levant. It is an evergreen; and, in the countries where it is native, grows in the hedges. It produces a quantity of long, flat, brown-coloured pods, which are thick, mealy, and of a sweetish taste. These pods are eaten by the poorer sort of inhabitants when there is a scarcity of other food; but they are apt to loosen the belly, and cause gripings of the bowels.

CERATOPHYLLUM, a genus of the polyandria order, in the monœcia class of plants, and in the natural method ranking under the 15th order, inundatæ. The male calyx is multipartite; no corolla; stamina from 16 to 20: the female calyx is multipartite; no corolla; one pistil; no style; one naked seed. There are two species, of no note.

CERBERA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 30th order, contortæ. The fruit is a monospermous plum. Of 5, the most remarkable species is,

Cerbera atrouai, a native of the warm parts of America It rises with an irregular stem to eight or ten feet, sending out many crooked diffused branches, with thick succulent leaves of a lucid green, smooth, and very full of a milky juice. The flowers come out in loose bunches at the end of the branches; they are of a cream-colour, having long narrow tubes, and at the top are cut into five obtuse segments, which seem twisted. The wood of this tree stinks most abominably, and the kernels of the nuts are a deadly poison, to which there is no antidote; so that the Indians will not even use the wood for fuel.

CERCELE, in heraldry. A cross cercele is a cross which opening at the ends, turns round both ways like a ram's horn.

CERCIS, the Judas tree, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 33d order, lomentaceæ. The calyx is quinquedentated, and gibbous below; the corolla papilionaceous, with a short vexillum or flag petal under the wings or side petals; a leguminous plant. There are only two species, both deciduous. The most remarkable is,

Cercis Canadensis, or Canadian cercis: it will grow to the size of twenty feet in some places. The branches are also irregular: the flowers are usually of a palish red, and show themselves in spring, before the leaves are grown to their size. The flowers are often eaten in sallads, and afford an excellent pickle.

CERDONIANS, in church history, persons who maintained most of the errors of Simon Magus, Saturnel, and other Gnostics. They asserted two principles, the one good, and the other evil: this last, according to them, was creator of the world, and the God that appeared under the old law; the first, whom they called unknown, was the father of Jesus Christ; who, they taught, was only incarnate in appearance, and was not born of a virgin, nor suffered death, but in appearance.

CEREALIA, in antiquity, feasts of Ceres, instituted by Triptolemus of Eleusis, in Attica.

CEREBELLUM, in anatomy, the hinder part of the brain. See ANATOMY.

CEREBRUM. See ANATOMY.

CERINTHE, honey-wort, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 41st order, asperifoliæ. The limb of the corolla is a ventricose tube, with the throat pervious; and there are two bilocular seeds. There are two species, natives of Germany, Italy, and the Alps. They are low annual plants, with purple, yellow, and red flowers, which may be propagated by seed sown in autumn, in a warm situation.

CERINTHIANS, in church history, a Christian sect, followers of Cerinthus, who lived and published his heresy in the time of the apostles themselves. They did not allow that God was the author of the creatures, but said that the world was created by an inferior power: they attributed to this creator an only son, but born in time, and different from the world: they admitted several angels and inferior powers; they maintained that the law and the prophets came not from God, but from the angels; and that the God of the Jews was only an angel. They distinguished between Jesus and Christ: and said, that Jesus was a mere man, born, like other men, of Joseph and Mary; but that he excelled all other men in prudence and wisdom; that Jesus being baptized, the Christ of the supreme God, that is, the Holy Ghost, descended upon him; and that by the assistance of this Christ, Jesus performed his miracles. It was partly to refute this sect that St. John wrote his gospel.

CEROPEGIA, in botany, a genus of the pentandria monogynia class. The flower con-

sists of a single petal; the tube is cylindraceous, oblong, and terminating with a long globose base; the limb is small, and divided into five segments: the fruit is two cylindraceous accuminated floscules, containing one cell, and divided by two valves; the seeds are numerous, imbricated, and oblong. There are six species.

CERTHIA, in ornithology, the creeper or ox-eye, a genus belonging to the order of picæ. The beak is arched, slender, sharp, and triangular; the tongue is sharp at the point; and the feet are of the walking kind, or having the toes open and unconnected. Of this genus near 50 species have been enumerated. The following are a few of the most remarkable:

1. The familiaris, or common ox-eye, is grey above and white underneath, with brown wings, and ten white spots on the ten prime feathers. This bird is found in most parts of Europe, though it is believed no where so common as in Britain. It may be thought more scarce than it really is by the less attentive observer; for, supposing it on the body or branch of any tree, the moment it observes any one, it gets to the opposite side, and so on, let a person walk round the tree ever so often. The facility of its running on the bark of a tree, in all directions, is wonderful; this it does with as much ease as a fly on a glass window. Its food is principally, if not wholly, insects, which it finds in the chinks and among the moss of trees. It builds its nest in some hole of a tree, and lays generally five eggs, very rarely more than seven: these are ash-coloured, marked at the end with spots and streaks of a deeper colour.

2. The hook-billed green creeper inhabits the Sandwich islands in general, and is one of the birds whose plumage the natives make use of in constructing their feathered garments; which having these olive-green feathers intermixed with the beautiful scarlet and yellow ones belonging to the next species, and yellow-tufted bee-eater, make some of the most beautiful coverings of these islanders.

3. The pusila, or brown and white creeper, is not above half the size of our European creeper. The upper part of the body is brown, with a changeable gloss of copper: the under parts are white. It is a native of the Cape, and is fond of honey.

4. The Loteni, or Loten's creeper, has the head neck, back, rump, scapulars, and upper tail-coverts, of green gold; beneath, from the breast to the vent, of velvet black, which is separated from the green on the neck by a transverse bright violet band. It inhabits Ceylon and Madagascar.

5. The cerulea, or blue creeper, has the head of a most elegant blue; but on each side there is a stripe of black like velvet, in which the eye is placed: the chin and throat are marked with black in the same manner; the rest of the body violet blue. It inhabits Cayenne. It makes its nest with great art. The outside is composed of dry stalks of grass, or such like; but within of very downy soft materials, in the shape of a retort, which it suspends from some weak twig, at the end of a branch of a tree, the opening or mouth downwards, facing the ground: the neck is a foot in length, but the real nest is quite at the top, so that the bird has to climb up this funnel-like opening to get at the nest. Thus it is secure from every harm; neither monkey, snake, nor lizard, daring to venture at the end of the branch, as it would not steadily support them.

6. The sannio, or mocking creeper, is of the size of the lesser thrush. On the cheeks is a narrow white spot: the head, especially on the crown, is inclined to violet; the plumage in general is olive-green. It inhabits both the islands of New Zealand. It has an agreeable note in general; but at times so varies and modulates the voice, that it seems to imitate the notes of all other birds; hence it was called by the English the mocking-bird. See Plate Nat. Hist. fig. 101.

CERTIFICATE, in law, a writing made in any court, to give notice to another court of any thing done therein. The clerks of the crown, assize, and the peace, are to make certificates into the king's bench of the tenor of all indictments, convictions, outlawries, &c.

CERTIFICATION *of assize of novel disseisin*, a writ granted for the re-examination or review of a matter passed by assize before any justices; as where a man appearing by his bailiff to an assize brought by another, has lost the day, and having something more to plead for himself, as a deed of release, &c. which the bailiff did not or might not plead for him, desires a farther examination of the cause, either before the same justices or others, and obtains letters patent to that effect.

CERTIORARI. The writ of certiorari is an original writ, issuing out of the court of chancery or the king's bench, directed in the king's name to the judges or officers of inferior courts, commanding them to certify or to return the records of a cause depending before them, to the end the party may have the more sure and speedy justice before the king or such justices as he shall assign to determine the cause. 1 *Bac. Abr.*

A certiorari lies in all judicial proceedings in which a writ of error does not lie; and it is a consequence of all inferior jurisdictions erected by act of parliament, to have their proceedings returnable in the king's bench. *Ld. Raym.* 469.

In particular cases the court will use their discretion to grant a certiorari, as if the defendant is of good character, or if the prosecution is malicious, or attended with oppressive circumstances. *Leach's Ham.* 2. *c.* 27. *s.* 28. *n.*

The courts of chancery and king's-bench may award a certiorari; to remove the proceeding from any inferior courts, whether they are of ancient or newly created jurisdiction, unless the statute or charter which creates them exempts them from such jurisdiction. 1 *Salk.* 144. *pl.* 3.

CERT-MONEY, a fine paid yearly by the residents of several manors to the lord thereof, and sometimes to the hundred, *pro certo lete*, that is, for the certain keeping of the leet.

CERVICAL *nerves*. See ANATOMY.

CERVIX, in anatomy, denotes properly the hinder part of the neck. See ANATOMY.

CERUSE, or CERUSS, white-lead, a sort of calx of lead, made by exposing plates of that metal to the vapour of vinegar. See CHEMISTRY.

CERVUS, the stag or deer-kind, in zoology, a genus of quadrupeds of the order of the pecora. The generic character is: horns solid, covered while young with a hairy skin, growing from the top, naked, annual, branched. Front teeth in the lower jaw, eight. Canine teeth, none; sometimes single in the upper jaw.

1. Cervus alces, or elk. The elk, by far the largest animal of this genus, is, when full grown, scarcely inferior to a horse in size. It is common to both continents, inhabiting only the coldest regions, and is observed to arrive at a greater magnitude in Asia and America than in Europe. In its shape it is much less elegant than the rest of the deer tribe; having a very short and thick neck, a large head, horns dilating almost immediately from the base into a broad palmated form, a thick, broad, heavy upper lip, hanging very much over the lower; very high shoulders, and long legs. Notwithstanding its awkward proportions, it is, however, of a noble and majestic appearance. It is also a mild and harmless animal, and principally supports itself by brousing the boughs of trees in the vast and dreary forests of the frozen zone. The greatest height of the elk is about seventeen hands, and its greatest weight about 1229 pounds. The horns have been known to measure each 32 inches in length. The female is rather smaller than the male, and has no horns. See Plate Nat. Hist. fig. 103.

In Europe the elk is found chiefly in Sweden, Norway, and some parts of Russia. In Asia it occurs in the woody tracts of the Russian dominions; and in Siberia in particular is found of gigantic magnitude. In America it seems to be most common in Canada, and the country round the great lakes, and is called by the name of moose-deer.

The elk, though naturally of an inoffensive and peaceable disposition, displays a high degree of courage, and even ferocity, when suddenly attacked; defending himself with great vigour, not only with his horns, but also by striking violently with his fore feet, in the use of which he is so dextrous as easily to kill a dog, or even a wolf, at a single blow.

2. Cervus tarandus, or rein-deer (see Plate Nat. Hist. fig. 104.), like the elk, is an inhabitant of the northern regions. In Europe its chief residence is in Norway and Lapland. In Asia it frequents the north coast as far as Kamtschatka, and the inland parts as far as Siberia. In America it occurs in Greenland, and does not extend farther south than Canada. The height of a full-grown rein-deer is four feet six inches: the body is of a somewhat thick and square form, and the legs shorter in proportion than those of the stag. Its general colour is brown above and white beneath; but as it advances in age, it often becomes of a greyish white. No animal of this tribe appears to vary so much in the form and length of its horns as the rein-deer. In general the horns are remarkable for their great length and proportional slenderness, and are furnished with a pair of brow antlers, with widely expanded and palmated tips directed forwards. In the young and middle-aged rein-deer the horns are remarkable for their slender form; but as the animal advances in age, they are of a stronger appearance. With the Laplanders, indeed, this animal is at once the

Caryophyllus aromaticus
Clove tree

92

Cassia fistula

93

Cassida viridis

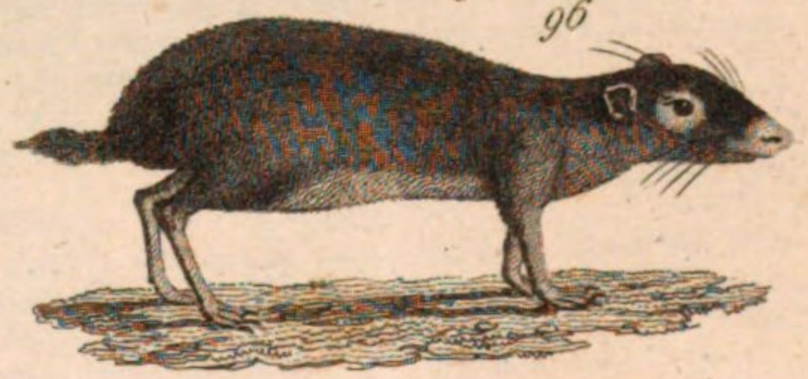
94

Castor fiber
Common Beaver

95

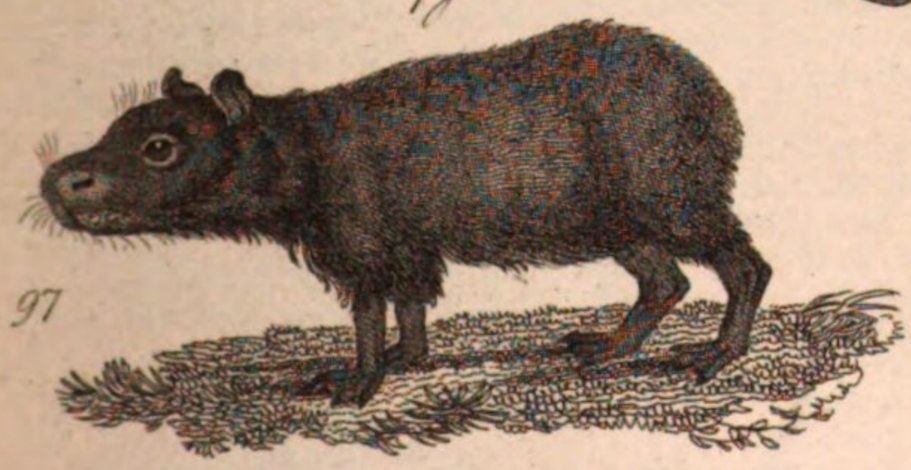
Cavia acuschy

96



Cavia capybara

97



Cavia paca
Spotted Cavy

98

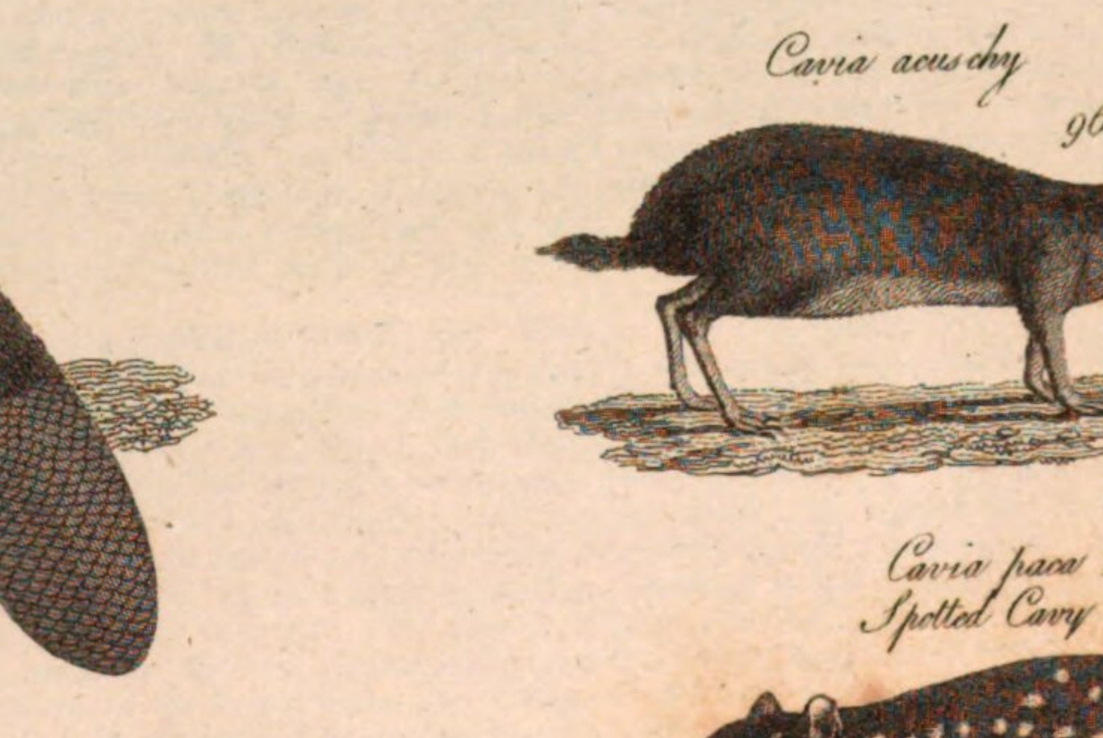
Cerambyx moschatus

100

Cerambyx arcuatus

99

Certhia sannio
Mocking creeper



101

Printed 1806, for Richard Phillips, 6. New Bridge Street, Blackfriars.

substitute of the horse, the cow, the sheep, and goat.

3. Cervus elaphus, or stag, is one of those innocent and peaceable animals that seem destined to embellish the forest, and animate the solitudes of nature. The elegance of his form, the lightness of his motions, the strength of his limbs, and the branching horns with which his head is decorated, conspire to give him a high rank among quadrupeds, and to render him worthy the admiration of mankind. It varies both in size and colour in different countries, but is generally about three feet and a half high, and of a reddish brown colour, whitish beneath. The horns vary as to size, &c. The general number of branches in a well-grown stag seems to be six or seven, but they are sometimes far more numerous.

The stag is a native of almost all the temperate parts of Europe, as well as of Asia. It also occurs in North America, where it occasionally arrives at a larger size than in the old continent, except in Siberia, where it is found of gigantic magnitude.

Stags in general cast or shed their horns sooner or later in the month of March, in proportion to their ages. At the end of June they are full-grown, and the animal rubs them strongly against the boughs of trees, or any convenient object, in order to free them from the skin, which is now become useless, and by the beginning of August they assume the full strength and consistence, which they retain throughout the remainder of the year.

4. Cervus dama, or fallow deer, is considerably smaller than the stag, and is of a brownish bay-colour, more or less deep in different individuals; whitish beneath, on the insides of the limbs, and beneath the tail, which is somewhat longer in proportion than that of the stag. In its general form, the animal greatly resembles the stag, having the same elegance of aspect, with a more gentle disposition. It is not so common as the stag, and is even a rare animal in some parts of Europe, as in France and Germany, but in Spain is said to be found nearly equal to the stag in size. The manners of the fallow deer resemble those of the stag, but it is observed to be less delicate in the choice of its food; eating a variety of vegetables which are refused by the former. It arrives at full growth and perfection in about three years, and is said to live about twenty.

The horns are annually shed, as in the stag, but at a somewhat later period.

5. Cervus Virginianus, Virginian deer, is a native of the northern parts of America, where it is found in vast herds, and is an animal of great importance to the Indian natives, who dry its flesh for their winter provision. The size of the animal is that of the fallow deer: its colour a light cinereous brown; the horns slender, bending very much forwards, with numerous branches on the interior sides, and no brow-antlers.

This species appears to occur in almost all parts of North America, and they abound in the greatest abundance in the vast savannas contiguous to the Mississippi and the great rivers which flow into it; grazing in innumerable herds, along with stags and buffaloes.

6. Cervus axis, or spotted axis (see Plate Nat. Hist. fig. 102.), is a most beautiful animal. Its size is nearly that of the fallow deer, and its colour an elegant light rufous-brown, distinctly and beautifully marked with very numerous white spots. It is described by Pliny among the animals of India, and is said to have been sacred to Bacchus. It has been introduced into Europe, and is occasionally seen in parks and menageries. It is readily tamed, and seems to suffer but little from a change of climate.

7. C. Axis, middle. Whether this is a variety of the former, or specifically distinct, does not appear perfectly clear. It is of a middle size, between the spotted axis and the great axis. In the colour of its hair, it resembles the first sort, but is never spotted. It inhabits dry hilly forests in Ceylon, Borneo, Celebes, and Java, where it is found in very numerous herds. Its flesh is much esteemed by the natives, and is dried and salted for use.

8. C. Axis, great. The existence of this species or variety is ascertained from a pair of horns in the British Museum, resembling the former kinds in shape, but of larger size: they measure two feet nine inches in length, are of a whitish colour, and are very strong, thick, and rugged. Mr. Pennant conjectures that they were brought from Ceylon or Borneo, having been informed by Mr. Loten, who had long resided in the former of these islands, that a very large kind of stag, as tall as a horse, of a reddish colour, and with trifurcated horns, existed there as well as in Borneo.

9. Cervus pygargus, or tailless roe. This species is described in the first volume of Dr. Pallas's Travels, and is a native of the mountainous parts of Hircania, Russia, and Siberia; inhabiting the loftiest parts of those regions, but in winter descending into the plains, the hair at that season assuming a hoary appearance. In its form it resembles the roebuck, but is larger. Its colour is brown, with the outsides of the limbs and under parts of the body yellowish. It has no tail, but a mere broadish cutaneous excrescence.

10. Cervus Mexicanus, or Mexican roe, is about the size of the common or European roebuck, and of a reddish colour, but when young is often spotted with white. The horns are thick, strong, and rugged: they bend forwards, and are about ten inches long. The flesh is said to be far inferior to the venison of Europe.

11. Cervus porcinus, porcine deer, has slender trifurcated horns, thirteen inches long and six inches at the base: the height from the shoulders to the hoof is two feet two inches, and about two inches higher behind; the body is thick and clumsy, the legs fine and slender; the colour on the upper part of the neck, body, and sides, is brown; the belly and rump lighter.

12. The cervus capreolus, or common roe, is of a reddish brown colour, and is the smallest of the European animals of this genus.

The common or general measure of the roe is three feet nine inches from nose to tail; the height before, two feet three inches; but behind, two feet seven inches; the horns are about six or eight inches long, and are strong, upright, rugged, and trifurcated: the general colour of the animal is reddish brown, more or less deep in different individuals, and the rump is white. It is an inhabitant of most parts of Europe, as far as Norway; it also occurs in some parts of Asia, but is not to be found in Africa. Whether it is a native of America seems somewhat doubtful, though some species nearly allied to it are found in that continent.

13. Cervus muntjac, or rib-faced deer, is a native of Java and Ceylon, and is somewhat smaller than the common roebuck, and of a thick form, like the porcine deer. The horns are trifurcated; but what seems principally to distinguish this animal, is the appearance of three longitudinal subcutaneous ribs, extending from the horns to the eyes. From each side of the upper jaw hangs a tusk; so that this species differs in that respect from most of the genus.

14. Cervus guineensis, or grey deer, is the size of a cat; the colour grey, with a line of black between the ears, a large spot of black above the eyes, and on each side of the throat a line of black, pointing downwards: the middle of the breast black; the fore legs and sides of the belly, as far as the hams, marked with black; the ears rather long; the under side of the tail black. It is said to be a native of Guinea.

CESARE, among logicians, one of the modes of the second figure of syllogisms; the minor proposition of which is an universal affirmative, and the other two universal negatives: thus,

Ce No immoral books ought to be read:
sa But every obscene book is immoral;
re Therefore no obscene book ought to be read.

CESSATION, cessatio a divinis, in the Romish church, is when, for any notorious injury to the church, a stop is put to all divine offices and the administration of the sacraments, and christians are deprived of church-burial. A cessation differs from an interdict in this, that, during the latter, divine service may be performed in such churches of any place interdicted, as are not expressly under the interdict, and even celebrated solemnly on certain high festivals, the church-doors being shut: but in a cessation, no religious service can be performed solemnly; the only liberty allowed is, in order to renew the consecrated hosts, to repeat every week a private mass in the parish-churches, the doors being shut, observing also not to ring the bell. Moreover it is lawful, during the cessation, to administer baptism, confirmation, and penance, to such persons as desire it, provided they are not excommunicated, or under an interdict.

CESSAVIT, in law, a writ that lies in many cases, upon this general ground; that he against whom it is brought has for two years ceased or neglected to perform such service, or to pay such rent, as he is bound to by his tenure, and has not upon his lands and tenements sufficient goods or cattle to be distrained.

CESSION, is where an ecclesiastical person is created a bishop, or where a parson of a parsonage takes another benefice, without dispensation, or otherwise not qualified, &c. in both cases, their first benefices are said to be void by cession: and to those benefices which the person who was created a bishop enjoyed, the king shall present for that time, whosoever is patron of them; and in the other cases the patron may present.

CESTRUM, bastard jasmin, a genus of the monogynia order, in the pentandria class

of plants; and in the natural method ranking under the 28th order, luridæ. The corolla is funnel-shaped; the stamina each sending out a little tooth about the middle of the inside. There are six species, all natives of the warmest parts of America; so cannot be preserved in this country without artificial heat. They are flowering shrubs, rising in height from five to twelve feet, with flowers of a white, or pale yellow colour. The flowers of one species, called Badmington jasmine, emit a strong scent after sunset. They may be propagated either by seed or cuttings.

CESTUI, a French word, signifying he or him, frequently used in our law-writings. Thus, cestui qui trust, a person who has lands, &c. committed to him for the benefit of another: and if such person does not perform his trust, he is compellable to it in chancery. Cestui qui vit, one for whose life any lands, &c. are granted. Cestui qui use, a person to whose use any one is infeoffed of lands or tenements. Formerly the feoffees to uses were deemed owners of the land, but now the possession is adjudged in cestui qui use.

CETUS, in astronomy, a constellation of the southern hemisphere, comprehending twenty-two stars in Ptolemy's catalogue, twenty-one in Tycho's, and in the Britannic catalogue ninety-seven.

In this constellation is a variable star which appears and disappears periodically, passing through the several degrees of magnitude both increasing and diminishing in about 333 days.

CETE, the seventh order in the mammalia class of animals; the characters of which are, breathing apertures on the head, tail horizontal, no claws. The animals of this order are all of the whale kind.

Nature has bestowed on this tribe an internal structure in all respects agreeing with that of quadrupeds; and in a few others the external parts are both similar. Cetaceous fish, like land-animals, breathe by means of lungs, being destitute of gills. This obliges them to rise frequently on the surface of the water to respire, to sleep on the surface, as well as to perform several other functions. They have the power of uttering sounds, such as bellowing and making other noises denied to genuine fish. Like land-animals they have warm blood, bring forth, and suckle their young, showing a strong attachment to them. Their bodies beneath the skin are entirely surrounded with a thick layer of fat (blubber), analogous to the lard on hogs. The number of their fins never exceeds three, viz. two pectoral fins, and one back fin; but in some species the last is wanting. Their tails are placed horizontally, or flat, in respect to their bodies; contrary to the direction of those of all other fish, which have them in a perpendicular site. This situation of the tail enables them to force themselves suddenly to the surface of the water to breathe, which they are so frequently constrained to do. Notwithstanding the many parts and properties which cetaceous fish have in common with land-animals, yet there still remain others which render it more natural to place them in the rank of fish: the form of their bodies agrees with that of fish; they are entirely naked, or covered only with a smooth skin; they live constantly in the water, and have all the actions of fish. This order comprehends the monodon, or narwhale, or sea-unicorn; balæna, or common whale; the physeter, cachalot, or spermaceti whale; and delphinus, dolphin, grampus, porpus, &c.

CHA, in commerce, a thin light silk-stuff made in China, and worn by the inhabitants for a summer-dress.

CHÆROPHYLLUM, chervil: a genus of the digynia order, in the pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The involucrum is reflexed-concave, the petals inflexed-cordate; the fruit oblong and smooth. There are ten species, two of which, called cow-weed and wild chervil, are weeds common in many places in Britain. The roots of the first have been found poisonous when used as parsnips; the flowers afford an indifferent yellow dye; the leaves and stalks a beautiful green. Its presence indicates a fertile soil, but it ought to be rooted out from all pastures early in the spring, as no animal but the ass will eat it. The leaves are recommended by Geoffroy as aperient and diuretic, and at the same time grateful to the palate and stomach. He even asserts that dropsies which do not yield to this medicine can scarcely be cured by any other. He directs the juice to be given in the dose of three or four ounces every fourth hour, and continued for some time, either alone or in conjunction with nitre and syrup of the five opening roots. The other species of chærophyllum are not possessed of any remarkable property.

CHÆTODON, in ichthyology, a genus of fishes belonging to the order of thoracici. The teeth are very numerous, thick, setaceous, and flexile; the rays of the gills are six. The back fin and the fin at the anus are fleshy and squamous. There are 23 species, distinguished from each other principally by the figure of the tail, and the number of spines in the back fin. The most remarkable is the acuminatus, or shooting fish, having a hollow cylindrical beak. It is a native of the East Indies, where it frequents the sides of the sea and rivers in search of food; from its singular manner of obtaining which it receives its name. When it spies a fly sitting on the plants that grow in shallow water, it swims to the distance of four, five, or six feet; and then, with a surprising dexterity, it ejects out of its tubular mouth a single drop of water, which never fails striking the fly into the water, where it soon becomes its prey. See Plate Nat. Hist. figs. 113, 114, 115, 116.

CHAFFERS, in our old records, signify wares or merchandize; and hence the word chaffering is used for buying and selling.

CHAIN, a kind of measure in France, in the trade of wood for fuel: there are chains for wood by tale, for wood by the rope, for faggots, for cleft wood, and for round sticks: there are also chains measuring the sheaves of all sorts of corn, &c.

CHAINS *in a ship*, those irons to which the shrouds by the masts are made fast to the chain-walls, which are the broad timbers made jetting out of the sides, to which the shrouds are fastened and spread out, the better to secure the masts.

CHAIN-SHOT, two bullets with a chain between them. They are used at sea to shoot down yards or masts, and to cut th shrouds or rigging of a ship.

CHAIN-PUMP. See PUMP.

CHAIN, in surveying, a measure of length, made of a certain number of links of iron wire, serving to take the distance between two or more places. Gunter's chain contains 100 such links, each measuring 7 $\frac{92}{100}$ inches, and consequently equal to 66 feet, or four poles. See SURVEYING.

CHALCEDONY, in natural history, a genus of semipellucid gems, of an even and regular not tabulated texture, of a semiopake crystalline basis, and variegated with different colours, dispersed in form of mists and clouds, and, if nicely examined, found to be owing to an admixture of various kinds of earths or metals, but imperfectly blended in the mass, and often visible in distinct moleculæ. Of this genus there are a great many species, as the bluish white chalcedony; the brownish-black chalcedony, or smoky jasper or capnitis of the antients; and the yellow and red chalcedony.

This stone is found abundantly in many countries, particularly in Iceland and the Ferro islands. It is most commonly amorphous, or in rounded masses. Its specific gravity is from 2.615 to 2.703; and it is composed of 84 parts of silica, and 16 of alumina, mixed with iron. When striped white and black, or brown alternately, it is called *onyx*; when striped white and grey, it is denominated *chalcedonix*. Black or brown chalcedony, when between the eye and a strong light, appears of a dark red.

CHALDRON, a dry English measure, consisting of thirty-six bushels, heaped up according to the sealed bushel kept at Guildhall, London: but on shipboard, twenty-one chaldron of coals are allowed to the score. The chaldron should weigh two thousand pounds.

CHALIZA, in Hebrew antiquity, the ceremony whereby a woman left a widow, pulled off her brother-in-law's shoes, who should have espoused her; after which she was at liberty to marry whom she pleased.

CHALK, in natural history, the English name of the white, dry, calcareous earth, with a dusty surface, found in hard masses, and called by authors creta, and terra creta. See CHEMISTRY.

CHALLENGE, taken either against persons or things: persons, as in assize the jurors, or any one or more of them; or in a case of felony, by a prisoner at the bar.

Challenge of jurors is of two kinds; either to the array, by which is meant the whole jury as it stands arrayed in the pannel or little square pane of parchment on which the jurors' names are written; or to the polls, by which are meant the several particular persons or heads in the array. 1 Inst. 156.

Challenge to the array is in respect of the partiality or default of the sheriff, coroner, or other officer that made the return; and it is then twofold: 1st. Principal challenge to the array, which if it is made good, is a sufficient cause of exception, without leaving any thing to the judgment of the triers; as if the sheriff is of kindred to either party; or if any of the jurors are returned at the denomination of either of the parties. 2nd. Challenge to the array for favour, which being no principal challenge must be left to the discretion and conscience of the triers; as

Cervus Axis
102

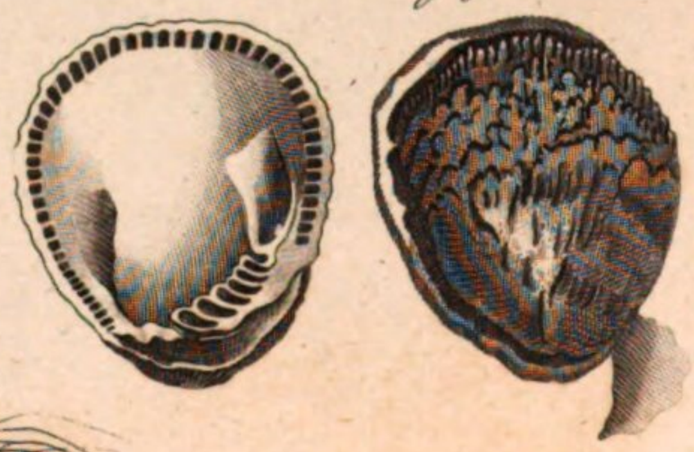
Cervus Alces
103

Cervus Tarandus
104

Charadrius pluvialis
Golden Plover
106

Centriscus scolopax
105

Chama gryphoides
107

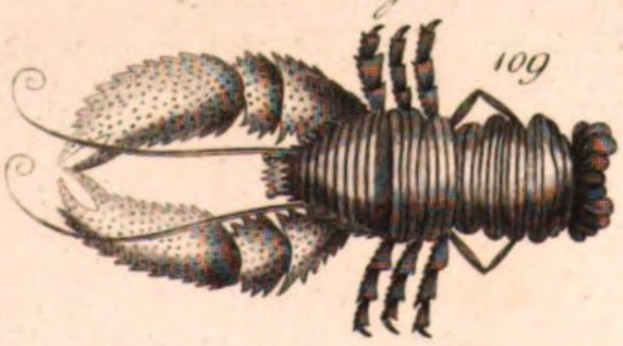


Cancer diogenes
Hermit Crab
110

Chaetodon acuminatus
113

Chama cordata
108

Cancer Strigosus
109



Cancer horridus
Horrid Crab
111

Cancer puricola
Violet Crab
112

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where either of the parties suspects that the juror is inclined to favour the opposite party. 1 Inst. 158.

Principal challenge to the polls, is where cause is shewn, which if found true, stands sufficient of itself, without leaving any thing to the triers; as if the juror is under the age of twenty-one, it is a good cause of challenge.

Challenge to the polls for favour, is when neither party can take any principal challenge; but shews causes of favour, as that the juror is a fellow-servant with either party.

In cases of high-treason, and misprision of high-treason, the prisoner shall have his peremptory challenge to the number of thirty-five. 1 Inst. 156. But with regard to petit-treason, murder, and other felonies, the 22 Hen. VIII. c. 14. continues in force, which takes away the peremptory challenge of more than twenty.

CHAMA, in zoology, a genus of shell-fish belonging to the order of testacea. The shell is thick and has two valves: there are 14 species, principally distinguished by the figure of the shells. See Plate Nat. Hist. figs. 107, 108.

There is a great variety among the several species of chama; some being perfectly smooth, some striated, and some rugose, or even spinose; whilst others are oblong, others roundish; and some are equilateral. Among the species of this genus, we may reckon the concha Veneris, or Venus's shell, with a spinose edge; the agate chama; and the chama gryphoides and cordata.

CHAMÆROPS, the dwarf palm, or little palmetto, a genus of the natural order of palmæ. The hermaphrodite calyx is tripartite; the corolla tripetalous; there are six stamina, three pistils, and three monospermous plums. The male is a distinct plant, the same as the hermaphrodite. There are three species, the most remarkable of which is the

Chamærops glabra, a native of the West Indies, and warm parts of America, also of the corresponding latitudes of Asia and Africa. It never rises with a tall stem; but when the plants are old, their leaves are five or six feet long, and upwards of two broad; these spread open like a fan, having many foldings, and at the top are deeply divided like the fingers of a hand. This plant the Americans call thatch, from the use to which the leaves are applied. It may be easily raised in this country from seeds brought from America; but as the plants are tender, they must be constantly kept in a bark-stove.

CHAMBER, in policy, the place where certain assemblies are held, also the assemblies themselves. Of these some are established for the administration of justice, others for commercial affairs.

Of the first kind are, 1. Star-chamber, so called, because the roof was painted with stars; the authority, power, and jurisdiction of which, are absolutely abolished by the statute 17 Car. I. 2. Imperial chamber of Spire, the supreme court of judicatory in the empire, erected by Maximilian I. This chamber has a right of judging by appeal, and is the last resort of all civil affairs of the states and subjects of the empire, in the same manner as the aulic council of Vienna. Nevertheless it is restrained in several cases; it takes no notice of matrimonial causes, these being left to the pope; nor of criminal causes, which either belong to particular princes or towns in their respective territories, or are cognizable by all the states of the empire in a diet. By the treaty of Osnaburgh in 1648, fifty assessors were appointed for this chamber, whereof twenty-four were to be protestants, and twenty-six catholics, besides five presidents, two of them protestants, and the rest catholics. 3. Apostolical chamber of Rome, that wherein affairs relating to the revenues of the church and the pope are transacted. This council consists of the cardinal-camerlingo, the governor of the rota, a treasurer, an auditor, a president, one advocate-general, a solicitor-general, a commissary, and twelve clerks. 4. Chamber of London, an apartment in Guildhall, where the city-money is deposited. Of the last sort are, 1. The chambers of commerce. 2. The chambers of assurance.

The chamber of commerce is an assembly of merchants and traders, where the affairs relating to trade are treated of. There are several established in most of the chief cities of France; and in our own country, we have lately seen chambers of this kind erected for various purposes. Chamber of assurance in France, denotes a society of merchants and others for carrying on the business of insuring; but in Holland, it signifies a court of justice, where causes relating to insurances are tried.

CHAMBERLAIN, an officer charged with the management and direction of a chamber.

CHAMBERLAIN. The office of lord great chamberlain of England is hereditary; and where a person dies seized in fee of this office, leaving two sisters, the office belongs to both, and they may execute it by deputy, but such deputy must be approved of by the king, and must not be of a degree inferior to a knight. To the lord-chamberlain the keys of Westminster-hall, and the court of requests, are delivered upon all solemn occasions. He disposes of the sword of state to be carried before the king, when he comes to the parliament, and goes on the right hand of the sword next the king's person. He has the care of providing all things in the house of lords in the time of parliament. To him belong livery and lodgings in the king's court, &c. and the gentleman usher of the black rod, yeoman usher, &c. are under his authority.

The lord chamberlain of the household has also superintendance of artificers retained in the king's service, messengers, comedians, revels, music, &c.

Chamberlain of London is commonly the receiver of all rents and revenues belonging to that city, and has great authority in making and determining the rights of freemen, and regulating matters concerning apprentices, orphans, &c.

Chamberlain of Chester, when there is no prince of Wales and earl of Chester, receives and returns all writs coming thither out of any of the king's courts.

CHAMBRANLE, among builders, an ornament of stone or wood bordering the three sides of doors, windows, and chimneys.

CHAMFER, or CHAMFRET, in architecture, an ornament consisting of half a scotia, being a kind of a small furrow or gutter on a column, called also scapus, stria, &c.

CHAMPAIN, or POINT CHAMPAIN, in heraldry, a mark of dishonour in the coat of arms of him who kills a prisoner of war after he has cried quarter.

CHAMPARTY, or CHAMPERTY, is the unlawful maintenance of a suit, in consideration of some bargain to have part of the lands or thing in dispute, or part of the gain. By stat. 33 Ed. I. st. 3. both the champartor, and he who consents thereunto, shall be imprisoned three years, and make fine at the king's pleasure.

CHAMPION, a person who undertook a combat in the place or quarrel of another; and sometimes the word is used for him who fought in his own cause. It appears that champions, in the just sense of the word, were persons who fought instead of those that, by custom, were obliged to accept the duel, but had a just excuse for dispensing with it, as being too old, infirm, or being ecclesiastics, and the like. Such causes as could not be decided by the course of common law were often tried by single combat; and he who had the good fortune to conquer, was always reputed to have justice on his side. Champions who fought for interest only were held infamous; these hired themselves to the nobility, to fight for them in case of need, and did homage for their pension. When two champions were chosen to maintain a cause it was always required that there should be a decree of the judge to authorise the combat: when the judge had pronounced sentence, the accused threw a gage or pledge, originally a glove or gauntlet, which being taken up by the accuser, they were both taken into safe custody till the day of battle appointed by the judge. Before the champions took the field, their heads were shaven to a kind of crown or round, which was left at the top: then they made an oath that they believed the person who retained them, to be in the right, &c. They always engaged on foot, and with no other weapon than a club and a shield, which weapons were blessed in the field by the priest, with great ceremony; and they always made an offering to the church, that God might assist them in the battle. The action began with railing, and giving each other ill language; and at the sound of a trumpet, they went to blows. After the number of blows or encounters expressed in the cartel, the judges of the combat threw a rod into the air, to advertise the champions that the combat was ended. If it lasted till night, or ended with equal advantage on both sides, the accused was reputed the victor. If the conquered champion fought in the cause of a woman, and it was a capital offence, the woman was burnt, and the champion hanged. If it was the champion of a man, and the crime capital, the vanquished was immediately disarmed, led out of the field, and hanged, together with the party whose cause he maintained. If the crime was not capital, he not only made satisfaction, but had his right hand cut off: the accused was to be close confined in prison, till the battle was over.

CHAMPION *of the king*, a person whose office it is, at the coronation of our kings, to ride armed into Westminster-hall, while the king is at dinner there, and, by the procla-

mation of a herald, make challenge to this effect, viz. "that if any man shall deny the king's title to the crown, he is there ready to defend it in single combat, &c." which being done, the king drinks to him; and sends him a gilt cup, with a cover, full of wine, which the champion drinks, and has the cup for his fee.

CHANCE, is more particularly used for the probability of an event; and is greater or less, according to the number of chances by which it may happen, compared with the number of chances by which it may either happen or fail. Thus, if an event has three chances to happen, and two to fail, the probability of its happening may be estimated $\frac{3}{5}$, and the probability of its failing $\frac{2}{5}$. Therefore, if the probabilities of happening and failing are added together, the sum will always be equal to unity.

If the probabilities of happening and failing are unequal, there is what is commonly called odds for, or against, the happening or failing, which odds are proportional to the number of chances for happening or failing.

The expectation of obtaining any thing, is estimated by the value of that thing, multiplied by the probability of obtaining it. The risk of losing any thing, is estimated by the value of that thing, multiplied by the probability of losing it. If, from the expectations which the gamesters have upon the whole sum deposited, the particular sums they deposit (that is, their own stakes) are subtracted, there will remain the gain, if the difference is positive; or the loss, if the difference is negative. Again, if from the respective expectations which either gamester has upon the sum deposited by his adversary, the risk of losing what he himself deposits is subtracted, there will likewise remain his gain or loss.

If there is a certain number of chances by which the possession of a sum can be secured, and also a certain number of chances by which it may be lost, that sum may be insured for that part of it, which shall be to the whole, as the number of chances there are to lose it, is to the number of all the chances.

If two events have no dependance on each other, so that p be the number of chances by which the first may happen, and q the number of chances by which it may fail; and likewise, that r be the number of chances by which the second may happen, and s the number of chances by which it may fail: multiply $p+q$ by $r+s$, and the product $pr+qr+ps+qs$ will contain all the chances by which the happening or failing of the events may be varied amongst one another.

From what has been said, it follows, that if a fraction expresses the probability of an event, and another fraction the probability of another event, and these two events are independant, the probability that these two events will happen, will be the product of the two fractions.

Ex. 1. Suppose a person playing with a single die offers to wager, that he will throw an ace each time for two successive throws; what probability has he of succeeding?

SOLUTION. Suppose the wager £.36, and that, on throwing the first time, an ace did come up; then, because there are six faces on the die, only one of which is right, his expectation on the second throw will be $\frac{1}{6}$th of £.36, or $\frac{36}{6}=$£.6; but the probability of this event being also $\frac{1}{6}$th, the expectation, before the first throw must necessarily be $\frac{1}{6}$th of £.6, or £.1. Therefore the probability of his losing the wager will be $1-\frac{1}{6}\times\frac{1}{6}=1-\frac{1}{36}=\frac{35}{36}$, from which it appears that no person ought to hazard such a wager, unless the value of 35 to 1 shall be laid against him.

Ex. 2. A person offers to lay a wager of £.1, that out of a purse containing $m+n$ counters, of which m are black, and n white, he will, blindfolded, at the first trial, draw a white counter; and also that, out of another purse containing M and N counters, of which M are black, and N white, he will also, blindfolded, at the first trial, draw a white counter; and that, if he fail in either trial, his wager shall be lost:—What probability is there that he shall succeed?

SOLUTION. If, as in the last example, he had already succeeded in the first trial, it would follow that his expectation on the second will be $\frac{N}{M+N}$: but if the success of the first trial be a condition of obtaining this expectation, then the probability of so doing will be $\frac{n}{m+n}$; which multiplied into that expectation, will give $\frac{n}{m+n}\times\frac{N}{M+N}$, or $\frac{Nn}{m+n\times M\times N}$, for the probability required.

Hence the probability of the happening of two *independant* events, will be equal to the product of the probabilities of their happening separately. Of course, if the two events are of the same kind, then the probability will be $\frac{n^2}{(m+n)^2}=\frac{n^2}{m^2+2mn+n^2}$. More generally:

I. Let the number of chances for the happening of an event be a, and the number of chances for its failing be b; then the probability of its happening once in any number of trials will be expressed by the series $\frac{a}{a+b}+\frac{ab}{(a+b)^2}+\frac{ab^2}{(a+b)^3}+\frac{ab^3}{(a+b)^4}+\frac{ab^4}{(a+b)^5}+\frac{ab^5}{(a+b)^6}$, &c. continued to as many terms as are equal to the number of trials given. Thus, if $a=1$, $b=5$, and the number of trials be 1, 2, 3, 4, 5, &c. then the probability will be $\frac{1}{6}$ for one trial; $\frac{1}{6}+\frac{5}{36}=\frac{11}{36}$ for two trials; $\frac{1}{6}+\frac{5}{36}+\frac{25}{216}=\frac{91}{216}$ for three trials, and so on.

II. Things remaining as before, the probability of the event's happening *twice* in any given number of trials, will be expressed by the following series, continued to as many terms, *wanting one*, as the number of trials given:—$\frac{a^2}{(a+b)^2}+\frac{2a^2b}{(a+b)^3}+\frac{3a^2b^2}{(a+b)^4}+\frac{4a^2b^3}{(a+b)^5}+\frac{5a^2b^4}{(a+b)^6}$ &c. $=\frac{1}{36}+\frac{10}{216}+\frac{75}{1296}+\frac{500}{7776}+\frac{3125}{46656}$. These being summed up, we have for two trials $\frac{1}{36}$; for three trials $\frac{16}{216}$; for four $\frac{171}{1296}$; for five $\frac{1526}{7776}$; for six $\frac{12281}{46636}$, &c.

III. The probability of the event's happening *three* times in any number of trials, will be expressed by the series $\frac{a^3}{(a+b)^3}+\frac{3a^3b}{(a+b)^4}+\frac{6a^3b^2}{(a+b)^5}+\frac{10a^3b^3}{(a+b)^6}$, which is to be continued to as many terms, wanting two, as is the number of terms given: thus a and b, as before, $\frac{1}{216}+\frac{15}{1296}+\frac{150}{7776}+\frac{1250}{46656}$, which being summed up for three trials $=\frac{1}{216}$, for four $=\frac{21}{1296}$, for five $=\frac{276}{7776}$, &c.

Generally $a=$ chances for happening,
$b=$ ditto for failing,
$l=$ number of times for producing the event in a given No. of trials,
$n=$ number of trials,
$a+b=s$; then the following series is universal:

$$\frac{a^l}{s^l}\times 1+\frac{lb}{s}+\frac{ll+1.b^2}{1.2.s^2}+\frac{ll+1.l+2.b^3}{1.2.3.s^3}$$
$$\frac{l.l+1.l+2.l+3.b^4}{1.2.3.4.s^4}.$$

For when $l=1$, the series will be
$\frac{a}{a+b}+\frac{ab}{(a+b)^2}$, &c. as in the first case;
$l=2$, the series will be
$\frac{a^2}{(a+b)^2}+\frac{2a^2b}{(a+b)^3}$, &c. as in the second case;
$l=3$, the series will be
$\frac{a^3}{(a+b)^3}+\frac{3a^3b}{(a+b)^4}$, &c. as in the third case;
and so on universally.

REMARK. The above series must be continued to so many terms exclusive of the common multiplicator $\frac{a^l}{s^l}$, as are denoted by the number $n-l+1$.

And, for the same reason, the probability of the contrary, that is, of the event's not happening so often as l times, making $n-l+1=p$, will be expressed by the series $\frac{b^p}{s^p}\times 1+\frac{pa}{s}+\frac{p.p+1.aa}{1.2.ss}+\frac{p.p+1.p+2.a^3}{1.2.3.s^3}$, which series is to be continued to so many terms, exclusive of the common multiplicator, as are denoted by the number l.

Either series may be used, according as l is less or greater than $\frac{n+1}{2}$. It is to be observed of these series, that they are both derived from the same principle: for, supposing two adversaries, A and B, contending about the happening of that event, which has every time a chances to happen, and b chances to fail; that the chances a are favourable to A, and the chances b to B, and that A should lay a wager with B that his chances should come up l times in n trials; then, by reason B lays a wager to the contrary, he himself undertakes that his own chances shall, in the same number of trials, come up $n-l+1$ times; and therefore, if in the first series, we change l into $n-l+1$, and *vice versa*; and also write b for a, and a for b; the second series will be formed. See Nature and Laws of Chance, by Thomas Simpson; Demoivre on Chances; Dodson's Mathematical Repository, vol. ii. p. 82, &c.

CHANCE-MEDLEY, in law, is the accidental killing of a man, not wholly without the killer's fault; it is also called manslaughter by misadventure, for which the offender shall have his pardon of course. 6 Ed. I. c. 9. But here is to be considered, whether the person who commits this manslaughter by chance-medley was doing a lawful thing; for if the act was unlawful it is felony. Chance-medley is properly applied to such killing as happens for self-defence in a sudden rencounter. 4 Black. 183.

CHANCEL, a particular part of the fabric of a christian church; it is the rector's freehold and part of his glebe, and therefore he is obliged to repair it; but where the rectory is impropriate, the impropriator must do it.

CHANCELLOR, an officer supposed originally to have been a notary or scribe under the emperors; and named cancellarius, because he sat behind a lattice, called in Latin cancellus, to avoid being crowded by the people. The chancellor originally presided over a political college of secretaries, for the writing of treaties, and other public business; and the court of equity, under the old constitution, was held before the king and his council, in the palace, where one supreme court for business of every kind was kept. At first the chancellor became a judge, to hear and determine petitions to the king, which were preferred to him; and in the end, as business increased, the people addressed their suit to the chancellor, and not to the king; and thus the chancellor's equitable power, by degrees, commenced by prescription.

Lord high chancellor of Great Britain, or lord keeper of the great seal, is the highest honour of the long robe; being made so per traditionem magni sigilli per dominum regem, and by taking the oaths: he is the first person of the realm next after the king, and princes of the blood, in all civil affairs; and is the chief administrator of justice next the sovereign, being the judge of the court of chancery, which is styled a court of equity. This equity consists in abating the rigour of the common law, and giving a remedy in cases where no provision, or not sufficient provision, had been made by the ordinary course of law. The jurisdiction of this court is of vast extent. Almost all causes of weight and moment, first or last, have their determination here. In this court relief is given in the case of infants, married women, and others not capable of acting for themselves. All frauds for which there is no remedy at law are cognizable here; as also all breaches of trust, and unreasonable or unconscionable engagements. It will compel men to perform their agreements; will remove mortgageors and obligors against penalties and forfeiture, on payment of principal, interest, and costs; will rectify mistakes in conveyances; will grant injunctions to stay waste; and restrain the proceedings of inferior courts, that they exceed not their authority and jurisdiction. 3 Black. 48. This court will not retain a suit for any thing under 10*l.* value, except in cases of charity, nor for lands under 40*s.* per annum.

The lord chancellor not only keeps the king's great seal, but also all patents, commissions, warrants, &c. from the king, are, before they are signed, perused by him: he has the disposition of all ecclesiastical benefices in the gift of the crown under 20*l.* a year, in the king's books; and he is speaker of the house of lords.

CHANCELLOR *of a cathedral*, an officer that hears lessons and lectures read in the church, either by himself or his vicar; to correct and set right the reader when he reads amiss; to inspect schools; to hear causes; apply the seal; write and dispatch the letters of the chapter; keep the books; take care that there are frequent preachings, both in the church and out of it; and assign the office of preaching to whom he pleases.

CHANCELLOR *of a diocese*, a lay officer under a bishop, who is judge of his court.

CHANCELLOR *of the duchy of Lancaster*, an officer appointed chiefly to determine controversies between the king and his tenants of the duchy-land, and otherwise to direct all the king's affairs belonging to that court.

CHANCELLOR *of the exchequer*, an officer who presides in that court, and takes care of the interest of the crown. He is always in commission with the lord treasurer, for the letting of crown lands, &c. and has power with others, to compound for forfeitures of lands, upon penal statutes: he has also great authority in managing the royal revenues, and national finances.

CHANCELLOR *of the order of the garter, and other military orders*, is an officer who seals the commissions and mandates of the chapter and assembly of the knights, keeps the register of their proceedings, and delivers acts thereof under the seal of their order.

CHANCELLOR *of an university*, is he who seals the diplomas, or letters of degrees, provision, &c. given in the university.

The chancellor of Oxford is usually one of the prime nobility, chosen by the members of the university in convocation. He is their chief magistrate: his office is durante vita, to govern the university, preserve and defend its rights and privileges, convoke assemblies, and do justice among the members under his jurisdiction. Under the chancellor is the vice-chancellor, who is chosen annually, being nominated by the chancellor, and elected by the university in convocation: he is always the head of some college, and in holy orders. His proper office is to execute the chancellor's power, to govern the university according to her statutes, to see that officers and students do their duty, that courts be duly called, &c. When he enters upon his office, he chooses four pro-vicechancellors out of the heads of the colleges, to execute his power in his absence.

The chancellor of Cambridge is also usually one of the prime nobility, and in most respects the same as that of Oxford, only he does not hold his office durante vita, but may be elected every three years. Under the chancellor there is a commissary, who holds a court of record for all privileged persons and scholars under the degree of master of arts, where all causes are tried and determined by the civil and statute law, and by the custom of the university. The vice-chancellor of Cambridge is chosen annually, by the senate, out of two persons nominated by the heads of the several colleges and hall.

CHANCERY, apostolic, a court in the church of Rome, belonging to the pope. The pope's datory and chancery courts were formerly one and the same thing: but the multitude of affairs to be transacted therein, obliged him to divide it into two tribunals, which are so nearly related to one another, that the chancery does no more than dispatch all that has passed through the datory court. The officers belonging to this court are the regent, prelates, and registers. There are also six masters in chancery, whose business it is to collect the bulls: each of these employments is purchased for six thousand crowns. These are subordinate to the master of the rolls, who keeps the registers of the bulls.

CHANDELIER, in fortification, a kind of moveable parapet, consisting of a wooden frame, made of two upright stakes, about six feet high, with cross planks between them; serving to support the fascines to cover the pioneers. The chandeliers differ from blinds in this, that the former cover the men only before, whereas the latter cover them also above. They are used in approaches, galleries, and mines, to hinder the workmen from being driven from their stations.

CHANNEL, in architecture, that part of the Ionic capital which is under the abacus.

CHANNEL *of the larmier*, the hollow soffit of a cornice which makes the pendant mouchette.

CHANNEL *of the volute*, in the Ionic capital, the face of the circumvolution inclosed by a listel.

CHANTLATE, in building, a piece of wood fastened near the end of the rafters, and projecting beyond the wall to support two or three rows of tiles, so placed as to prevent the rain-water from trickling down the sides of the walls.

CHAOS, in zoology, a genus of insects belonging to the order of zoophyta. The body has no shell or covering, and is capable of reviving after appearing to be dead for a considerable time. It has no joints, or external organs of sensation. There are five species, mostly obtained by infusions of different vegetables in water, and only discoverable by the microscope.

CHAPEAU, in heraldry, an antient cap of dignity worn by dukes, being scarlet-coloured velvet on the outside, and lined with a fur.

CHAPEL, a place of divine worship, served by an incumbent under the denomination of a chaplain.

In England there are several sorts, 1. Parochial chapels, which, differing from parish churches only in the name, are generally small, as the inhabitants within the district are few. If there is a presentation *ad ecclesiam* instead of *ad capellam*, and an admission and institution upon it, it is no longer a chapel, but a church. 2. Chapels which adjoin to and are part of the church: such were formerly built by honourable persons as burying-places for themselves and their families. 3. Chapels of ease, built in very large parishes for the convenience of such as cannot repair to the parish church. These are served by inferior curates provided at the charge of the rector, and consequently removeable at his pleasure. 4. Free chapels, such as were founded by the kings of England, free from all episcopal jurisdiction, and to be visited only by the founder and his successors: the visitation is made by the lord chancellor. The king likewise may license any subject to build and endow a chapel, and by letters patent exempt it from the visitation of the ordinary. 5. Chapels in universities belonging to particular colleges, which, though consecrated, and though sacraments are administered there, are not liable to the visitation of the bishop. 6. Domestic chapels, built by gentlemen for the private service of God in their own families. These may be erected without the leave of the bishop, and need not be consecrated, though they were antiently: they are not subject to the visitation of the ordinary.

Knights of the CHAPEL, called also poor knights of Windsor, were instituted by Henry VIII. in his testament. Their number was at first thirteen, but has been since augmented to twenty-six. They assist in the funeral services of the kings of England: they are subject to the office of the canons of Windsor, and live on pensions assigned them by the order of the garter. They bear a blue or red cloke, with the arms of St. George on the left shoulder.

CHAPLAIN, an ecclesiastic who officiates in a chapel.

The king of Great Britain has forty-eight chaplains in ordinary, who wait four each month, preach in the chapel, read the service to the family, and to the king in his private oratory, and say grace in the absence of the clerk of the closet. Besides, there are twenty-four chaplains at Whitehall, fellows of Oxford or Cambridge, who preach in their turns, and are allowed 30*l. per annum* each. According to a statute of Henry VIII. the persons vested with a power of retaining chaplains, together with the number each is allowed to qualify, is as follows: an archbishop, eight; a duke or bishop, six; marquis or earl, five; viscount, four; baron, knight of the garter, or lord-chancellor, three; a duchess, marchioness, countess, baroness, the treasurer and controller of the king's house, clerk of the closet, the king's secretary, dean of the chapel, almoner, and master of the rolls, each of them two; chief justice of the king's bench, and warden of the cinque ports, each one. All these chaplains may purchase a licence or dispensation, and take two benefices with cure of souls. A chaplain must be retained by letters testimonial under hand and seal; for it is not sufficient that he serve as chaplain in the family.

CHAPLET, a string of beads used by the Roman catholics to count the number of their prayers. The invention of it is ascribed to Peter the Hermit, who probably learned it of the Turks, as they owe it to the East Indians. Chaplets are sometimes called paternosters, and are made of coral, of diamond, of wood, &c. The common chaplet contains fifty ave-marias and five pater-nosters.

CHAPPE', in heraldry, the dividing an escutcheon by lines drawn from the centre of the upper edge to the angles below, into three parts, the sections on the sides being of a different metal or colour from the rest.

CHARA, a genus of the monandria order, in the monœcia class of plants. There is neither male calyx nor corolla; and the anthera is placed under the germen. The female calyx is tetraphyllous; no corolla; the stigma quinquefid, with one roundish seed. There are 4 species.

CHARACTER, in a general sense, denotes any mark whatever, serving to represent either things or ideas: thus letters are characters, types, or marks, of certain sounds; words, of ideas, &c. See LETTER, &c.

CHARACTER. If one person apply to another for the character of a third peron, and a good character as to his solvency be given, yet if, in consequence of this opinion, the party asking the question suffer loss through the person's insolvency, no action lies against him who gave the character if it were fairly given. 1 Esp. Rep. 442.

But if a man wickedly asserts that which he knows to be false, and thereby draws his neighbour into a loss, it is actionable. 3 T. R. 351. But if the party giving credit also knew that the party credited was in bad circumstances an action will not lie. 1 Esp. Rep. 290.

CHARACTER, a mark or abbreviation used in certain arts and sciences.

CHARACTERS *in Algebra and Arithmetic.*

a, *b*, *c*, *d*, &c. the first letters of the alphabet, are the characters of given quantities; and *z*, *y*, *x*, &c. the last letters, are the characters of quantities sought. See ALGEBRA.

m, *n*, *r*, *s*, *t*, &c. are characters of indeterminate exponents both of ratios and of powers: thus, x^m, y^n, z^r, &c. denote undetermined powers of different kinds; *mx*, *ny*, *rz*, different multiples or submultiples of the quantities *x*, *y*, *z*, according as *m*, *n*, *r*; are either whole numbers or fractions.

$+$ is the sign of the real existence of the quantity it stands before, and is called an affirmative or positive sign. It is also the mark of addition, and is read *plus*, or more; thus, $a + b$, or $3 + 5$, implies *a* is added to *b*, or 3 added to 5.

$-$ before a single quantity, is the sign of negation or negative existence, shewing the quantity to which it is prefixed to be less than nothing. But between quantities it is the sign of subtraction, and is read *minus*, or less; thus, $a - b$, or $8 - 4$, implies *b* subtracted from *a*, or 8 after 4 has been subtracted.

$=$ is the sign of equality, though Des Cartes and some others use this mark ∞; thus, $a = b$ signifies that *a* is equal to *b*. Wolfius, and some others, use the mark $=$ for the identity of ratios.

$\times$ is the sign of multiplication, shewing that the quantities on each side the same are to be multiplied by one another, as $a \times b$ is to be read *a* multiplied into *b*; 4×8, the product of 4 multiplied into 8. Wolfius and others make the sign of multiplication a dot between the two factors; thus $5 . 4$ signifies the product of 5 and 4. In algebra the sign is frequently omitted, and the two quantities put together; thus *bd* expresses the product of *b* and *d*. When one or both of the factors are compounded of several letters, they are distinguished by a line drawn over them; thus, the factum of $a + b - c$ into *d*, is wrote $d \times \overline{a + b - c}$. Leibnitz, Wolfius, and others, distinguish the compound factors by including them in a parenthesis thus $(a + b - c)\,d$.

$\div$ is the sign of division; thus, $a \div b$ denotes the quantity *a* to be divided by *b*. In algebra the quotient is often expressed like a fraction, thus $\frac{a}{b}$ denotes the quotient of *a* divided by *b*. Wolfius makes the sign of division two dots; thus $12 : 4$ denotes the quotient of 12 divided by 4, $= 3$. If either the divisor or dividend, or both, be composed of several letters, for example $a + b \div c$, instead of writing the quotient like a fraction, $\frac{a+b}{c}$, Wolfius includes the compound quantities in a parenthesis, thus $(a + b) : c$.

$\mathfrak{C}$ is the character of involution; *vv* is the character of evolution.

$\supset$ or $[\overline{\ }$ are signs of majority; thus, $a \supset b$ expresses that *a* is greater than *b*.

$\subset$ or $\overline{\ }]$ are signs of minority; and when we would denote that *a* is less than *b*, we write $a \subset b$, or $a \overline{\ }] b$.

∞ is the character of similitude used by Wolfius, Leibnitz, and others: it is used in other authors for the *difference* between two quantities, while it is unknown which is the greater of the two.

$::$ is the mark of geometrical proportion disjunct, and is usually placed between two pair of equal ratios, as, $3 : 6 :: 4 : 8$, shews that 3 is to 6 as 4 is to 8.

$\therefore$ the mark of geometrical proportion continued, implies the ratio to be still carried on without interruption, as 2, 4, 8, 16, 32, 64 $\therefore$ are in the same uninterrupted proportion.

$\surd$ is the character of radicality, and shews, according to the index of the power that is set over it, or after it, that the square, cube, or other root, is extracted, or to be extracted; thus, $\surd 16$, or $\surd^2 16$, or $\surd (2)\, 16$, is the square root of 16. $\surd 25$, the cube root of 25, &c. This character sometimes affects several quantities, distinguished by a line drawn over them; thus $\surd \overline{b + d}$ denotes the sum of the square roots of *b* and *d*. When any term, or terms, of an equation are wanting, they are generally supplied by one or more asterisks: thus in the equation $y^2 + py + \frac{1}{4}p^2 + q \left\{ \begin{matrix} \\ - py - \frac{1}{2}p^2 \end{matrix} \right\} = 0$, the term $\pm py$ vanishing, is marked with an asterism, as $y^2 * - \frac{1}{4}p^2 + q$. See ALGEBRA.

CHARACTERS *used in Astronomy.* See ASTRONOMY.

CHARACTERS *used in the arithmetic of infinites.*

$\dot{}$ the character of an infinitesimal or fluxion; thus, $\dot{x}$, $\dot{y}$, &c. express the fluxions or differentials of the variable *x* and *y*; and two, three, or more dots, denote second, third, or higher fluxions. Mr. Leibnitz, instead of a dot, prefixes the letter *d* to the variable quantity, in order to avoid the confusion of dots in the dfferencing of differentials. See CALCULUI DIFFERENTIALIS.

CHARACTERS *in Medicine and Pharmacy.*

℞ recipe	M. manipulus, a handful
á, *áá*, or ana, of each alike	P. a pugil
℔ a pound, or a pint	P. Æ. equal quantities
℥ an ounce	S. A. according to art
ʒ a drachm	q. s. a sufficient quantity
℈ a scruple	q. pl. as much as you please
gr. grains	P. P. pulvis patrum, the jesuits' bark.
ß or *ss*, half of any thing	
cong. congius, a gallon	
coch. cochleare, a spoonful	

CHARACTERS used in Music, and of musical notes, with their proportions, are as follow.

𝄐 character of a large	8	𝅗𝅥 minim	$\frac{1}{2}$
𝄓 a long	4	♩ crotchet	$\frac{1}{4}$
𝅝 a breve	2	♪ quaver	$\frac{1}{8}$
𝅝 a semibreve	1	𝅘𝅥𝅯 semiquaver	$\frac{1}{16}$
		𝅘𝅥𝅰 demisemiquaver	$\frac{1}{32}$

♯ character of a sharp note: this character at the beginning of a line, or space, denotes that all the notes in that line are to be taken a semitone higher than in the natural series; and the same affects all the octaves above or below, though not marked: but when prefixed to any particular note, it shews that note alone to be taken a semitone higher than it would be without such character.

♭ or *b*, character of a flat note: this is the contrary to the other above, that is, a semitone lower.

♮ character of a natural note: when in a line or series of artificial notes, marked at the beginning ♭ or ♯, the natural note happens to be required, it is denoted by this character.

𝄞 character of the treble cliff.

𝄡 character of the mean cliff.

𝄢 bass cliff.

𝄴, or $\frac{2}{4}$, or $\frac{4}{8}$, characters of common duple

time; signifying the measure of two crotchets to be equal to two notes, of which four make a semibreve.

C $\frac{C}{2}$ $\frac{C}{3}$ characters that distinguish the movements of common time; the first implying slow, the second quick, and the third very quick.

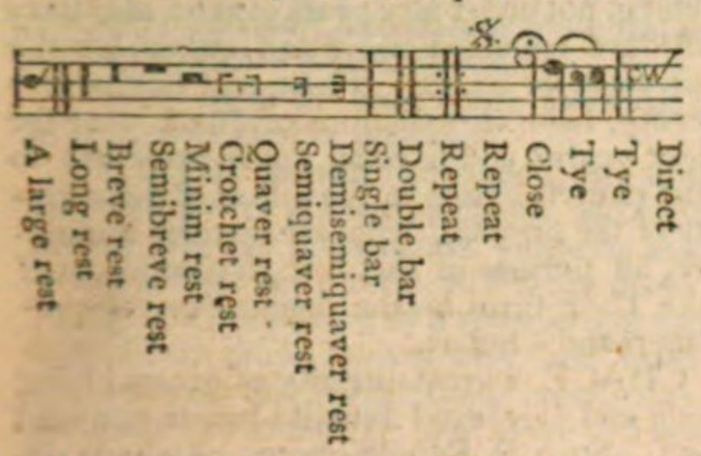
$\frac{1}{2}$, $\frac{3}{2}$, $\frac{3}{4}$, $\frac{3}{8}$, $\frac{3}{16}$, characters of simple triple time, the measure of which is equal to three semibreves, or to three minims.

$\frac{6}{4}$, or $\frac{6}{8}$, or $\frac{6}{16}$, characters of mixed triple time, where the measure is equal to six crochets, or six quavers.

$\frac{9}{4}$, or $\frac{9}{8}$, or $\frac{9}{16}$, or $\frac{9}{1}$, or $\frac{9}{2}$, characters of compound triple time.

$\frac{12}{4}$, $\frac{12}{8}$, $\frac{12}{16}$, or $\frac{12}{1}$, or $\frac{12}{2}$, characters of that species of triple time called the measure of twelve times. See TRIPLE.

Characters of the rests or pauses of time.



NUMERAL CHARACTERS used to express numbers, are either letters or figures. The Arabic character, called also the common one, because it is used almost throughout Europe in all sorts of calculations, consists of these ten digits, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0. See ARITHMETIC.

The Greeks had three ways of expressing numbers: first, every letter, according to its place in the alphabet, denoted a number, from α, one, to ω, twenty-four. 2. The alphabet was divided into eight units, α one, β two, γ three, &c. into eight tens, ι ten, κ twenty, λ thirty, &c. and eight hundreds, ϱ one hundred, σ two hundred, τ three hundred, &c. 3. I stood for one, Π ($\pi\acute{\epsilon}\nu\tau\epsilon$) five, Δ ($\delta\acute{\epsilon}\kappa\alpha$) ten, H ($H\kappa\alpha\tau\acute{o}\nu$) a hundred, X ($\chi\iota\lambda\iota\alpha$) a thousand, M ($\mu\upsilon\varrho\iota\alpha$) ten thousand; and when the letter Π inclosed any of these, except I, it shewed the inclosed letter to be five times its value; as $\overline{|\Delta|}$ fifty, $\overline{|H|}$ five hundred, $\overline{|X|}$ five thousand, $\overline{|M|}$ fifty thousand.

The Hebrew numerals consisted of their alphabet divided into nine units; thus, א one, ב two, &c.: nine tens; thus, י ten, כ twenty, &c.: nine hundreds; thus, ק one hundred, ר two hundred, &c. and ך five hundred, ם six hundred, ן seven hundred, ף eight hundred, ץ nine hundred. They expressed thousands by the word אלף, with the other numerals prefixed to signify the number of thousands: thus, אלפים two thousand, גאלפים three thousand, &c.

CHARADRIUS, in ornithology, a genus belonging to the order of grallæ. The beak is cylindrical and blunt; the nostrils are linear; and the feet have each three toes. Among the species, of which there are 27 or 28, are,

1. The Alexandrinus, or Alexandrian dottrel, is of a brownish colour, with the forehead, collar, and belly, white; the prime tail-feathers on both sides are white; and the legs are black. It is about the size of a lark, and lives upon insects.

2. The Ægyptius has a black streak on the breast, white eye-brows, the prime tail-feathers streaked with black at the points, and bluish legs. It is found in the plains of Egypt, and feeds on insects.—3. The morinellus has an iron-coloured breast, a small white streak on the breast and eye-brows, and black legs. It is found in Cambridgeshire, Lincolnshire, and Derbyshire. On Lincoln-heath, and on the moors of Derbyshire, they are migratory; appearing there in small flocks of eight or ten only in the latter end of April, and staying there all May and part of June, during which time they are very fat, and much esteemed for their delicate flavour. In the months of April and September they are taken on the Wiltshire and Berkshire downs.

4. The pluvialis (see Plate Nat. Hist. fig. 106.) is black above, with green spots, white underneath, and the feet are ash-coloured. It is the green plover of Ray, and is a native of Europe. They lay four eggs, sharply pointed at the lesser end, of a dirty white colour, and irregularly marked, especially at the thicker end, with blotches and spots. They make a shrill whistling noise; and may be enticed within shot by a skilful imitator of their note.

5. The œdicnemus, or stone curlew of Ray, is of a grey colour, with two of the prime wing-feathers black, but white in the middle: it has a sharp bill, and ash-coloured feet; and is about the size of a crow. In Hampshire, Norfolk, and on Lincoln-heath, it is called the curlew, from a similarity of colours to the curlew. It breeds in some places in rabbit-burrows; also among stones on the bare ground, laying two eggs of a copper-colour spotted with a darker red. The younger run soon after they are hatched. These birds feed in the night on worms and caterpillars: they will also eat toads, and catch mice. They inhabit fallow lands and downs; and prefer dry places, being never seen in any waters. When they fly, they extend their legs straight out behind; are very shy birds; run far before they take to wing; and often squat: are generally seen single, and are esteemed very delicate food.

CHARAG, the tribute which the Christians and Jews pay to the grand signior. It is generally a pistole a head, and sometimes four crowns. The Christians who come to travel in Turkey pay it at the first town they arrive at: others begin to pay it at nine or sixteen years old; but women, priests, rabbis, and religious, are exempted.

CHARCOAL, according to modern chemistry, is an oxide of carbon. When charcoal, however, is prepared in the usual way, by exposing wood in close vessels to a red heat, it always contains a portion of hydrogen; for if a quantity of this charcoal is exposed to a strong heat in a retort of porcelain, iron, or coated glass, a great quantity of gas is obtained. The gas which comes over first is a mixture of carbonic acid and carbureted hydrogen; but the proportion of carbonic acid diminishes, and at last it ceases to come over at all; yet the carbureted hydrogen continues as copious as ever.

The evolution of these gases was long ascribed by chemists to the water which charcoal usually contains, and which it is known to absorb from the atmosphere with considerable avidity. If that was the case, the proportion of carbureted hydrogen ought to diminish at the same rate with the carbonic acid; the hydrogen of the one being equally derived from the decomposition of water with the oxygen of the other. But as the evolution of carbureted hydrogen continues after that of carbonic acid has ceased, it is scarcely possible to deny, that the hydrogen which thus escapes constituted a component part of the charcoal.

If, therefore, we consider the experiments of Morveau on the combustion of the diamond as decisive, we must conclude, that common charcoal is composed of three ingredients, namely, carbon, hydrogen, and oxygen; and it is of course a triple compound.

CHARGE, in gunnery. The mode of charging is too well known to require description. It is only to be noted, that if the ball is red-hot, a tompion, or trencher of green wood, is to be driven in before it. The weight of the powder necessary for a charge is commonly one-half or one-third the weight of the ball, or still less; and indeed, in most cases of service, the quantity of powder used is too great for the intended execution. In the British navy, the allowance for 32-pounders is 7-16ths of the weight of the ball. But it is probable, that if the powder in all ship-guns was reduced to one-third of the weight of the ball, or even less, it would be a considerable advantage, not only by saving ammunition, but by keeping the guns cooler and quieter, and at the same time more effectually injuring the vessels of the enemy. With the present allowance of powder, the guns are heated, and their tackle and furniture strained, and all this only to render the ball less efficacious: for a ball which can but just pass through a piece of timber, and in the passage loses almost all its motion, is found to rend and fracture it much more than when it passes through with a much greater velocity. See Robins's Tracts, vol. i. Again, the same author observes, that the charge is not to be determined by the greatest velocity that may be produced, but that it should be such a quantity of powder as will produce the least velocity necessary for the purpose in view; and if the windage be moderate, no field-piece should ever be loaded with more than one-sixth, or at the utmost one-fifth, of the weight of its ball in powder; nor should the charge of any battering-piece exceed one-third of the weight of its bullet. Ibid. Different charges of powder, with the same weight of ball, produce different velocities in the ball, which are in the same subduplicate ratio of the weights of powder; and when the weight of powder is the same, and the ball varied, the velocity produced is in the reciprocal subduplicate ratio of the weight of the ball; which is agreeable both to theory and practice. See Philos. Trans. 1778, and Hutton's Tracts, vol. i.

But this is on a supposition that the gun is of an indefinite length; whereas, on account of the limited length of guns, there is some variation from this law in practice as well as in theory; in consequence of which it appears that the velocity of the ball increases with the charge only to a certain point, which is peculiar to each gun, where the velocity is the greatest; and that by farther increasing the charge, the velocity gradually diminishes, till the bore is quite full of powder. By an easy fluxionary process, calling the length of the bore of the gun b, the length of the charge producing the greatest velocity

ought to be $\frac{b}{2.718281828}$, or about $\frac{3}{8}$ of the length of the bore; where 2.718281828 is the number whose hyp. log. is 1. But, for several reasons, in practice the length of the charge producing the greatest velocity falls short of that above mentioned, and the more so as the gun is longer. From many experiments it is found, that the charge producing the greatest velocity, in guns of various lengths of bore, from 15 to 40 calibers, is as follows:

Length of bore in calibers.	Length of charge for greatest veloc.
15	$\frac{3}{30}$
20	$\frac{3}{12}$
30	$\frac{3}{10}$
40	$\frac{3}{20}$.

CHARGE, in heraldry, is applied to the figures represented on the escutcheon, by which the bearers are distinguished from one another; and it is to be observed, that too many charges are not so honourable as fewer.

CHARGE and DISCHARGE. A charge is a thing done that binds him who does it, or that which is his, to the performance thereof; and discharge is the removal of that charge. In all cases where an executory thing is created by deed, there, by consent of all the parties, it may by deed be defeated and discharged.

CHARITABLE USES: lands given to alms, and aliened, may be recovered by the donor. 13 Ed. 1. c. 41. Lands, &c. may be given for the maintenance of houses of correction, or of the poor. 35 Eliz. c. 7. Money given to put out apprentices, either by parishes, or public charities, to pay no duty. 8 Anne, c. 9.

CHARLES'S-WAIN, in astronomy, seven stars in the constellation called ursa major, or the great bear.

CHART, or *sea-chart*, an hydrographical map, or a projection of some parts of the earth's superficies in plano, for the use of navigators. Charts differ very considerably from geographical or land maps, which are of no use in navigation. Nor are sea-charts all of the same kind; some being what we call plane charts, others Mercator-charts, and others globular charts.

Plane CHART is a representation of some part of the superficies of the terraqueous globe, in which the meridians are supposed parallel to each other, the parallels of latitude at equal distances, and consequently the degrees of latitude and longitude every where equal to each other. See NAVIGATION.

Mercator's CHART, is that wherein the meridians are straight lines parallel to each other, and equidistant; the parallels are also straight lines, and parallel to each other: but the distance between them increases from the equinoctial towards either pole, in the ratio of the secant of the latitude to the radius.

If the superficies of the terrestrial globe is supposed to be taken off, and extended on a plane, so as to make the meridians parallel to each other, and the degrees of longitude every where equal, it is easy to conceive that it must be productive of the most notorious errors; for an island in latitude 60°, where the radius of the parallel is only equal to one-half of the radius of the equator, will have its length from east to west distorted in a double ratio to what it was on the globe; that is, its length from east to west, in comparison of its breadth from north to south, will be represented in a double proportion to what it really is: whence it follows, that in whatever proportion the degrees of any parallel are increased or diminished by a projection in plano, the degrees of longitude ought to be increased or diminished in the same ratio; for otherwise the true bearings and distances of places will be lost, as in the case of the plane-chart, where the degrees of latitude and longitude are all equal.

Though this projection is generally called Mercator's projection, yet our countryman, Mr. Wright, had long before invented it, demonstrated its use, and shewn a ready way of constructing it, by enlarging the meridian line, by a continued addition of secants: but neither of these gentlemen is thought the original author of it, it having been hinted by Ptolemy about two thousand years ago. See NAVIGATION.

Globular CHART, a meridional projection, wherein the distance of the eye from the plane of the meridian, upon which the projection is made, is supposed to be equal to the sine of the angle of 45°. This projection comes the nearest of all to the nature of the globe, because the meridians therein are placed at equal distances, the parallels also are nearly equidistant, and consequently the several parts of the earth have their proper proportion of magnitude, distance, and situation, nearly the same as on the globe itself.

CHARTA, MAGNA, the great charter of liberties granted first by king John, and afterwards, with some alterations, confirmed in parliament by king Henry the Third. It is so called, either for the excellence of the laws therein contained, or because there was another charter, called the charter of the forests, which was the less of the two; or in regard of the great wars and trouble in obtaining it. King Henry the Third, after it had been several times confirmed by him, and as often broken, at last, in the 37th year of his reign, confirmed it in the most solemn manner in Westminster-hall. Afterwards king Ed. I. confirming this charter, in the 35th year of his reign, made an explanation of the liberties therein granted to the people, adding some; and in the confirmation, he directed that this charter should be read twice a year to the people, and sentence of excommunication to be constantly denounced against all that by word, or deed, or counsel, shall act contrary thereto, or in any degree infringe it.

CHARTER, is a deed whereby the king passes any grant to any one person or more, or to any body politic.

CHARTER-PARTY, is a contract under hand and seal, executed by the freighter and the master or owner of the ship, containing the terms upon which the ship is hired to freight: the masters and owners usually bind themselves, the ship, tackle, and furniture, that the goods freighted shall be delivered (dangers of the sea excepted) well-conditioned at the place of discharge; and they also covenant to provide mariners, tackle, &c. and to equip the ship complete and adequate to the voyage. The freighter stipulates to pay the consideration-money for the freight, and penalties are annexed to enforce the reciprocal covenants. A charter-party is the same in the civil law, as an indenture at common law; and is distinguished from a bill of lading, inasmuch as the former adjusts the terms of the freight, and the latter ascertains the contents of the cargo.

CHARTREUSE, or *grande chartreuse*, a celebrated monastery, the capital of all the convents of the Carthusian monks, situated on a steep rock in the middle of a large forest of fir-trees, about seven miles north-east of Grenoble, in the province of Dauphiny, in France. From this mother-convent all the others of the same order take their name; among which was the chartreuse of London, corruptly called the CHARTER-HOUSE, now converted into an hospital, endowed with a revenue of 600*l.* per annum.

Here are maintained eighty decayed gentlemen, not under fifty years of age; also forty boys are educated and fitted either for the university or trades. Those sent to the university, have an exhibition of 20*l.* a year for eight years: and have an immediate title to nine church-livings in the gift of the governors of the hospital, who are sixteen in number, all persons of the first distinction, and take their turns in the nomination of pensioners and scholars.

CHACE, a great quantity of ground lying open and privileged for wild beasts and wild fowl. Such is Enfield-chace. A chace differs from a forest, inasmuch as it may be in the hands of a subject, which a forest in its proper nature cannot; and from a park, in that it is not inclosed, and has more officers. A chace is not endowed like a forest with so many liberties, as the courts of atttachment, swainmote, and justice-seat; and cannot lawfully be made, without licence from the king under the broad seal.

CHATTELS or *catals*, all sorts of goods and property, moveable or immoveable, except freehold property.

CHAZINZARIANS, in church history, a sect of heretics who adored the cross.

CHECK, or *check roll*, a roll or book, wherein are contained the names of such persons as are attendants and in pay to the king, or other great personages.

Clerk of the CHECK, in the king's household, has the check and control of the yeomen of the guard, and all the ushers belonging to the royal family; allowing their absence or defects in attendance, or diminishing their wages for the same, &c. He also, by himself or deputy, takes the view of those that are to watch in the court, and has the setting of the watch, &c. Clerk of the check in the king's navy at Plymouth, is also the name of an officer invested with the like power.

CHECKS, or *drafts*, on bankers, are instruments by means of which a creditor may assign to a third person, not originally party to the contract, the legal as well as equitable interest in a debt raised by it, so as to vest in such an assignee a right of action against the original debtor. 1 H. B. 602. These instruments are uniformly made payable to bearer, which constitutes a characteristic difference between them and bills of exchange; and the legislature has considered them in a more favourable point of view by exempting them from the stamp-duties. They are equally negotiable with bills, although, strictly speaking, not due before payment is

demanded. When given in payment they are considered as cash; and it is said, may be declared upon as a bill of exchange; and the moment this resemblance begins, they are governed by the same principles of law as bills of exchange.

Checks payable on demand, or where no time of payment is expressed, are payable on presentment without any indulgence or days of grace; but the presentment should be made within a reasonable time after the receipt, otherwise the party upon whom the check is drawn, will not be responsible, and the person from whom the holder received it will be discharged. Therefore, where circumstances will allow of it, it is advisable for the holder of a check to present it on the same day it is received.

CHECKY, in heraldry, is when the shield, or a part thereof, as a bordure, &c. is chequered, or divided into chequers or squares, in the manner of a chess-board.

This is one of the most noble and most antient figures used in armoury.

CHEEKS, among mechanics, are almost all those pieces of their machines and instruments, that are double, and perfectly alike; as the cheeks of a mortar, which are made of strong wooden planks, of a semicircular form, bound with thick plates of iron, and fixed to the bed with four bolts: these cheeks rise on each side of the mortar, and serve to keep it at what elevation is given it: the cheeks of a printing-press are its two principal pieces, placed perpendicular and parallel to each other, and serving to sustain the three sommers, &c.

CHEEKS, in ship-building, two pieces of timber, fitted on each side of the mast, at the top, serving to strengthen the mast there, and having holes in them, called hounds, through which the ties run to hoist the yards. Also the uppermost rail, or piece of timber in the beak of a ship, and those on each side of the trail-board, are called the upper and lower cheek.

The knees also which fasten the beak-head to the bows of a ship, are called cheeks.

CHEIRANTHUS, stock gilliflower, and wall-flower: a genus of the 39th natural order, siliquosæ, and belonging to the tetradynamia class of plants. The germen is marked with a glandulous denticle on each side; the calyx is close, with two of its leaves gibbous at the base; the seeds plane. There are 22 species, of which the following are most worthy of notice.

1. Cheiranthus annuus, or ten weeks stock, with an upright, woody, smooth stalk, divided into a branchy head, twelve or fifteen inches high, with spear-shaped, blunt, hoary leaves, and all the branches terminated by long erect spikes of numerous flowers, of different colours in different varieties.

2. Cheiranthus cheiri, or the common wall-flower, the branches terminating in long erect spikes or numerous flowers, which in different varieties are yellow, bloody, white, &c.

3. Cheiranthus incanus, the hoary cheiranthus, the top of the stalk and all the branches terminated by erect spikes or flowers from one to two or three feet long, of different colours in different varieties. The two last sorts are very hardy evergreen biennials or perennials; but the first, being an annual plant, must be continued by seed sown every year; and even the two last, notwithstanding their being perennial, degenerate so much in their flowers after the first year, that it will be proper also to raise an annual supply of them. The seeds are to be chosen from such flowers as have five, six, or more petals, or from such as grow near to the double ones. When fine doubles of the two last kinds are obtained, they may be multiplied by slips from the old plants.

CHEKAO, a kind of paste, prepared by calcination and trituration from a hard stony substance, and afterwards washing the powder in large quantities of fair water. The Chinese use the chekao in drawing the elegant figures we see in the wholly white china-ware, which they afterwards varnish in the common way. See the article PORCELAIN.

CHELIDONIUM, celandine, horned or prickly poppy: a genus of the monogynia order, in the pentandria class of plants: and in the natural method ranking under the 27th order, rhæadeæ. The corolla is tetrapetalous, the calyx diphyllous, the siliqua unilocular and linear. There are five species. One of them, viz. chelidonium majus, is an article in the materia medica. It grows on old walls, among rubbish, and in waste shady places. The herb is of a blueish green colour; the root of a deep red; and both contain a gold-coloured juice; the smell is disagreeable, the taste somewhat bitterish, very acrid, burning and biting the mouth; the root is the most acrid. The juice takes off warts; cures tetters, ring-worms, and the itch; and, diluted with milk, it consumes opaque white spots on the eye. Horses, cows, goats, and swine, refuse to eat the herb.

CHELONE, in botany, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The calyx is quinquepartite; the rudiment of a 5th filament among the highest stamina; the capsule bilocular. There are five species, viz.

1. Chelone glabra, 2. chelone hirsuta, 3. chelone penstemon, 4. chelone obliqua, and 5. C. campanulata. They are all natives of North America; and are herbaceous flowery perennials, with upright stalks two feet high, decorated with spear-shaped leaves, and beautiful spikes of monopetalous, ringent flowers, red, rose-coloured, blue, and purple. They flower from Sept. to Nov. and are sometimes succeeded by ripe seeds in this country. They are hardy, and may be propagated by seeds in any soil; but the two first multiply so fast by their creeping roots that the seeds are seldom regarded. The last species is the most beautiful.

CHEMISE, in fortification, the wall with which a bastion, or any other bulwark of earth, is lined for its greater support and strength: or it is the solidity of the wall from the talus to the stone-row.

Fire-CHEMISE, a piece of linen-cloth, steeped in a composition of oil of petrol, camphor, and other combustible matters, used at sea, to set fire to an enemy's vessel.

CHEMISTRY is that branch of science, the object of which is to ascertain the simple substances or elements of bodies, the properties of these, and their action on each other. The methods made use of to obtain this knowledge are analysis and synthesis. Chemistry comprehends almost all the changes in natural objects, with which we are more immediately connected, and in which we have the greatest interest: it is subservient to the various arts of life, and the several branches of manufacture which are carried on in every civilized state. Dyeing, bleaching, tanning, glass-making, the working and composition of metals, &c. are all processes in chemistry. In agriculture chemistry investigates the nature of soils; it explains the phenomena of the growth and nourishment of vegetables, and the nature and action of manures. As a science it is connected with all the phenomena of nature, the causes of rain, snow, hail, dew, wind, and earthquakes: it has been called in to the aid of the culinary arts; and its high importance in medicine has been long and universally acknowledged. Chemistry therefore is highly worthy of our attention, because beyond every other branch of study it increases our knowledge, extends the number of our resources, and is thus calculated to promote our enjoyments, and augment our power over the material world. Besides, no study can give us more exalted ideas of the wisdom and goodness of the great First Cause than this, which exhibits the most astonishing effects frequently produced by the most simple means; and displays to our view the great care which has every where been taken to secure the comfort and happiness of every living creature.

The history of chemistry.—The word chemistry is said to be of Egyptian origin, and equivalent to our phrase natural philosophy, comprehending all the knowledge of natural objects which the antients possessed. It afterwards acquired a more limited signification, and was confined to the art of working metals, which was in the highest estimation among the antients. In the third century it was used in a still more limited sense, signifying the art of making gold and silver. In this sense the science was eagerly cultivated by the Greeks; from them it passed to the Arabians, and by these it was introduced into Europe. Those who professed it assumed the form of a sect, under the name of alchymists, who laid it down as a first principle, that all metals are composed of the same ingredients, or that the substances which compose gold exist in all metals, and are capable of being brought into the pure state: hence the great object of their researches was to discover the means of producing this change, and of converting the baser metals into gold. The substance which possessed this wonderful property was called "the philosopher's stone," the touch of which was to change every thing into gold.

From the eleventh to the fifteenth centuries alchymy was in its most flourishing state. The writers who appeared during that period were numerous; among the most celebrated were Albertus Magnus, Roger Bacon, Arnoldus de Villa Nova, Raymond Lully, and the two Isaacs of Holland. Some of their books are altogether unintelligible; others display great acuteness, and an extensive acquaintance with natural objects. They often reason with great accuracy, though generally from mistaken principles. They all boast that they are in possession of the philosopher's stone, and profess to communicate the method of making it; but their language is enigmatical, and evidently intended not

to be understood by any but the adepts in their own mysteries. Their writings and vaunted professions gained implicit credit; and the covetous were filled with the desire of enriching themselves by means of discoveries which they pretended to communicate. This laid the unwary open to the tricks of a set of impostors, who offered to communicate their secret for a suitable but large reward. Thus they contrived to get possession of a sum of money with which they absconded or tired out the patience of their pupils by intolerably tedious, expensive, and ruinous processes.

Chemists had for many ages hinted at the importance of discovering a universal remedy, which should be capable of curing, and even of preventing all diseases; and several of them had asserted, that this remedy was to be found in the philosopher's stone, which not only converted baser metals to gold, but possessed also the most sovereign virtue, was capable of curing all diseases in an instant, and even of prolonging life to an indefinite length, and of conferring on the adepts the gift of immortality on earth. This notion gradually gained ground; and the word chemistry, in consequence, at length acquired a more extensive signification, and implied not only the art of making gold, but the art also of preparing the universal medicine.

About the time that the first of these branches was sinking into discredit, the second, and with it the study of chemistry, acquired an unparalleled degree of celebrity, and attracted the attention of all Europe. This was owing to the appearance of Theophrastus Paracelsus, who was born in 1493, near Zurich in Switzerland; and was, in the 34th year of his age, after a number of whimsical adventures, which had raised his reputation to a great height, appointed by the magistrates of Basil to deliver lectures in their city; he was the first public professor of chemistry in Europe.

The character of this extraordinary man is universally known. That he was an impostor, and boasted of secrets which he did not possess, cannot be denied; but it must be acknowledged that his talents were great, and that his labours were not entirely useless. He contributed not a little to dethrone Galen and Avicenna, who at that time ruled over medicine with absolute power; and to restore Hippocrates and the patient observers of nature to that chair, from which they ought never to have been expelled. He certainly gave chemistry an eclat which it did not before possess; and this must have induced many of those laborious men who succeeded him to turn their attention to the science. Nor ought we to forget that by carrying his speculations concerning the philosopher's stone, and the universal medicine, to the greatest height of absurdity, and by exemplifying their emptiness and inutility in his own person, he undoubtedly contributed more than any man to their disgrace and subsequent banishment from the science.

Van Helmont, who was born in 1577, may be considered as the last of the alchymists. His death completed the disgrace of the universal medicine. His contemporaries, and those who immediately succeeded him, attended solely to the improvement of chemistry. The chief of them were Agricola, Beguin, Glaser, Erkern, Glauber, Kunckel, Boyle, &c.

The foundations of the alchymistical system being thus shaken, the facts which had been collected soon became a heap of rubbish, and chemistry was left without any fixed principles, and destitute of an object. It was then that a man arose, thoroughly acquainted with the whole of these facts, capable of arranging them, and of perceiving the important purposes to which they might be applied, and able to point out the proper objects to which the researches of chemists ought to be directed. This man was Beccher. He accomplished the arduous task in his work entitled Physica Subterranea, published at Francfort in 1669. The publication of this book forms a very important æra in the history of chemistry. It then escaped for ever from the trammels of alchymy, and became the rudiments of the science which we find it at present.

Ernest Stahl, the editor of the Physica Subterranea, adopted, soon after Beccher's death, the theory of his master; but he simplified and improved it so much, that he made it entirely his own; and accordingly it has been always distinguished by the name of the Stahlian theory.

Ever since the days of Stahl, chemistry has been cultivated with ardour in Germany and the North; and the illustrious philosophers of these countries have contributed highly towards its progress and its rapid improvement. The most deservedly celebrated of these are Margraf, Bergman, Scheele, Klaproth, &c.

In France, soon after the establishment of the Academy of Sciences in 1666, Homberg, Geoffroy, and Lemery, acquired celebrity by their chemical experiments and discoveries; and after the new-modelling of the Academy, chemistry became the peculiar object of a part of that illustrious body. Rouelle, who was made professor of chemistry in Paris about the year 1745, contrived to infuse his own enthusiasm into the whole body of the French literary men; and from that moment chemistry became the fashionable study. Men of eminence appeared every where, discoveries multiplied, the spirit pervaded the whole nation, extended itself over Italy, and appeared even in Spain.

After the death of Boyle, and of some other of the earlier members of the Royal Society, little attention was paid to chemistry in Britain, except by a few individuals. The spirit which Newton had infused for the mathematical sciences was so great, that for many years they drew within their vortex almost every man of eminence in Britain. But when Dr. Cullen became professor of chemistry in Edinburgh in 1756, he kindled a flame of enthusiasm among the students, which was soon spread far and wide by the subsequent discoveries of Black, Cavendish, and Priestley; and meeting with the kindred fires which were already burning in France, Germany, Sweden, and Italy, the science of chemistry burst forth at once with unexampled lustre. (See the article AIR pages 29 and 30.) Hence the rapid progress which it has made during the last forty years, the universal attention which it has excited, and the unexpected light which it has thrown on the arts and manufactures.

As the theory now universally received derived, in a great degree, its origin and support from the discovery of the composition of water (See AIR as above), we shall proceed to state this important point of doctrine.

Water was long considered as an elementary principle; no one had been able to decompose it: but since the experiments of Cavendish, Lavoisier, and others, its true nature has been accurately ascertained; and water may now be decomposed with as much facility as almost any other substance with which we are acquainted. Water is composed of oxygen and hydrogen: it may, by undeniable experiments, be converted into these gases, and by the combustion of them in proper proportions, a quantity of water will be produced equal to the weight of the gases employed: of this we shall proceed to give the requisite proofs by experiments.

Experiment 1. A tube of common glass E F (fig. 18), well annealed, and difficult to be fused, about an inch in diameter, is placed across a furnace C F E D, in a position somewhat inclined, and to its upper extremity is adapted a glass retort A, containing a known quantity of distilled water, and resting on a furnace V X. To the lower extremity of the glass tube F, is applied a worm S S, connected with the double tubulated flask H; and to the other tubulure is adapted a bent glass tube K K, destined to convey the gas to an apparatus proper for determining the quality and quantity of it. When the whole is thus arranged, a fire is to be kindled in the furnace C E, and maintained in such a manner as to bring the glass tube E F to a red-heat, but without fusing it: at the same time so much fire is to be maintained in the furnace V X, as to keep the water in the retort A in a continual state of ebullition. In proportion as the water in the retort A assumes the state of vapour by ebullition, it fills the interior part of the tube E F, and expels the atmospheric air, which is evacuated by the worm S S, and the tube K K. The steam of the water is afterwards condensed by cooling in the worm S S, and falls drop by drop, in the state of water, into the tubulated flask H. When the whole of the water in the retort A is evaporated, and the liquor in the vessels suffered to drain off completely, there is found in the flask H a quantity of water exactly equal to that which was in the retort A: of course there has been no disengagement of any gas: so that this operation was merely a common distillation, which gave absolutely the same result as if the water had never been brought to a state of incandescence in passing through the glass tube E F.

Exp. 2. Every thing being arranged as in the preceding experiment, 28 grains of charcoal reduced to fragments, and which had been previously exposed for a long time to a white heat in close vessels, were next introduced into the glass tube E F. The operation was then conducted as before, and the water in the retort A kept in a continual state of ebullition till it was totally evaporated. The water in the retort A was distilled, as in the preceding experiment; and being condensed in the worm S S, had fallen, drop by drop, into the flask H; but at the same time there had been disengaged a considerable quantity of gas which escaped through the tube K K, and was collected in a proper apparatus. When the operation was finished, there was found nothing in the tube

EF but a few ashes; and the 28 grains of charcoal had totally disappeared.

The gases disengaged were found to weigh altogether 113.7 grains: and there were found two different kinds of gas, viz. 144 cubic inches of carbonic acid gas (211), weighing 100 grains; and 380 cubic inches of a very light gas, weighing 13.7 grains. This last gas took fire on being applied to a lighted body in contact with the air. In examining afterwards the weight of the water which had passed into the flask, it was found less than that in the retort A by 85.7 grains.

In this experiment, therefore, 85.7 grains of water, and 28 grains of charcoal, formed carbonic acid gas equal to 100 grains; and a peculiar gas susceptible of inflammation, equal to 13.7 grains.

Exp. 3. The apparatus being arranged as above, instead of the 28 grains of charcoal, 274 grains of thin shavings of iron, rolled up in a spiral form, were introduced into the tube EF: the tube was then brought to a red heat as before; and in the same manner the whole of the water in the retort A was made to evaporate. In this experiment there was disengaged only one kind of gas which was inflammable: there was obtained of it about 406 cubic inches, weighing 15 grains; and the 274 grains of iron, put into the tube EF, were found to weigh 85 grains above what they did when introduced; and the water first employed was diminished 100.

The volume of these iron shavings was found to be greatly enlarged. The iron was scarcely any longer susceptible of attraction by the magnet; it dissolved without effervescence in acids: in a word, it was in the state of a black oxide, like that which has been burnt in oxygen gas. In this experiment there was a real oxidation of the iron by the water, entirely similar to that effected in the air by the aid of heat: 100 grains of water were decomposed; and of these 100 grains 85 united to the iron, to reduce it to the state of black oxide: these 85 grains, therefore, were oxygen; the remaining 15 grains, combined with caloric, formed an inflammable gas. It thence follows that water is composed of oxygen and the base of inflammable gas, in the proportion of 85 to 15, or of 17 to 3. Water therefore, besides oxygen, which is one of its principles, and which is common to it with a great many other substances, contains another peculiar to itself, and which is its constituent radical. This radical has been called *hydrogen*, that is to say, *the generator of water*; and the combination of this radical with caloric, is distinguished by the name of hydrogen gas. See AIR, page 31.

This radical then is a new combustible body; that is, a body which has so much affinity for oxygen as to be able to take it from caloric, and to decompose oxygen gas. This combustible body itself has so great an affinity for caloric, that unless engaged in some combination, it is always in the aeriform or gaseous state, at the degree of pressure and temperature in which we live.

If it is true, as has been shewn, that water is composed of hydrogen, combined with oxygen, it thence results, that by re-uniting these principles, water ought to be re-formed. This indeed is what takes place, as will be seen by the following experiment:

Exp. 4. Take a wide-mouthed glass balloon, A (fig. 19), capable of containing about four gallons, and cement to its mouth a small plate of copper BC, having above it a cylinder of the same metal, *g* D, pierced with three holes to receive three tubes. The first of these, *h* H, is destined to be connected at its extremity *h*, with an air-pump, in order that the balloon A may be exhausted of air. The second tube, *gg*, communicates by its extremity M M, with a reservoir of oxygen gas, and is destined to convey it into the balloon A. The third tube, D *d*, communicates by the extremity N N, with a reservoir of hydrogen gas: the extremity of this tube terminates in an aperture so small as scarcely to admit a very delicate needle. It is through this aperture that the hydrogen gas contained in the reservoir is to pass into the balloon A. In the next place, the small plate BC is pierced with a fourth hole, into which is inserted with cement a glass tube, through which passes a wire FL, having at its extremity L, a small ball destined to make an electric spark pass between the ball and the extremity *y*, of the tube that conveys the hydrogen gas into the balloon A. The wire FL is moveable in the glass tube, in order that the metallic ball L may be brought nearer to, or removed from, the point *y*: the three other tubes CH, *g g*, H *h*, D *d*, are each furnished with a cock.

That the gases may be conveyed in a very dry state through the tubes which conduct them into the balloon A, and that they may be deprived of water as much as possible, you must put into the swelled parts M M and N N of the tubes, some salts capable of attracting the moisture with great activity, such as acetite of potash, muriate of lime, or nitrate of lime. These salts should be only coarsely pounded, in order that they may not form a mass, and that the gases may pass freely into the interstices left between the fragments. You must be provided with a sufficient quantity of very pure oxygen gas, and nearly a triple volume of hydrogen gas, equally pure. To obtain it in this state, and free from all mixture, you must extract it from water, decomposed by means of very pure and ductile iron.

When every thing has been thus prepared, adapt to the air-pump the tube *h* H, and exhaust the air in the large balloon A; then fill it with oxygen gas, by means of the tube *g g*; and by a certain degree of pressure, force the hydrogen gas to pass into the balloon A, through the extremity *y* of the tube *d* D *y*; then kindle this gas by means of an electric spark, and if you renew the quantity of each of these two gases, the combustion may be continued for a long time.

In proportion as the combustion proceeds, water is deposited on the internal surface of the balloon A: the quantity of this water gradually increases, and it unites itself into large drops, which run down the sides of the vessel, and are collected in the bottom of it.

It was by an experiment of this kind that Lavoisier ascertained that 85 parts, by weight, of oxygen, and 15 parts, also by weight, of hydrogen, are required to compose an hundred parts of water.

Hence it is evident that water is not a simple substance; that it is composed of two principles, oxygen and hydrogen; and that its two principles separated from each other, have so great an affinity for caloric, that at the common degree of temperature and pressure they cannot exist but under the gaseous form.

Chemical operations and instruments.—The reduction of solids into powders of different degrees of fineness, by means of *pulverization*, &c. is a necessary preliminary operation previously to their being chemically acted upon. But these processes can never reduce substances into their primary or elementary particles: they do not even destroy the aggregation of bodies; for every particle, after the most accurate trituration, forms a small whole, resembling the original mass from which it was divided. The real chemical operations, on the contrary, such as solution, destroy the aggregation of bodies, and separate their constituent and integrant particles from each other. Brittle substances are reduced to powder by means of hammers, pestles and mortars, stones, and mullers. Pestles and mortars are made either of metal, glass, porcelain, marble, agate, &c. according to the hardness and properties of the bodies to be pounded. Wedgewood's ware affords a most excellent kind of mortar for most purposes, as it is very strong, and not liable to be acted upon by acids. Many bodies cannot be reduced to powder by the foregoing methods: such are fibrous substances, as wood, horns of animals, elastic gum, and metals which flatten under the hammer; for these, files, rasps, knives, and graters, are necessary.

The separation of the finer parts of bodies from the coarser, which may want farther pulverization, is performed by means of sifting or washing.

A *sieve* for sifting, generally consists of a cylindrical band of thin wood, or metal, having silk, leather, hair, wire, &c. stretched across it. Sieves are of different degrees of fineness.

Washing is used for procuring powders of an uniform fineness much more accurately than by means of the sieve; but it can only be used for such substances as are not acted upon by the fluid which is used. The powdered substance is mixed with water, or some other convenient fluid: the liquor is allowed to settle for a few moments, and is then decanted off: the coarsest powder remains at the bottom of the vessel, and the finer passes over with the liquor. By repeated decantations in this manner, various sediments are obtained, of different degrees of fineness: the last, or that which remains longest suspended in the liquor, being the finest.

Filtration is a finer species of sifting. It is sifting through the pores of paper, or flannel, or fine linen or sand, or pounded glass, or porous stones, and the like; but is used only for separating fluids from solids, or gross particles that may happen to be suspended in them, and not chemically combined with the fluids. Thus salt-water cannot be deprived of its salt by filtration; but muddy water will deposit its mud. No solid, even in the form of powder, will pass through the above-mentioned filtring substances: hence if water or other fluid, containing sand, insects, mud, &c. is placed in a bag or hollow vessel, made of any of those substances, the sand, &c. will remain on the filtre, and the liquor will pass through, and may be received clear in a vessel under it. Unsized paper is a very con-

venient substance for making filtres for chemical purposes. It is wrapped up in a conical form, and put into a glass funnel, which serves to strengthen the paper and support the weight of the fluid when poured into it.

Decantation is often substituted instead of filtration, for separating solid particles which are diffused through liquors. These are allowed to settle to the bottom, and the clear fluid is gently poured off. If the sediment is extremely light, and apt to mix again with the fluid, by the slightest motion, a syphon is used for drawing off the clear fluid.

Lixiviation is the separation by means of water, or other fluid, of such substances as are soluble in it, from other substances that are not soluble in it. Thus, if a certain mineral consists of salt and sand, or salt and clay, &c. the given body being broken to powder, is placed in water, which will dissolve the salt, and keep it suspended, whilst the earthy matter falls to the bottom of the vessel, and, by means of filtration, may be separated from the fluid.

Evaporation separates a fluid from a solid, or a more volatile fluid from another which in less volatile.

Simple evaporation is used when the more volatile or fluid substance is not to be preserved. Various degrees of heat are employed for this purpose, according to the nature of the substances. It is performed in vessels of wood, glass, metal, porcelain, &c. Basons made of Wedgewood's ware are very convenient, as they are not apt to break by sudden changes of heat. Small flasks of thin glass also: these are placed either over the naked fire, or in a vessel filled with sand, which is then called a sand-bath. This affords a more regular degree of heat, and renders the vessels less liable to be broken.

When the fluid which is evaporated must be preserved, then the operation is called distillation.

Distillation is evaporating in close vessels, when we wish to separate two fluids of different degrees of volatility, and to preserve the most volatile, or both of them. The substance to be subjected to distillation, is put into some vessel that will resist the action of heat, called a retort, an alembic, or a still; having a beak or neck projecting from it, to which is attached another vessel, to receive the fluid that rises first, which is called the receiver. The vessel that contains the liquor to be distilled is placed upon the fire, or in a sand-bath, or over a lamp; the heat causes the most volatile fluid to rise in the form of vapour, and to pass into the receiver, where it is again condensed by cold. This condensation is sometimes assisted by making the vapour pass through a tube which is immersed in a vessel containing cold water.

A (fig. 1, Plate) represents a retort used for distillation. It is a vessel, either of glass or baked earth, for containing the liquid to be distilled. When it has a small neck, *a*, with a stopple fitted to it, for introducing the materials through, it is called a tubulated retort. B is the receiver for condensing the vapour which is raised, and into which the neck of the retort is inserted. The joining, *b*, is made air-tight by means of some substance applied to it, called a lute. Various methods are used for supporting both the retort and receiver, according to the degree of heat employed in the process, and several other circumstances. See LUTE.

When great heat is employed, earthen retorts are used, which are placed on or in the fire. When a less heat is wanted, glass retorts are generally employed; which must not be placed immediately on the fire, unless they are coated over with a composition of clay and sand, which is sometimes done. Glass retorts are generally placed in a sand-bath, or suspended over a lamp, for which Argand's lamp is the best. The receiver is placed upon some stand convenient for the purpose, with a ring made of hay under it, or some such contrivance, to keep it steady.

A (fig. 2) is a vessel called a mattrass, for the same purpose, having a vessel, B, called an alembic, fitted to the head. The liquid raised by heat into the state of vapour, is condensed in the alembic, and falls into a groove all round its inside, whence it runs out by the spout C, into the receiver D.

Fig. 3, are conical tubes that fit into one another, for lengthening the necks of retorts, &c. to connect them with the receivers at any distance: they are called adopters.

Fig. 4, are phials with bent glass tubes fitted in them, for disengaging gases, and similar experiments.

Fig. 5, represents an improved chemical apparatus, such as is used by Mr. Davy in his experiments at the Royal Institution. A is a japanned tin vessel, filled within two or three inches of the top with water. Just below the surface of the water is fixed a shelf having several holes bored through it, to which small funnels are attached underneath. The glass receiver B, intended to receive the gas, is filled with water; and being inverted with its mouth under water, it is raised up gently, and placed upon the shelf over one of the holes, where it will remain full of water, which is kept up by the pressure of the atmosphere in the same way as the mercury is retained in the tube of the barometer. The material from which the gas is to be disengaged is put into the retort G, which is put through, and suspended in one of the rings of the lamp furnace D. E is an improved Argand's lamp, having two concentric wicks, placed on the shelf F. The shelf is moveable up and down to bring the lamp to a convenient distance from the retort. The lamp is to be lighted, and as soon as the substances in the retort act upon each other sufficiently, the gas will begin to be disengaged, and will ascend through the hole in the shelf into the vessel B, and displace the water with which it had been filled. When the water is displaced, the receiver is full of gas which was disengaged from the retort, and may be preserved in it by keeping its mouth always under water in the cistern. This gas may be transferred from the vessel B to any other, in the following manner: Fill the vessel into which the gas is to be transferred with the fluid in the trough, and place it on the shelf over one of the holes. Then take the vessel B, and keeping its mouth still under the fluid, bring it under the hole on which the vessel is placed; then depressing its bottom, and elevating its mouth, so as to bring it more to a horizontal position, the gas in it will escape and rise up through the hole on which the other vessel has been placed, and will fill it by displacing the fluid.

If the oxyd of manganese is put into the retort G, and the lamp applied to it, great plenty of oxygen gas will escape from the retort, and will fill the receiver B.

When the gas to be procured is absorbable by water, quicksilver is used instead of water, and a much smaller vessel than A is made use of, which is generally made of wood or stone. A small glass vessel, capable of containing an ounce measure, is used for measuring gases; for if this phial is successively filled and inverted under a large jar, we may thereby throw into that jar any required quantity of an elastic fluid, and as much of another as we please.

G (fig. *5) is a strong glass graduated tube, for receiving a mixture of gases that are to be exploded by the electric spark. Near the closed end two wires pass through the glass, and almost touch each other: they are cemented in, so as to make the holes air-tight. Gases may be introduced into this tube; and if the interval between the two wires is made a part of the electric circuit, by putting chains connected with a Leyden phial to the rings of the wires, the spark will pass through the interrupted space between the two wires, and explode the gases.

A (fig. 6) is a glass retort, the beak of which is adjusted to a double tubulated balloon B. To the upper opening of the balloon is fitted a glass tube C, the other extremity of which is conveyed into the liquor contained in the glass vessel D: with this are connected two or three, or more similar vessels, by means of glass tubes, and to the last tubulure of the range of vessels is adapted a glass tube which is conveyed under a receiver placed upon the shelf of the pneumatic cistern. A (fig. 5).

Water is poured into the first of these vessels; caustic potash into the next, or such other substances as are necessary for absorbing the gases; and the joinings are well fluted. By this method the purest and most concentrated products are obtained; because the water, which is always the receiver, becomes saturated with them. In this way the common muriatic acid, the oxygenated muriatic acid, volatile alkali, &c. &c. may be made in the best manner.

Large vessels for containing air, and expelling any given quantity, are called gazometers. They are of various constructions; one of the best is the following: A B (fig. 7) is a cylindrical vessel of tin, japanned, nearly filled with water; and having a tube C in the middle, open at top, and branching, to communicate with the cock D. Within this vessel there is another cylindrical vessel, generally of glass, of smaller size, F, open at bottom; which is inverted and suspended by the lines e e, which go over the pulleys f, f, f, f, and have weights g g, attached to them, to balance the vessel F. While the cock D remains shut, if the vessel F is pressed downwards, the air included within it will remain in the same situation, on the principle of the diving-bell; but if the cock is opened, and the vessel F is pressed down, the air included within it will escape through the cock; and if a blow-pipe is attached to this cock, a stream of the gas may be thrown upon lighted charcoal, or any other body. By means of the graduated rod h, also, the

quantity thrown out is exactly ascertained: this rod is so divided as to express the contents of the inner vessel in cubic feet, &c. This instrument also answers for breathing any of the gases, by applying a mouth-piece to the cock. To render it more portable, the weights g g are sometimes included in the uprights i i, which are hollow and wide enough to receive them. Sometimes also there is another branch from the bottom of the pipe, in the middle, directed to the side of the other cylinder, and coming upwards by the side to the top, where there is another cock attached.

Crystallization.—When a salt is dissolved in water, or other fluid, and by evaporation the fluid is driven off, the salt gradually acquires the solid form, and in doing this, it arranges its particles in a particular manner; some salts arrange themselves in the form of pyramids, some of prisms of different kinds, &c. Vessels of earthenware, or glass, are employed for such crystallizations. They must be placed where they are perfectly still, and well defended from dust or accidents.

Solution.—When a salt is mixed with water, it loses its state of solidity; the particles of salt are divided and unite themselves to those of the water, forming a liquid, of which all the parts are homogeneous, or of the same kind. The same takes place when resin is mixed with spirits of wine. In this process neither the salt nor the water is decomposed; and the salt may be recovered again in its original state and quantity, by driving off the water by evaporation.

The dissolution of metals by acids, however, is of a different nature: here, either the metal, the acid, or the water, is altered, and different products are obtained. Vessels of glass are generally used for solutions and dissolutions. The liquid used for dissolving a metal, or other solid substance, is usually called a solvent, or menstruum.

Precipitation.—The recovery or separation of a body from its solvent, by the addition of a third substance, so that the former may re-appear in a solid state, however divided, is called precipitation. The substance thus recovered, is called a precipitate, and the superadded body that occasions this precipitation is called a precipitant.

Fusion.—The melting, or causing any body to pass from the solid to the liquid state, by the action of fire, is called fusion. The fusion of metallic substances requires vessels sufficiently strong to resist the fire. These vessels are mostly, if not always, made of earthenware, or porcelain, or a mixture of clay and powder of black-lead. They are called crucibles, and are generally of the forms represented fig. 8; sometimes these vessels have covers made of earthenware; but sometimes the fused metal must be exposed to a current of air. In that case the crucibles are broad and shallow, as at fig. 9. These are called cupels; and they are formed of calcined bones, mixed with a small quantity of clay, or of a mixture of clay and black-lead powder. But the cupels must not be placed in a closed furnace, or be surrounded by coals; for, in that case, the required current of air could not have access to the fused metal. They are therefore placed under a sort of oven of earthenware, which is called a muffle, as represented fig. 10; which, with the included cupel, is exposed to the heat of a furnace.

Furnaces.—In the application of the action of heat to bodies, furnaces of different forms are employed, according to the operations for which they are destined. A furnace is a kind of hollow cylindric tower, A B C D (fig. 11); sometimes a little wider at the top, with notches *m*, *m*, *m*, to give a passage to the air. This furnace ought to have at least two lateral apertures; an upper one F, which is the door of the fire-hole H I; and a lower one G, which is the door of the ash-hole C D. In the interval between these two doors the furnace is divided into two parts by a horizontal grate, destined to support the charcoal. The place occupied by this grate is indicated by the line H I; above the grate is the fire-hole where the fire is maintained; and below it is the ash-hole, where the ashes are collected as they are formed.

Another kind of furnace often necessary, is that called the reverberating furnace (fig. 12); it consists of an ash-hole H I K L, a fire-hole K L M N, a laboratory M N R R, and a dome R R S S; above the dome is a tube T T V V, to which several more can be added if required. In the laboratory is placed a retort, which is supported by two iron bars that run across the furnace; the neck of it passes through the lateral aperture O, and has adapted to it a receiver. As a strong heat is sometimes required for this furnace, a large volume of air must be made to pass through it; and in that case a great deal of heat is disengaged. For this reason, instead of one aperture to the ash-hole, there must be two: when only a moderate heat is required, one of them may be shut; if a strong heat is necessary, they may be both opened. It will be of advantage also to make the upper aperture T T of the dome pretty large. The use of the dome is to reverberate the heat and flame on the retort, in order that it may every where be exposed to nearly an equal heat; by which means the vapours can be condensed only in the beak of the retort and in the receiver, and are also forced to proceed thither. When matters which do not require a strong degree of heat are to be fused, the reverberating furnace may be employed as a fusing furnace. The laboratory M N R R in that case is removed; and the dome R R S S is placed on the fire-hole M N, as represented.

One of the best fusing furnaces ever made, is that constructed by Lavoisier, and which is represented fig. 13. The following is the description which he gives of it in his Elements of Chemistry. This furnace is in the form of an elliptical spheroid A B C D, cut off at the two ends by two planes which pass perpendicular to the axis through the foci of the ellipse. From this shape it is capable of containing a considerable quantity of charcoal, while it leaves sufficient space in the intervals for the passage of the air. That no obstacle may oppose the free access of external air, it is perfectly open below, and stands upon an iron tripod. The grate is made of flat bars, set on edge, with considerable interstices between them. To the upper part A B is added a chimney, or tube of baked earth, eighteen feet long, and equal in width to nearly half the diameter of the furnace. Lavoisier recommends, as a thing of importance, to make the tube F G A B as bad a conductor of heat as possible; it must therefore be constructed neither of iron-plate, nor of copper, as is commonly the case.

Another kind of furnace is that necessary for assaying. In this furnace the metal must, at the same time, be exposed to the most violent heat; and, secured from the contact of the air, become incombustible by its passage through the coals: on this account it has been called the assaying or cupelling furnace. It is generally of a square form (fig. 14); and, like the other furnaces, has an ash-hole A A B B, a fire-hole B B C C, a laboratory C C D D, and a dome D D E E. The laboratory is destined for receiving the muffle, which is a kind of small oven (fig. 10) made of baked earth, and close at the bottom. It rests on bars which traverse the furnace: and being adjusted to the door of the laboratory, is luted in with clay. It is in this small oven the cupels are placed, and the muffle is surrounded with charcoal: that above it being conveyed through the door I of the dome; and that below it, through the door K of the fire-hole. The air which enters through the apertures of the ash-hole, after having served for the purposes of combustion, escapes through the upper aperture E E of the dome. In regard to the muffle, the air penetrates to it through the door G, and promotes the oxidation of the metal. This furnace, however, is attended with the following inconvenience: if the door G of the laboratory is shut, the oxidation, for want of air, takes place slowly; while, on the other hand, if it is open, the current of cool air causes the metal to become fixed, and retards the operation. To obviate this inconvenience, hot air should be conveyed to the muffle from without, by causing it to pass through an earthen tube, kept in a state of ignition by the furnace itself; and thus the interior part of the muffle would never become cold.

A very useful kind of furnace is that invented by Dr. Black. It consists (fig. 15) of a cylindrical or elliptical body of sheet iron, coated within with a mixture of loam and clay. The aperture X at top is closed occasionally with an iron saucer full of sand, which forms a sand-bath: B is the door of the fire-place, and C is the ash-pit register, which slides so as to admit more or less air. D is an iron tube which goes into the chimney of the room, to carry off the smoke.

Blow-pipes are used for directing the flame of a candle or lamp against any bit of ore or other substance required to be examined. They ought to have a bulb upon the middle of their stem, to contain the moisture that is formed from the breath, as fig. 16.

The blow-pipe contrived by Dr. Black, of a conical form, represented in fig. 17, is the most convenient: *a* is the nozzle.

Of simple substances.—The object of chemistry, in subjecting to experiment the different bodies in nature, is that we may thereby be enabled to examine separately the substances which enter into their composition. This science has, during the last thirty years, made a very rapid progress. Formerly oil and salt, as well as water, were considered as elementary bodies: now it is ascertained that they are compound substances. Salts, as we shall hereafter see, are composed of an acid with some base, and their neutral state is the result of this union. Acids again are formed by the combination of an acidifying principle (oxygen) which is common to all, and a radical peculiar to each particular acid. See Acid. The radicals of the acids are not always simple substances: they are

often compounded of hydrogen and carbon. The bases of the alkaline salts are often not more simple than those of the acids; as has been proved with respect to ammonia, which is composed of hydrogen and azote. See AMMONIA.

It results from our knowledge of the gases (see AIR, pages 28 to 35) that there are a certain number of substances which we may consider as simple bodies, whether they are so or not, because no means have yet been discovered by which they may be decomposed.

The substances of this kind are,

Simple substances, which may be considered as the elements of bodies.	Light Caloric Oxygen Azote or nitrogen Hydrogen
Simple non-metallic substances, oxidable and acidifiable.	Carbon Sulphur Phosphorus Muriatic radical Fluoric radical Boracic radical
Simple, earthy, salifiable substances.	Lime Magnesia Barytes Alumina Silica Strontian Zirconia Glucina Yttria
Simple metallic substances oxidable.	Platina Gold Silver Mercury Copper Iron
Simple metallic substances oxidable, and some of them acidifiable.	Lead Tin Zinc Antimony Bismuth Cobalt Nickel Manganese Uranium Titanium Tellurium Columbium Tantalium Chrome Arsenic Molybdena Tungsten.

These simple substances may be combined with each other, and with other substances, in order to form compounds.

Of light. The physical properties of light will be considered under OPTICS. This substance seems to have considerable influence upon many chemical processes. The effect of light upon vegetation is well known. Many flowers follow the course of the sun; and plants that grow in houses, seem solicitous, as it were, to get at the light. Plants that grow in the shade, or in darkness, are pale, and without colour: and when this is the case, they are said to be etiolated or blanched. Gardeners avail themselves of this fact to render vegetables white and tender. The more plants are exposed to the light, the more colour they acquire. Yet the dead vegetable is deprived of colour by exposure to it.

Vegetables are not only indebted to light for their colour, their taste and odour are derived from the same source. From this cause it happens that hot climates are the native countries of perfumes, odoriferous fruits, and aromatic resins. The action of light on the organs of vegetables causes them to pour out streams of pure air from the surfaces of their leaves, while exposed to the sun: whereas, on the contrary, when in the shade, they emit air of a noxious quality. Even animals, in general, droop when deprived of light; and it appears to be of great importance to the health and happiness of human beings.

All metallic oxydes, but especially those of mercury, bismuth, lead, silver, and gold, become of a deeper colour by exposure to the sun; some of them become perfectly revived, others only partially. Many bodies, if exposed to light, either at high or low temperatures, combine with it, and emit it again under certain circumstances. These are called solar phosphori. Substances of this kind have been prepared by various chemists; the principal of which are, the phosphorus of Canton, Baldwin, Homberg, and the Bolognian phosphorus. These have the property of shining in the dark. Various animal and vegetable substances seem to possess this phosphorus. The glow-worm is a remarkable instance. Dead fish, rotten sea-weeds, and great numbers of insects, have this property in a great degree.

Instruments for measuring the degree or intensity of light are called photometers.

Of caloric. All the bodies in nature are immersed in caloric, which penetrates their parts throughout, and which fills up the intervals left between the particles. In some cases the caloric is fixed in these bodies, and in such a manner as even to contribute to their solidity; but it often separates their particles also, by exercising on them a repulsive force; and it is on its greater or less action or accumulation that the transition of bodies from the solid state to the liquid, and from the liquid to the aeriform, depends.

The combination of caloric with	forms	
Oxygen	forms	Oxygen gas, or vital air
Azote or nitrogen	—	Azotic gas, or mephitic air
Oxygen and azote	—	Nitrous gas
Oxygen and carbon	—	Carbonic acid gas, and gas oxide of carbon.
Oxygen and the muriatic radical	—	Muriatic acid gas
Oxygen and the muriatic radical, surcharged with oxygen	—	Oxymuriatic acid gas
Oxygen and sulphur	—	Sulphurous acid gas
Oxygen and the fluoric radical	—	Fluoric acid gas
Ammonia	—	Ammoniacal gas
Hydrogen	—	Hydrogen gas
Hydrogen and sulphur	—	Sulphurated hydrogen gas
Hydrogen and phosphorus	—	Phosphorized hydrogen gas
Hydrogen and carbon	—	Carbonated hydrogen gas
Water	—	Aqueous gas, and so of all other evaporable liquids.

Of oxygen. Oxygen is a substance diffused in great abundance throughout nature; it forms nearly a third in weight of our atmosphere. Animals absorb a great quantity of it by respiration; and it combines with other bodies to convert them into oxides and acids.

A certain number of conditions must be united, in order that a body may be oxygenated. The first is, that the constituent particles of this body must not exercise between themselves an attraction stronger than that which they exercise on oxygen. If they do not possess this superior force of attraction for oxygen, it may be communicated to them artificially, by exposing them to heat; that is to say, by introducing into them caloric, which, separating them from each other, diminishes the force of their reciprocal attraction, and allows them to exercise a more powerful one on the oxygen: oxygenation will then take place. The degree of heat necessary to produce this phenomenon is not the same for all substances: some may be oxygenated at a temperature so low that we never find them but in an oxygenated state. Of this kind is the muriatic radical, which never presents itself to us simply, but always in an acid, which it has been hitherto impossible to decompose. To oxygenate the greater part of bodies, and almost all simple substances, in general, it will be sufficient to expose them to the action of the atmospheric air, and to raise them to the proper temperature. The temperature necessary to oxygenate lead, mercury, and tin, is not greater than that in which we live; but, on the other hand, a pretty high degree of heat is necessary to oxygenate iron and copper in the dry way, and when the oxygen is not assisted by the action of humidity. Sometimes the oxygenation takes place with great rapidity, and in that case is accompanied with heat, light, and even flame: such is the combustion of phosphorus in the air, and in oxygen gas. That of sulphur is much less rapid. Such also is the combustion of iron in pure oxygen gas. Example: If a piece of iron wire bent in a spiral shape, as A (fig. 20.), is hung in a receiver B filled with oxygen gas, and by means of a small piece of phosphorus, it is inflamed, the metal will burn with the greatest brilliancy. Tin, lead, and the greater part of the metals, oxidate slowly, and without the disengagement of the caloric being sensible.

There is still another method of oxygenating simple substances. Instead of exposing them to oxygen united with caloric, the oxygen may be presented to them in union with some metal for which it has little affinity. The red oxide of mercury is one of those best fitted for accomplishing this object, because the oxygen in that state adheres very little to the metal: it is disengaged from it at that degree of heat at which glass begins to become red. The black oxide of manganese, the red oxide of lead, the oxide of silver, and almost all the metallic oxides, can, in a certain degree, produce the same effect.

Every metallic reduction or revivification, is an oxygenation of charcoal or some other combustible matter by a metallic

Retorts &c 4

1

2

3

Pneumatic apparatus 5

5

Wolfes apparatus 6

Gazometer 7

8 Crucibles

9

10

12 Reverberating Furnace

11 Furnace

13

14 Assaying Furnace

15 Dr. Blacks Furnace

16 Blow pipes

17

Lavoisiers Furnace

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oxide. The charcoal, by combining with the oxygen and caloric, escapes under the form of carbonic acid gas, and the metal remains pure and revived.

All combustible substances may be oxygenated also by combining them either with the nitrate of potash, or that of soda, or with the oxygenated muriate of potash. At a certain degree of heat the oxygen abandons the nitrate or the muriate, and combines with the combustible body, but with great violence. The reason is as follows. The oxygen, in combining with the nitrates, and particularly with the oxygenated muriates, enters along with a quantity of caloric almost equal to that necessary for constituting it oxygen gas. At the moment of its combination with the combustible body, all this caloric becomes suddenly free, and produces terrible detonations. This method of oxygenation, therefore, must not be attempted but with the utmost caution, and when very small quantities of matter are employed.

There are different degrees of oxygenation: the first degree forms oxides, the second forms weak acids, the third strong acids, and the fourth hyperoxygenated acids.

The combination of oxygen with

Simple non-metallic substances.

- Caloric — forms oxygen gas
- Hydrogen — water
- Azote (Degrees of oxygenation)
  - 1, — base of atmospheric air.
  - 2, — nitrous oxide
  - 3, — nitrous gas
  - 4, — nitric acid
- Carbon
  - 1, — oxide of carbon
  - 2, — carbonic acid
- Sulphur
  - 1, — oxide of sulphur, soft sulphur
  - 2, — sulphurous acid
  - 3, — sulphuric acid
- Phosphorus
  - 1, — oxide of phosphorus
  - 2, — phosphorous acid
  - 3, — phosphoric acid
- The muriatic radical
  - 1, — muriatic acid
  - 2, — oxymuriatic acid
  - 3, — hyperoxymuriatic acid
- The fluoric radical — 1, — fluoric acid
- The boracic radical — 1, — boracic acid.

The combination of oxygen with (Degrees of oxygenation)

- Gold
  - 1, forms yellow oxide of gold
  - 2, — red oxide of gold, precipitate of Cassius
- Platina
  - 1, — yellow oxide of platina
- Silver — 1, — oxide of silver
- Copper
  - 1, — reddish-brown oxide of copper
  - 2, — green and blue oxide of copper
- Iron
  - 1, — black oxide of iron
  - 2, — yellow and red oxide of iron
- Tin
  - 1, — grey oxide of tin
  - 2, — white oxide of tin

Simple metallic substances.

- Lead
  - 1, — grey oxide of lead
  - 2, — yellow and red oxide of lead
- Mercury
  - 1, — black oxide of mercury
  - 2, — yellow and red oxide of mercury
- Bismuth
  - 1, — grey oxide of bismuth
  - 2, — white oxide of bismuth
- Cobalt — 1, — grey oxide of cobalt
- Nickel — 1, — oxide of nickel
- Zinc
  - 1, — grey oxide of zinc
  - 2, — white oxide of zinc
- Antimony
  - 1, — grey oxide of antimony
  - 2, — white oxide of antimony
- Arsenic
  - 1, — grey oxide of arsenic
  - 2, — white oxide of arsenic
  - 3, — arsenic acid
- Manganese
  - 1, — black oxide of manganese
  - 2, — white oxide of manganese
- Tungsten
  - 1, — oxide of tungsten
  - 2, tungstic acid
- Molybdena
  - 1, oxide of molybdena
  - 2, molybdic acid
- Titanium — 1, oxide of titanium
- Chrome
  - 1, oxide of chrome
  - 2, chromic acid.

In the mineral kingdom almost all the oxidable and acidifiable radicals seem to be simple substances; but in the vegetable kingdom there are scarcely any which are not composed of two substances, hydrogen and carbon. Azote and phosphorus are often joined with them, and the result is radicals with four bases.

From these observations, it appears that the oxides and the animal and vegetable acids may differ from each other three ways. 1st. By the number of acidifiable principles which constitute their base; 2d, By the difference in the proportions of these principles; 3d, By the different degrees of oxygenation. This is more than sufficient to account for the great number of varieties which nature exhibits to us. It thence appears, therefore, that some of the vegetable acids can be converted into each other. Nothing is necessary for this purpose but to change the proportion of carbon and hydrogen, and to oxygenate them more or less. Carbon and hydrogen, by the first degree of oxygenation, give tartareous acid; by a second degree oxalic acid; and by a third the acetous, or acetic acid.

Of azote or *nitrogen.* Azote is a principle diffused in great abundance throughout nature: when combined with caloric, it forms azotic or mephitic gas, which in volume is three fourths of the atmosphere, and in weight somewhat less than atmospheric air. It always remains in the state of gas at the temperature and pressure of the atmosphere which we experience; and we are unacquainted with any degree of compression or cold capable of reducing it to the solid, or even to the liquid state. Azote is one of the essential constituent parts of animal matter; it is combined in them with carbon and hydrogen, and sometimes with phosphorus; the whole being connected by a certain portion of oxygen, which reduces them to the state of oxide, or to the acid state, according to the degree of oxygenation.

The nature of animal matters, therefore, may vary, like that of vegetable matters, three ways: 1st, By the number of the substances which enter into the combination of their radicals; 2d. By the difference in the proportion of these substances; 3d. By the different degrees of oxygenation.

The combination of azote with

Simple substances.

- Caloric — forms azotic gas
- Oxygen (Degrees of oxygenation)
  - 1, the base of atmospheric air
  - 2, nitrous oxide
  - 3, nitrous gas
  - 4, nitric acid
- Hydrogen — ammonia
- Carbon, Hydrogen, and sometimes Phosphorus, Oxygen — animal matters.

Of hydrogen. Hydrogen is one of the constituent principles of water, and thence it has received its name. It forms in the composition of water fifteen hundredth parts of its weight, while oxygen forms the other eighty-five parts. The affinity of hydrogen for caloric is so great, that it constantly remains in the state of gas at the degree of heat and pressure in which we live; it is impossible, therefore, to procure it free from all combination, and consequently we are unacquainted with the nature of this principle. It is one of the most abundant principles in nature; for besides entering into the composition of water, which is itself so abundant on the earth, it is one of those principles which act the most conspicuous part in the vegetable and animal kingdoms, by combination with different substances.

Having already referred to the production of hydrogen gas, (see AIR, p.31) we shall now shew the means of obtaining it by experiment.

Exp. Let the gun-barrel *x y* (fig. 21) pass through a furnace F, and adjust to one extremity of it the bent tube A, and let the other extremity terminate in the tube B, carried under the receiver C. When the apparatus is thus disposed, and the several parts luted together, the gun-barrel must be brought to a red heat, and the water poured in drop by drop through A; and when it comes in contact with the gun-barrel, it is decomposed; the iron seizes on the oxygen of the water, and the hydrogen escapes through B in a state of gas.

This gas may also be obtained by pouring a solution of sulphuric acid over filings of iron or zinc.

Exp. Put iron filings into the jar A with two tubulures *a* and *b*, adjust to *b* the small glass tube ending in a capillary bore, and through *a* pour the diluted sulphuric acid: the gas will speedily be disengaged; and if a taper is applied to *x*, it will continue to burn with a fine blue flame as long as the decomposition goes on. This is called the philosophical candle.

Simple substances.

The combination of hydrogen with

- Caloric — forms hydrogen gas
- Oxygen — water
- Azote — ammonia, or volatile alkali
- Sulphur — the base of sulphurated hydrogen gas
- Phosphorus — the base of phosphorized hydrogen gas
- Carbon
  - the base of carbonated hydrogen gas
  - fixed and volatile oils
  - the radicals of the vegetable acids
  - and when azote and phosphorus are joined with it
  - the radicals of the animal kingdom.

Of carbon. Carbon appears to be a simple substance, for hitherto it has not been possible to decompose it. Modern experiments seem to prove that it exists completely formed in vegetables, in which it is combined with hydrogen, and sometimes with azote and with phosphorus; and that it assists to form in them compound radicals, which are afterwards carried to the state of oxides or of acids, according to the proportion of oxygen united with them. To obtain the carbon contained in animal or vegetable matters, nothing is necessary but to expose them, first to a moderate and then to a very strong degree of heat, in order to decompose the last portions of water, which the charcoal strongly retains. In these operations chemists employ retorts of earthenware or porcelain, into which the combustible matters are introduced; and they are exposed to a strong heat in a reverberating furnace. The heat converts those substances which are susceptible of it into gas; and the carbon, which is more fixed, remains combined with a little earth and some fixed salts.

In the arts, the carbonization of wood is effected by a simpler and cheaper process. The wood is cut into pieces nearly of the same size and length; these pieces are disposed in heaps, and are covered with earth, in such a manner as to prevent all communication with the air, except what is necessary to make the wood burn, and to drive off the oil and water formed during the combustion; they are then kindled, and when they have burnt a sufficient time, the fire is extinguished by stopping the holes which served to introduce the air.

There are two methods of analysing charcoal, viz. 1st, By its combustion in oxygen gas: 2d, Its oxygenation by the nitric acid. In both cases it is converted into carbonic acid, and it leaves a residuum of lime, potash, and some neutral salts. It is not yet fully ascertained whether the potash exists in charcoal before its combustion.

Exp. Under a bell glass A, (fig. 23.) filled with oxygen gas, and inverted over mercury in the trough BC, introduce some charcoal in the saucer D. The charcoal must be wrapped in cotton; having also a small particle of phosphorus in it, in order that the whole may take fire upon the introduction of the heated wire HGI through the mercury. The charcoal will then burn with great brilliancy. It will be found that to saturate 28 parts of carbon with oxygen, 72 parts of the latter are required, and the aeriform acid produced is equal in weight to the sum of the weight of the carbon and of the oxygen.

Exp. Very pure carbon may be thus procured: Put into a glass tube *z* (fig. 24.), closed at one of its extremities, and reduced to a capillary bore at the other, one part of phosphorus; and above it, at the distance of several inches, five parts of carbonate of lime, reduced to powder. Place the tube in the middle of the furnace F, so that the coals can heat the carbonate of lime only, the part of the tube containing the phosphorus being in the ash-hole. When the lime is brought to a red heat, the tube is to be raised, that the phosphorus may burn; the phosphorus lays hold of the oxygen of the carbonic acid, and becomes phosphoric acid; which unites to the lime, and forms phosphate of lime, while the carbon remains by itself.

The combination of carbon not oxygenated with

- Oxygen — forms carbonic oxide and carbonic acid
- Hydrogen — the carbono-hydrous radical, fixed and volatile oils
- Iron — carburet of iron, or plumbago
- Zinc — carburet of zinc.

Of sulphur. Sulphur is one of those combustible substances which have the greatest tendency to combination. At the common temperature of the atmosphere it is concrete; and it does not liquefy but at a heat several degrees higher than that of boiling water. It is found completely formed, and almost in its utmost degree of purity, in volcanic productions. It is found also, and much oftener, in the state of sulphuric acid, in argil, gypsum, &c.

To extract the sulphur of the sulphuric acid united to these substances, it must be deprived of its oxygen. This may be effected by combining it at a red heat with carbon: the carbon takes from it its oxygen, and thence is formed carbonic acid, which combining with caloric, disengages itself in the state of gas: the result then is a sulphuret, which may be decomposed by an acid: the acid unites to the base of the sulphuret, and the sulphur is precipitated.

Ex. We may here shew the nature of sublimation: Put some lumps of sulphur into the vessel A (fig. 25.), to which the receiver B is adapted and luted round. A is put on a sand-bath, made hot by the furnace C; the sulphur melts, a smoke rises which is deposited in B in the form of vegetation, and hence it has been called flowers of sulphur. In this way sulphur may be combined with alcohol. Put pounded sulphur into a glass retort A (fig. 26.), suspend within it the bottle B containing alcohol, then put on the cover C, and adjust the beak *x* to the mattrass *z*; lute the joinings, and heat the retort by the furnace F. The sulphur will be sublimed, and the alcohol will be volatilized. In this state the bodies meet, the alcohol dissolves the sulphur, and a liquor will be obtained in *z* slightly coloured, which is sulphurated alcohol. To prove that sulphur is held in combination by the alcohol, add to it some distilled water, and the sulphur will be precipitated.

The combination of sulphur not oxygenated with

	Degrees of oxygenation.	
Oxygen	1,	forms oxide of sulphur, or soft sulphur
	2,	— sulphurous acid
	3,	— sulphuric acid
Hydrogen	—	the base of sulphurated hydrogen gas
Copper	—	sulphuret of copper, or pyrites of copper
Iron	—	sulphuret of iron, or pyrites of iron
Lead	—	sulphuret of lead, or galena
Mercury	—	sulphuret of mercury, or ethiops mineral; cinnabar
Zinc	—	sulphuret of zinc, or blende.
Antimony	—	sulphuret of antimony, or crude antimony
Arsenic	—	sulphuret of arsenic, or orpiment; realgar
Potash	—	sulphuret of potash, or liver of sulphur with a base of fixed vegetable alkali
Soda	—	sulphuret of soda, or liver of sulphur with a base of fixed mineral alkali
Lime	—	sulphuret of lime, or liver of sulphur with a calcareous base
Magnesia	—	sulphuret of magnesia, or liver of sulphur with a base of magnesia
Barytes	—	sulphuret of barytes, or liver of sulphur with a base of ponderous earth
Ammonia	—	sulphuret of ammonia, or volatile liver of sulphur; fuming liquor of Boyle.

Of Phosphorus.—Phosphorus is a simple combustible substance, for no experiment gives us reason to think that it can be decomposed. It was not known to the old chemists; and it was discovered in 1667 by a German, named Brandt, who made a mystery of his process. A short time after Brandt's secret was discovered by Kunckel, who published the process, and on that account it was called Kunckel's phosphorus.

It was from urine alone that this phosphorus was first extracted; and though the method was described, particularly by Homberg, in the Memoirs of the Academy of Sciences for 1722, the English, for a long time, supplied this article to all Europe. It was not made in France till 1737, when it was prepared for the first time in the Botanical Garden, in the presence of commissioners appointed by the Academy of Sciences.

At present it is extracted by a more convenient and economical process, from the bones of animals, which are real phosphate of lime. The simplest method, according to Gahn, Scheele, Rouelle, &c. is to calcine the bones of full-grown animals until they are almost entirely white; to pound and sift them, and then to pour over them sulphuric acid diluted with water; but less than is necessary for dissolving the whole matter.

The sulphuric acid unites itself to the earth of the bones, and forms sulphate of lime; by these means the phosphoric acid is disengaged, and remains in a free state in the liquor. The liquor is then to be decanted, and the residuum being washed, the water employed for this purpose must be added to the decanted liquor. The whole must then be evaporated, in order to separate the sulphate of lime which crystallizes in silky filaments, and you will thus obtain phosphoric acid, under the form of white transparent glass; which, when reduced to powder, and mixed with a third of its weight of charcoal, and distilled, will yield good phosphorus.

Phosphorus is found in almost every animal substance, and in some plants, which, according to chemical analysis, have an animal character. In this state it is generally combined with carbon, hydrogen, and azote, from which there result radicals with four bases. Phosphorus inflames at the temperature of 401 degrees.

It has so great an affinity for oxygen, as to decompose oxygen gas. Example. A receiver containing three or four quarts of oxygen gas (fig. 23) was placed over the mercurial trough B C, and about 61¼ grains of phosphorus distributed in the saucer D, and introduced under the receiver A, and kindled by means of a red-hot wire. The combustion took place with great rapidity, producing a brilliant flame, and the disengagement of a great degree of light and heat; the inside of the receiver became covered with white light flakes, which were found to be concrete phosphoric acid. The quantity of oxygen gas employed was 16.2 cubic inches; after the absorption there remained 23 cubic inches, of course 139 inches of gas was absorbed. About 45 grains of phosphorus were burnt, and these combined with the oxygen formed the phosphoric acid. This experiment proves that, at a certain temperature oxygen has more affinity for phosphorus than it has for caloric; that the phosphorus decomposes the oxygen gas by seizing on its base; and that the caloric passes into the surrounding bodies, and produces in them heat.

The following experiment, made on a larger scale, proves the justness of the preceding results in a manner more rigorous and exact. Take a large glass balloon, A (fig. 27), the aperture of which, E F, is about three inches in diameter, and cover the aperture with a plate of ground glass, pierced with two holes to receive the two tubes, *y y y*, *x x x*, furnished with cocks. Before you cover it with the plate, introduce into it a supporter, C B, with a porcelain cup, D, containing 150⅔ grains of phosphorus; and after you have closely shut the balloon, by luting on the glass plate, exhaust the balloon of air by connecting the tube *x x x* with an air-pump. Then weigh the whole apparatus by a nice balance, and fill the balloon with oxygen gas by means of the tube *y y y*, connected with a hydro-pneumatic machine. By the help of this machine you may ascertain in a very accurate manner, the quantity of oxygen gas introduced into the balloon, and that consumed during the course of the operation.

When every thing is thus arranged, kindle the phosphorus by means of a burning glass; the combustion will be exceedingly rapid, and accompanied with a large flame and a strong heat. In proportion as it is effected, there is formed such a quantity of white flakes, which attach themselves to the inside of the vessel, that it is soon rendered entirely opake.

When the whole apparatus has cooled, and you have ascertained the quantity of oxygen gas employed, weigh the balloon again before you open it. Then wash, dry, and weigh, the small quantity of phosphorus remaining in the cup, in order that it may be deducted from the whole quantity of phosphorus employed in the experiment. By observing these precepts, it will be easy to determine, 1st, the weight of the phosphorus burnt; 2d, the weight of the oxygen gas which has combined with the phosphorus; 3d, the weight of the flakes obtained by the combustion. This experiment will give nearly the same results as the preceding.

It thence appears that the phosphorus, in burning, combines itself with oxygen equal to one and a half of its own weight; and that the weight of the white flakes, or concrete phosphoric acid, produced, is equal to the sum of the weight of the phosphorus burnt, and that of the oxygen combined with it.

The combination of phosphorus not oxygenated w th

	Degrees of oxygenation.	
Oxygen	1,	forms oxide of phosphorus
	2,	— phosphorous acid
	3,	— phosphoric acid
Hydrogen	—	phosphuret of hydrogen, or the base of phosphorized hydrogen gas
Azote	—	phosphuret of azote
Carbon	—	phosphuret of carbon
Sulphur	—	phosphuret of sulphur
Iron	—	phosphuret of iron, called formerly siderit.

Of Earths.—By analysing earths, and freeing them from substances with which they are mixed, chemists have obtained nine simple or primitive earths, viz. lime, magnesia, barytes, alumina, silex, strontian, zirconia, yttria, and glucina.

Lime is rarely found in a pure state; it is contained in chalk, which may be deemed a neutral salt, being formed by the combination of lime with carbonic acid. The best process for obtaining lime in a state of purity is this: wash chalk in distilled water, brought to a state of ebullition, and then dissolve it in distilled acetous acid: this acid, by combining with the lime, expels the carbonic acid, which escapes under the gaseous form; then precipitate the lime by carbonate of ammonia, for the acetous acid abandons the lime, in order to combine with the ammonia, and the lime is precipitated: wash and calcine this precipitate, and the residuum will be pure lime.

Lime is soluble in water, but in very small quantities; more than 600 parts of water are necessary to dissolve one of it. It has a pungent, hot, and acrid taste; it turns blue vegetable colours green. It takes up water with avidity. When thrown into this liquid it splits, swells up, acquires a larger volume, and a great heat. It dissolves in acids without effervescence. The borate of soda and the phosphates of urine dissolve it also.

Lime, when alone, is infusible, even though the fire may be urged by oxygen gas, as has been proved by Lavoisier; but if combined with acids, it forms a fusible body, for lime is a salifiable base. Of all these bases it is that most abundantly diffused throughout nature. See LIME.

Magnesia has never yet been found free from every kind of foreign matter. To procure it in the utmost degree of purity, crystals of the sulphate of magnesia (Epsom salt), of which it forms the base, must be dissolved in distilled water, and decomposed by alkaline carbonates: the sulphuric acid combines with the alkalies; the magnesia with the carbonic acid, and is precipitated. This precipitate must then be calcined, in order to disengage the carbonic acid; and what remains will be pure magnesia.

Pure magnesia is exceedingly white, tender, and in appearance spongy. When perfectly pure, it is not sensibly soluble in water. It excites no sensible savour on the tongue; and in this respect it is greatly different from lime. It gives a light green colour to the tincture of turnsole. Lavoisier has proved by experiment that magnesia is as infusible as lime. See MAGNESIA.

Barytes, or ponderous earth, has never yet been found pure and free from all combination. It is found under the pulverulent form, and exceedingly white. It gives a very slight tint of green to blue vegetable colours. Its specific gravity is from 4.2 to 4.3000. Analysis has proved that 100 parts of carbonate of barytes contain 62 of barytes, 22 parts of carbonic acid, and 16 parts of water. See BARYTES.

Alumina or pure argil is found chiefly in the different kinds of clay, of which it forms the base, and where it is often mixed with silex. To obtain it very pure, sulphate of alumina (alum) must be dissolved in water, and afterwards decomposed by alkaline carbonates. The alkali combines with the sulphuric acid, which then abandons the alumina; and the latter combines with the carbonic acid abandoned by the alkali. The alumina must then be freed from this acid by calcination; and after this process it will remain pure. It absorbs water with avidity, and becomes diluted in that liquid. It adheres strongly to the tongue. The borate of soda and the phosphates of urine dissolve it. When exposed to heat, it becomes dry, shrinks, and cracks. By the action of the fire it acquires so great hardness as to strike fire with steel: it is then no longer susceptible of being diluted in water. Alumina, even when perfectly pure, is completely fusible in the fire, if urged by a current of oxygen gas. The result of its fusion is a vitreous, opake, and very hard substance, which scratches glass in the same manner as precious stones do. See ALUM and ALUMINA.

Silex, or vitrifiable earth, is almost in its state of purity in rock-crystal: but to have it perfectly pure, one part of beautiful rock-crystal must be fused with four parts of pure alkali; the mixture must then be dissolved in water, and precipitated by an excess of acid; the precipitate will be pure silex, which is rough and harsh to the touch; its particles, when diluted in water, are easily precipitated.

The fluoric acid dissolves silex exceedingly

well: it is also the solvent of glass. Alkalies dissolve silex in the dry way, and with it form glass. Silex cannot be fused by a burning lens; but by exposing it to a fire, urged by oxygen gas, Lavoisier produced a commencement of fusion on its surface. See SILEX.

Strontian was discovered by Dr. Hope, professor of chemistry at Glasgow. It is found in the state of a carbonate, that is, combined with carbonic acid, in a vein of lead ore, at Strontian in Argyleshire, in the western part of Scotland. It has been found also combined with carbonic acid at Lead-hills, in the same country. Some of it has since been discovered at Montmartre in France, combined with sulphuric acid; and it is found in quantities in the neighbourhood of Bristol.

Strontian was at first confounded with barytes; which indeed it resembles in several respects, though it differs from it in others.

Carbonate of strontian is decomposed by the sulphuric acid, and carbonic acid is disengaged: the sulphate of strontian, thus obtained, is very little soluble in water. It dissolves with effervescence in the nitric and muriatic acids, and carbonic acid is disengaged. These nitrates and muriates of strontian are not deliquescent, and are decomposed by the sulphates of lime, potash, and others. It may be deprived of its acid by calcination; its earth is then soluble in water, but in greater quantity in boiling than in cold water, for a part of it is precipitated by cooling.

The carbonate of strontian is lighter than carbonate of barytes: the specific gravity of the latter is from 42. to 43.000, that of the carbonate of strontian is only from 36. to 37.000. Analysis has proved, that 100 parts of the carbonate of strontian contain 62 parts of strontian, 30 parts of carbonic acid, and 8 parts of water. See STRONTIAN.

Zirconia is a simple earth, lately discovered by Klaproth, in the jargon of Ceylon, of which it is a constituent part, and even the most abundant; for it has been found by analysis, that 100 parts of the jargon of Ceylon contain 64 parts and a half of zirconia, 32 parts of silex, and two parts and a half of the oxide of iron. To obtain zirconia pure, it must be united to the muriatic acid, with which it forms a muriate of zirconia; this muriate must be dissolved in a large quantity of water, and the zirconia must be precipitated by potash: if it is carefully washed, and then brought to a red heat in a crucible, it will be perfectly pure. Calcined zirconia has a white colour. It is rough to the touch like silex; it has no taste, and is not soluble in water. Its specific gravity is at least 43.000; that of distilled water being 10.000.

When separated from its solutions by caustic alkalies, this earth retains a pretty large quantity of water, which gives it the semi-transparency of horn; it has then the appearance of gum-arabic, both by its slightly yellow colour and its fracture and transparency. It is susceptible of uniting with carbonic acid. It unites also with the sulphuric and nitrous acids: alkalies, and the first six primitive earths, separate it from the latter acid. It will not alone fuse by the blowpipe; but it fuses with the borate of soda, and gives a transparent colourless glass.

Yttria is also a newly discovered earth, and will be described under the article YTTRIA.

Glucina is a simple earth, lately discovered by Vauquelin, in the aigue-marine, called the occidental. It is a white granulated earth, which effervesces with acids. In 100 parts of this aigue-marine there are 14 of glucina. It is soluble in the carbonate of ammonia, as well as in the sulphuric acid. In the latter case, the solution has at first a saccharine, and afterwards an astringent taste. Its chrystals are sweet, like the solution. It has some resemblance to alumina; as it is soft to the touch, adheres to the tongue, is light, dissolves in potash, and is precipitated from its solution by ammonia. But it differs from alumina by its combinations with acids being exceedingly sweet, by giving no alum when mixed with sulphate of potash, by being entirely soluble in carbonate of ammonia, and by not being precipitated from its solutions by oxalate of potash and tartrite of potash, as alumina is.

It has been found by analysis, that 100 parts of earth contain 68 of silex, 15 of alumina, 14 of glucina, 2 of lime, and one of the oxide of iron.

Of Acids.—According to the theory of Lavoisier, all acids consist of a certain base, united to oxygen, which is considered as the cause of acidity. See ACID. We are already acquainted with the bases of the sulphuric, nitric, phosphoric, and arsenic acids; we know that hydrogen, carbon, and oxygen, form the bases of the vegetable acids; and that the same substances, in combination with nitrogen, constitute the animal acids, such as prussic, &c. But we are totally unacquainted with the bases of the muriatic, boracic, and fluoric acids. Acids are either solid, liquid, or gaseous. They excite a peculiar sensation on the palate, called sour. They change most of the blue vegetable colours red. Most of them unite to water in all proportions; and some have so strong an attraction for it, as to be incapable of appearing in the solid form.

All the acids combine with the alkalies. These combinations have been termed neutral salts. See ACID and ALKALI. These salts are easily formed by art; and nature exhibits a great number, especially of those which are formed by acids of simple radicals. Neutral salts are distinguished by two names; one expressing the acid, and the other the alkaline base. The first of these names may have two variations of termination, corresponding to two different states of the acid in the salt. The termination ate, is employed when the acid is one of those which are completely saturated with oxygen, and whose names end in ic; thus the salts compounded with the nitric acid, are called nitrates. Words terminating in ite, serve to distinguish the presence of those weak acids which are not fully saturated with oxygen, and which, when alone, have names ending in ous; thus, nitrites are salts compounded with nitrous acid. For the crystallization of salts, see CRYSTALLIZATION.

All metallic substances combine with at least some of the acids. But the alkalies and earths enter into the composition of neutral salts without any uniting medium; whereas the metals do not combine with acids, unless they have been first more or less oxygenated: we may therefore say, that the metals themselves are not soluble in acids, but only the metallic oxyds. When a metallic substance is put into an acid, the first requisite, in order that it may dissolve, is, that it become oxydated in it. For this purpose, it must take up oxygen, either from the acid, or from the water with which the acid is diluted; the oxygen then must have more affinity for the metal than it has either for the hydrogen or for the base of the acid; and consequently a decomposition, either of the water or of the acids, must take place.

On these observations the explanation of the principal phenomena of metallic solutions depend. In metallic solutions, an effervescence, or disengagement of gas, often takes place. The gas disengaged by nitric acid, is nitrous gas; that disengaged by sulphuric acid, is sulphurous acid gas, if it be this acid that has furnished the oxygen; but it is hydrogen gas, if the oxygen has been furnished by the water. Nitric acid and water being composed of substances which, taken separately, exist only in the state of gases, as soon as they are deprived of their oxygen, the other principle assumes the gaseous form. It is this rapid passage from the liquid to the gaseous state, that constitutes effervescence. The case is the same with the sulphuric acid.

In general, the metals do not take from these acids all their oxygen; they do not reduce the one to azote, and the other to sulphur, but to nitrous gas and sulphurous acid. Metallic substances dissolve without effervescence, when they have been previously oxidated; for in that case, the metal no longer has a tendency to decompose either the acid or the water. There is therefore no disengagement of gas, and consequently no effervescence.

No metal dissolves with effervescence in oxygenated muriatic acid. In this case, the metal takes from the acid its excess of oxygen; and the result is a metallic oxyd, and simple muriatic acid. There is no effervescence, because there is no disengagement of gas.

Metals which have very little affinity for oxygen, and which have not the power to decompose either the acid or the water, are insoluble in acids, unless they have been first oxydated. For this reason, silver, mercury, and lead, are not soluble in muriatic acid, when exposed to it in their metallic state; but if previously oxydated, they are exceedingly soluble, and the solution takes place without effervescence.

The following is a table of the acids hitherto known:

Mineral acids.	
Sulphurous,	Oxygenated muriatic,
Sulphuric,	Hyper-oxygenated muriatic,
Nitrous,	Carbonic,
Nitric,	Fluoric,
Muriatic,	Boracic,
	Mellitic.
Metallic acids.	
Arsenious,	Molybdic,
Arsenic,	Chromic,
Tungstic,	Columbic.
Vegetable acids.	
Acetic,	Benzoic,
Malic,	Camphoric,
Oxalic,	Gallic,

Citric,	Succinic,
Tartaric,	Suberic.

Animal acids.

Phosphorous,	Lactic,
Phosphoric,	Saccho-lactic,
Sebacic,	Prussic.
Laccic.	

Of sulphurous acid.—This is sulphur combined with oxygen, but not to saturation. It is the sulphurous acid gas when absorbed by water. The salts formed by the combination of this acid with different bases, are called sulphites; they are not employed for any useful purpose; they are converted into sulphates by heat.

Of sulphuric acid.—Sulphuric acid, formerly called spirit or oil of vitriol, is formed by the combination of sulphur, which is its base, and oxygen. It is obtained when the combustion of sulphur is carried on very slowly with access of atmospheric air; but it is produced with more facility by the addition of saltpetre, now called nitrate of potash, which furnishes oxygen abundantly, and enables the combustion to go on more rapidly.

In operations of this kind, on a large scale, the mixture of sulphur and saltpetre is burnt in large chambers, the sides of which are cased with plates of lead, and water is placed on the floor, to collect the sulphuric vapours. The water is afterwards put into large retorts, and distilled by a moderate heat; water slightly acid passes over, and concentrated sulphuric acid remains in the retort. This acid suffers congelation by intense cold; it is unctuous to the touch, attracts moisture from the atmosphere with great avidity, and, when mixed with water, produces a heat above that of boiling water. It acts rapidly on all inflammable substances, rendering them black, the acid itself becoming brown, or even blackish. It combines with nitrous acid, and forms a compound which dissolves silver, but scarcely any other metal.

Sulphates are neutral salts, formed by the sulphuric acid with certain bases. Thus, sulphate of potash, formerly called vitriolated tartar, is produced by the combination of the sulphuric acid and potash.

Sulphate of soda, formerly called Glauber's salt, is formed by the combination of soda with the sulphuric acid. It is found frequently in mineral waters. See SULPHUR.

Nitrous acid.—Nitrous acid exists in the state of gas, in the form of a red vapour; it is nitrous gas combined with a limited quantity of oxygen: it is rapidly absorbed by water, and, when combined with it, is of a yellow or orange colour. It emits copious orange-coloured or red fumes. Different quantities of water convert its colour to a deep blue, green, yellow, &c. while the vapours still continue of their original yellowish-red colour.

Liquid nitrous acid, generally called spirit of nitre in the shops, is only nitric acid (to be afterwards described), holding in solution a quantity of nitrous gas. If this nitrous acid is heated, the nitrous gas is disengaged, which coming into the air, attracts oxygen, and becomes nitrous acid gas, appearing in the form of red fumes, and the liquid is converted into colourless nitric acid.

The following is the process made use of for procuring nitrous acid: Take a quantity of sulphate of iron (martial vitriol), deprived of its water of crystallization by heat, and mix with it an equal weight of dry nitrate of potash; put the mixture into a glass retort, to which a very spacious receiver has been luted, containing a little water, and begin to distil with a very slow fire. As soon as the red vapours cease to come over, let the fire be slackened; and when the vessels are cooled, the receiver must be cautiously withdrawn, and its contents quickly transferred through a glass funnel into a bottle furnished with a ground stopper. It may also be obtained by decomposing nitrate of potash, by means of sulphuric acid, with the assistance of heat.

The nitrites are very little known.

Of nitric acid.—The constituent principles of this acid are oxygen and nitrogen (or azote). It differs from the last-mentioned acid, only in not having any nitrous gas in a loosely combined state. Oxygen and nitrogen with caloric, form nitrous gas, which, with a greater quantity of oxygen, forms nitric acid.

Nitric acid is transparent, liquid, and colourless; when diluted with water, it is sold in the shops by the name of aqua-fortis. It possesses in an eminent degree all the properties of acids. It is capable of oxydating all the metals, except gold and platina. It thickens and blackens oils, converting them to a coal, or inflaming them, according to the nature of the oil and the degree of concentration of the acid. It is procured by redistilling nitrous acid, or at least heating it till it is deprived of its fumes. The combinations of nitric acid with different bases, are called nitrates. These salts have the property of detonating with, or inflaming charcoal, and other easily inflammable bodies, at a red heat. It is upon this property that the composition of gunpowder is founded, which consists of five parts of nitrate of potash, one of charcoal, and one of sulphur.

Nitrate of potash, nitre, or saltpetre, is formed by the combination of the nitric acid with potash. It is produced spontaneously in various situations, sometimes effloresceing on the surface of the earth, and on the walls of old buildings. It may be artificially produced by the putrefaction of animal and vegetable substances; light earths, such as lime and marl, ashes, the refuse of soap-manufactures, &c. being stratified for this purpose with straw, dung, and putrifying animal and vegetable substances, and wetted with urine, blood, dunghill-water, and the mother-waters of saltpetre, turned, and exposed to a current of air. It is formed in these processes by the extrication of nitrogen, by the decomposition of the animal and vegetable substances, which combines with the oxygen of the atmosphere, forming nitric acid; and this, uniting with the alkali, which is separated at the same time from these substances, forms the nitrate of potash. See NITRE.

Nitrate of lime, formerly termed nitrous selenite, is found adhering to, and embodied in, calcareous stone, and dissolved in various mineral springs. It is formed near inhabited places, and is yielded by the lixiviation of old plaister, and by the mother-waters of saltpetre, as they are termed by the manufacturers. It may be frequently observed as an efflorescence upon old damp walls.

Of muriatic acid.—Muriatic acid, formerly termed marine acid, or acid of sea-salt, is supposed to consist of oxygen, in combination with a peculiar but hitherto unknown basis; for it has never yet been decomposed. It exists in the gaseous state, and forms muriatic acid gas, which has been considered already. This, absorbed by water, constitutes liquid muriatic acid. The muriatic acid is diffused in great abundance throughout the mineral kingdom, and is united chiefly with soda, lime, and magnesia; it is found with these three bases in sea-water, and in that of several lakes. In mines of rock-salt it is for the most part united with soda.

The muriatic acid does not adhere very strongly to the earths and alkalies. The sulphuric acid is capable of separating it from them; and it is by means of this acid that chemists obtain the muriatic.

Experiment. Put eight parts of purified muriate of soda, reduced to fine powder, into the retort A (fig. 28.), and five parts of sulphuric acid diluted with a small quantity of water. Adapt to the retort the matrass C, to receive the portion of impure sulphuric and muriatic acid which passes over towards the end of the operation. D, E, and F, are a series of bottles in which water is put, the quantity of which is equal to the weight of the salt employed. These bottles are furnished with safety-tubes, G G. The joinings must be well luted, and the heat gradually increased till nothing more can be disengaged. The muriatic acid will pass over in the state of gas, and unite itself in a large proportion with the water in the receiver. The water thus saturated is muriatic acid. It is a colourless fluid. It emits copious white fumes in contact with moist atmospheric air, which is muriatic acid gas, that escapes from it, and condenses again, by combining with the humidity of the air. Its combinations with earths, alkalies, and metals, form muriates.

Muriate of potash, the febrifuge salt of Sylvius, is formed by the combination of muriatic acid with potash. It is found in sea-water and old plaister. It has a strong bitter disagreeable taste.

Muriate of soda, marine salt, common salt, is formed by the combination of muriatic acid with soda. It is found native in mines, in many places, but particularly in Poland and Hungary. It is also obtained by extracting it from sea-water by evaporation, &c. It is always contaminated by a quantity of muriate of magnesia, muriate of lime, and sometimes by the sulphate of lime. It occasions clay to fuse readily, and is employed in glazing earthenware. It assists the fusion of glass also. It has a penetrating pleasant taste, decrepitates on hot coals, and by great heat is volatilized.

Muriate of ammonia, or sal ammoniac, is formed by the combination of the muriatic acid with ammonia, and is found native in many parts, particularly in the neighbourhood of volcanoes. It is obtained artificially by sublimation, from the soot formed by the combustion of the excrements of animals which feed on saline plants.

Muriate of lime is found in mineral waters, but particularly in the waters of the sea, to which it contributes to give their bitter taste. It speedily deliquesces. It fuses with a moderate heat, and by calcination becomes the phosphorus of Homberg.

Muriate of barytes is not known to exist native. The sulphuric and fluoric acid de-

compose it very readily; hence this salt is highly useful to detect the presence of these acids in any mixture.

Of oxygenated muriatic acid.—Oxygenated muriatic acid is muriatic acid with an excess of oxygen. By this, however, the acid properties of the muriatic acid are not increased, as is the case with other acids, but, on the contrary, diminished. In the state of gas, when absorbed by water, it forms liquid oxygenated muriatic acid, which, in a liquid form, is of a greenish-yellow colour. It has a bitter taste, and a very suffocating odour. Instead of reddening blue vegetable colours, it has the remarkable property of destroying them entirely. It thickens oils and animal fats, and renders them less disposed to combine with alkalies. It is readily obtained by the distillation of muriatic acid with substances containing much oxygen, such as the oxyds of metals, particularly the native oxyd of manganese.

When it is exposed to the light, oxygen gas is separated, and the acid is reduced to the state of ordinary muriatic acid. It removes the stain of common ink, though it does not affect printers' ink. It is therefore used for cleaning old books and prints. Half an ounce of minium being added to three ounces of muriatic acid, will render it fit for this purpose. The muriatic acid, taking oxygen from the minium, or red oxyd of lead, is converted into oxygenated muriatic acid.

Nitro-muriatic acid, called formerly aqua regia, is an acid analogous to oxygenated muriatic acid. It is produced by adding muriatic acid to nitric acid, in the proportion of one part of the former to two of the latter. During this combination an effervescence takes place, heat is set free, and oxygenated muriatic acid gas is evolved; the action may be assisted by the application of heat. The mixture becomes yellow. This acid has the property of dissolving gold and platina, which cannot be acted upon by any other acid; for the muriatic acid attracts part of the oxygen of the nitric acid, being thus converted partly into nitrous acid and partly into nitrous gas, whilst the muriatic acid becomes converted by this addition of oxygen into oxygenated muriatic acid, or nitro-muriatic acid. The same combination may be produced by mixing together oxygenated muriatic acid and nitrous gas. Oxygenated muriatic acid may be combined with a great number of the salifiable bases; the salts which it forms detonate with carbon and with several metallic substances. These detonations are exceedingly dangerous, because the oxygen entering into the muriatic acid, with a large quantity of caloric, its expansion gives rise to violent explosions.

Oxygenated muriate of potash is made by introducing the oxygenated muriatic gas into a solution of potash; its crystals, as well as those of the common muriate, being formed on evaporation in the dark. It gives a faint taste, with a sensation of coldness in the mouth; the crystals have somewhat of a silvery appearance, and emit light by attrition. It is decomposed by the action of light, parting with its oxygen, and becoming simple muriate of potash. Heat also separates its oxygen from it, in the form of oxygen gas, 100 grains yielding 75 cubic inches of oxygen gas. When three parts of oxygenated muriate of potash, and one of sulphur, are triturated in a mortar, the mixture detonates violently. The same effect is produced when the mixture is struck with a hammer on an anvil.

Phosphorus detonates with oxygenated muriate of potash with a prodigious force. Similar effects are produced with other inflammable substances, or with metallic bodies. The oxygenated muriate of potash increases the blackness of ink; and the colours of log-wood, weld, cochineal, and archil, are improved by it, if no heat is employed. When employed in the composition of gunpowder, instead of nitre, the effects produced by its ignition are augmented in a very great degree, and the mixture will explode by mere trituration.

In this and other salts formed in the same way, the acid gets a still greater dose of oxygen, and is denominated hyper-oxymuriatic acid; but it cannot be separately exhibited.

Of carbonic acid.—This acid, already noticed under carbonic acid gas, exists in the gaseous state; and in combination with different bases it constitutes carbonates.

Carbonate of potash, formerly called mild vegetable alkali, is made by exposing a solution of alkali to the carbonic acid gas until saturated. It has now less of the urinous taste, but still changes the blue colour of violets to a green. It does not attract moisture from the air, but rather parts with its water of crystallization. By exposure to heat it loses its acid, is rendered pure alkali, and is capable of uniting with silex, and forming glass. It is decomposed by quick-lime, and by all the acids.

Carbonate of soda was formerly termed mild mineral alkali. It is decomposed by quick-lime, by the acids, and by fire, in the same manner as the former carbonate.

Carbonate of ammonia, or concrete volatile alkali, may be obtained from many animal substances, but it is not found naturally. It is formed by the combination of carbonic acid with ammonia. When the muriate of ammonia is heated with carbonate of lime, the products are muriate of lime and carbonate of ammonia, which latter sublimes in a solid form.

Carbonate of lime, called also mild calcareous earth, chalk, &c. is formed by the combination of carbonic acid and lime. It has not been crystallized by art, although found variously crystallized in its native state. By intense heat the acid is disengaged, and pure lime remains. It is decomposed by almost all the acids, their superior degree of attraction for lime forming other calcareous salts, the carbonic acid escaping in a gaseous form, and occasioning effervescence.

Carbonate of barytes has no taste, is not altered in the air, is almost insoluble in water, but is decomposed by heat and by all the acids. It is poisonous.

Carbonate of magnesia, or the common magnesia of the shops, is obtained by precipitation from the sulphate of magnesia. It is soluble in water in the proportion of several grains to an ounce. It loses its water and acid by calcination, the residue being pure magnesia, sometimes called calcined magnesia. See CARBON.

Of fluoric acid.—The composition of this acid is unknown. In a gaseous state it forms fluoric acid gas; united to water, it constitutes liquid fluoric acid. It exists completely formed in fluate of lime, known under the name of fluor, or Derbyshire spar. It is combined in it with calcareous earth, forming an insoluble salt. To obtain this acid alone, and separated from its base, put fluor spar into a leaden retort, and pour over it sulphuric acid; adapt a leaden receiver to the retort, half-filled with water, and expose the retort to a gentle heat. The sulphuric acid seizes on the basis of the spar, and forms with it sulphate of lime; and the fluoric acid passes over in the state of gas, and is absorbed by the water in the receiver. If it is received in a mercurial apparatus, it will pass over in the state of gas.

The distinguishing property of the fluoric acid is its power of dissolving silex. Its odour resembles muriatic acid. When exposed to moist atmospheric air, it emits white fumes. Its action upon all inflammable substances is very feeble; it does not afford oxygen to them. It has no action upon most of the metals, but it dissolves many of their oxyds. It must be kept in well-closed leaden or tin bottles, or glass phials, coated within with wax or varnish. It is employed for etching on glass. See FLUOR.

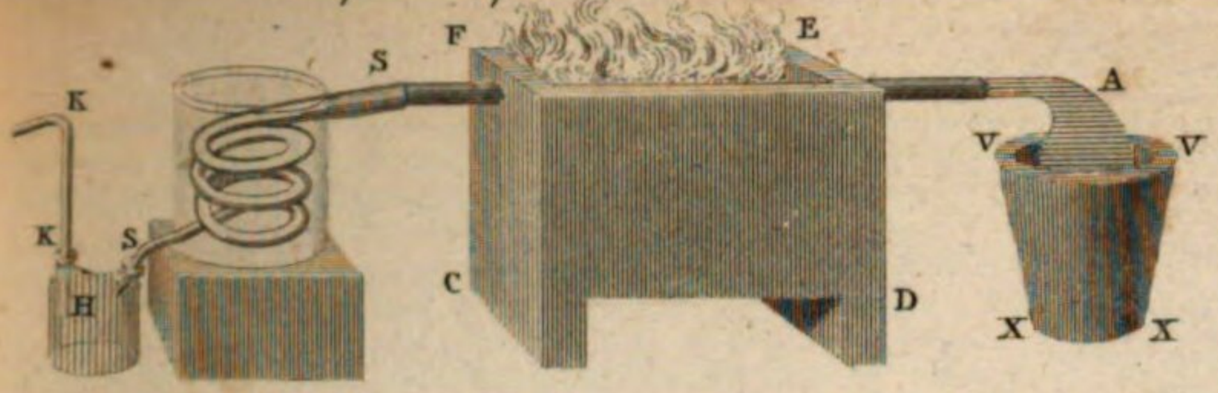
Of boracic acid.—The boracic acid, before known under the name of Homberg's sedative salt, is a concrete acid extracted from borax, a salt brought from India. Its base is unknown. It exists in brilliant, glittering, white scales, soft, and unctuous to the touch. Its taste is bitterish, with a slight acidity. When mixed with burning spirit of wine, it causes a green, surrounded with a white flame. To extract boracic acid from borax, the latter must be dissolved in boiling water; the liquor is then to be filtred while very warm, and sulphuric acid poured into it: this acid seizes on the soda of the borax; and the boracic acid, being separated, becomes free. By cooling it may be obtained under a crystallized form.

Borate of soda, or borax, is formed by the combination of the boracic acid with soda. It is found in a crystallized state at the bottom of certain salt-lakes, in a barren volcanic district of the kingdom of Thibet. A still purer kind comes from China. It is obtained in a pure state by a second crystallization, being previously calcined to destroy the greasy matter. When purified, it is white and transparent. It has a cooling taste, and renders the blue vegetable infusions green. Exposed to a moderate heat, it melts with its water of crystallization; and is reduced into a white opaque light mass, when it is commonly called calcined borax. It serves as a flux to vitrifiable earths; it also vitrifies clay, but less completely. It is employed in forming reducing fluxes; and it may also be used in producing the fusion of glass. In soldering metals, it is highly useful, cleansing the surface of the metal, and assisting the fusion of the solder. See BORAX.

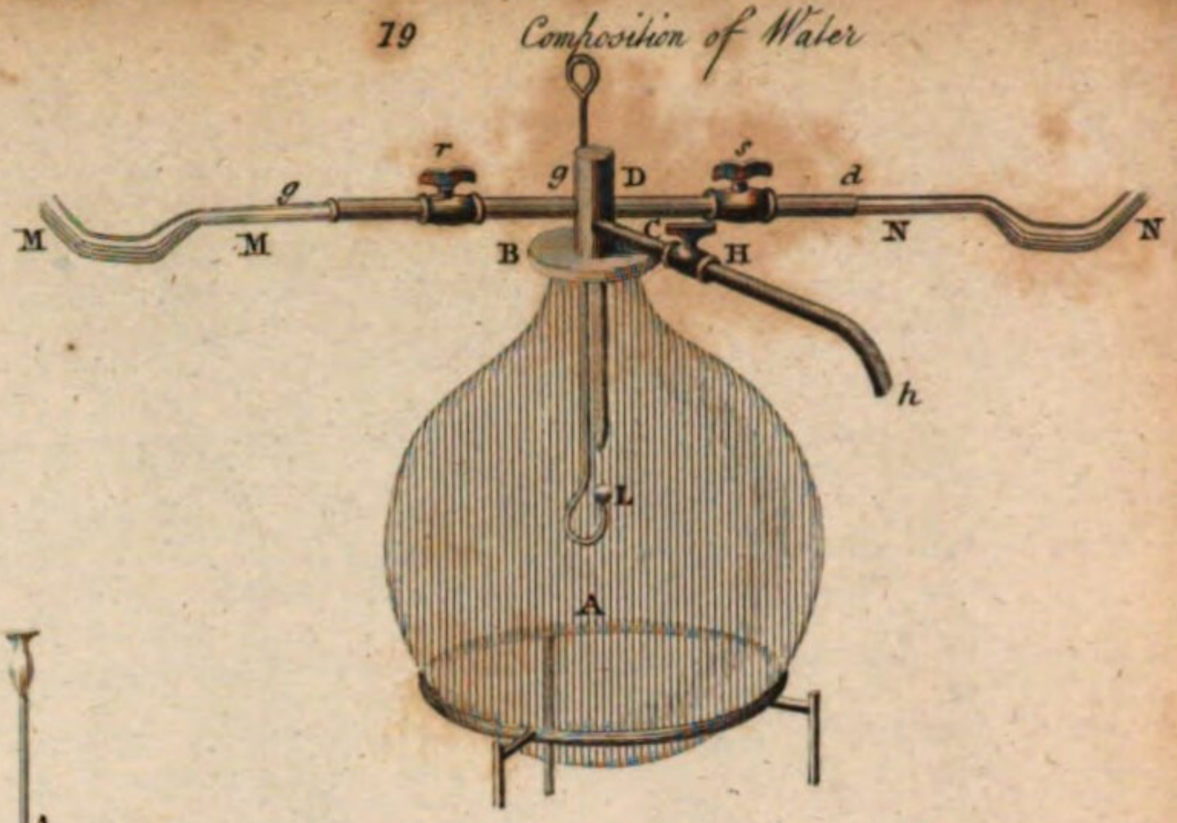
Of mellitic acid.—A yellow mineral somewhat resembling amber, found at Arten in Thuringen, has been found by Klaproth and Vauquelin to consist of alumina combined with a peculiar acid, which (from mellite the name of the mineral) is called the mellitic acid. It is crystallizable, soluble in water, decomposable by heat, and forms with the salifiable bases peculiar salts called mellats.

Of arsenious acid.—Formerly chemists were embarrassed with the nature of the poisonous substance known in commerce by the name of white arsenic. Experiments have shewn that this substance is the metal arsenic,

Decomposition of Water 18

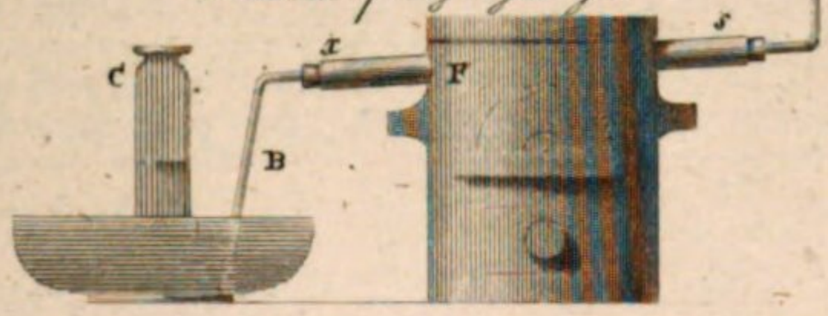


19 Composition of Water

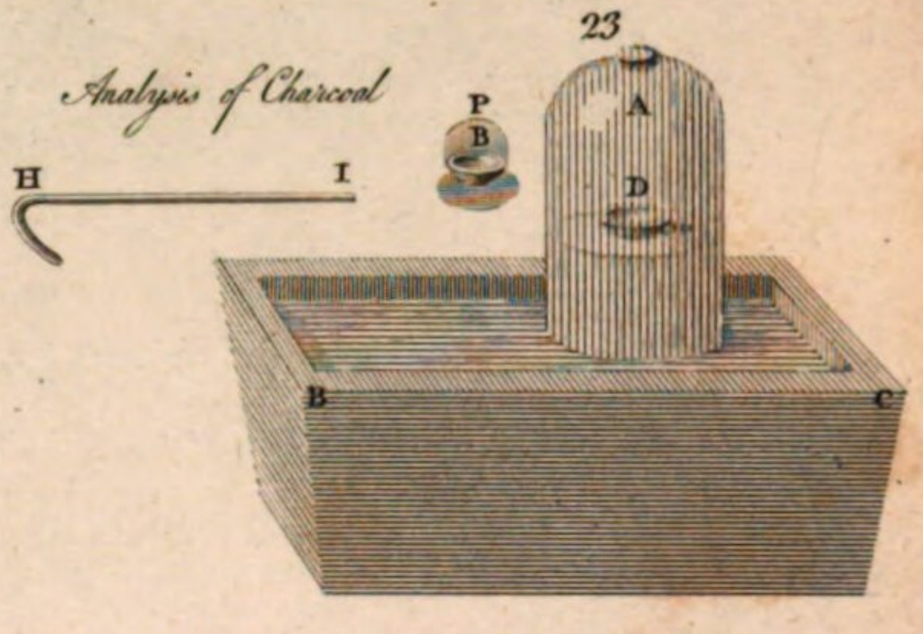


20 Combustion of Iron Wire

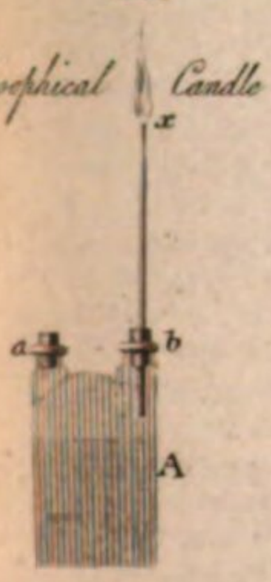
21 Production of Hydrogen Gas



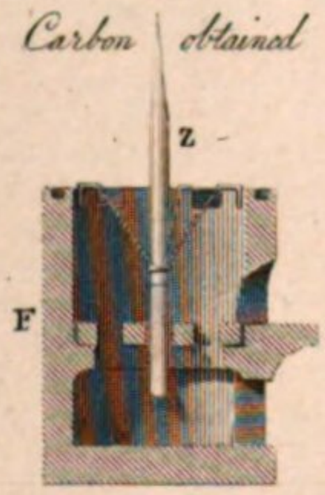
23 Analysis of Charcoal



22 Philosophical Candle

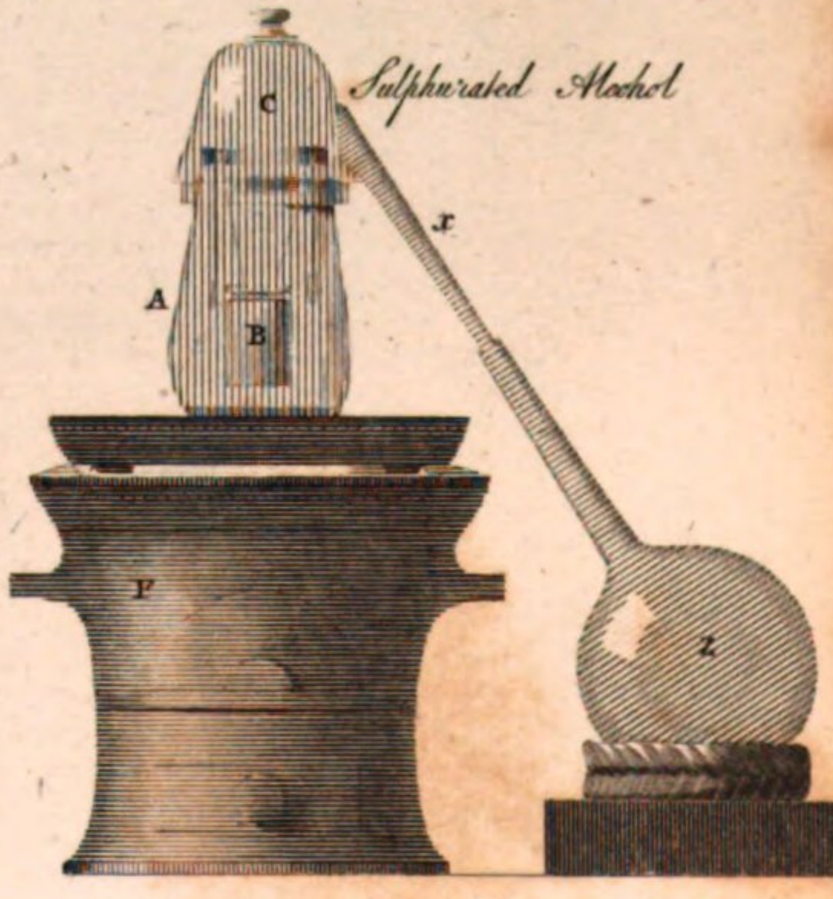


24 Carbon obtained

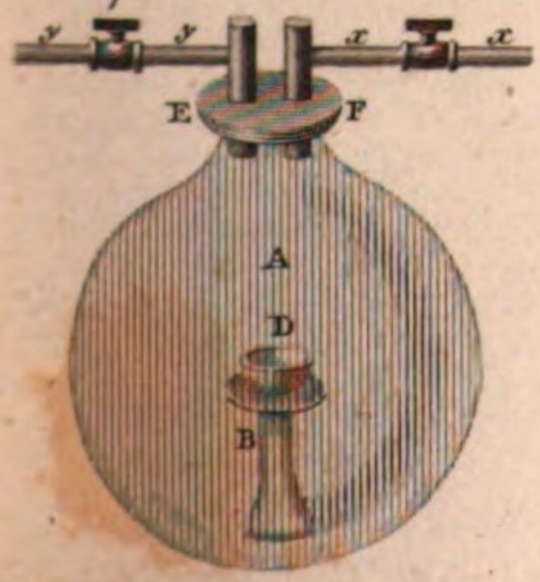


Sublimation 25

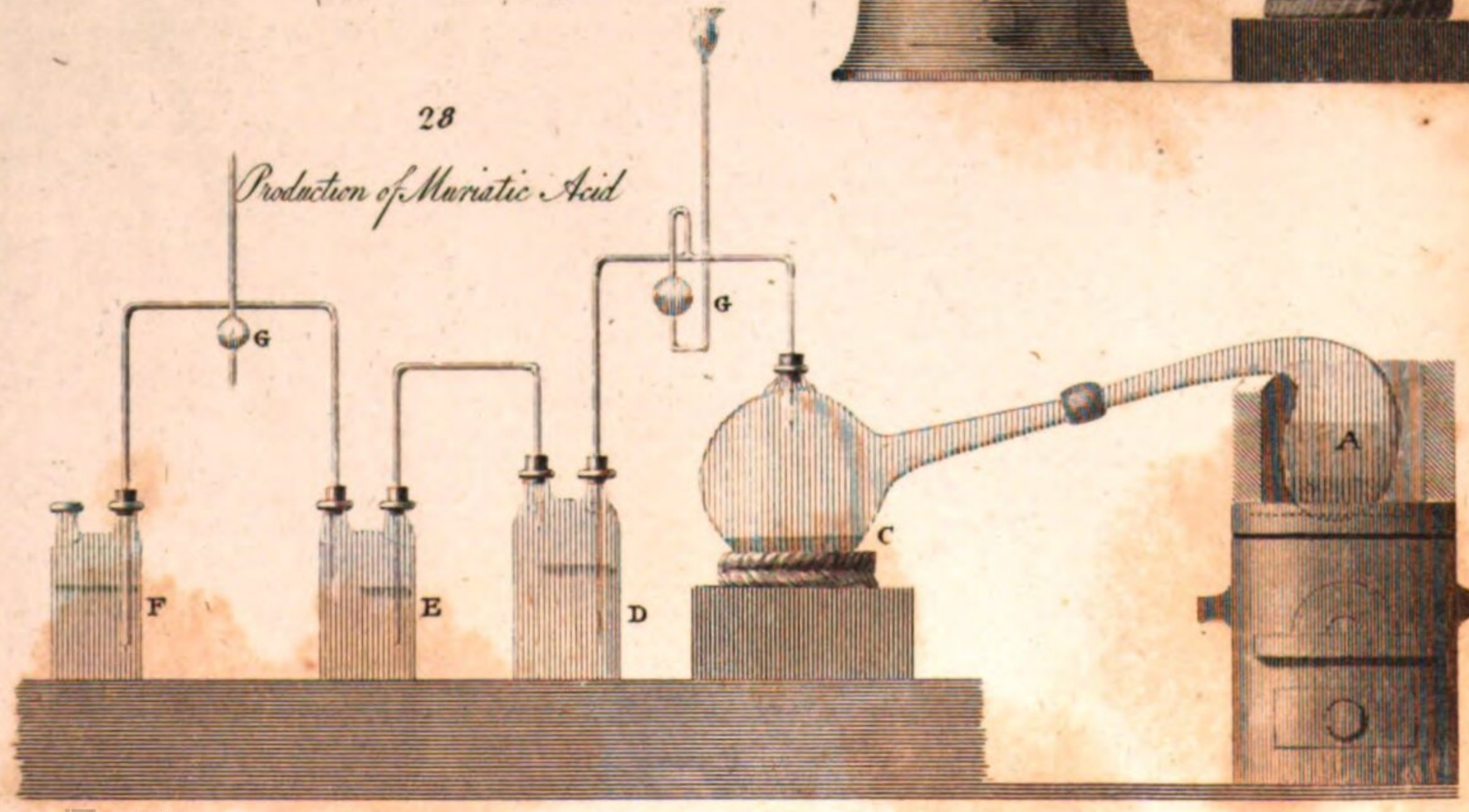
26 Sulphurated Alcohol



Phosphoric acid 27



28 Production of Muriatic Acid



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oxygenated in the first degree. It is therefore called arsenious acid. It possesses a weak acid taste; it sensibly reddens the tincture of litmus. If placed on burning coals, or on a red-hot iron, it is volatilized in the form of a white vapour, which has a strong smell resembling garlic. It is in a small degree soluble in water. The white arsenic of the shops is chiefly obtained from arsenical ores of cobalt. These are thrown into a furnace resembling a baker's oven, with a long flue, or chimney, into which the fumes pass, and are condensed into a greyish powder. This is refined by a second sublimation in close vessels, with a little alkali. As the heat is considerable, it melts the sublimed arsenic into opaque crystalline masses, which are known in commerce by the name of white arsenic.

Of arsenic acid.—Arsenic acid is produced only by art. It appears in the form of a white pulverulent matter. All the preparations of arsenic are deadly poison; the hydro-sulphurets are the best antidotes. A weak solution of hydro-sulphuret of potash, soda, or lime, is therefore often administered with success, if given in time, to persons who have been poisoned by arsenic. Sulphureous mineral waters may also be given. In such cases oil, milk, butter, &c. which are too often resorted to, should never be employed, if a sulphuret, or hydro-sulphuret, can possibly be procured.

Of tungstic acid.—This acid does not exist in an uncombined state in nature. It is procured from a mineral called tungsten, which is a combination of this acid with lime (tungstate of lime), or from wolfram, which is this acid united to iron and manganese. It appears in a pulverulent form, harsh to the touch. It is tasteless, and insoluble in water. It is not capable of turning blue vegetable colours red, until it has been first rendered soluble by ammonia. It is of a yellow colour, which becomes blue on being exposed to the light.

Of molybdic acid.—We are indebted to Mr. Hatchett for a thorough knowledge of the properties of this acid, and of all its combinations. It is molybdena oxygenated; for this metal is susceptible of oxygenation to such a degree as to become a concrete acid. It is soluble in about 570 parts of water. The solution reddens tincture of litmus. It is not applied to any use.

Of chromic acid.—This acid is very little known. In nature it is found combined with oxyd of lead, in the mineral called chromate of lead, or the red-lead of Siberia; also united to iron, alumina, and silex, in the substance called chromate of iron.

Of columbic acid.—This acid is as little known as the last. It is found in the newly discovered ore called columbium, or columbat of iron.

Of acetous acid.—This acid exists, mixed with other substances, in common vinegar. Since this acid is very volatile, it is obtained pure by distilling vinegar in a sand-heat. It is also called distilled vinegar, and is perfectly colourless, and of a pleasant sour taste and odour. Its base is carbon and hydrogen; the addition of oxygen forms acetous acid. The same principles form the bases of the other vegetable acids, but in different proportions.

The acetites of potash and soda, are obtained by neutralizing the carbonates of these alkalis with acetous acid, and evaporating and crystallizing the solution. It was formerly supposed, that when deprived of part of its carbon, it formed another state of the acid, which was called acetic acid: but it has been shewn by Gren, that there exists but one state of the acid, and what was called acetic acid differed only in the degree of concentration.

Of malic acid.—This acid is found in the juice of unripe apples and other fruits, and is procured by saturating the juice of apples with potash, and adding a solution of acetite of lead till it no longer occasions a precipitate; wash this precipitate, which is malate of lead; pour over it sulphuric acid until the liquor acquires an acid taste without any mixture of sweetness, and filtre the whole in order to separate the malic acid from the sulphate of lead which is formed.

Of oxalic acid.—Oxalic acid, formerly called the acid of sugar, is prepared from sugar by treating it with nitric acid. It has a stronger attraction for lime than any other acid. It is therefore employed to discover the presence of lime in any solution. It is always concrete. It forms with alkalis, earths, and metals, salts called oxalates.

Of citric acid.—Citric acid is found in the juice of lemons and oranges, unripe grapes, and other sour fruits. It crystallizes, and when concrete is not changed by the air. It dissolves in water, and has a very pleasant acid taste. It is used for a variety of purposes, and of late extensively in the art of calico-printing.

Of tartaric acid.—The tartar found adhering to casks in which wine has been fermented, is a salt composed of a peculiar acid combined with potash, but in such a manner, that the acid is in considerable excess. The salt is known under the name of acidulous tartrat of potash, and the acid which enters into its composition is the tartaric acid. This may be obtained by dissolving two pounds of crystals of tartar in water, and throwing in chalk by degrees, until the liquid is saturated. A precipitate forms, which is tartrite of lime. By adding nine ounces of sulphuric acid, and five ounces of water, to this tartrite, and digesting them together for twelve hours, the tartaric acid is set at liberty, and may be cleared from the sulphate of lime by means of cold water. The acidulous tartrat of potash, or cream of tartar, is formed from crude tartar, by solution, and subsequent filtration and evaporation. See TARTAR.

Of benzoic acid.—This acid is obtained by sublimation from the resin called benzoin, and exists in the balsam of Peru and that of Tolu, and some other substances of this kind. It is also found in urine, and many animal substances. See BENZOIN.

Of camphoric acid.—The camphoric acid is camphor oxygenated to acidity, by boiling it with nitric acid. This acid exists in the form of white crystals, which effloresce in the air. Its taste is acid and bitter. It reddens blue vegetables. See CAMPHOR.

Of gallic acid.—This acid is found in the gall-nuts, bark of trees, and in all those vegetables called astringents. Its taste is sour and astringent. It reddens vegetable blues. It crystallizes. It has a strong tendency to unite with metallic oxyds. It forms with the several metals precipitates of different colours. With gold, it forms a brown precipitate; with silver, grey; mercury, an orange; copper, a brown; lead, a white; and iron, a black precipitate. The base of ink is iron, thus precipitated; one pound of powdered nutgalls being infused for four hours, without boiling, in common water, with six ounces of gum-arabic, and six ounces of sulphate of iron, or green copperas, good black ink is produced. To obtain gallic acid, dissolve two ounces of common alum in water, and precipitate the solution by letting fall into it a solution of potash; wash the precipitate well, and transfer it into a decoction of gall-nuts (obtained by infusing one ounce of gall-nuts in sixteen of water, and evaporating the liquor to one-half), agitate the mixture frequently during the course of 24 hours, and then filtre it. The fluid which passes through the filtre is gallic acid; which may be obtained in the form of needle-shaped crystals, by evaporating it slowly till a pellicle appears, and then letting it stand undisturbed.

Of succinic acid.—This acid is obtained by distillation from amber, and is therefore called also acid of amber. It is very soluble in hot water, and crystallizes by cooling. See AMBER.

Suberic acid.—This acid is obtained by the action of nitric acid on cork. It reddens vegetable blues, and has the peculiar property of turning the blue solution of indigo in sulphuric acid to green.

Phosphorous acid.—When phosphorus is burnt slowly, and does not become completely saturated with oxygen, it forms an acid, called phosphorous acid. It is liquid, transparent, and of considerable density. It has an unpleasant taste, and emits a disagreeable odour when rubbed, and especially when warmed. It is more volatile than phosphoric acid.

Of phosphoric acid.—Phosphorus saturated with oxygen, forms phosphoric acid, which is capable of existing in a dry state. It dissolves in water, and affords a transparent fluid void of odour. When exposed to heat, it is rendered viscous, and by degrees becomes consistent, and loses its transparency. When urged by a violent heat, it melts into a transparent glass, which again attracts moisture when exposed to the air, and becomes converted into liquid phosphoric acid. When melted in an earthen crucible, it acts upon the crucible, and fuses into a glass, which is not soluble in water, and exhibits no signs of acidity. It has a strong attraction for all the alkalis and earths. This acid is obtained from bones, which are chiefly phosphate of lime. It may also be obtained by the rapid combustion of phosphorus in oxygen. See PHOSPHORUS.

Sebacic acid, called the acid of fat, is obtained from the fat of animals. It is concrete, and soluble in water. It is sour, and without odour.

Laccic acid has been discovered by Dr. Pearson, in a substance called white lac, formed by certain insects of the coccus tribe. By exposing this substance to such a degree of heat as was just sufficient to liquefy it, a fluid was obtained, to which the doctor has given the name of laccic acid.

Lactic acid is found in the whey of milk. It is concrete, and liquefies in the air. It is sour, and oxydates the metals.

Saccho-lactic acid, was discovered by

Scheele, who obtained it by treating sugar of milk with nitric acid. It is also obtained by treating gum-arabic with nitric acid.

Of prussic acid.—The prussic acid is formed by exposing the horns, hoofs, or dried blood of animals, with an equal quantity of fixed alkali, to a red heat. The alkali is found to be neutralised by the acid thus formed, and, on evaporation, will yield a salt in crystals, which is then called prussiate of potash or of soda, according to the alkali which has been employed. The prussiates of alkali precipitate all metals from their solution; the alkali uniting with the acid which holds the metal in solution, whilst the prussic acid unites with the metallic oxyd, and communicates to it a peculiar colour. Thus gold is precipitated of a yellow colour, lead of a white, copper of a brownish-red, and iron of a dark blue, forming a prussiate of iron, or the substance called Prussian blue. From this substance the prussic acid may be again separated, by digestion with pure alkali, the prussiate of alkali being again formed, and the iron left in the state of a brown oxyd. This acid has a sour taste and suffocating smell, but, except its capacity of combining with alkalis and metals, it manifests no conspicuous acid properties. It does not redden the most delicate vegetable blues.

For the remainder of the compounds formed by the acids with the salifiable bases, see the Tables.

Of metals.—Among the most useful substances in nature, are the metals. Many of the mechanic arts depend upon them; and without a knowledge of them, perhaps mankind would never have attained their present degree of civilization. Their use is still unknown to many nations inhabiting the numerous islands of the South Sea. They are seldom met with in the earth in a native or pure state, but generally in combination with oxygen, sulphur, arsenic, and the acids. In their different states of combination, they are said to be mineralized, and they are then called ores.

The ores of metals are generally found in mountainous countries, chiefly in crevices of rocks, forming veins of ore; which are distinguished into level, inclined, direct, or oblique, according to the angle they make with the horizon. The part of the rock resting on the vein, is called the roof, and that on which the vein rests, the bed of the vein. The cavities made in the earth, in order to extract these ores, are called mines. The metallic matter of ores is generally incrusted, and intermingled with some earthy substance, different from the rock in which the vein is situated, which is termed its matrix. This, however, ought not to be confounded with the mineralizing substance with which the metal is combined, such as sulphur, &c.

The art of distinguishing ores from each other, and the method of describing them with accuracy and precision, are called Mineralogy.

The art of assaying or analysing them, in order to ascertain the component parts, forms a branch of chemistry, called the Docimastic art. See ASSAYING.

To procure the pure metal from the ore, it is first cleared as much as possible from the foreign or stony substances with which it is blended, and which are called the gangue, by first reducing the ore to powder, in which state it is called slich, and then by washing. It is then torrified, or roasted, to dissipate the sulphur and arsenic; and lastly fused by the addition of some flux containing the coaly principle, to disengage the oxygen with which the metal has been impregnated during the previous calcination or torrefaction.

Metals are distinguished from all other bodies by a peculiar brilliancy, which is termed metallic lustre, and by their weight, or specific gravity; the heaviest fossil, not metallic, being lighter than the lightest metal. They are also distinguished by their malleability, or their property of being extended under the hammer, and their ductility, or the property of being drawn into wire: though these two qualities are not possessed by all the metals. They are fusible by a sufficient degree of heat, and when suffered to cool gradually, they crystallize into regular figures. (See CRYSTALLIZATION.) If continued in fusion, they lose their brilliancy, and become an opaque powder, or metallic oxyd, acquiring weight, and absorbing a certain portion of oxygen during the transition. This process was formerly called calcination; it is now called oxydation. The pure metal itself was formerly known by the name of regulus; as the regulus of tin, of gold, &c.

That metals are calcined or oxydated in consequence of their absorbing oxygen, is proved by this process taking place only when oxygen is present, and by their giving it out in exactly the same quantity and proportion on their reduction to their metallic state. They undergo this process also from the action of humidity. The water is decomposed, its hydrogen being dissipated, whilst its oxygen unites with the metal. They are soluble in acids, and are precipitated from them by alkalis. Some of the acids are decomposed during their combination with metals; their oxygen combining with the metal, forming a metallic oxyd, which is then dissolved by the remainder of the acid, and forms a metallic salt.

When perfectly fused, they are for the most part miscible, or combinable with each other, or with unmetallic substances, as sulphur, phosphorus, and charcoal If urged by a stronger heat, they are converted into a vitriform substance, or metallic glass. These metallic glasses, as well as the oxyds, possess other properties than their reguli. They are of different colours: and the metallic oxyds tinge the earthy and saline glasses with which they vitrify, with various colours conformably to the difference of their own nature. They do this frequently, even when added in but small quantity. Such metallic oxyds as do not themselves yield a transparent glass, may deprive another of its transparency if fused with it. On the combination of other glasses with the metallic ones, and on the colouring of the first by means of the latter, depends the preparation of artificial gems and glass pastes, the pigments for enamel and porcelain-painting, the enamel itself, and the glazings for earthenware.

The operation by which metallic glasses and oxyds are restored to the reguline form, is called the reduction or reviving of metals.

In their reduction from the oxyds and glasses, the addition of a combustible substance is always necessary; charcoal, for instance, or such matters as contain carbon; as soap, pitch, resin, fat, and oil. In the smelting-works, the fuel itself is employed as a means of reduction, by fusing the metal interspersed among the coals. Some metals, as iron and platinum, grow soft before they fuse, and on this depends their very useful property of being welded.

Metals are the best conductors of electricity and galvanism.

Of platinum.—Platinum is found only in a metallic form in small grains. It was unknown in Europe before the year 1748. It is brought from South America. It is the heaviest, hardest, and most infusible, of all the metals. It is ductile, and may be hammered into plates, or drawn into wire. It may be welded together in a white heat, is unalterable in the air, and is on this account found a very valuable material for making specula, or reflecting mirrors for telescopes. No acid acts upon it, except the nitro-muriatic. It is of a white colour, between that of silver and tin.

The process which is generally used for obtaining malleable platinum, is as follows: Triturate common platinum (which is generally in grains) with water, to wash off every contaminating matter that water can carry away. Mix the platinum with about one-fifth part white arsenic, and one fifteenth part potash, putting the whole into a proper crucible in the following manner: having well heated the crucible, put in one-third of the mixture; apply to this a strong heat, and add one-third more; after a renewed application of heat, throw in the last portion. After a thorough fusion of the whole, cool and break the mass. Fuse it a second time, and if necessary, even a third time, till it comes to be magnetic. Break it into small pieces, and melt those pieces in separate crucibles; and in portions of a pound and a half of the platinum to each crucible, with an equal quantity of arsenious acid, and half a pound of potash. After cooling the contents of the different crucibles in an horizontal position, in order to have them throughout of equal thickness, heat them under a mufle, to volatilize the arsenious acid; and keep them in this state without increase of heat, for the space of six hours. Heat them next in common oil, till the oil shall have evaporated to dryness. Then immerse them in nitric acid, boil them in water, heat them to redness in a crucible, and hammer them into a dense mass. They are now fit to be heated in a naked fire, and hammered into bars for use. Platinum is generally mixed with iron, and therefore it is magnetic. It forms alloys with most of the metals. That with copper is the most useful; it takes a fine polish, and does not tarnish. See PLATINUM.

Of gold.—Gold is always found in nature in a metallic state. It is generally met with in grains, called gold-dust, mixed with the sand of rivers; being carried away by them, from the rocks and mountains, where it is found in leaves or ramifications, adhering to quartz, and other stones. It is found chiefly in Africa and Hungary; and some has been discovered lately in the county of Wicklow, in Ireland, where the largest piece of native gold hitherto seen was found. Its weight was 22 ounces, and it was almost pure. Small quantities of gold have been found in a vast variety of substances. Indeed, in very minute quanti-

ties it is frequently met with; and from this circumstance, and from its being found after chemical processes where none was ever expected, many of the supposed formations of gold by the alchymists have taken their origin. It has been obtained from rotten manure, garden-mould, uncultivated earth, and from vegetables.

It is of a rich yellow colour; and is the heaviest of the metals, except platinum. It is not very hard when pure. It is the most ductile of all the metals. Gold-leaf transmits light of a lively green colour; but silver, copper, and all the rest of the metals which can be formed into leaves, are perfectly opaque, being much thicker. Gold melts at 32 degrees of Wedgewood's pyrometer, and is volatilized by an intense heat, such as that of a mirror or lens. It cannot be oxydated by any heat of a furnace, but may by electricity and galvanism.

Gold is not acted upon by any acid, except the oxygenated muriatic, or nitro-muriatic acids, which latter was called from this aqua regia, because gold was named by the alchymists the king of the metals. This solution of gold, called nitro-muriate of gold, yields by evaporation crystals of a beautiful yellow colour, which, when dissolved in water, tinge the skin indelibly of a deep purple. When precipitated from this solution by tin, it forms the purple precipitate of Cassius, so much used in enamelling. This consists of an oxyd of gold, mixed with an oxyd of tin. If, into a solution of gold, a piece of charcoal is put, and exposed to the sun's rays, the gold will be revived, and appear in a metallic state on the charcoal, forming a kind of gilding.

Gold may be taken from its solution by æther, which then retains it in solution, forming an æthereal solution of gold. If any substance is dipped in the nitro-muriate of gold, and then exposed to a stream of hydrogen gas, the gold will be reduced, and the substance covered with it. When ammonia is added to a solution of gold, a yellow precipitate is formed, called fulminating gold, because it has the property of exploding when exposed to heat.

Gold is precipitated from its solution in a metallic state by green sulphate of iron. Gold easily alloys with mercury, which is therefore employed for the purpose of extracting it from the substances with which it is mixed. The mercury, being more volatile, is driven off by heat, and the gold remains free. With silver it forms an alloy of considerable ductility. Copper heightens its colour, and renders it harder without much impairing its ductility. Tin and lead considerably impair its tenacity. With platinum it forms an alloy which is very ductile. With zinc it affords a brittle and hard mixture, susceptible of polish. It unites well with iron, and hardens it remarkably.

On account of its peculiar property of not tarnishing in the air, it is much used for defending other metals; and on account of its beautiful lustre, it is much employed in ornaments. See GOLD.

Of silver.—Silver is often found native, and also combined with lead, copper, mercury, cobalt, sulphur, arsenic, &c. When found in the metallic state, it appears in grains or leaves, adhering to various substances. It is found in the greatest quantities in Peru and Mexico; but there are silver-mines in many other countries. When pure it is of a very brilliant white. It is malleable, ductile, and laminable, in a great degree, though inferior to gold in these qualities. It may be beaten out into leaves, which are only $\frac{1}{160000}$ part of an inch in thickness. It melts at 28 degrees of Wedgewood's pyrometer, and is volatilized in very high temperatures. It does not tarnish in the air, except when sulphureous vapours are present. It forms alloys with most of the metals. With gold it forms a metal of a greenish colour, called green gold. Copper makes it much harder, without lessening its ductility. It forms an amalgam with mercury. The alloy of British coinage is fifteen parts of fine silver and one of copper. It unites to phosphorus and sulphur, forming phosphuret and sulphuret of silver.

Silver is acted upon by the sulphuric and nitric, but not by the muriatic acid. With the nitric acid it forms a colourless solution, which stains animal and vegetable substances with an indelible black colour: hence it is used as a permanent ink, and is employed for dying human hair black; though, for this purpose, it should be used with great caution, and much diluted, as it is extremely caustic or corrosive. It is also employed for marking linen. Nitric acid dissolves more than half its weight of silver, the solution depositing crystals. When these are fused by a gentle heat, they lose some of the acid, and being poured into moulds, form the substance called lunar caustic (nitrate of silver), used in surgery.

Nitrate of silver, prepared with common silver, is greenish, but this is on account of the copper usually mixed with the silver. Silver is precipitated from its solution in nitric acid, by muriatic acid, in the form of a white curd; which, when fused, forms a semi-transparent mass of the consistence of horn, called horn silver, but more properly muriate of silver. It soon blackens in the air, and is very little soluble in water. Since the muriatic acid has a strong affinity for the oxyd of silver, and since the muriate of silver is not very soluble in water, the nitrate of silver is employed as a re-agent, to discover the presence of muriatic acid in any liquid; for if it contains that acid, muriate of silver will fall down in a white cloud, on dropping nitrate of silver into it.

The nitric acid sold in the shops is usually adulterated with muriatic or sulphuric acid, or with both: hence the nitrate of silver is used to free the nitric from the two latter acids. For this purpose nitrate of silver is poured into it by degrees, until no more precipitate is produced; after which it is rendered clear by filtring. Nitric acid thus purified is called by artists precipitated aqua-fortis; but it still contains some silver, from which it cannot be freed, except by distillation.

When precipitated from nitrate of silver by ammonia, it forms fulminating silver; a very dangerous preparation, for it explodes by the mere contact of any body. More than a grain cannot be exploded at a time with any safety. When mercury is added to the nitric solution of silver, a precipitation of the silver is formed, resembling vegetation in appearance, called arbor Dianæ, or the tree of Diana. See ARGENTUM ARBORESCENS. If a few drops of the nitrate of silver are put upon a piece of glass, and a copper wire placed in it, a beautiful precipitation of the silver will take place, in the form of a plant. The affinity of silver for other metals, and its solution in acids, are the properties on which PLATING, SILVERING depend. See SILVER.

Of mercury.—Mercury, called also quicksilver, always appears in a liquid state, in the common temperature of the atmosphere; but in intense cold, as at 40 below zero, it becomes solid, and is then malleable, resembling silver. It is found in nature, sometimes in a pure state, but chiefly united to sulphur, when it forms cinnabar; and sometimes to silver. It is also united to the acids, and to oxygen. It is mostly found in Spain and South America. Like other fluids, it boils, and is converted into vapour. This process is employed to separate it from other substances. It is acted upon by most of the acids. It combines with sulphur and phosphorus; and forms alloys with most of the metals, which are then called amalgams. On this property depend some of the methods of gilding and of silvering mirrors. When acted upon by heat and air for a long time, it absorbs oxygen, and is converted into a real oxyde, called precipitate per se, or red oxyd of mercury. When the heat is increased, this oxyd gives out its oxygen, the mercury reassuming its metallic appearance. When agitated long in air, mercury is converted into a black oxyd.

The sulphuric acid acts on mercury, if assisted by heat; sulphureous acid gas is then disengaged, and a white oxyd is formed. Hot water being poured on this, it becomes a yellow oxyd, called turbith mineral, the water holding in solution sulphate of mercury. The nitric acid dissolves mercury, even without heat, nitrous gas being disengaged; one part of the acid oxydates the metal, whilst the other dissolves the oxyd.

The nitrate of mercury is corrosive. When dry, it detonates upon coals. By a moderate heat it yields oxygen, or nitrogen gas; the remaining oxyd becoming yellow, and at length a lively red, being the red precipitate of mercury; and if fresh nitric acid is distilled from it three or four times, it appears in small crystals, of a very superb red colour. The muriatic acid does not sensibly act on mercury, except by long digestion; when it oxydates a part, which oxyd it dissolves. It completely dissolves the mercurial oxyds; and when these have a small quantity of oxygen, and are nearly in a metallic state, the muriate of mercury is formed. When, on the contrary, it is saturated with oxygen, the oxy-muriate of mercury, or corrosive sublimate of mercury, is formed.

To obtain the mild muriate of mercury, mercurius dulcis, or calomel, equal parts of quicksilver and of oxygenated muriate are completely blended by trituration, and exposed to sublimation. A beautiful artificial cinnabar may be prepared, by triturating mercury and flowers of sulphur with a solution of caustic vegetable alkali, keeping it at a proper temperature, and afterwards washing it repeatedly with boiling water. See MERCURY.

Of copper.—Copper is found native, but in very small quantities. It is generally met with in the state of an oxyd, or united to acids and sulphur. There are many copper-mines in Britain, Germany, &c. The largest cop-

per-mine perhaps known, is that at the Paris mountain, in the isle of Anglesea.

Pure copper is of a red colour, very tenacious, ductile, and malleable. It melts at 27 degrees of Wedgewood's pyrometer, and burns with a green flame. When heated in contact with air, it is changed into a blackish red oxyd, which by a more violent heat is converted into a brown glass. The nitric acid dissolves copper with effervescence, and the solution has a blue colour. The acid first oxydates the metal; a large quantity of nitrous gas is then disengaged, and the copper afterwards dissolves. This is nitrate of copper. The sulphuric acid does not dissolve copper, unless when concentrated; and very fine blue crystals, known under the name of sulphate of copper, are the result. This is what is commonly called blue vitriol. The muriatic acid does not dissolve copper, but when concentrated, and in a state of ebullition; the solution is green, the taste of which is caustic, and exceedingly astringent. The acetous acid, in a sufficient degree of concentration, dissolves copper; but when not sufficiently concentrated, it only imperfectly oxydates it, forming verdigris; which, being dissolved in vinegar, forms crystallised acetite of copper, known under the name of distilled verdigris. Iron precipitates copper from its solution. For this purpose nothing is necessary but to immerse the iron in the solution; the acid seizes on the iron, and abandons the copper. The copper thus precipitated is called copper of cementation. This process is employed for obtaining the copper found in water near mines of copper.

Copper may be alloyed with most of the metals. As an alloy of silver it renders it more fusible: this mixture is employed as a solder for silver plate. Copper, when alloyed with tin, forms bronze, a metal used for making bells, cannon, statues, &c. When alloyed by cementation with the oxyd of zinc, called calamine, it forms brass. With arsenic it forms white tombac. The salts formed with copper have a poisonous quality. It is employed for making kitchen-utensils, but very improperly; for as these vessels are liable to be corroded by the salts and acids used in culinary preparations, they often become dangerous, and may thus make us swallow slow poison. Kitchen-utensils of tinned iron are far preferable, because iron possesses no quality injurious to health. See COPPER.

Of iron.—No metal is so universally diffused throughout nature as iron. It is found in animals, in vegetables, and in almost all bodies. It is the most useful of all metals, as well as the most plentiful, otherwise it probably would be also the dearest. It is seldom found native, but combined with a great variety of substances, and it is particularly distinguished by its magnetical properties. It is the hardest and most elastic of the metals. It is very ductile, and possesses the property of being welded. It is very difficult to fuse.

Exposed to the action of water, iron soon rusts or oxydates. It attracts the oxygen and carbonic acid, and is changed into a brown substance, which is a mixture of oxyd of iron and carbonate of iron. Iron-filings agitated in water become oxydated, and assume the form of a black powder called martial ethiops. When iron ore is fused in large furnaces, it is made to flow into a kind of mould formed in sand. This first product, which is exceedingly brittle, and not at all malleable, is called cast iron. In this state, by pouring it into different kinds of moulds, it is formed into stoves, pipes, cannon, and other articles.

Cast or crude iron contains carbon and oxygen. The presence of the former appears from its coating the utensils employed in its fusion with plumbago or black-lead, which contains nine-tenths of carbon, and one of iron. Crude iron is in three states, white, grey, or black, according as it contains a larger proportion of carbon, an exact proportion of carbon and oxygen, or a larger proportion of oxygen. To render the iron malleable, it must be freed from the carbon and oxygen which it contains. For this purpose it is fused; and kept in that state for some time, stirring and kneading it all the while; by this the carbon and oxygen unite, and are expelled in the form of carbonic acid gas. It is then subjected to the action of large hammers, or to the pressure of rollers, by which the remaining oxyd of iron and other impurities are forced out. The iron is now no longer crystallized or granular in its texture; it is fibrous, and ductile, and is in a purer state, though far from being absolutely pure. It is capable of being welded and worked by hammers into any form. It is now called forged or wrought iron.

There are several varieties of iron in this state, arising from the intermixture of other substances. There is one kind of forged iron, which when cold is ductile, but when heated is extremely brittle. It is also fusible. This is termed hot-short-iron. Cold short-iron possesses precisely the opposite properties, being highly ductile while hot, but when cold extremely brittle. The causes of these peculiarities have not been perfectly explained. Iron is capable of being reduced to a third state, which is that of steel. It is converted into steel by exposing it to heat in contact with carbonaceous substances, which unite themselves with it. Thus we have three states in which iron may exist, viz. cast iron, forged iron, and steel.

Cast iron contains too great a quantity of carbonaceous substance: it may be called steel too much steelified; it is therefore exceedingly brittle, and not at all malleable.

Forged iron is iron purified from all foreign substances.

Steel is formed by bedding in charcoal, in a close furnace, alternate layers of malleable iron and charcoal, and exposing them to a strong fire for six or eight days. This process is called cementation. During this operation, the iron combines with a quantity of carbon, and is converted into blistered steel. This is either rendered more perfect and malleable by subjecting it to the operation of the hammer; or is fused, and cast into small bars, forming cast steel. Those kinds of cast iron which contain but little oxygen, may be converted into a sort of steel by a similar process. In this process, the iron gains an increase of weight by the carbon it has acquired.

Steel holds a middle rank between cast and forged, or malleable iron. It is composed of very small grains, and when hot, possesses a considerable degree of malleability. It is specifically heavier than forged iron. It is denser than forged iron, but it is not harder To communicate to it the necessary hardness, it must be tempered; that is, after being exposed to a greater or less degree of heat, according to the required degree of hardness, it must be suddenly cooled by immersion in cold water. Tempering renders it harder, more elastic, and more brittle. It may be made so hard as to scratch glass. Steel, thus hardened, may have its softness and ductility restored by again heating, and suffering it to cool slowly. A polished bit of steel, when heated with access of air, acquires very beautiful colours. It first becomes of a pale yellow, then of a deeper yellow, next reddish, then deep blue, and at last bright blue. At this period it becomes red-hot, and the colours disappear; at the same time that the metallic scales, or the black imperfect oxyd of iron which is formed, incrust its surface. All these different shades of colour indicate the different tempers the steel has acquired by the increase of heat. Artists have availed themselves of this property, to give to surgical and other sharp instruments those degrees of temper, which their various uses require. Tempered steel is more elastic, and harder, than iron.

Wootz, a metal brought from the East Indies, was examined by Dr. Pearson, who discovered that it was iron united to carbon, and also to oxygen. Iron combines with sulphur and phosphorus, forming sulphuret and phosphuret of iron. It combines also with most of the metals; but it was supposed till lately, that it could not be amalgamated with mercury. Mr. Arthur Aikin has, however, contrived a method of effecting this. Where iron is united to oxygen in the proportion of 73 parts of iron to 27 of oxygen, it forms the black or green oxyd of iron, which may be obtained by bringing a bar of iron to a red heat, and subjecting it to the hammer; the scales which fly off, are the black oxyd of iron. This oxyd is attracted by the magnet, and if exposed to a white heat in a crucible, will absorb 21 parts more of oxygen; and is then converted into the red or brown oxyde of iron, and will not be affected by the magnet.

Iron does not combine with oxygen, in more than these two proportions. Iron is acted upon by all the acids. The nitric acid is rapidly decomposed by iron. A portion of the oxygen of the acid oxydates the iron, which then dissolves, and the remainder of the acid passes off in nitrous gas. Sulphuric acid diluted with water being poured on iron, a considerable effervescence takes place, in consequence of the disengagement of the hydrogen gas of the water; its oxygen effecting the oxydation of the metal, while the acid dissolves the metal without being decomposed. This solution yields by evaporation the sulphate of iron. Common copperas is this salt in an impure state. See IRON.

Of lead.—This metal is scarcely ever found in the native state. It is chiefly mineralized by sulphur, and is then called galena. The pure metal is of a greenish colour. When cut it is bright, but soon tarnishes in the air. It may be easily cut with a knife, and it soils the fingers when rubbed. It has little or no elasticity. It fuses at 540 degrees Fahrenheit. When exposed to heat with access of air it fuses, and is oxydated at the surface.

If this oxyd is removed, more is formed, and thus the whole may be converted into grey oxyd of lead, which when exposed to a strong heat, is converted into a yellow oxyd, called massicot. If this yellow oxyd is exposed to a still more violent heat, it assumes a beautiful red colour, and becomes red lead, or minium. Litharge is a semi-vitrified oxyd of lead, obtained by keeping a stream of air upon fused lead: it is generally procured in the process of separating silver from lead. If litharge is exposed to a strong heat, it becomes converted into glass of lead, which forms the basis of the common glazing for earthenware. Lead combines with sulphur and phosphorus. Nitric acid converts lead into a white oxyd. Sulphuric acid in a state of ebullition oxydates, by means of a portion of its oxygen, a considerable part of the lead exposed to its action; another part of the lead is dissolved and forms sulphate of lead. Muriatic acid poured over lead, and assisted by heat, oxydates one part of it, and dissolves another. The affinity of muriatic acid for the oxyds of lead is so great, that the latter decompose all the combinations of this acid. They decompose the muriate of soda, the muriate of ammonia, &c. and form muriate of lead, or patent yellow. The acetous acid corrodes lead, and the result is a white oxyd, known under the name of white lead. All the oxyds of lead are soluble in vinegar, and form acetat of lead, known under the name of sugar of lead.

Lead is applied to a great variety of uses in the arts. It is employed for making water-pipes, for lining boxes, for covering houses, for musket-bullets and small shot, and various other purposes. It is sometimes mixed with the metal employed for tinning utensils of copper: this practice is highly dangerous, and deserves the severest reprehension and punishment. Lead forms alloys with other metals, which are used as solders.

Of tin.—Tin is scarcely ever found native. It is generally combined with sulphur, iron, and other substances. It is of a colour approaching to that of silver, but somewhat duller. Next to lead, it is the softest, and the least elastic of all the metals. In tenacity it is superior only to lead; though not very ductile, it may be reduced to very thin leaves. It is less sonorous than copper, silver, or iron. Except cast iron, it is the lightest of all metals. It fuses with less heat than any of the other metals, and is a long time before it becomes red. It may be easily bent, and in that case emits a kind of crackling noise; it is the only metal which possesses this property.

When tin has been kept some time in a state of fusion, and is then exposed to the action of the air, its surface becomes wrinkled, and covered with a grey pellicle, which is oxyd of tin. If this first stratum is removed, the tin appears below in all its brilliancy; but it soon loses its splendour, and its surface is again oxydated. By continuing to expose it to heat, you may at length oxydate the whole of it. This oxyd is what is called putty of tin, used for polishing mirrors, lenses, &c. and for rendering glass white and opaque, converting it into enamel.

Tin is soluble in sulphuric acid. With muriatic acid it forms muriate of tin, of great use in dyeing. Tin when fused detonates with nitrate of potash, and also with oxygenated muriate of potash when struck with a hammer. Tin combined with sulphur forms aurum musivum, used by the japanners. It alloys with other metals, forming solder. With lead and antimony it constitutes pewter, used for various domestic vessels. With mercury it is employed for silvering mirrors. See TIN.

Of zinc.—This metal is mostly procured from calamine, which is a sort of oxyd of zinc. When it is mineralized by sulphur it is called blende. It is nearly of the colour of tin. It is scarcely at all ductile. Zinc, when exposed to heat, soon enters into fusion, and long before it becomes red; the degree of heat which is required for this purpose, being only a very little higher than that necessary to fuse lead: when brought to a red heat it burns with a blue flame, and throws out white flakes, called flowers of zinc.

The nitric acid, even when diluted with water, dissolves zinc with violence, and forms a nitrate of zinc. The sulphuric acid diluted with water dissolves zinc rapidly; in this the water is decomposed, and a great deal of hydrogen gas escapes. By evaporation may be obtained sulphate of zinc, or white vitriol in crystals. The muriatic acid dissolves zinc with effervescence; and hydrogen gas is produced in the same manner as with the sulphuric acid; afterwards there is a precipitation of black flakes, which is muriate of zinc. One part of zinc alloyed with three parts of copper, forms the metal called brass. See ZINC.

Antimony.—Antimony is rarely found native. It is generally combined with sulphur, forming sulphuret of antimony. It is of a whitish colour, and so brittle that it readily breaks under the hammer. Its interior texture appears to be laminated. It volatilizes entirely in the fire, and communicates the same property to metals with which it is mixed. It fuses at a degree of heat somewhat higher than that necessary to fuse zinc. If kept in fusion it oxydates, and is converted into grey oxyd of antimony. If the heat is increased, this is converted into white oxyd of antimony, known under the name of flowers of antimony. This oxyd is vitrifiable, and then becomes glass of antimony.

Antimony combines with phosphorus and sulphur. Wine and the acetous acid dissolve antimony, and then become emetic. The acid of tartar forms with it the well-known salt, the antimoniated tartrat of potash, or emetic tartar.

Antimony is employed in commerce in two states; 1st, under the form of crude antimony, which is nothing else than sulphuret of antimony freed from its matrix; 2nd, under the form of regulus of antimony, or metallic antimony. See ANTIMONY.

Of bismuth.—Bismuth is often found native. It is also combined with oxygen, sulphur, iron, and arsenic. See BISMUTH.

Of cobalt.—Cobalt has never been found but in a state of combination. It is found united to sulphur, arsenic, and other metallic substances. It is of a pale or grey colour, inclining to red; it is hard, but fusible. In the fire it has a considerable degree of fixity, and does not inflame, or emit fumes. It fuses, but requires almost as strong a degree of heat as is necessary to fuse iron.

Oxyd of cobalt, when freed from arsenic, is known under the name of zaffer. Zaffer, when fused with three parts of quartz, and one part of potash, forms glass of a beautiful blue colour. This glass pulverized forms smalt, from which the blue employed for colouring starch is made. It is used also by the painters of earthenware, porcelain, &c. and by enamellers. Cobalt is soluble in acids. The nitric and sulphuric acids dissolve it with effervescence. The muriatic acid does not dissolve cobalt cold; but by the aid of heat it dissolves a portion of it. The acid has a more powerful action on the zaffer, and the solution is of a beautiful green colour. The nitro-muriatic acid dissolves cobalt, and forms a sympathetic ink. See COBALT.

Of nickel—Nickel is generally found in a metallic state. It was discovered not long since by Cronstedt, a Swedish mineralogist. It is of a reddish colour, very little malleable, and very difficult of fusion. When exposed to the air it oxydates, and very rapidly when heated. It forms alloys with most of the metals, and is acted upon by most of the acids. See NICKEL.

Of manganese.—This metal is found only in combination. It is generally united to oxygen, for which it has a strong affinity, so that it is very difficult to preserve it in a metallic state. The black oxyd of manganese is found very generally. It is procured in the greatest purity in the neighbourhood of Exeter, and is very much used for obtaining the oxygenated muriatic acid gas employed in bleaching, It is also used by glass-makers for destroying the green or yellow tint of glass; and for this reason has been called glass-maker's soap. It is also employed for giving a violet colour to glass and porcelain. In a metallic state it is of a grey colour, not at all malleable, and more infusible than iron. It alloys with all the metals, except mercury. See MANGANESE.

Uranium was discovered by Klaproth in 1789, in the mineral called pechblende, which is an oxyd of uranium. It is of a grey colour, very porous and soft; more difficult of fusion than manganese. It is very little known, on account of its scarcity.

Titanium is a newly discovered metal. It was first observed in a mineral called menachanite, found in Cornwall, and afterwards in an ore called titanite. It is of a reddish yellow colour, and very infusible. It is very little known. See TITANIUM.

Chrome is a metal lately discovered by Vauquelin; respecting the nature and properties of which we are as yet little acquainted. Vauquelin gave it the name of chrome, because it communicates the red colour to the ruby, and the green to the emerald. It was found by this chemist in the state of an acid, in a substance before known under the name of the red lead of Siberia. The mineralizing substance of this red lead is a real acid, the radical of which is chrome. It is likewise found in France, combined with iron.

Arsenic is often found native. When combined with sulphur it is called orpiment. It is also often united with metals. See ARSENIC.

Molybdena is found united to sulphur. It is in this state very like plumbago. It is extremely difficult to obtain in a metallic state, and is therefore very scarce, and little known. It is capable of oxygenation, so as to form an acid. See MOLYBDENA.

Tungsten is never found pure, and is very scarce. It is acidifiable; and its combination with lime forms tungstate of lime. It is also

united to iron and manganese, in the ore called wolfram. The metal is brittle, hard, and very infusible. It is very little known; but is said to have one valuable property, viz. that of rendering all vegetable colours fixed; but this does not appear to be certain.

For the remaining compounds into which metals enter, and the order of their affinities, &c. see SALTS and METALS.

Vegetable substances.—Besides the substances which we have already described, nature exhibits another class which are called living, or organized beings. These are animals and vegetables, which at first sight appear to be very different from each other, yet it is not easy to say precisely, in what the difference between them consists.

Vegetables in general differ from animals, in the former being fixed to the earth, and not being able to change their situation; while the latter are possessed of loco-motive power, which they are obliged to exercise, in order to procure food for their sustenance.

Almost all vegetables are composed of three principal parts: the bark, or exterior covering; the wood or woody fibre, which in trees constitutes the principal part; and the pith, which seems to correspond to the marrow of animals. The constituent principles of vegetables, are hydrogen, carbon, and oxygen. Those are common to all vegetables. Such other substances as exist in particular vegetables, are only essential to the composition of those in which they are found, and do not belong to vegetables in general. Of these elements, hydrogen and oxygen have a strong tendency to unite with caloric, and be converted into gas, while carbon is a fixed element, having little affinity with caloric. On the other hand, oxygen, which in the usual temperature, tends almost equally to unite with hydrogen or with carbon, has a much stronger affinity with carbon, when at the red heat, and unites with it, to form carbonic acid.

Vegetables are analyzed by various means, by heat, by acids, by water, and by fermentation. Some of these processes form products which did not exist in the living vegetables. Though all vegetables consist of hydrogen, carbon, and oxygen, yet these elements do not exist in them in a simple and uncombined state, but joined together in various proportions, forming a variety of compound substances, which mixed together in an organic form, make up the whole vegetable. We shall now describe the principal substances which are to be met with in vegetables.

1. Mucilage. Various parts of vegetables impart to water, if boiled with them, a certain viscous consistency: this is called mucilage. Some trees suffer their mucilage to transude, either spontaneously or by incisions made in them. When it has become concrete by drying in the air, it is called gum. This substance is without taste; soluble in water, but not in oils or alcohol. It is not changed by exposure to the air. It appears to consist of oxygen, hydrogen, nitrogen, carbon, and lime.

2. Oils. Oil was formerly supposed to be a simple substance; but Lavoisier proved that it is composed of carbon and hydrogen; it also contains a small portion of oxygen. Oils are divided into fat or fixed oils, and volatile or essential oils. Fixed oil is usually obtained by expression, chiefly from the seeds and kernels of plants. It is generally mixed with mucilage. It does not combine with water or alcohol. It has a great affinity for oxygen, which thickens it, and makes it pass into the concrete state. Some fixed oils, as linseed and walnut-oil, dry of themselves, or become solid, in the air; but this property is much increased by boiling, and adding oxyd of lead, which constitutes drying oil. Fixed oils are volatilized by a strong heat, and when volatilized, take fire by the contact of an ignited body. When added to acids, they attract oxygen from the acids, and form a kind of resinous substance. With alkalis, they form soap; and dissolve sulphur and phosphorus.

Volatile oils are generally procured by distilling aromatic plants with water. The water rises, accompanied by the oil, part of which is dissolved in the water; but the greatest quantity separates to the surface, or the bottom. They are soluble in alcohol, dissolve resin, sulphur, and phosphorus, and are very inflammable. They attract oxygen; and by long keeping are converted into resin, charcoal, and water. See OIL.

3. Resins exist in the vessels of certain trees, and frequently exude from them spontaneously. Sometimes they are procured by making incisions in the trees, and sometimes by distilling the wood. They are considered as volatile oils combined with oxygen. They are soluble in alcohol and oils, but not in water. It is this property that renders them so valuable as varnishes. They are inflammable, and melt with a slight heat. The principal resins are the turpentines, mastic, copal, sandarac, &c. See RESINS, &c.

4. Gum resins appear to be a natural mixture of resin and mucilage. They are partly soluble in water, and partly in alcohol. Gum ammoniac, assafœtida, &c. are gum resins. See GUM.

5. Caoutchouc, or elastic gum, very much resembles a resin. It is very elastic, inflammable, and insoluble in water or fat. It is partly soluble in volatile oils, and entirely so in melted spermaceti, and in nitric ether. It gives out heat as often as it returns to its dimensions after strong tension. See CAOUTCHOUC.

6. Camphor is a volatile oil, rendered concrete by carbon. It is very inflammable, and sublimes by a gentle heat. It is soluble in ether, alcohol, acids, and oils. It is highly odorous, and has been supposed to prevent the spreading of contagious disorders; but this has been denied by some. See CAMPHOR.

7. Wax is a vegetable substance, found in the greatest quantity on the anthers of flowers. The surfaces of many leaves are also coated with it. It is collected by the bees. It is insoluble in water and alcohol, but soluble in volatile and fixed oils. It is very inflammable. Its principles are the same as those of volatile oil. See WAX.

8. Honey is chiefly formed in the pistils or female organs of flowers, whence it is collected by the bees. It appears to be sugar dissolved in mucilage. See HONEY.

9. Sugar is very extensively distributed through the vegetable kingdom. It is procured in the greatest quantity from the sugar-cane; but it may also be obtained from the sugar-maple, the beet-root, carrots, &c. Its constituent principles are oxygen, carbon, and hydrogen. See SUGAR.

10. Gluten is an elastic substance, very much resembling an animal matter, found in many vegetables, but chiefly in wheat-flour. It is insoluble in water, and very slightly so in alcohol. It hardens by heat into a brownish transparent horny matter; and differs from all other vegetable substances by its containing a larger quantity of nitrogen and some ammonia.

11. Fecula, or starch, forms the principal part of the substance which is washed away in order to obtain the gluten from the grain. When the fluid is suffered to stand, a white powder subsides, which is the starch. It is not soluble in cold water nor in alcohol; but it is soluble in hot water, forming with it a well-known paste. Barley consists almost entirely of it. It appears to be only a slight alteration from mucilage, differing from that only by its being insoluble in cold water. There are also coloured feculæ, as indigo.

12. Tannin, or the tanning principle, is found in the bark of trees, and all those parts of vegetables which are called astringent. It has the property of forming a compound with gelatine or animal jelly that is solid, elastic, and insoluble in water. On its combination in this manner with the gelatinous part of skin, depends the art of tanning or making leather. See CUTIS.

13. Woody fibre constitutes the basis of wood. It may be procured separate from every other substance, by boiling woodshavings in water to dissolve the extractive matter, and then in alcohol to separate the resins, &c. It is insipid, insoluble in water, and combustible. When heated without access of air, it is converted into charcoal, which has been already described.

14. Colouring matter is found in vegetables combined with, 1. the extractive principle; 2. with resin; 3. with fecula; 4. gum.

The greater part of the colouring matters have a great affinity for many of the earths, but chiefly for alumina; also for the white metallic oxyds, particularly oxyd of tin; and also for animal fibrous matters, and for oxygen. On these properties, and the methods of transferring the colouring principle of one body to another so that it shall be durably fixed, depends the whole art of dyeing. See DYEING.

15. Acids. The acids which exist ready formed in vegetables, are the citric, malic, oxalic, gallic, benzoic, tartaric, acetic, and suberic. They have been already described.

16. Besides the substances already enumerated, many others are found in vegetables, such as sulphur, iron, manganese, lime, alumina, magnesia, barytes, &c. All the vegetables of the class called gramina, or grasses, have an epidermis or outer skin, composed of silex. This is particularly observable in canes, which, when struck together in the dark, produce sparks of fire.

Vinous fermentation.—If mucilaginous saccharine vegetable substances, under a proper combination of water and heat (from 60 to 70° Fahrenheit), are not entirely excluded from air, they experience in a very short time a striking change in their mixture. An internal commotion takes place; the mass grows turbid; a large quantity of air-bubbles are discharged from its inner part, which, on account of the toughness of the matter wherein they are inclosed, form a stratum on the surface of the fluid, known by the name of yeast. These air-bubbles consist of carbonic acid gas. After a time these appearances cease; the fermented liquor becomes clear and transparent, and no more gas is disengaged. The liquor now has lost its sweetness and viscidity, and has acquired the vinous taste and

intoxicating quality. Wine is made in this matter from the juice of the grape; if the fermentation is checked when at its height, by excluding the air, the wine begins to ferment anew, and effervesce when again exposed to it. The sparkling wines, as champaign, are prepared in this manner, and hence should be considered as imperfect wines. Not only the juice of the grape, but all mucilaginous substances containing sugar, are capable of the vinous fermentation.

To understand these phenomena it must be observed that alcohol, which is the essence of a vinous fluid, consists of the same principles as sugar, only combined in different proportions. Alcohol contains more hydrogen and less carbon and oxygen. In the process of fermentation, therefore, a considerable part of the oxygen combines with the carbon which the saccharine fluid contains. These two form the carbonic acid gas which is expelled in the process; and the quantities of these being lessened, and the hydrogen left behind, this very essential change is effected in the liquor.

To prepare vinous liquors from grain or corn, they are converted into malt: by this process, the gluten which forms the germ is separated, and the fecula appears to be converted into sugar by the germination of the seed. From malt, beer is made by extraction and fermentation. If wine, beer, or any other fermented liquor, is distilled, a fluid is obtained which is colourless, of a strong heating taste, a penetrating odour, and an intoxicating property. This is alcohol, ardent spirit, or spirit of wine. In this state it contains a quantity of water. If this alcohol is re-distilled, and reduced to two-thirds, it is obtained very pure, and is called rectified alcohol. Alcohol is very inflammable and volatile; it dissolves resins, essential oils, camphor, sulphur, phosphorus, &c. It is composed of hydrogen, carbon, and a small quantity of oxygen. Strong acids and alcohol have a considerable re-action on each other; and this produces ether, which is a very volatile, inflammable, odorous fluid. Nitric acid with alcohol produces nitric æther, and sulphuric acid with alcohol produces sulphuric æther. See FERMENTATION.

Acetous fermentation.—When wine, or any fermented or vinous liquor, is exposed to a heat, from 75° to 85° Fahrenheit, and access of air is permitted, the fluid becomes turbid, and a new change of principles takes place. It loses its taste and smell, it becomes sour, and is converted into vinegar. Though vinegar is chiefly prepared from fluids which have undergone the vinous fermentation, yet this is not necessary to the production of vinegar; for simple mucilage is capable of passing into the state of acetous fermentation. When the saccharine principle predominates in any substance exposed to the necessary conditions of fermentation, alcohol is produced. When mucilage is most abundant, vinegar or acetous acid is the product; and when gluten is most predominant, ammonia will be discovered, and putrefaction or the putrid fermentation will take place.

The process of the acetous fermentation is still more simple than that of the vinous, and consists merely in the fluid imbibing the oxygen from the atmosphere, for which it has a strong attraction; and by the access of which to the point of saturation, it is converted into an acid.

Putrid fermentation.—This is the last change, or final decomposition, of vegetables. Without moisture, heat, and a due access of air, this does not take place. In this state of fermentations ammonia is formed, accompanied by a very offensive smell. Vegetables which contain albuminous matter and gluten, are most liable to putrefaction.

Animal substances.—The constituent principles of animal substances are nearly the same with those of vegetables; but the former contain much more nitrogen and phosphorus, and the latter more carbon and hydrogen.

The proximate constituent parts of animal substances, or simple combinations of the above-mentioned radicals, are the following:

1. Gelatine, or animal jelly, is very generally dispersed through all the parts of animals, even in bones, but exists in the greatest quantity in the tendons, membranes, and the skin. It is a mucous substance, very soluble in warm water, but not in alcohol; insipid, and without smell; when cold, it congeals to a cohesive, tremulous substance. It forms the basis of soups, broths, &c. and imparts to them their nutritious qualities. When evaporated to dryness, it forms portable soup, glue, isinglass, &c. The union of this substance in the skin with tannin constitutes leather.

2. Fibrin, or animal fibre, forms the basis of the muscular, or fleshy parts of animals. It is fibrous in its structure, transparent, insoluble in water and alcohol except by a long-continued heat in a digester. It coagulates by the mere contact of air, and in a temperature of 120°, in which it differs from albumen, and also by its insolubility in cold liquid ammonia. It is soluble in acids and alkalis; by its union with the latter soap is formed. Chaptal employed this property to make soap from wool. With nitric acid it affords more nitrogen gas than any other substance. Pure fibrin may be obtained by washing away all the other parts from muscular fibre. It is very analogous to vegetable gluten.

3. Albumen is the principal constituent part of the serum of blood, and is also called coagulable lymph. The white of eggs consists almost entirely of albumen. It is insoluble in hot or cold water, oils, or alcohol; and coagulates by a heat of 160° Fahrenheit, into a white solid mass, also by acids, oxyds, and alcohol. The coagulum is only soluble in alkalis. See ALBUMEN.

4. Animal oil differs from the vegetable oils, in being generally solid at the temperature of the atmosphere, but is very similar to them in its other properties. It contains more oxygen, and also sebacic acid. Among animal oils may be ranked fat, tallow, lard, suet, butter, &c. Fish oil is generally more liquid than other animal oils. Spermaceti is an animal oil, found in the head of a species of whale. Animal fibre may be converted into a substance resembling spermaceti, by treatment with the nitric acid, and also by exposing it to a current of water for several months.

5. Bones consist chiefly of phosphate of lime, with carbonate of lime and gelatine.

6. Blood, when suffered to rest, separates into two parts; the one a coagulum or clot, called the crassamentum; the other a fluid called the serum. The crassamentum consists of fibrin, mixed with albumen or lymph, and colouring matter. The fibrin may be separated from the albumen and colouring part, by washing. The colouring part contains much iron, in an oxydated state, owing to the oxygen it receives in its passage through the lungs. The serum consists of albumen and gelatine, mixed with muriate and carbonate of soda, and phosphate of lime. It is coagulable by heat, the acids, and alcohol.

7. Milk, if suffered to rest, throws up on its surface a butyraceous oil, cream. If the remaining skimmed-milk is suffered to remain, it becomes sour, and separates into two parts; a curd, which is chiefly albumen; and whey, which is nearly analogous to serum, mixed with sugar and lactic acid. It may be made to pass into the vinous fermentation. Milk may be separated into its constituent parts, by the addition of acids and neutral salts. By the addition of rennet (which is the stomach of a calf, in which the milk has soured), milk is separated into curd and whey. Of the former cheese is made, by pressing and drying it. By agitating milk, the oily part of the cream is separated in a more solid form, constituting butter. This is also prepared by agitating the cream alone, which separates the butter from the rest of the milk which remains, called butter-milk.

8. Nails, horns, hoofs, and quills, resemble coagulated albumen.

The animal acids and phosphorus have been already described. Many other animal substances, such as bile, urine, saliva, &c. are very complicated, and but imperfectly known.

Of putrefaction.—Every animal body, when deprived of life, and exposed to the air, undergoes a decomposition, or resolution of its parts. Its colour becomes pale, then changes to blue and green; the parts become soft, and send out a fetid smell, arising from the disengagement of a very noxious gas. The organization is destroyed, and the constituent parts of the animal substance form new arrangements, and are chiefly resolved into the gaseous state. What remains is a dry powder, consisting of a mixture of earths and charcoal.

TABLE I. Of compound oxydable and acidifiable bases.

Names of the radicals		
Oxydable or acidifiable hydro-carbonous or carbono-hydrous radicals from the vegetable kingdom.	Tartaric	Radicals.
	Malic	
	Citric	
	Oxalic	
	Acetic	
	Succinic	
	Benzoic	
	Camphoric	
	Gallic	
	Suberic	
Oxydable or acidifiable radicals from the animal kingdom, which mostly contain azote.	Lactic	
	Saccholactic	
	Sebacic	
	Prussic	
	Laccic	
Carbono-hydrous radical from the mineral kingdom.	Mellitic.	

TABLE II. Of the binary combinations of oxygen with simple substances.

	Names of the simple substances.	First degree of oxygenation.	Second degree of oxygenation.	Third degree of oxygenation.	Fourth degree of oxygenation.
Combinations of oxygen with simple non-metallic substances.	Caloric	Oxygen gas			
	Hydrogen	Water*			
	Azote	Nitrous oxyd	Nitric oxyd, or base of nitrous gas	Nitrous acid	Nitric acid
	Carbon	Charcoal, or carbonous oxyd	Carbonic oxyd	Carbonic acid	
	Sulphur	Oxyd of sulphur	Sulphurous acid	Sulphuric acid	
	Phosphorus	Oxyd of phosphorus	Phosphorous acid	Phosphoric acid	
	Muriatic radical	-	Muriatic acid	Muriatic acid	Hyperoxymuriatic acid
	Fluoric radical	-	Fluoric acid		
	Boracic radical	Boracic oxyd	Boracic acid		
Combinations of oxygen with the simple metallic substances.	Antimony	Grey oxyd of antimony	White oxyd of antimony		
	Silver	Oxyd of silver			
	Arsenic	Grey oxyd of arsenic	White oxyd of arsenic	Arseniac acid	
	Bismuth	Grey oxyd of bismuth	White oxyd of bismuth		
	Cobalt	Grey oxyd of cobalt			
	Copper	Brown oxyd of copper	Blue and green oxyds of copper		
	Tin	Grey oxyd of tin	White oxyd of tin		
	Iron	Black oxyd of iron	Yellow and red oxyds of iron		
	Manganese	Black oxyd of manganese	White oxyd of manganese		
	Mercury	Black oxyd of mercury	Yellow and red oxyds of mercury		
	Molybdena	Oxyd of molybdena	- - - -	Molybdic acid	
	Nickel	Oxyd of nickel			
	Gold	Yellow oxyd of gold	Red oxyd of gold		
	Platina	Yellow oxyd of platina			
	Lead	Grey oxyd of lead	Yellow and red oxyds of lead		
	Tungstein	Oxyd of tungstein	- - - -	Tungstic acid.	
	Zinc	Grey oxyd of zinc	White oxyd of zinc		

TABLE III. Of the combinations of oxygen with the compound radicals.

Names of the radicals.	*Names of the resulting acids.*
Tartaric	Tartaric acid
Malic	Malic acid
Citric	Citric acid
Oxalic	Oxalic acid
Acetic	Acetic acid
Succinic	Succinic acid
Benzoic	Benzoic acid
Camphoric	Camphoric acid
Gallic	Gallic acid
Suberic	Suberic acid
Lactic	Lactic acid
Saccholactic	Saccholactic acid
Sebacic	Sebacic acid
Prussic	Prussic acid
Laccic	Laccic acid
Mellitic	Mellitic acid.

TABLE IV. Of the binary combinations of azote with the simple substances.

Simple substances.	*Results of the combinations.*
Caloric	Azotic gas
Hydrogen	Ammoniac
Oxygen	Nitrous oxyd
	Nitric oxyd
	Nitrous acid
	Nitric acid

Simple substances.	*Results of the combinations.*
Charcoal	This combination is hitherto unknown; should it ever be discovered, it will be called, according to the principles of our nomenclature, azuret of charcoal. Charcoal dissolves in azotic gas, and forms carbonated azotic gas
Phosphorus	Azuret of phosphorus. Still unknown
Sulphur	Azuret of sulphur. Still unknown. We know that sulphur dissolves in azotic gas, forming sulphurated azotic gas
Compound radicals	Azote combines with charcoal and hydrogen, in the compound oxydable and acidifiable bases, and is generally contained in the radicals of the animal acids
Metallic substances	Such combinations are hitherto unknown; if ever discovered, they will form metallic azurets, as azuret of gold, of silver, &c.
Lime, Magnesia, Barytes, Argil, Potash, Soda	Entirely unknown. If ever discovered, they will form azuret of lime, azuret of magnesia, &c.

TABLE V. Of the binary combinations of hydrogen with simple substances.

Simple substances.	Resulting compounds.
Caloric	Hydrogen gas
Azote	Ammoniac
Oxygen	Water
Sulphur	Hydruret of sulphur, or sulphuret of hydrogen
Phosphorus	Hydruret of phosphorus, or phosphuret of hydrogen
Charcoal	Hydro-carbonous, or carbono-hydrous radicals
Metallic substances as iron, &c.	Metallic hydrurets, as hydruret of iron, &c.

These combinations take place in the state of gas, and form respectively, sulphurated and phosphorated oxygen gas.

TABLE VI. Of the binary combinations of sulphur with simple substances.

Simple substances.	Resulting compounds.
Caloric	Sulphuric gas
Oxygen	Oxyd of sulphur
	Sulphurous acid
	Sulphuric acid
Hydrogen	Sulphuret of hydrogen
Azote	azote
Phosphorus	phosphorus
Charcoal	charcoal
Antimony	antimony
Silver	silver
Arsenic	arsenic
Bismuth	bismuth

* Only one degree of oxygenation of hydrogen is hitherto known.

Cobalt	Sulphuret of cobalt
Copper	copper
Tin	tin
Iron	iron
Manganese	manganese
Mercury	mercury
Molybdena	molybdena
Nickel	nickel
Gold	gold
Platina	platina
Lead	lead
Tungstein	tungstein
Zinc	zinc
Potash	potash
Soda	soda
Ammoniac	ammoniac
Lime	lime
Magnesia	magnesia
Barytes	barytes
Argill	argill.

TABLE VII. Of the binary combinations of phosphorus with the simple substances.

Simple substances.	Resulting compounds.
Caloric	Phosphoric gas
Oxygen	Oxyd of phosphorus
	Phosphorous acid
	Phosphoric acid
Hydrogen	Phosphuret of hydrogen
Azote	Phosphuret of azote
Sulphur	Phosphuret of sulphur
Charcoal	Phosphuret of charcoal
Metallic substances	Phosphurets of metals
Potash	Phosphuret of potash, soda, &c.
Soda	
Ammoniac	
Lime	
Barytes	
Magnesia	
Argill	

TABLE VIII. Of the binary combinations of carbon.

Simple substances.	Resulting compounds.
Oxygen	Oxyd of charcoal or carbonous oxyd
	Carbonic oxyd
	Carbonic acid
Sulphur	Carburet of sulphur
Phosphorus	Carburet of phosphorus
Azote	Carburet of azote
Hydrogen	Carbono-hydrous radicals
	Fixed and volatile oils
Metallic substances	Carburets of metals
Alkalies and earths	Carburet of potash, &c.

TABLE IX. Of the combinations of azote or nitrogen in the state of nitrous acid with the salifiable bases, arranged according to the affinities of these bases with the acid.

Names of the bases.	Names of the neutral salts.	Notes.
Barytes	Nitrite of barytes	These salts are only known of late, and have received no particular name in the old nomenclature.
Potash	potash	
Soda	soda	
Lime	lime	
Magnesia	magnesia	
Ammoniac	ammoniac	
Argill	argill	
Oxyd of zinc	zinc	As metals dissolve both in nitrous and nitric acids, metallic salts must of consequence be formed having different degrees of oxygenation. Those wherein the metal is least oxygenated must be called nitrites, when more so, nitrats; but the limits of this distinction are difficultly ascertainable. The older chemists were not acquainted with any of these salts.
iron	iron	
manganese	manganese	
cobalt	cobalt	
nickel	nickel	
lead	lead	
tin	tin	
copper	copper	
bismuth	bismuth	
antimony	antimony	
arsenic	arsenic	
mercury	mercury	
silver	It is extremely probable that gold, silver, and platina, form only nitrats, and cannot subsist in the state of nitrites.	
gold		
platina		

TABLE X. Of the combinations of azote, completely saturated with oxygen, in the state of nitric acid, with the salifiable bases, in the order of the affinity with the acid.

Bases.	Names of the resulting neutral salts.
Barytes	Nitrat of barytes
Potash	potash
Soda	soda
Lime	lime
Magnesia	magnesia
Ammoniac	ammoniac
Argill	argill
Oxyd of zinc	Nitrat of zinc
iron	iron
manganese	manganese
cobalt	cobalt
nickel	nickel
lead	lead
tin	tin
copper	copper
bismuth	bi-muth
antimony	antimony
arsenic	arsenic
mercury	mercury
silver	silver
gold	gold
platina	platina.

TABLE XI. Of the combinations of sulphuric acid with the salifiable bases, in the order of affinity.

Names of the bases.	Resulting compounds.
Barytes	Sulphat of barytes
Potash	potash
Soda	soda
Lime	lime
Magnesia	magnesia
Ammoniac	ammoniac
Argill	argill
Oxyd of zinc	zinc
iron	iron
manganese	manganese
cobalt	cobalt
nickel	nickel
lead	lead
tin	tin
copper	copper
bismuth	bismuth
antimony	antimony
arsenic	arsenic
mercury	mercury
silver	silver
gold	gold
platina	platina.

TABLE XII. Of the combinations of the sulphurous acid with the salifiable bases, in the order of affinity.

Names of the bases.	Names of the neutral salts.
Barytes	Sulphite of barytes
Potash	potash
Soda	soda
Lime	lime
Magnesia	magnesia
Ammoniac	ammoniac
Argill	argill
Oxyd of zinc	zinc
iron	iron
manganese	manganese
cobalt	cobalt
nickel	nickel
lead	lead
tin	tin
copper	copper
bismuth	bismuth
antimony	antimony
arsenic	arsenic
mercury	mercury
silver	silver
gold	gold
platina	platina.

TABLE XIII. Of the combinations of phosphorous and phosphoric acids, with the salifiable bases, in the order of affinity.

Names of the bases	Names of the neutral salts formed by Phosphorous acid, Phosphites of	Phosphoric acid, Phosphats of
Lime	lime	lime
Barytes	barytes	barytes
Magnesia	magnesia	magnesia
Potash	potash	potash
Soda	soda	soda
Ammoniac	ammoniac	ammoniac
Argill	argill	argill
Oxyd of zinc	zinc	zinc

Oxyd of	Phosphites of	Posphats of
iron	iron	iron
manganese	manganese	manganese
cobalt	cobalt	cobalt
nickel	nickel	nickel
lead	lead	lead
tin	tin	tin
copper	copper	copper
bismuth	bismuth	bismuth
antimony	antimony	antimony
arsenic	arsenic	arsenic
mercury	mercury	mercury
silver	silver	silver
gold	gold	gold.

TABLE XIV. Of the combinations of carbonic acid with the salifiable bases, in the order of affinity.

Names of bases.	Resulting neutral salts.
Barytes	Carbonat of barytes
Lime	lime
Potash	potash
Soda	soda
Magnesia	magnesia
Ammoniac	ammoniac
Argill	argill
Oxyd of zinc	zinc
iron	iron
manganese	manganese
cobalt	cobalt
nickel	nickel
lead	lead
tin	tin
copper	copper
bismuth	bismuth
antimony	antimony
arsenic	arsenic
mercury	mercury
silver	silver
gold	gold
platina	platina.

TABLE XV. Of the combinations of muriatic acid with the salifiable bases, in the order of affinity.

Names of the bases.	Resulting neutral salts.
	Muriat of
Barytes	barytes
Potash	potash
Soda	soda
Lime	lime
Magnesia	magnesia
Ammoniac	ammoniac
Argill	argill
Oxyd of	
zinc	zinc
iron	iron
manganese	manganese
cobalt	cobalt
nickel	nickel
lead	lead
tin	smoking of tin / solid of tin
copper	copper
bismuth	bismuth
antimony	antimony
arsenic	arsenic
mercury	sweet of mercury / corrosive of mercury
silver	silver
gold	gold
platina	platina.

TABLE XVI. Of the combinations of oxygenated muriatic acid with the salifiable bases, in the order of affinity.

Names of the bases.	Names of the neutral salts.
	Oxygenated muriat of
Barytes	barytes
Potash	potash
Soda	soda
Lime	lime
Magnesia	magnesia
Argill	argill
Oxyd of	
zinc	zinc
iron	iron
manganese	manganese
cobalt	cobalt
nickel	nickel
lead	lead
tin	tin
copper	copper
bismuth	bismuth
antimony	antimony
arsenic	arsenic
mercury	mercury
silver	silver
gold	gold
platina	platina.

TABLE XVII. Of the combinations of fluoric acid with the salifiable bases, in the order of affinity.

Names of the bases.	Names of the neutral salts.
Lime	Fluat of lime
Barytes	barytes
Magnesia	magnesia
Potash	potash
Soda	soda
Ammoniac	ammoniac
Oxyd of zinc	zinc
manganese	manganese
iron	iron
lead	lead
tin	tin
cobalt	cobalt
copper	copper
nickel	nickel
arsenic	arsenic
bismuth	bismuth
mercury	mercury
silver	silver
gold	gold
platina	platina
And by the dry way,	
Argill	Fluat of argill.

TABLE XVIII. Of the combinations of boracic acid with the salifiable bases, in the order of affinity.

Bases.	Neutral salts.
Lime	Borat of lime
Barytes	barytes
Magnesia	magnesia
Potash	potash
Soda	soda
Ammoniac	ammoniac
Oxyd of zinc	zinc
iron	iron
lead	lead
tin	tin
cobalt	cobalt
copper	copper
nickel	nickel
mercury	mercury
Argill	argill.

TABLE XIX. Of the combinations of arseniac acid with the salifiable bases, in the order of affinity.

Bases.	Neutral salts.
Lime	Arseniat of lime
Barytes	barytes
Magnesia	magnesia
Potash	potash
Soda	soda
Ammoniac	ammoniac
Oxyd of zinc	zinc
manganese	manganese
iron	iron
lead	lead
tin	tin
cobalt	cobalt
copper	copper
nickel	nickel
bismuth	bismuth
mercury	mercury
antimony	antimony
silver	silver
gold	gold
platina	platina
Argill	argill.

TABLE XX. Of the combinations of tungstic acid with the salifiable bases.

Bases.	Neutral salts.
Lime	Tungstat of lime
Barytes	barytes
Magnesia	magnesia
Potash	potash
Soda	soda
Ammoniac	ammoniac
Argill	argill
Oxyd of antimony, &c.	antimony, &c.

TABLE XXI. Of the combinations of tartaric acid with the salifiable bases, in the order of affinity.

Bases.	Neutral salts.
Lime	Tartrite of lime
Barytes	barytes
Magnesia	magnesia
Potash	potash
Soda	soda
Ammoniac	ammoniac
Argill	argill
Oxyd of zinc	zinc
iron	iron
manganese	manganese
cobalt	cobalt
nickel	nickel
lead	lead
tin	tin
copper	copper
bismuth	bismuth
antimony	antimony
arsenic	arsenic
silver	silver
mercury	mercury
gold	gold
platina	platina.

TABLE XXII. The malic acid combines with the salifiable bases, forming with

Potass	Malat of potass
Soda	soda
Ammonia	ammonia
Barytes	barytes
Strontian	strontian
Lime	lime
Magnesia	magnesia
Alumina	alumina

The order of affinity is unknown.

TABLE XXIII. Of the combinations of citric acid with the salifiable bases, in the order of affinity.

Bases.	Neutral salts.
Barytes	Citrat of barytes
Lime	lime
Magnesia	magnesia
Potash	potash
Soda	soda
Ammoniac	ammoniac
Oxyd of zinc	zinc
manganese	manganese
iron	iron
lead	lead
cobalt	cobalt
copper	copper
arsenic	arsenic
mercury	mercury
antimony	antimony
silver	silver
gold	gold
platina	platina
Argill	argill.

TABLE XXIV. Of the combinations of the suberic acid with the salifiable bases, in the order of affinity.

Names of the bases.	Names of the neutral salts.
Barytes	Suberat of barytes
Potass	potass
Soda	soda
Lime	lime
Ammonia	ammonia
Magnesia	magnesia
Alumina	alumina.

TABLE XXV. Of the combinations of the oxalic acid with the salifiable bases, in the order of affinity.

Bases.	Neutral salts.
Lime	Oxalat of lime
Barytes	barytes
Magnesia	magnesia
Potash	potash
Soda	soda
Ammoniac	ammoniac
Argill	argill
Oxyd of zinc	zinc
iron	iron
manganese	manganese
cobalt	cobalt
nickel	nickel
lead	lead
copper	copper
bismuth	bismuth
antimony	antimony
a senic	arsenic
mercury	mercury
silver	silver
gold	gold
platina	platina.

TABLE XXVI. Of the combinations of acetic acid with the salifiable bases, in the order of affinity.

Bases.	Neutral salts.
Barytes	Acetat of barytes
Potash	potash
Soda	soda
Lime	lime
Magnesia	magnesia
Ammoniac	ammoniac
Oxyd of zinc	zinc
manganese	manganese
iron	iron
lead	lead
tin	tin
cobalt	cobalt
copper	copper
Oxyd of nickel	Acetat of nickel
arsenic	arsenic
bismuth	bismuth
mercury	mercury
antimony	antimony
silver	silver
gold	gold
platina	platina
Argill	argill.

TABLE XXVII. Of the combinations of succinic acid with the salifiable bases, in the order of affinity.

Bases.	Neutral salts.
Barytes	Succinat of barytes
Lime	lime
Potash	potash
Soda	soda
Ammoniac	ammoniac
Magnesia	magnesia
Argill	argill
Oxyd of zinc	zinc
iron	iron
manganese	manganese
cobalt	cobalt
nickel	nickel
lead	lead
tin	tin
copper	copper
bismuth	bismuth
antimony	antimony
arsenic	arsenic
mercury	mercury
silver	silver
gold	gold
platina	platina.

TABLE XXVIII. Benzoic acid combines with Barytes forming Benzoat of barytes

Lime	lime
Potass	potass
Soda	soda
Ammonia	ammonia
Magnesia	magnesia
Alumina	alumina

Order of affinity unknown.

TABLE XXIX. Camphoric acid combines with Lime forming Camphorat of lime

Potass	potass
Soda	soda
Barytes	barytes
Ammonia	ammonia
Magnesia	magnesia
Alumina	alumina.

TABLE XXX. Lactic acid combines with Potass forming Lactat of potass

Soda	soda
Ammonia	ammonia
Barytes	barytes
Lime	lime
Alumina	alumina
Magnesia	magnesia.

TABLE XXXI. Of the combinations of saccholactic acid with the salifiable bases, in the order of affinity.

Bases.	Neutral salts.
Lime	Saccholat of lime
Barytes	barytes
Magnesia	magnesia
Potash	potash
Soda	soda
Ammoniac	ammoniac
Argill	argill
Oxyd of zinc	zinc
manganese	manganese
iron	iron
lead	lead
tin	tin
copper	copper
bismuth	bismuth
antimony	antimony
arsenic	arsenic
silver	silver
mercury	mercury
gold	gold
platina	platina.

TABLE XXXII. Of the combinations of the prussic acid with the salifiable bases, in the order of affinity.

Bases.	Neutral salts.
Potash	Prussiat of potash
Soda	soda
Ammoniac	ammoniac
Lime	lime
Barytes	barytes
Magnesia	magnesia
Oxyd of zinc	zinc
iron	iron
manganese	manganese
cobalt	cobalt
nickel	nickel
lead	lead
tin	tin
copper	copper
bismuth	bismuth
antimony	antimony
arsenic	arsenic
silver	silver
mercury	mercury
gold	gold
platina	platina.

TABLE XXXIII. Mellitic acid combines with Potass forming Mellat of potass

Soda	soda
Ammonia	ammonia
Lime	lime
Barytes	barytes
Alumina	alumina.

The combinations of the remaining acids with the salifiable bases are for the most part unknown; when ascertained they will be denominated from their constituent acids as follows:

From the Sebacic acid	Sebats
Laccic acid	Laccats
Gallic acid	Gallats.

GLOSSARY OF CHEMICAL TERMS.

Affinity, the same with elective attraction (see the article ATTRACTION), means that attraction which exists between the very minute particles of bodies. It is essentially different from the attraction of gravitation, since it is not governed by the masses or specific gravity of the particles. It has been termed elective attraction, because something analogous to preference or choice may be observed in this kind of action of bodies on each other. Thus, spirit of wine will dissolve resin, but water will not; on the contrary gum will dissolve in water, while it is insoluble in spirit. Nay, some fluids will let fall the particles of certain bodies, in order to take up and combine with those of others. Thus, if a quantity of silver is added to aqua-fortis (nitric acid), the cohesion of the particles of silver will be destroyed, and they will unite forcibly with those of the aqua-fortis. The fluid will remain perfectly clear, because the particles even in this state of combination, are so extremely minute that

the rays of light will suffer no interruption in passing through them. If however, to this solution of silver, a quantity of mercury is added, the aqua-fortis will be attracted by the mercury, and the silver will be thrown down or precipitated to the bottom of the vessel in which the fluid is contained. (Hence the chemical term precipitation.) If again copper is added, it will assume the place of the mercury, which of course in its turn will be precipitated. If to this solution of copper, a piece of bright iron (for rust would prevent the action of the acid) is introduced, the surface of the iron will be dissolved, and the copper precipitated, and will be deposited on the bar of iron. The iron may afterwards be precipitated by the introduction of an alkali. On this principle are founded the tables of affinity or elective attraction, which state the substances in order as they have an attraction for each other. It is a general maxim in chemistry, that for bodies to act in this manner on each other, one of them must be in a fluid state. A double elective attraction or affinity is, when two bodies, each compounded of two principles, mutually change a principle of each. Thus, when the salt which is compounded of mercury with nitric acid is presented to a solution of vitriolated tartar, the vitriolic acid will quit the alkali, and unite with the mercury, and the nitric acid will combine with the alkali. This is also sometimes called the attraction of combination.

Calcination, applied to the metals, is their oxygenation by means of heat.

Concentration, the separation and evaporation by means of heat of the watery particles from any fluid; by which the fluid is said in common language to become stronger, or less diluted.

Crucible, a vessel usually made of clay, employed as a melting-pot for metals or other substances.

Crystallization, is when a body passing from a fluid to a solid state, assumes a regular form. See the article CRYSTALLIZATION.

Decantation, the separation of a fluid from the solid concrete particles which it contains. This is done by leaving the fluid at rest in a conical vessel, when the foreign matter will deposit itself at the bottom, and if the fluid is very gently poured off it will be obtained tolerably clear. A syphon is sometimes employed with advantage when the matter deposited is light, and there is danger of shaking the vessel. A thick woollen thread steeped in the liquor, and inclining over the edge of the vessel into another, makes a very good syphon for this purpose.

Decoction is the extracting, by the application of heat and moisture, of some portion of matter from certain substances, as the gums and essential oils from vegetables. When the extract is made in cold water it is called infusion.

Decrepitation, the small and successive explosions which take place when salts are exposed to heat to expel their water of crystallization.

Desiccation (drying), the expelling or evaporating humid matter from any substance by means of heat.

Detonation, an explosion caused by the sudden expansion of certain substances, when either a very rapid combination or decomposition takes place.

Digestion, the slow action of a solvent upon any substance, often assisted by the heat of a sand-bath.

Distillation, the operation which by means of heat and moisture separates volatile matters from those which are fixed, or matters more or less volatile from one another.

Effervescence, the escape of volatile matters from the mass of a fluid, which in their passage through cause a kind of ebullition.

Efflorescence. When solid or consistent bodies spontaneously become converted into powder, the surface appears covered with a white dust. This effect is occasioned by the loss of the water of crystallization.

Extract, the solid matter left behind when the watery parts are evaporated from a decoction or infusion.

Fixed, an epithet descriptive of such bodies as resist the action of heat, so as not to rise in vapour. It is opposed to volatile.

Fulmination, a still more violent and sudden explosion than detonation.

Fusion, the passing of a solid body to a fluid state by means of heat.

Infusion, the extraction of resinous, gummy, or other matters, by the action of water in the common temperature of the atmosphere.

Lixiviation, the process of separating by solution in water those matters which are soluble in any body from those which are insoluble; generally applied to the fixed residues of bodies for the purpose of extracting the saline parts, which dissolve in the water, and afterwards crystallize on evaporation.

Mixture, the aggregation or mechanical union of bodies which have no affinity or chemical combination. It is opposed to solution, where the particles of the fluid and solid body are permanently combined. In mere mixtures, when set at rest, one part will commonly subside and form a sediment.

Oxidation, the combination of any other body with oxygen.

Precipitation, the effect which takes place in solution, in consequence of elective attraction, when one matter is let fall to the bottom in consequence of the fluid particles combining with another. (See Affinity, above.) The product is also called a precipitation.

Reagent, a body which is brought in contact with another to promote the separation of its principles or constituent parts. The reagents are the immediate means of precipitation.

Rectification, the further purification of matters by a second or third distillation or sublimation.

Reduction, the bringing back the oxyds or calces of metals to the pure metallic state, by expelling the oxygen, which is generally done by exposing the oxyd to the action of heat along with some matter containing carbon; when the oxygen and carbon go off in the form of carbonic acid gas, leaving the metal pure.

Residuum (formerly called caput-mortuum), that part of a body which remains after a part has been separated by an operation, such as distillation or sublimation.

Saturation. Most bodies that have a chemical affinity for each other will only unite in certain proportions. When, therefore, a fluid has dissolved as much of any substance as it will dissolve, it is said to have reached the point of saturation. Thus, water will dissolve one quarter of its weight of common salt; and if more is added, it will sink to the bottom in a solid state. Some fluids will dissolve more of certain substances when hot than when cold. Thus water when hot will dissolve a much larger quantity of nitre than when cold.

Solution, the dispersion of the particles of a solid body in any fluid in so equal a manner, that the compound liquor shall be perfectly and permanently clear and transparent. This happens when the particles of the fluid have an affinity or elective attraction for the particles of the solid. When solid particles are only dispersed in a fluid by mechanical means, it is mixture, and the compound is commonly opaque and muddy.

Sublimation is to dry matters what distillation is to humid ones. It is the process by which the volatile are separated from the fixed parts of bodies by the application of heat alone without moisture.

Vitrification, the conversion into glass of such substances as are capable of assuming that form.

Volatilization, the reducing into vapour such substances as are capable of assuming that state.

CHENOLEA, a genus of the order monogynia, in the pentandria class of plants. The calyx is globular, one-leafed, five-parted; caps. one-celled, with one smooth seed. There is one species, a native of the Cape.

CHENOPODIUM, *goose-foot*, or *wild orach*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. The calyx is pentaphyllous and pentagonal; no corolla; one seed, lenticular, superior. There are 23 species, 13 of which are natives of Britain. Most of them have an aromatic smell. A species which grows near the Mediterranean is used by the Egyptians in sallads, on account of its saltish aromatic taste. From this plant kelp is made in other countries. The most remarkable are:

1. Chenopodium ambrosoides, or the oak of Cappadocia. These are easily propagated from seeds, and thrive best in a rich soil.

2. Chenopodium bonus Henricus, or common English mercury, found growing naturally in shady lanes in many places in Britain. It was formerly used as spinach, but is now disused, being greatly inferior. As an article of the materia medica, it is ranked among the emollient herbs, but rarely used in practice. The leaves are applied by the country-people for healing slight wounds, cleansing old ulcers, and the like purposes. The roots are given to sheep that have a cough. Goats and sheep are not fond of the herb; cows, horses, and swine, refuse it.

3. Chenopodium botrys, or the oak of Jerusalem, like that of Cappadocia, thrives best in a rich light earth, and may be easily propagated from seeds, as indeed all the other species may.

CHEMICAL CHARACTERS

SIMPLE OR UNDECOMPOUNDED SUBSTANCES

METALS

Platinum (P)
Gold
Silver (S)
Copper (C)
Lead (L)
Tin (T)
Iron (I)
Zinc (Z)
Antimony (A)

INFLAMABLES

Carbon or Diamond
Hydrogen
Sulphur
Phosphorus

ALKALIS

Potass
Soda (S)

EARTHS

Argill (A)
Baryt (B)
Lime (L)
Magnesia (M)
Silex (S)

Compound Acidifiable Bases

Radical Muriatic (M)
Boracic (B)
Oxalic (O)
Prussic (P)
Sebacic (S)
Succinic (Su)
Tartaric (T)

Compound Substances not Acidifiable

Alkohol (A)
Ether (E)
Bitumen (I)
Fat Oil (F)
Volatile Oil (V)
Mucus (M)

OXYGEN & CALORIC combined with different substances

Oxyd of Nitrogen Gas
Nitrous Oxyd Gas
Acid Gas
Acid
Nitric Acid
Muriatic Acid Liquid (M)
Oxy Muriatic Acid Liquid (M)
Oxalic Acid concrete (O)
Sulphuric Acid Liquid
Phosphoric Acid concrete
Arsenic Acid concrete (A)
Oxyd of Iron (I)
Oxyd of Mercury (M)
Water
Aqueous Gas

Combinations of Caloric with different Substances

	Solid	Fluid	Gas
Nitrogen			
Oxygen			
Sulphur			
Hydrogen			
Mercury (M)	(M)	(M)	(M)
Arsenic	(A)	(A)	(A)
Zinc	(Z)	(Z)	(Z)

Combination of two Substances — Caloric Sometimes forms a third

Ammonia
Ammoniacal Gas

Hydrogen Gas Combined with

Sulphuret of
- Potass
- Ammonia
- Lime
- Iron

Alloy of Amalgam of
- Gold
- Platina (P) (M)
- Silver (S) (M)
- Tin (T) (M)

Alloy of
- Silver & Gold (S)
- Silver & Copper (S) (C)
- Copper & Tin (C) (T)

Carbon
Sulphur
Phosphorus

Carburet of Iron (I) (C)

SALTS with an alkaline Earthy or Metallic Basis

Sulphat of
- Potass (V)
- Iron (I)
- Argill (V)
- Ammonia
- Potass (V)
- Silver (S)
- Ammonia
- Baryt (B) (V)
- Soda (S) (M)
- Baryt (B) (M)
- Tin (T) (M)

Nitrat of

Muriat of

Acetat of
- Argill (V) (A)
- Copper (C) (A)
- Potass (V) (A)
- Lead (L) (A)

Prusiat of Oxalat of
- Potass (V) (O)
- Potass with excess of base (V) (O)
- Iron (I) (O)
- Potass (V) (P)
- Iron (I) (P)

Gallat of Iron (I) (G)

Tartrite of Fluat of Borat of
- Soda (S) (B)
- Lime (L) (B)
- Potass (V) (F)
- Lime (L) (F)
- Potass (V) (T)
- Potass with excess of base (V) (T)

Citrat of Potass (V) (C)

Malat of Potass (V) (Ma)

Phosphat of Carbonat of
- Strontian (S)
- Lime (L)
- Potass (V)
- Ammonia
- Soda (S)
- Lime (L)
- Iron (I)

Molybdat of Potass (V) (Mo)

Arseniat of
- Copper (C) (A)
- Iron (I) (A)

Chromat of Iron (I) (Ch)

Tungstat of
- Lime (L) (T)
- Iron (I) (T)

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4. Chenopodium scoparia, the belvidere, or annual mock cypress, is an ornamental plant. It is eaten in China.

CHERLERIA, a genus of the decandria trigynia class of plants. The flower has properly no petals; the nectaria are five in number, roundish and emarginated, very small, and placed in a circular direction. The fruit is a capsule, formed of three valves, and containing three seeds. There is one species.

CHERMES, in zoology, a genus of insects belonging to the order hemiptera. The rostrum is situated on the breast; the feelers are longer than the thorax; the four wings are deflected; the thorax is gibbous; and the feet are of the jumping kind. There are 17 species. It is an insect to be met with in great numbers upon the fig-tree. The larva has six feet. It is like the insect, when provided with wings. Its form is oblong, and its motion is slow. The chrysalis differs from it by two flat buds that spring from the thorax, and inclose the wings, afterwards seen in the perfect insect. These chrysalids are frequently met with on plants; and the two plates of their thorax give them a broad uncouth appearance, and a heavy look. When the little chrysalids are going to be metamorphosed, they remain motionless under some leaves upon which they fix themselves. Their skin then divides upon the head and thorax, and the perfect insect comes forth with his wings. The perfect insect is furnished with four wings, large in proportion to its body. Several species are provided at the exremity of their body with a small sharp-pointed implement, but which lies concealed, and which they draw out in order to deposit their eggs, by making a puncture in the plant that suits them. By this method the fir-tree chermes produces that enormous scaly protuberance which is to be found at the summit of the branches of that tree, and which is formed by the extravasation of the juices occasioned by the punctures. The young larvæ shelter themselves in cells contained in the tumour. The white down, under which the larva of the pine-chermes is found, seems to be produced much in the same manner. That of the box-tree chermes produces no tubercula like those; but its punctures make the leaves of that tree bend and grow hollow in the shape of a cap, which, by the union of those inflected leaves, produces at the extremity of the branches a kind of knobs, in which the larvæ of that insect find shelter. The box chermes, as well as some others, has yet another peculiarity, which is, that the larva and its chrysalis eject at the anus a white sweet-tasted matter, that softens under the touch, and is not unlike manna. This substance is found in small white grains within the balls formed by the box-leaves, and a string of the same matter is often seen depending from the anus of the insect.

CHERT, among miners, denotes a kind of flinty stone, found in thin strata in quarries of lime-stone. This stone is usually amorphous, occurring sometimes in mass, sometimes in round balls. Its specific gravity is from 2.699 to 2.708; colour usually greyish blue, but it sometimes is found grey, blue, green, and brown of different shades. Different colours frequently appear in the same specimen. It is called by Kirwan, hornstone, and by him it is said to consist of

72 parts of silica
22 ——— alumine
6 ——— carbonate of lime.

100.

CHESS, an ingenious game, performed with different pieces of wood, on a board divided into 64 squares or houses, in which chance has so small a share, that it may be doubted whether a person ever lost but by his own fault. Each gamester has eight dignified pieces, viz. a king, a queen, two bishops, two knights, and two rooks, also eight pawns; all which, for distinction sake, are painted of two different colours, as white and black.

As to their disposition on the board, the white king is to be placed on the fourth black house from the corner of the board, in the first and lower rank; and the black king is to be placed on the fourth white house on the opposite or adversary's end of the board. The queens are to be placed next to the kings, on houses of their own colour. Next to the king and queen, on each hand, place the two bishops; next to them the two knights; and last of all, on the corners of the board, the two rooks. As to the pawns, they are placed without distinction on the second rank of the house, one before each of the dignified pieces.

Having thus disposed the men, the onset is commonly begun by the pawns, which march straight forward in their own file, one house at a time, except the first move, when it can advance two houses, but never moves backwards. The manner of their taking the adversary's men is sideways, in the next house forwards; where having captivated the enemy, they move forward as before. The rook goes forward or crossways through the whole file, and back again. The knight skips backward and forward to the next house, save one, of a different colour, with a sidling march, or a slope, and thus kills his enemies that fall in his way, or guards his friends that may be exposed on that side. The bishop walks always in the same colour of the field that he is placed in at first, forward and backward, aslope, or diagonally, as far as he lists. The queen's walk is more universal, as she takes all the steps of the before-mentioned pieces, excepting that of the knight: and as to the king's motion, it is one house at a time, and that either forward, backward, sloping, or sideways.

As to the value of the different pieces, next to the king is the queen, after her the rooks, then the bishops, and last of all the dignified pieces comes the knight. The difference of the worth of pawns is not so great as that of noblemen; only, it must be observed, that the king's bishop's pawn is the best in the field, and therefore the skilful gamester will be careful of him. It ought also to be observed, that whereas any man may be taken, when he falls within the reach of any of the adversary's pieces, it is otherwise with the king, who, in such a case, is only to be saluted with the word *check*, warning him of his danger, out of which it is absolutely necessary that he move; and if it so happens that he cannot move without exposing himself to the like inconveniency, it is check-mate and, the game is lost.

CHIAROSCURO, effect produced in painting or drawing, by an artful conduct and union of colours and light and shade. See PAINTING.

CHIAROSCURO is also used, improperly, to express the general effect of light and shade produced in painting or drawing by the use of one tint only, as in designs executed in white and black, or white and brown, &c.

CHIEF, in heraldry, is that which takes up all the upper part of the escutcheon, from side to side, and represents a man's head.

CHILDREN, are in law a man's issue begotten on his wife. In case land is given by will to a man and his children, who has such alive, the devisee takes only an estate for life; but if there is no child living, it is held to be an estate tail. 1 Vent. 214.

CHILIAD, denotes a thousand of any things, ranged in several divisions, each whereof contains that number.

CHILIAGON, in geometry, a regular plane figure of 1000 sides and angles. It is easily demonstrable that the sum of all the angles of such a figure is equal to 196 right ones. For the internal angles of every plane figure are equal to twice as many right angles as the figure hath sides, except those four which are about the center of the figure. Hence it may be resolved into as many triangles as the figure has sides.

CHILTERN HUNDREDS, *stewards of the*. Of the hundreds into which many of the English counties were divided by king Alfred for their better government, the jurisdiction was originally vested in peculiar courts; but came afterwards to be devolved to the county courts, and so remains at present; except with regard to some, as the Chilterns in Buckinghamshire, which have been by privilege annexed to the crown. These having still their own courts, a steward of those courts is appointed by the chancellor of the exchequer, with a salary of 20*s*. and all fees, &c. belonging to the office. This is made a matter of convenience to the members of parliament. When any of them wishes to resign, he accepts the stewardship of the Chiltern hundreds, which vacates his seat.

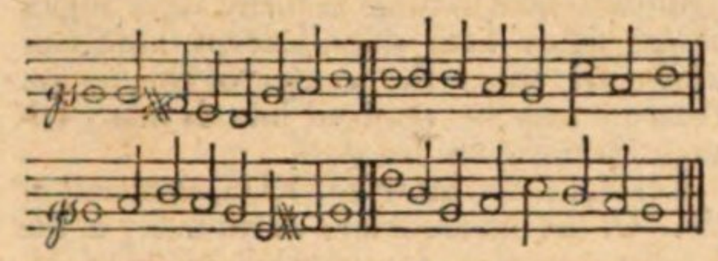
CHIMARRHIS, a genus of the class and order pentandria monogynia. The essential character is; cor. funnel-form; caps. interior, obtuse; two-celled; two-valved; seeds one in each cell. There is one species, a lofty tree, a native of Martinico.

CHIMES *of a clock*, a kind of periodical music, produced at equal intervals of time, by means of a particular apparatus added to a clock.

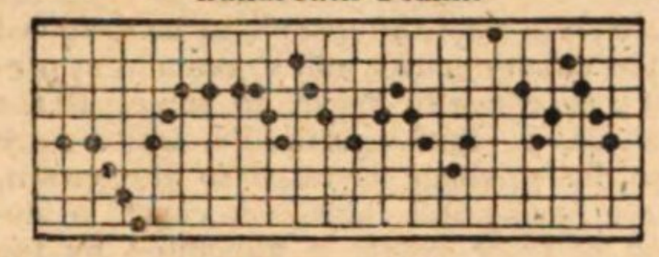
In order to calculate numbers for the chimes, and adapt the chime-barrel, it must be observed that the barrel must turn round in the same time that the tune it is to play requires in singing. As for the chime-barrel, it may be made of certain bars that run athwart it, with a convenient number of holes punched in them, to put in the pins that are to draw each hammer; and these pins, in order to play the time of the tune rightly, must stand upright, or hang down from the bar, some more some less. To place the pins rightly, you may proceed by the way of changes on bells, viz. 1, 2, 3, 4; or rather make use of the musical notes. Observe what is the compass of your tune, and divide the barrel accordingly from end to end. Thus in the following example the tune is eight notes in compass, and therefore the barrel is divided into eight parts: these divisions are struck round the barrel,

opposite to which are the hammer-tails; but when two notes of the same sound come together in a tune, there must be two hammers to that bell to strike it. Then you are to divide it round about, into as many divisions as there are musical bars, semibriefs, minims, &c. in your tune. Thus the hundredth Psalm tune has twenty semibriefs, the first note of it is also a semibrief, and therefore on the chime-barrel must be a whole division from 5 to 5; as may be understood by conceiving the surface of a chime-barrel to be represented by the following tables, as if the cylindrical superficies of the barrel was stretched out at length, or extended on a plane; and then such a table so dotted or divided, if it was to be wrapped round the barrel, would shew the places where all the pins are to stand in the barrel: for the dots running about the table, are the places of the pins that play the tunes.

The notes of the hundredth Psalm.



A table for dividing the chime-barrel of the hundredth Psalm.



If you would have your chimes complete, you ought to have a set of bells to the gamut notes; so as that each bell having the true sound of sol, la, mi, fa, you may play any tune with its flats and sharps, nay even the bass and treble, with one barrel. And by setting the names of your bells at the head of any tune, you may transfer that tune to your chime-barrel, without any skill in music; but observe, that each line in the music is three notes distant; that is, there is a note between each line, as well as upon it.

CHIMNEY. The rules for building chimneys are, 1. That no timber be laid within twelve inches of the fore side of the chimney-jambs. 2. That all the joists on the back of any chimney be laid with a trimmer. 3. That no timber be laid within the funnel of any chimney.

CHIMNEY-SWEEPERS. The overseers, &c. of any parish, may bind any boy of the age of eight years or upwards, who is chargeable to the parish, to any person using the trade of a chimney-sweeper, till he shall attain the age of 16 years, provided that it be done with the consent of the parent of such boy. And no master shall have more than six apprentices at one time. Every master shall cause his name and place of abode to be put upon a brass plate, and to be fixed upon the front of a leathern cap, which he shall provide for each apprentice, who shall wear the same when out upon his duty; on pain of forfeiting for every such apprentice, above such number, or without having such cap, not exceeding 10*l*. nor less than 5*l*.

For an apparatus for sweeping chimneys, see MACHINES.

CHIOCOCCA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 48th order, aggregatæ. The corolla is funnel-shaped and equal; the berry unilocular, dispermous, inferior. There are two species.

CHIONANTHUS, the snow-drop, or fringe-tree, a genus of the monogynia order, belonging to the diandria class of plants, and in the natural method ranking under the 44th order, sepiariæ. The corolla is quadrifid, with the segments very long; the fruit is a plumb. There are 4 species described by botanists. The most remarkable is the

Chionanthus Virginica, common in Virginia and South Carolina, where it grows by the side of rivulets. It rises to ten feet.

CHIRONIA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 20th order, rotaceæ. The corolla is wheel-shaped; the pistil declining downwards; the stamina placed in the tube of the corolla; the antheræ in their last stage spiral; the seed-case bilocular. There are 10 species, of which the most remarkable is the

Choronia frutescens, a native of the Cape of Good Hope. The flowers are tubulous, and spread open at the top. They are of a bright red colour, and when a large number of them open on the same plant, they make a fine appearance. They are produced from June to autumn, and the seeds ripen in October.

CHIROGRAPHER OF FINES. The officer in the common pleas, who engrosses fines in that court, acknowledged into a perpetual record, after they are acknowledged and fully passed by those officers by whom they were examined, and that write or deliver the indentures of them to the party. This officer also makes two indentures, one for the buyer and another for the seller; and makes one other indented piece, containing also the effect of the fine, which he delivers over to the custos brevium.

CHIRURGERY. See SURGERY.

CHITON, a genus of the order of vermes testaceæ. The shell is plated, and consists of many parts lying upon each other transversely. The inhabitant is a species of doris. There are nine species. See Plate Nat. Hist. fig. 117.

CHIVALRY, a tenure of land by knight's service, whereby the tenant is bound to perform some noble or military office to his lord.

CHLORA, a genus of the monogynia order, in the octandria class of plants. The calyx is octophyllous, the corolla monopetalous and octofid; the capsule unilocular, bivalved, and polyspermous. There are four species.

CHLORANTHUS, a genus of the class and order tetrandria monogynia. The essential character is, calyx none; corolla three-lobed, petal by the side of the germ; anthers growing to the petal; drupe seeded. There is one species, a native of China.

CHLORITES, in natural history, a kind of green jasper, but almost as pellucid as the coarser emeralds. This mineral enters as an ingredient into different mountains. It is sometimes amorphous, and sometimes crystallised in oblong, four-sided, acuminated crystals. Its texture is foliated; it is opaque and green. There are four species.

1. The earthy chlorite is composed of scales scarcely cohering, either heaped together, or investing other stones. It feels greasy, gives an earthy smell when breathed on, and is difficult to pulverize. The colour is grass-green, sometimes greenish-brown, or a very dark green inclining to black. When the powder of the chlorite is exposed to the blow-pipe, it becomes brown: it froths and melts into a dark-brown glass; with borax it forms a greenish-brown glass.

2. Common chlorite, texture earthy; colour dark green; streak mountain-green.

3. Foliated chlorite, colour dark green, sometimes crystallized in six-sided tubes; greasy or pearly, texture foliated.

4. Shistose chlorite, structure slaty; fragments flatted; colour greenish-grey, or dark green inclining to black; streak mountain-green.

Supposing that these analyses are accurate, the difference between them shews that the chlorite is not a chemical combination, but a mechanical mixture.

CHOCOLATE, in commerce, a kind of paste, or cake, prepared chiefly from the cacao-nut.

When the cacao is properly roasted, and well cleaned, it is pounded in a mortar, to reduce it into a coarse mass, which is afterwards ground on a stone till it is of the necessary fineness: the paste being sufficiently ground, it is put hot into tin moulds, in which it congeals in a very little time. The form of these moulds is arbitrary; the cylindrical ones, holding two or three pounds, are the most proper; because the larger the cakes are, the longer they will keep. These cakes are very liable to take any good or bad scent, and therefore they must be carefully wrapt up in paper, and kept in a dry place. Complaints are made, that the Spaniards mix with the cacao-nuts too great a quantity of cloves and cinnamon, besides other drugs, as musk, ambergris, &c. The grocers of Paris use few or none of these ingredients; they only choose the best nuts, which are called caracca, from the place whence they are brought; and with these they mix a very small quantity of cinnamon, the freshest vanilla, and the finest sugar, but very seldom any cloves. In England, the chocolate is made of the simple cacao, excepting that sometimes sugar, and sometimes vanilla, is added.

Chocolate, fresh from the mill, as it cools in the tin pans into which it is received, becomes strongly electrical, and it retains this property some time after it has been turned out of the pans.

Chocolate ready made, and cacao-paste, are prohibited to be imported from any part beyond the seas. If made and sold in Great Britain, it pays inland-duty 1s. 6d. per pound avoirdupois: it must be inclosed in papers containing one pound each, and produced at the excise-office, to be stamped. Upon three days notice given to the officer of excise, private families may make chocolate for their own use, provided no less than half a hundredweight of nuts are made at one time.

CHOENIX, a dry measure, containing the forty-eighth part of a medimnus, or six bushels. Hence the celebrated proverb of Pythagoras, Super chœnice ne sedeas.

CHOLERA MORBUS. See MEDICINE.

CHONDRILLA, a genus of the polygamia æqualis order, in the syngenesia class

of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the calyx calyculated; the pappus simple and stalked; the florets in a manifold series. There are three species.

CHORD, in geometry, a right line drawn from one part of an arch of a circle to the other. See GEOMETRY.

CHORDS, *Line of*, one of the lines of the sector and plane scale. See MATHEMATICAL INSTRUMENTS.

CHORDS, or CORDS, in music, are strings, by the vibration of which the sensation of sound is excited, and by the divisions of which the several degrees of tune are determined.

To find the number of vibrations made by a musical chord, or string, in a given time, having its weight, length, and tension, given. Let l be the length of the chord in feet; 1 its weight, or rather a small weight fixed to the middle, and equal to that of the whole chord; and w the tension, or a weight by which the chord is stretched. Then the time of one vibration will be expressed by $\frac{11}{7}\sqrt{\frac{l}{32\frac{1}{6}w}}$; consequently the number of vibrations per second is equal to $\frac{7}{11}\sqrt{\frac{32\frac{1}{6}w}{l}}$. Thus, if $w = 28800$, or the tension equal to 28800 times the weight of the chord, and the length of it three feet, then the last theorem gives 354 nearly for the number of vibrations made in each second of time. But if $w = 14400$, there would be only 250 vibrations per second; and if $w = 288$, there would be $35\frac{16}{45}$ vibrations per second.

CHORIAMBUS, in antient poetry, a foot consisting of four syllables, whereof the first and last are long, and the two middle ones are short; or, which is the same thing, it is made up of a trochæus and iambus: such is the word nōbĭlĭtās.

CHOROGRAPHY, the art of making a map of some country or province.

Chorography differs from geography, as the description of a particular country does from that of the whole earth; and from topography, as the description of a country differs from that of a town or district.

CHOSE, *in action*, is an incorporeal thing, and only a right, as an annuity, bond, covenant, &c. and generally all causes of suit, for any duty or wrong, are accounted choses in action. Choses in action may be also called choses in suspense, as having no real existence, and not being properly in our possession.

CHRIST, order of, a military order, founded by Dionysius I. king of Portugal, to animate his nobles against the Moors.

The arms of this order are gules, a patriarchal cross, charged with another cross argent: they had their residence at first at Castromarin, afterwards they removed to the city of Thomar, as being nearer to the Moors of Andalusia and Estremadura.

CHROMATIC, in the antient music, the second of the three kinds into which the consonant intervals were subdivided iuto their concinnous parts. The other kinds are enharmonic and diatonic.

CHROMATICS, that part of optics which explains the several properties of colours. See OPTICS.

CHRONIC, or CHRONICAL, among physicians, an appellation given to diseases that continue a long time, in contradistinction to those that soon terminate and are called acute. See MEDICINE.

CHRONICLE, in matters of literature, a species or kind of history, disposed according to the order of time, and agreeing in most respects with annals. The word chronicle is now become obsolete, being seldom used except in speaking of the old English histories, as Stowe's chronicle, Holingshed's chronicle, &c.

CHRONOLOGY, the art of measuring and distinguishing time; with the doctrines of dates, epochs, æras, &c. is a science of the utmost importance for the right understanding of history. It depends and is founded on 1st, astronomical observations, especially of the eclipses of the sun and moon, combined with calculations of the year, and æras of different nations. 2dly, On the testimonies of credible authors. 3dly, Such epochs in history as have never been controverted. 4thly, Antient medals, coins, monuments, and inscriptions.

Sir Isaac Newton has shewn that the chronology of antient kingdoms is involved in the greatest uncertainty; and that the Europeans had no chronology before the existence of the Persian empire, or 536 years before Christ, when Cyrus conquered Darius: that the antiquities of the Greeks are full of fables, till this period, and that after this time several Greek historians introduced the computation by generations.

The chronology of the Latins was still more uncertain: their old records having been burnt by the Gauls 120 years after the expulsion of their kings, and 388 before the birth of Christ. The chronologers of Gaul, Spain, Germany, Scythia, Sweden, Britain, and Ireland, are of a still later date; for Scythia beyond the Danube had no letters till Ulphilas, their bishop, formed them, about the year 276. Germany had none till it received them from the western empire of the Latins about the year 400. The Huns had none in the days of Procopius, about the year 526; and Sweden and Norway received them still later.

Sir Isaac Newton, after a general account of the obscurity and defects of the antient chronology, observes, that though many of the antients computed by successions and generations, yet the Egyptians, Greeks, and Latins, reckoned the reigns of kings equal to generations of men, and three of them to a hundred, and sometimes to 120 years, and this was the foundation of their technical chronology. He then proceeds, from the ordinary course of nature, and a detail of historical facts, to shew the difference between reigns and generations; and that, though a generation from father to son may at an average be reckoned about 33 years, or three of them equal to 100 years, yet, when they are taken by the eldest sons, three of them cannot be estimated at more than about 75 or 80 years; and the reigns of kings are still shorter; so that 18 or 20 years may be allowed as a just medium. Sir Isaac then fixes on four remarkable periods, viz. the return of the Heraclidæ into the Peloponnesus, the taking of Troy, the Argonautic expedition, and the return of Sesostris into Egypt after his wars in Thrace; and he settles the epoch of each by the true value of a generation. To instance only his estimate of that of the Argonautic expedition: Haying fixed the return of the Heraclidæ to about the 159th year after the death of Solomon, and the destruction of Troy to about the 76th year after that period, he observes, that Hercules the Argonaut was the father of Hyllus, the father of Clerdius, the father of Aristomachus, the father of Aristodemus, who conducted the Heraclidæ into Peloponnesus: so that, reckoning by the chiefs of the family, their return was four generations later than the Argonautic expedition, which therefore happened about 43 years after the death of Solomon. This is farther confirmed by another argument: Æsculapius and Hercules were Argonauts: Hippocrates was the 18th inclusively from the former by the father's side, and the 19th from the latter by the mother's side: now, allowing 28 or 30 years to each of them, the 17 intervals by the father, and the 18 intervals by the mother, will on a medium give 507 years; and these, reckoning back from the commencement of the Peloponnesian war, or the 431st year before Christ, when Hippocrates began to flourish, will place the Argonautic expedition in the 43d year after the death of Solomon, or 937 years before Christ.

The other kind of reasoning by which sir Isaac Newton endeavours to establish this epoch, is purely astronomical. The sphere was formed by Chiron and Musæus for the use of the Argonautic expedition, as is plainly shewn by several of the asterisms refering to that event: and at the time of the expedition the cardinal points of the equinoxes and solstices were placed in the middle of the constellations Aries, Cancer, Chelæ, and Capricorn. This point is established from the consideration of the antient Greek calendar, which consisted of 12 lunar months, and each month of 30 days, which required an intercalary month. Of course this lunisolar year, with the intercalary month, began sometimes a week or two before or after the equinox or solstices: and hence the first astronomers were led to the before-mentioned disposition of the equinoxes and solstices: and that this was really the case, is confirmed by the testimonies of Eudoxus, Aratus, and Hipparchus. Upon these principles sir Isaac proceeds to argue in the following manner. The equinoctial colure in the end of the year 1689 cut the ecliptic in ♉ 6° 44′; and by this reckoning the equinox had then gone back 36° 44′ since the time of the Argonautic expedition. But it recedes 50′ in a year, or 1° in 72 years, and consequently 36° 44 in 2645 years; and this, counted backwards from the beginning of 1690, will place this expedition about 25 years after the death of Solomon. But as there is no necessity for allowing that the middle of the constellations, according to the general account of the antients, should be precisely the middle between the prima Arietis and ultima Caudæ, our author proceeds to "examine what were those stars through which Eudoxus made the colures to pass in the primitive sphere, and in this way to fix the position of the cardinal points." Now from the mean of five places he finds, that the great circle, which in the primitive sphere, described by Eudoxus, or which at the time of the Argonautic expedition, was the equinoctial colure, did in the

end of 1989 cut the ecliptic in ♉ 6° 29′ 15″. In the same manner our author determines that the mean place of the solstitial colure is ♌ 6° 28′ 46″, and as it is at right angles with the other, he concludes that it is rightly drawn. And hence he infers that the cardinal points, in the interval between that expedition and the year 1689, have receded from those colures 1s. 6° 29′; which, allowing 72 years to a degree, amounts to 2627 years; and these counted backwards, as above, will place the Argonautic expedition 43 years after the death of Solomon. Our author has, by other methods also of a similar nature, established this epoch, and reduced the age of the world 500 years.

The use of chronology.—The divisions of time which are considered in chronology, relate either to the different methods of computing days, months, and years, or to the remarkable æras or epochas from which any year receives its name, and by means of which the date of any event is fixed.

Days have been very differently terminated and divided by different people in different ages, which it is of some importance to a reader of history to be acquainted with. The antient Babylonians, Persians, Syrians, and most other eastern nations, with the present inhabitants of the Balearic islands, Greeks, began their day with the sun's rising. The antient Athenians and Jews, with the Austrians, Bohemians, Marcomanni, Silesians, modern Italians, and Chinese, reckon from the sun's setting; the antient Umbri and Arabians, with the modern astronomers, from noon; and the Egyptians and Romans, with the modern English, French, Dutch, Germans, Spaniards, and Portuguese, from midnight.

The Jews, Romans, and most other antient nations, divided the day into twelve hours, and the night into four watches. But the custom which prevails in this western part of the world at present is, to divide the day into 24 equal portions: only with some the 24 are divided into twice 12 hours; whereas others, particularly the Italians, Bohemians, and Poles, count 24 hours without interruption.

Different people have made their years to begin at different times, and have used a variety of methods to give names to them, and distinguish them from one another.

The Jews began the year for civil purposes in the month of *Tizri*, which answers to our September; but for ecclesiastical purposes with *Nisan*, which answers to our April, at which time they kept the passover. The Athenians began the year with the month *Hecatombæon*, which began with the first new moon after the summer solstice. The Romans had at first only ten months in their year, which ended with December; but Numa added January and February. At present there are in Rome two ways of reckoning the year. One begins at Christmas, on account of the nativity of our Saviour; and the notaries of Rome use this date, prefixing to their deeds, *a nativitate:* and the other at March, on account of the incarnation of Christ, and therefore the pope's bulls are dated *anno incarnationis.* The antient French historians began the year at the death of St. Martin, who died in the year 401 or 402; and they did not begin in France to reckon the year from January till 1564, by virtue of an ordinance of Charles IX. Before that time they began the day next after Easter, about the 25th of March. In England, also, till of late, we had two beginnings of the year, one in January, and the other on March 25; but by act of parliament in 1752, the first day in January was appointed to be the beginning of the year for all purposes.

Most of the eastern nations distinguish the year by the reigns of their princes. The Greeks also had no better method, giving names to them from the magistrates who presided in them, as in Athens from the Archons. The Romans also named the year by the consuls; and it was a long time before any people thought of giving names to the years from any particular æra or remarkable event. But at length the Greeks reckoned from the institution of the Olympic games, and the Romans from the building of Rome. They did not, however, begin to make these computations till a number of years had elapsed since those events could not be computed with exactness, and therefore they have greatly antedated them.

About A. D. 360, the Christians began to reckon the years from the birth of Christ, but not time enough to enable the chronologers of that age to fix the true time of that event.

The Greeks distributed their years into systems of four, calling them Olympiads, from the return of the Olympic games every four years. And the Romans sometimes reckoned by *lustra*, or periods of five years.

The greatest difficulty in chronology has been, to accommodate the two methods of computing time by the course of the moon and that of the sun, to each other; then earest division of the year by months being twelve, and yet twelve lunar months falling eleven days short of a complete year. This gave birth to many cycles in use among the antients, the principal of which are as follows:

It appears from the relation which Herodotus has given of the interview between Solon and Crœsus, that, in the time of Solon, and probably that of Herodotus also, it was the custom with the Greeks to add, or, as it is termed, to *intercalate*, a month every other year; but as this was evidently too much, they probably rectified it, by omitting the intercalation whenever they observed, by comparing the seasons of the year with their annual festivals, that they ought to do it. If, for instance, the first fruits of any kind were to be carried in procession on any particular day of a month, they would see the necessity of intercalating a month, if, according to their usual reckoning, those fruits were not then ripe, or they would omit the intercalation if they were ready. And had no other view interposed, their reckoning could never have erred far from the truth. But it being sometimes the interest of the chief magistrates to lengthen or shorten a year, for the purposes of ambition, every other consideration was often sacrificed to it, and the greatest confusion was introduced into their computations. Finding themselves, therefore, under a necessity of having some certain rule of computation, they first adopted four years, in which they intercalated only one month. But this producing an error of fourteen days in the whole cycle, they invented the period of eight years, in which they intercalated three months; in which was an excess of only one day and fourteen hours, and therefore this cycle continued in use much longer than either of the preceding.

But the most perfect of these cycles was that which was called the Metonic, from Meton, an Athenian astronomer, who invented it. It consisted of nineteen years, in which seven months were intercalated. This brought the two methods to so near an agreement, that after the expiration of the period, not only do the new and full moons return on the same day of the year, but very nearly on the same hour of the day. This cycle was adopted by the Christians at the council of Nice, for the purpose of settling the time for keeping Easter, and other moveable feasts. This period, however, falling short of nineteen years almost an hour and a half, it has come to pass that the new and full moons in the heavens have anticipated the new and full moons in the calendar of the book of Common Prayer four days and a half. These last are called *calendar new moons*, to distinguish them from the true new moons in the heavens.

It has not been without difficulty and variety that the computation by years has been accommodated to that by days; since a year does not consist of any even number of days, but of 365 days, 5 minutes, and 49 seconds nearly. It will appear from what has been observed, that so long as mankind computed chiefly by months, it was not of much consequence to determine with exactness the number of days in the year; and this method sufficiently answered every civil and religious purpose. But the Egyptians, and other nations addicted to astronomy, were not satisfied with the method of computing by lunar months, the days of which varied so very much from one another in different years. They therefore made the year the standard; and dividing that into days, made use of months only as a commodious intermediate division; and, without regard to the course of the moon, distributed the days of the year into twelve parts, as nearly equal as they conveniently could. By this means the same day of the month would fall on the same part of the sun's annual revolution, and therefore would more exactly correspond to the seasons of the year. The Mexicans divided their year into eighteen parts.

The Egyptians, as also the Chaldeans and Assyrians, reckoned at first 360 days to the year, but afterwards 365. The consequence of this was, that the beginning of their year would go back through all the season, though slowly; namely, at the rate of about six hours every year. Of this form too were the years which took their date from the reign of Nabonassar of Babylon, Yesdigerd of Persia, and the Seleucidæ of Syria.

It must be observed, however, that the people who reckoned their year from these epochas, namely, the Egyptians, Persians, and Jews, as also the Arabians, had a different and more fixed form of the year for astronomical purposes; but as no use was made of it in civil history, the account of it is omitted in this place.

The inconvenience attending the form of the year above-mentioned, was in a great measure remedied by the Romans in the time of Julius Cæsar, who added one day every fourth year, which (from the place of

its insertion, viz. after the sixth of the calends of March) was called *bissextile*, or leap-year. This form of the year is still called the Julian year. But the true length of the year being not quite six hours more than the 365 days, this allowance was too much; and pope Gregory XIII. introduced another amendment, in the year 1582, by ordering that once in 133 years a day should be taken out of the calendar, in the following manner, viz. from the year 1600 every hundredth year (which, according to the Julian form, is always bissextile or leap-year) was to be common; but every four-hundredth year was to continue bissextile, as in the Julian account.

The Mahometans make their year to consist of lunar months only, without endeavouring to adapt it to the course of the sun; so that with them the beginning of the year goes through all the seasons at the rate of about eleven days every year. But since the exact time of twelve moons, besides the 354 whole days, is about eight hours and 48 minutes, which make 11 days in 36 years, they are forced to add 11 days in 30 years, which they do by means of a cycle, invented by the Arabians, in which there are 19 years with 354 days only, and 11 intercalary of 355 days, and they are those in which the number of hours and minutes more than the whole days in the year is found to be more than half a day, such as 2, 5, 7, 10, 13, 16, 18, 21, 24, 26, and 29, by which means they fill up all the inequalities that can happen.

It has been of some consequence to Christians to adjust the days of the week to the days of the month, and of the year, in order to get a rule for finding Sunday. Had there been no bissextile, it is evident that, since the year consists of 52 weeks and one day, all the varieties would have been comprized in seven years. But the bissextile returning every fourth year, the series of dominical letters succeeding each other is interrupted, and does not return in order; but after four times 7 years, or 28 years, which is therefore commonly called the solar cycle, serve as a rule to find Sunday, and consequently all the days of the week of every month and year.

Besides the above-mentioned periods of years, called cycles, there are some other combinations or systems of years that are of use in chronology; as that called the *indiction*, which is a period of 15 years, at the end of which a certain tribute was paid by the provinces of the Roman empire, and by which the emperors ordered public acts to be dated.

But the most remarkable of all the periods in chronology, is that called the Julian period, invented by Joseph Scaliger; and called Julian, from the years of which it consists being Julian years. His object was to reduce to a certainty the different methods of computing time, and fixing the dates of events by different chronologers. For this purpose nothing was necessary but a series of years, some term of which was fixed (that, for instance, by which the present year should be denominated), comprehending the whole extent of time; since, if each chronologer would apply that common measure to his particular scheme, they would all perfectly understand one another. To accomplish this, he combined the three periods of the sun, the moon, and the indiction, together; that is, multiplying the numbers 28, 19, and 15, into one another, which produces 7980; after which period, and not before, all the three cycles will return in the same order every year, being distinguished by the same number of each. In order to fix the beginning of this period, he took the cycles as he then found them settled in the Latin church; and tracing them backwards through their several combinations, he found that the year in which they would all begin together was the year before the creation 714, according to Usher; and that the first year of the Christian æra would be 4714 of this period. There is a farther convenience in this period, viz. that if any year is divided by the number composing the cycles, viz. 28, 19, or 15, the quotient will shew the number of the cycles that have elapsed since the commencement of it, and the remainder will give the year of the cycle, corresponding to the year given.

We cannot help observing that this boasted period seems to have been unnecessary for the chief purpose for which it was invented, viz. to serve as a common language for chronologers; and that now little use is made of it, notwithstanding all writers still speak of it in the same magnificent terms. The vulgar Christian æra answers the same purpose as effectually.

All that can be necessary for chronologers to speak the same language, and be perfectly understood by one another, and by all mankind, is to give every year the same name or designation; which is most conveniently done by expressing them in a series of numbers in arithmetical progression, any one term of which they shall agree to affix to the same year, a year in which any well-known event happened. Let it, for example, be that in which the peace of Amiens was made, and let it be called 1801. If, besides this, it is only agreed in what part of the revolution of the sun, or in what month and day, the year begins, there can be no difficulty in giving a name to every other year preceding or following it, and thereby ascertaining the interval between all transactions. For all the events that took place the year before that peace, will be referred to the year 1800, and all in the year after it to 1802. This period having had a commencement since the date of history, is no inconvenience; for whenever we have gone back to number 1 of this period, the year preceding it may be called *one before its commencement*, the year preceding that *two* before it, &c. and thus proceeding *ad infinitum* both ways.

That Christ might not have been born in the first of that system of years to which it serves to give a name, is no inconvenience whatever; since, whatever differences of opinion there may be among chronologers about the time when Christ was born, they all agree in calling the present year, and consequently every other year, by the same name; and therefore they have the same idea of the interval between the present year and any other year in the system. The real time of Christ's birth can no more affect the proper use of this system than that of any other indifferent event; since, using the same system of dates, they may say Christ was born in the third, fourth, fifth, or sixth year before the Christian æra.

Whenever, therefore, chronologers ceased to date events from the Creation, which was very absurd (since they did not agree in fixing the intervals between the present year and the date of that event, and therefore gave all the years different names), they had no occasion to have recourse to any such period as the Julian; since another, capable of answering the same purposes, was already in common use, supplying them with a language which they all equally understood.

Æras or epochas are memorable events from which time is reckoned, and from which any subsequent year receives its denomination. The Greeks for a long time had no fixed æra; afterwards they reckoned by Olympiads, which were games celebrated in honour of Jupiter once in four years, and began in midsummer, 776 years before Christ. The Athenians gave names to their years from their archons. The Romans called their years from the names of the consuls who presided in them; and afterwards they dated events from the building of their city, supposing it to have been built 753 years before Christ.

Some histories are regulated by the era of Nabonassar, who began his reign in the year 747 before Christ, of the Julian period 3867. It is supposed to have commenced on the 26th of February in the afternoon.

The Jews before Christ reckoned by the year of the Seleucidæ, sometimes called the year of the Contracts; which began in the year 312 before Christ, of the Julian period 4402, some time in the spring.

The Christians, about 360 years after the birth of Christ, began to make use of that æra, which is now used in all Christian countries.

The Mahometans reckon their years from the flight of Mahommed from Mecca. This æra is called the Hegyra. It began in the year 622 after Christ, of the Julian period 5335, on the 16th of July.

The old Spanish æra is dated from the year 38 before Christ, about the time when they were subdued by the Romans. It was used till the year 1333, under John I. of Castile.

The Egyptians long reckoned from the battle of Actium, which happened in the year 31 before Christ, of the Julian period 4683, on the 3d of September.

Before the Christian æra was used, the Christians for some time made use of the Diocletian æra, which took its rise from the persecution by Diocletian, in the year 284 after Christ.

The æra of Yerdigerd is dated from the last king of Persia; who was conquered by the Saracens under Abubecher, in the battle of Merga, in the year 632 after Christ, of the Julian period 5345, on the 16th of June.

With regard to all these methods of denominating time, care must be taken that the year be reckoned according to the method of computation followed by the people who use it. Thus, in reckoning from the Hegyra, a person would be led into a mistake who should make those years correspond to Julian years. He must deduct eleven days from every year which has elapsed since the commencement of it. Thus, though the first year of this æra corresponded to the year 622 after Christ, and began on the 16th of July, the year 326 of the Hegyra corresponded to the year 937 of Christ, and began November 8: and the year of the Hegyra 655 commenced on the 19th of Jan. 1257.

This compendium of chronology is sufficient for the purpose of reading history, but is by no means a complete account of the methods of computing time in every particular country which has been mentioned. To have done this, would have carried us beyond our present purpose, and too far into the customs of particular countries. For a fuller account, the reader may be referred to Dr. Blair, and other chronologers.

PROBLEMS IN CHRONOLOGY.

1. To find whether any given year be leap-year.

Rule.—Divide the given year by 4: if 0 remains, it is leap-year; but if 1, 2, 3, remains, it is so many years after.

Every fourth year is leap-year, so called from leaping or advancing a day more that year than any other; that year has then 366 days in it, and February 29.

2. To find the dominical letter before the year 1800.

Rule. To the given year add its fourth part, omitting fractions; divide that sum by 7; the remainder taken from 7 leaves the index of the letter in the common year's reckoning.

1 2 3 4 5 6 7
A B C D E F G

But in leap-years this letter and its preceding one (in the retrograde order which these letters take) are the dominical letters.

The dominical letter is that letter of the alphabet which points out in the calendar the Sundays throughout the year; thence also called the Sunday letter. Of these letters there are consequently seven before mentioned, beginning with the first letter of the alphabet; and as in leap-year there is an intercalary day, there are then two; one serving January and February, and its following letter the remaining part of the year.

3. To know on what day in the week any proposed day of the month will fall.

Rule. First find the dominical letter, then the day of the week the first of the proposed month falls on, which is known by the two following lines:

At Dover Dwell George Brown, Esquire,
Good Christopher Finch, And David Frier:

where the first letter of each word answers to the letter belonging to the first day of the months in order, from January to December. If I would know on what day of the week the 24th of June will be this year (1806); I find the Dominical letter is E, and by the lines just read, E is the first of June, which is, of course, Sunday; the 22nd also is Sunday, therefore the 24th will be a Tuesday.

4. To find the year of the solar, lunar or golden number, and indiction cycles.

Rule. To the given year add 9 for the solar, 1 for the lunar, 3 for the indiction: divide the sums in order by 28, 19, and 15, the remainder in each shows the years of its respective cycle.

The solar cycle, or the cycle of the sun, is a period of 28 years; in which time all the varieties of the dominical letters will have happened, and the 29th year the cycle begins again, when the same order of the letters will return as were 28 years before.

At the birth of Christ, nine years had passed in this cycle.

The lunar cycle, or cycle of the moon, or golden number, is a period of 19 years; containing all the variations of the days on which the new and full moons happen, after which time they fall on the same days they did 19 years before, and she begins again with the sun.

But when a centesimal or hundredth year falls in the cycle, the new and full moon, according to the new style, will fall a day later than otherwise. The birth of Christ happened in the second year of this cycle.

The Roman indiction is a cycle of 15 years, which first began the third year before Christ.

5. To find the epact till the year 1900.

Rule. Multiply the golden number for the given year by 11; divide that product by 30, and from the remainder take 11, leaves the epact. If the remainder is less than 11, add 19 to it, and the sum will be the epact.

6. To find the moon's age.

Rule. To the epact add the number and day of the month; their sum, if under 30, is the moon's age. But if that sum is above 30, the excess in months of 31 days, or the excess above 29 in a month of 30 days, shows the age or days since the last conjunction.

The moon's age taken from 30, leaves the day of the next new moon.

When the solar and lunar cycles begin together, the moon's age on the first of each month, or the monthly epacts, are called the numbers of the month, and are as follows, viz.

For	Jan.	Feb.	Mar.	April.	May.	June.
These	0.	2.	1.	2.	3.	4.
For	July.	Aug.	Sep.	Oct.	Nov.	Dec.
These	5.	6.	7.	8.	9.	10.

7. To find when Easter-day will happen.

Rule. Find on what day of March the new moon falls nearest to the 21st in common years, or nearest the 20th in leap-years; then the Sunday next after the full, or 15th day of that new moon, will be Easter-day.

If the 15th day falls on a Sunday, the next Sunday is Easter-day.

Among the earliest writers on chronology, after the discovery of printing, was Paulus Constantinus Phrygio, whose "Chronicon Regum Regnorumque omnium" was printed at Basil in 1534. A second was Bibliander's work, in 1558; and a third, Eggard's "Tabulæ Chronologicæ," printed at Rostock, 1577. Among the most valuable which are now in use upon the continent, are the tables of Du Fresnoy and Berger, both originally published in 1719. The title only of the latter, we believe, ("Synchronistische Universalhistorie,") is known in England; but those of the former have been long received in credit; although they are now superseded not only by Dr. Blair's Tables, but by professor Playfair's System of Chronology, 1784.

The following, as the greater epochs in the chronology of history, have been selected from Dr. Blair. The history of the intervals may be easily supplied by the memory of a retentive reader.

Bef. Chr.	
4004	Creation of the world
3875	The murder of Abel
3874	The birth of Seth
3017	Enoch translated
2348	The deluge
2247	The tower of Babel built
2000	The birth of Abraham
1921	The covenant made with Abraham
1728	Joseph sold into Egypt
1689	The death of Jacob
1635	The death of Joseph, which concludes the book of Genesis
1574	The birth of Aaron
1571	The birth of Moses
1491	God's appearance to Moses in the burning bush
1451	The Israelites under Joshua pass the river Jordan
1285	Deborah defeats the Canaanites
1263	The Argonautic expedition undertaken
1236	The death of Gideon
1188	Jephthah's vow
1184	Troy taken
1117	Sampson betrayed to the Philistines
1104	The return of the Heraclidæ to Peloponnesus
1095	The Israelites ask for a king. Saul anointed
1070	Athens governed by archons
1048	Jerusalem taken by David
1044	The migration of the Ionic colonies from Greece
1023	Absalom's rebellion
1004	Solomon's dedication of the temple
926	The birth of Lycurgus
907	Homer supposed to have flourished
897	The death of Ahab
896	Elijah's translation
814	The kingdom of Macedon begins
800	Jonah prophesies
790	Amos
785	Hosea
758	Nahum
757	Isaiah, who prophesied above 60 years
754	Micah prophesies
753	The æra of the building of Rome
750	The rape of the Sabines
731	Habakkuk prophesies
721	Samaria taken. The first eclipse of the moon upon record
710	Senacherib's army destroyed
696	Isaiah the prophet put to death
686	Archilochus the poet flourishes
677	The combat of the Horatii and Curiatii
658	Byzantium built
627	Jeremiah prophesies
628	Zephaniah
623	Draco establishes his laws at Athens
605	The beginning of the captivity
600	Sappho flourishes
593	Ezekiel prophesies
591	Institution of the Pythian games
587	Jerusalem taken by Nebuchadnezzar
560	Pisistratus usurped the tyranny of Athens
558	Daniel prophesies
539	Pythagoras flourishes
536	Cyrus gives an edict for the return of the Jews
528	Haggai prophesies
527	Zechariah
525	Cambyses conquers Egypt
520	Confucius flourishes
515	The temple of Jerusalem finished
509	The consular government begins at Rome
490	The battle of Marathon
480	The defeat of Salamis
458	Ezra flourishes
456	Nehemiah the prophet
451	Laws of the twelve tables compiled
445	Herodotus reads his history at Athens
431	Beginning of the Peloponnesian war

Bef. Chr.
430 About this time the history of the Old Testament finishes
401 The retreat of the 10,000 Greeks under Xenophon. The 30 tyrants expelled from Athens by Thrasybulus
398 The military catapultæ invented
390 Plato made his first voyage into Sicily
357 Dionysius the tyrant expelled Syracuse
343 The war between the Romans and Samnites
340 The Carthaginians defeated by Timoleon
336 Philip of Macedon killed by Pausanias
327 Alexander's expedition into India
323 The death of Alexander
322 Demosthenes put to death by Antipater
296 Athens taken by Demetrius Poliorcetes
286 Lysimachus takes possession of Macedon
284 The septuagint translation of the Old Testament thought to have been made
278 The Gauls under Brennus cut to pieces
264 The beginning of the first Punic war
260 The Carthaginians defeated at sea by the Romans
256 Regulus defeated by the Carthaginians
241 Agis, king of Sparta, put to death
235 The temple of Janus shut the first time after Numa
224 The colossus of Rhodes thrown down by an earthquake
218 The second Punic war begins. Annibal passes the Alps
216 The battle of Cannæ
212 Syracuse taken by Marcellus
202 Annibal defeated at Zama
200 The first Macedonian war begins
190 The first Roman army enters Asia
187 Antiochus the Great defeated and killed
167 The first library erected at Rome
149 The third Punic war begins
146 Carthage destroyed by Publius Scipio
137 Ptolemy Phryocon began a new restoration of learning at Alexandria
116 Cleopatra assumes the government of Egypt
107 Cicero born
101 Marius and Catullus defeat the Cimbri
100 The birth of Julius Cæsar
99 Lusitania conquered by the Romans
89 The Mithridatic war begins
81 Cicero made his first oration
66 Mithridates defeated by Pompey
65 The reign of the Seleucidæ ends in Syria
63 Cataline's conspiracy detected
55 Cæsar's first expedition against Britain
50 Cæsar besieges Pompey in Brundusium
48 The battle of Pharsalia
44 Cæsar killed in the senate-house
40 Jerusalem occupied by Antigonus
31 The battle of Actium: Marc Antony and Cleopatra defeated
25 The Egyptians adopt the Julian year
8 Augustus corrects the calendar
4 Our Saviour's birth: four years before the common æra

CHRISTIAN ÆRA.

Aft. Christ.
8 Our Saviour disputes with the Jewish doctors
14 Augustus dies at Nola
17 Twelve cities in Asia destroyed by an earthquake
26 St. John the Baptist enters on his ministry
27 John baptizes our Saviour
33 Our Saviour's crucifixion
36 St. Paul converted
37 Tiberius dies at Misenum
39 St. Matthew writes his gospel
43 Claudius's expedition into Britain
44 St. Mark wrote his gospel
51 Caractacus carried in chains to Rome
52 The council of the apostles at Jerusalem
54 The death of Claudius
59 Nero puts his mother Agrippina to death
61 Boadicea, the British queen, defeats the Romans
62 St. Paul sent in bonds to Rome
64 The first persecution against the Christians
66 The Jewish war begins
67 St. Peter and St. Paul put to death
70 Titus destroys Jerusalem
95 The second persecution against the Christians
102 Pliny the Younger sends Trajan his celebrated account of the Christians
107 The third persecution against the Christians
118 The fourth persecution against the Christians
130 Adrian rebuilds Jerusalem
135 Conclusion of the Jewish war, when the Jews were all banished Judea
146 The worship of Serapis introduced at Rome
202 The fifth persecution against the Christians
235 The sixth persecution against the Christians
250 The seventh persecution
252 A great pestilence in the Roman empire
257 The eighth persecution of the Christians
269 Zenobia takes posession of Egypt
272 The ninth persecution against the Christians
293 Carausius killed by Alectus
286 The Roman empire attacked by the northern nations. Carausius reigns in Britain
303 The tenth persecution against the Christians
312 Maxentius defeated by Constantine
319 Constantine begins to favour the Christians
325 The first general council of Nice
340 The death of Constantine the Great
343 Persecution of the Christians in Persia
364 The Roman empire divided into the eastern and western
388 The tyrant Maximus defeated
406 The Vandals, Alans, and Suevi, spread into France and Spain
410 Rome taken and plundered by Alaric
420 The kingdom of the French begins upon the lower Rhine
426 The Romans leave Britain
435 The Theodosian codex published
449 The Saxons arrive in Britain
452 The city of Venice takes its rise
455 Rome taken by Genseric
475 Hengist's massacre of the British nobles
476 The western empire finishes
493 The kingdom of Italy passes from the Heruli to the Ostro-Goths
496 Clovis baptized, and christianity embraced in France
510 Paris made the capital of the French dominions
511 Arthur defeats the Saxons in the battle of Badon-hill
516 The computing of time by the Christian æra introduced by Dionysius
529 The code of Justinian published
533 The digest of Justinian published
536 Rome taken by Belisarius
551 The manufacture of silk introduced into Europe from India by some monks
558 A terrible plague all over Europe, Asia, and Africa, which continues near fifty years
580 Cosroes the Great defeated, and dies of grief
597 Augustin the monk arrives in England
606 The power of the popes begins
622 The Hegira of Mahomet begins
637 Jerusalem taken by the Saracens
640 Alexandria taken by the Saracens, and the great library there burnt
653 The Saracens take Rhodes, and cut to pieces the famous colossus
709 Ina, king of Wessex, publishes his laws
748 The computing of years from the birth of Christ began to be used in histories about this time
750 The Merovingian race ends in France
751 The second race of the French kings begins with Pepin, surnamed the Little
762 Bagdad built by Almansor
774 Pavia taken by Charlemagne
778 The battle of Roncevaux
800 The emperors of the West, or of Germany, begin
822 The Saracens besiege Constantinople
810 A civil war among the Saracens
828 The heptarchy of England united under Egbert
838 The Picts defeated by the Scots
840 The death of Lewis the Debonnaire
843 The French peers make a new division of the French dominions
853 The Normans get possession of some cities in France
867 The Danes conquer Northumberland
872 Alfred defeated by the Danes
878 Alfred conceals himself in Athelney
879 The kingdom of Arles begins
886 The university of Oxford said to have been founded
888 The dominions of Charles le Gros divided into five kingdoms
904 The Hungarians ravage Italy
912 The Normans establish themselves in France under Rollo
936 The Saracen empire divided by usurpation into seven kingdoms
964 The kingdom of Italy conquered by Otho
987 The third race of the French kings begins under Hugh Capet
996 Otho III. makes the empire of Germany elective
1013 The Danes, under Sueno, get possession of England
1035 The kingdoms of Castile and Arragon begin
1043 The Turks take possession of Persia
1065 Jerusalem taken by the Turks from the Saracens

Aft. Chr.
1066 The conquest of England under William duke of Normandy
1080 The Domesday survey compiled
1096 The first crusade to the Holy Land
1110 Learning revived at the university of Cambridge
1118 The order of the knights templars instituted
1140 King Stephen defeated and taken prisoner in the battle of Lincoln
1146 The empress Matilda retires out of England
1147 The second crusade
1151 The canon law composed by Gratian
1154 The party names of Guelfs and Gibbelines begin
1162 The emperor Frederick destroys Milan
1172 Henry II. takes possession of Ireland
1177 Saladin repulsed before Jerusalem
1189 The kings of England and France go to the Holy Land
1192 Richard Cœur de Lion defeats Saladin at Ascalon
1204 Normandy conquered, and re-united to France
1215 Magna Charta signed by king John
1227 The Tartars under Gingis-kan overrun the Saracen empire
1233 The inquisition trusted to the Dominicans
1253 The famous astronomical tables are composed by Alfonso XI. king of Castile
1273 The empire of the present Austrian family begins
1279 The mortmain-act passed in England
1283 Wales conquered by Edward the First
1293 The regular succession of the English parliaments begins
1307 The beginning of the Swiss cantons
1310 The knights of St. John take Rhodes
1312 The knights templars condemned
1346 The battle of Cressy
1349 The order of the garter instituted
1352 The Turks enter Europe
1356 The battle of Poictiers
1381 Wat Tyler's insurrection
1388 The battle of Otterburn
1414 The council of Constance
1440 The art of printing discovered
1455 The battle of St. Albans
1471 The battle of Tewksbury
1478 Lorenzo de Medici expelled Florence
1485 The battle of Bosworth
1497 The Portuguese first sail to the East Indies
1508 The league of Cambray formed
1517 The Reformation begun by Luther
1522 Rhodes taken by the Turks
1527 Rome taken by Charles V.
1534 The Reformation takes place in England
1545 The council of Trent begins
1571 The victory of Lepanto obtained
1572 The massacre of Paris
1582 Pope Gregory introduces the new style
1587 Mary queen of Scots beheaded
1588 The destruction of the Spanish armada
1596 Cadiz taken by the English
1604 Ostend taken by the Spaniards
1608 The invention of the telescope
1614 Napier invents the logarithms
1618 The synod of Dort begins
1619 Harvey discovers the circulation of the blood
1621 The civil war with the Huguenots in France
1629 Nine members imprisoned for their speeches in the house of commons
1640 The Scots army enters England
1642 King Charles demands the five members
1645 The battle of Naseby
1649 King Charles beheaded
1652 The first war between the English and Dutch begins
1660 The Restoration of Charles II.
1662 The Royal Society established
1680 The great comet observed
1683 Lord Russel beheaded
1688 The Revolution in England
1692 The sea-fight of La Hogue
1704 Gibraltar taken by admiral Rook
1706 The battle of Ramillies
1709 The battle of Pultowa
1720 The South Sea scheme begins
1727 The siege of Gibraltar by the Spaniards
1750 The interest on the public funds reduced to three per cent.
1752 The new style introduced into Great Britain
1766 The American stamp-act repealed
1772 The revolution in Denmark
1773 The order of the Jesuits suppressed
1775 The American war commenced
1779 The siege of Gibraltar begun
1780 The riots in London
1782 The sea-fight under Rodney
1783 The preliminaries of a general peace signed. America declared independant
1789 The revolution in France begins
1793 Louis XVI. beheaded
1798 The battle of the Nile.
1799 Buonaparte made first consul of France
1805 The victory off Trafalgar

CHRONOMETER, in general, denotes any instrument, or machine, used in measuring time. See CLOCKWORK.

Several machines have been invented for measuring time, under the name of chronometers, upon principles very different from those on which clocks and watches are constructed. The lamp chronometer consists of a chamber-lamp, which is a cylindrical vessel about three inches high, and one inch diameter, placed in a stand. The inside of this vessel must be every where exactly of the same diameter. To the stand is fixed a handle which supports a frame, about twelve inches high, and four wide. This frame is to be covered with oiled paper, and divided into twelve equal parts by horizontal lines; at the end of which are written the numbers for the hours, from 1 to 12, and between the horizontal lines are diagonals that are divided into halves, quarters, &c. On the handle, and close to the glass, is fixed a style or gnomon. Now as the distance of the style from the flame of the lamp is only half an inch, if the distance of the frame from the style is only six inches, then, while the float that contains the light descends by the decrease of the oil one inch, the shadow of the style on the frame will ascend twelve inches, that is, its whole length, and shew by its progression the regular increase of the hours with their several divisions. It is absolutely necessary, however, that the oil used in this lamp should be always of the same sort, and quite pure, and that the wick also be constantly of the same size and substance; as it is on these circumstances, and the uniform figure of the vessel, that the regular progress of the shadow depends.

CHROSTASIMA, in natural history, a genus of pellucid gems, comprehending all those which appear of one simple and permanent colour in all lights: such are the diamond, carbuncle, ruby, garnet, amethyst, sapphire, beryl, emerald, and the topaz.

CHRYSALIS, or AURELIA, in natural history, a state of rest and seeming insensibility, which butterflies, moths, and several other kinds of insects, must pass through before they arrive at their winged or most perfect state. In this state, no creatures afford so beautiful a variety as the butterfly kinds, and they all pass through this middle state without one exception. The figure of the aurelia or chrysalis generally approaches to that of a cone; or at least the hinder part of it is in this shape; and the creature, while in this state, seems to have neither legs nor wings, nor to have any power of walking. It seems indeed to have hardly so much as life. It takes no nourishment in this state, nor has it any organs for taking any; and indeed its posterior part is all that seems animated, this having a power of giving itself some motions. The external covering of the chrysalis is membranaceous, and considerably large, and is usually smooth and glossy: but some of them have a few hairs; some are also as hairy as the caterpillars from which they are produced; and others are rough or shagreened all over. In all of these there may be distinguished two sides; the one of which is the back, the other the belly of the animal. On the anterior part of the latter, there may always be distinguished certain little elevations running in ridges, and resembling the fillets wound about mummies: the part whence these have their origin is esteemed the head of the animal. The other side, or back, is smooth, and of a rounded figure in most of the chrysalises; but some have ridges on the anterior part, and sides of this part; and these usually terminate in a point, and make an angular appearance on the chrysalis.

From this difference is drawn the first general distinction of these bodies. They are by this divided into two classes; the round and the angular kinds. There are also several subordinate distinctions of these kinds; but, in general, they are less different from one another than the caterpillars whence they are produced. The head of those of the first class usually terminates itself by two angular parts, which stand separate one from another, and resemble a pair of horns. On the back, eminences and marks are discovered, which imagination may form into eyes, nose, chin, and other parts of the human face.

There are a great variety and a great deal of beauty in the figures and arrangement of the eminences and spots on the other parts of the body of the chrysalises of different kinds. It is a general observation, that those chrysalises which are terminated by a single horn, afford day-butterflies of the kind of those which have buttoned antennæ, and the wings of which, in a state of rest, cover the under part of their body, and which use all

their six legs in walking, those of many other kinds using only four of them. Those chrysalises which are terminated by two angular bodies, and which are covered with a great number of spines, and have the figure of a human face on their back in the greatest perfection, afford butterflies of the day-kind; and of that class the characters of which are, their walking on four legs, and using the other two, that is, the anterior part, in the manner of arms or hands. The chrysalises which have two angular bodies on their heads, but shorter than those of the preceding, and whose back shews but a faint sketch of the human face, and which have fewer spines, and those less sharp, always turn to that sort of butterfly the upper wings of which are divided into segments, one of which is so long as to represent a tail, and whose under wings are folded over the upper part of the back. A careful observation will establish many more rules of this kind, which are not so perfect as to be free from all exceptions; yet are of great use, as they teach us in general what sort of fly we are to expect from the chrysalis, of which we know not the caterpillar, and therefore can only judge from appearances. These are the principal differences of the angular chrysalises; the round ones also have their different marks not less regular than those.

The greater number of the round chrysalises have the hinder part of their body of the figure of a cone; but the upper end, which ought to be its circular plane base, is usually bent and rounded into a sort of knee; this is usually called the head of the chrysalis; but there are also some of this kind, the head of which is terminated by a nearly plane surface: some of the creeping ten-legged caterpillars give chrysalises of this kind, which have each of them two eminences that seem to bring them towards the angular kind.

Among the angular chrysalises there are some whose colours seem as worthy our observation as the shapes of the others. Many of them appear superbly clothed in gold. These elegant species have obtained the name of chrysalis and aurelia, which are derived from Greek and Latin words, signifying gold; and from these all other bodies of the same kind have been called by the same names, though less, or not at all, entitled to them. Some are all over of an elegant green, as is the chrysalis of the fennel caterpillar; others of an elegant yellow; and some of a bright greenish tinge, variegated with spots of a shining black; we have a very beautiful instance of this kind in the chrysalis of the cabbage-caterpillar. The general colour of the chrysalis of the common butterflies, however, is brown.

The several species of insects, as a fly, spider, and an ant, do not differ more evidently from one another in regard to appearance, than do a caterpillar, its chrysalis, and a butterfly produced from it; yet it is certain, that these are all the product of the same individual egg; and nothing is more certain, than that the creature which was for a while a caterpillar, is, after a certain time, a chrysalis, and then a butterfly. These great changes produced in so sudden a manner, seem like the metamorphoses recorded in the fables of the antients; and indeed it is not improbable that those fables first took their origin from such changes.

The parts being distinguishable in the chrysalis, we easily find the difference of the species of the fly that is to proceed from it. The naked eye shews whether it is one of those that have, or those that have not, a trunk; and the assistance of a microscope shews the antennæ so distinctly, that we are able to discern whether it belongs to the day or night class; and often to what genus, if not the very species: nay, in the plumose horned kinds, we may see, by the antennæ, whether a male or female phalæna is to be produced from the chrysalis; the horns of the female being in this state evidently narrower, and appearing less elevated above the common surface of the body, than those of the male. All these parts of the chrysalis, however, though seen very distinctly, are laid close to one another, and seem to form only one mass; each of them is covered with its own peculiar membrane in this state, and all are surrounded together by a common one; and it is only through these that we see them; or rather we see on these the figures of all the parts moulded within, and therefore it requires attention to distinguish them. The chrysalis is soft when first produced, and is wetted on the front with a viscous liquor; its skin, though very tender at first, dries and hardens by degrees: but this viscous liquor, which surrounds the wings, legs, &c. hardens almost immediately; and in consequence fastens all those limbs, &c. into a mass, which were before loose from one another: this liquor, as it hardens, loses its transparency, and becomes brown; so that it is only while it is yet moist that these parts are to be seen distinct.

It is evident from the whole, that the chrysalis is no other than a butterfly, the parts of which are hidden under certain membranes which fasten them together; and, when the limbs are arrived at their due strength, they become able to break through these membranes, and expand and arrange themselves in their proper order. The first metamorphosis, therefore, differs in nothing from the second, except that the butterfly comes from the body of the caterpillar in a weak state, with limbs unable to perform their offices, whereas it comes from the chrysalis perfect.

Mr. Reaumur, in his History of Insects, vol. 1. has given many curious particulars on the structure and uses of the several coverings that attend the varieties of the caterpillar kind in this state. These creatures in general remain wholly immoveable, and seem to have no business in it but a patient attendance on the time when they are to become butterflies; and this is a change that can happen to them, only as their parts, before extremely soft and weak, are capable of hardening and becoming firm by degrees, by the transpiration of that abundant humidity which before kept them soft; and this is proved by an experiment of Mr. Reaumur, who, inclosing some chrysalises in a glass tube, found, after some time, a small quantity of water at the bottom of it; which could have come there no other way, but from the body of the inclosed animal. This transpiration depends greatly on the temperature of the air; it is increased by heat, and diminished by cold; but it has also its peculiarities in regard to the several species of butterfly to which the chrysalis belongs.

According to these observations, the time of the duration of the animal in the chrysalis state must be, in different species, very different; and there is indeed this wide difference in the extremes, that some species remain only eight days in this state, and others eight months.

CHRYSIS, or gold-fly, a genus of insects belonging to the hymenoptera order. The mouth is armed with jaws, but has no proboscis; the antennæ are filiform, bent, and consist of 12 articulations. The abdomen is arched, with a scale on each side; the anus is dentated, and armed with a sting; the wings lie plain, and the body appears as if gilt. There are seven species, of which the lucidula is one: it is beautified with the most splendid colours. The fore part of the head is green and gold, and the hinder of a bright azure. The thorax is azure and green: the abdomen is green and gold before, and of a coppery red behind. This species lives in holes of walls. The larvæ, which resemble those of the wasp, likewise inhabit the holes of decayed walls. See Plate Nat. Hist. fig. 120.

CHRYSITRIX, in botany: a genus of the diœcia order, in the polygamia class of plants. In the hermaphrodite, the glume is two-valved, the corollæ from chaff numerous and bristly; many stamina, one within each chaff; one pistillum. The male is the hermaphrodite; it has no pistillum. There is one species, a native of the Cape.

CHRYSOBALANUS, COCOA PLUM: a genus of the monogynia order, in the icosandria class of plants; and in the natural method ranking under the 36th order, pomaceæ. The calyx is quinquefid, the petals five; plum kernel five-furrowed and five-valved. There is only one species, the chrysobalanus icacō, a native of the Bahama islands and many other parts of America, but commonly grows near the sea. It rises with a shrubby stalk eight or nine feet high. The flowers are white, and are succeeded by plums like damsons; some blue, some red, and others yellow. The stone is shaped like a pear, and has five longitudinal furrows. The plums have a sweet luscious taste; and are brought to the tables of the inhabitants by whom they are much esteemed.

CHRYSOCOMA, GOLDY-LOCKS: a genus of the polygamia æqualis order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the pappus simple; the calyx hemispherical and imbricated; the style hardly longer than the florets. There are thirteen species, the most remarkable of which are the linosyris and the cernua. These are herbaceous flowering perennials, growing from one to two feet high, ornamented with narrow leaves, and compound floscular flowers of a yellow colour.

CHRYSOGONUM, a genus of the polygamia necessaria order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is paleaceous; the pappus monophyllous, and tridented: the calyx pentaphyllous; the seeds wrapped up each in a tetraphyllous calyculus, or little cup. There is one species, a native of Virginia.

CHRYSOLITE, in natural history, a gem which the antients knew under the name of the topaz; and the true chrysolite of the an-

tients, which had its name from its fine gold-yellow colour, is now universally called topaz by modern jewellers.

The chrysolite is found in angular fragments, in grains, and crystallized. The primitive form of its crystals is a right-angled parallelopid, whose length, breadth, and thickness, are as 5, $\sqrt{8}$, $\sqrt{5}$. The edges of the prism are usually truncated. The texture is foliated. Its fracture is conchoidal: it causes double refractions, and its specific gravity is from 3.265 to 3.45. Colour green. It is infusible at 150 degrees, but loses its transparency, and becomes a blackish grey. With borax it melts without effervescence into a transparent glass of a green colour. There are two varieties.

1. Common chrysolite, found in Ceylon, South America, and in Bohemia, amidst sandy gravel. Colour yellowish g een, sometimes verging to olive-green, sometimes to yellow.

2. Olive chrysolite, found commonly in basalt; sometimes in small grains, sometimes in pretty large pieces. It has not been observed in crystals: colour olive-green. The first variety is, according to the analysis of Klaproth, composed of

41.5 magnesia
38.5 silica
19.0 oxyde of iron.

99.0

The second is composed of

37.58 magnesia
50.00 silica
11.75 oxyde of iron
.21 lime

99.54

CHRYSOMELA, in zoology, a genus of insects with bracelet-like antennæ, thickest towards the extremities; the body of an oval form, and the thorax rounded. Of this genus, which belongs to the order of coleoptera, there are 122 different species, denominated from the trees on which they feed, as the chrysomela of tansy, beech, alder, willow, &c. some being of one colour, some of another, with a tinge of gold-colour diffused through it.

CHRYSOPHYLLUM, the BULLY TREE: a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 43d order, viz. dumosæ. The corolla is campanulated, decemfid, with the segments alternately a little patent. The fruit is a ten-seeded berry. There are six species, natives of the West Indies. The most remarkable are:

1. The Chrysophyllum cainito, rises thirty or forty feet high. The flowers come out at the extremities of the branches, disposed in oblong bunches, which are succeeded by fruit of the size of a golden pippin, very rough to the palate, and astringent; but when kept some time mellow, as is practised here with medlars, they have an agreeable flavour.

2. Chrysophyllum glabrum, never rises to the height of the cainito, nor do the trunks grow to half the size. The flowers come out, clusters from the side of the branches, and are succeeded by oval smooth fruit, about the size of a bergamot pear. It contains a white clammy juice when fresh; but after being kept a few days, it becomes sweet, soft, and delicious. Inclosed are four or five black seeds, of the size of those of a pomkin. Both species are often preserved in large stoves.

CHRYSOPRASE. This mineral, which is found in several parts of Germany, is always amorphous. Its fracture is either even or inclined to the splintery, with very little lustre; its colour green; specific gravity 2.479. In a heat of 130 degrees Wedgewood, it whitens and becomes opaque. It is found by Klaproth to be composed of

96.16 silica
1.00 oxide of nickel
0.83 lime
0.08 alumine
0.08 oxide of iron.

98.15

CHRYSOSPLENIUM, a genus of the digynia order, in the decandria class of plants; and in the natural method ranking under the 12th order, succulentæ. The calyx is quadrifid or quinquefid, and coloured; no corolla; the capsule birostrated, unilocular, and polyspermous. Its English name is golden saxifrage. There are two species, common in all the northern parts of Europe.

CHUPMESSAHITES, a sect of Mahometans, who believed that Jesus Christ was God, and the redeemer of the world.

CHURCH, the place which christians consecrate to the worship of God. By the common law and general custom of the realm, it was lawful for earls, barons, and others of the laity, to build churches; but they could not erect a spiritual body-politic to continue in succession, and capable of endowment, without the king's licence; and before the law shall take knowledge of them as such, they must also have the bishop's leave and consent to be consecrated or dedicated by him. 3 Inst. 203.

CHURCHWARDENS, the guardians or keepers of the church, are persons annually chosen in Easter week, by the joint consent of the minister and parishioners, or according to the custom of the respective places; to look after the church and church-yard, and things thereunto belonging. They are entrusted with the care and management of the goods and personal property of the church, which they are to order for the best advantage of the parishioners; but they have no interest in, or power over, the freehold of the church itself, or of any land or other real property belonging to it: these are the property of the parson or vicar, who alone is interested in their loss or preservation. The churchwardens therefore may purchase goods and other articles for the use of the parish; they may likewise, with the assent of the parishioners, sell, or otherwise dispose of, the goods of the church, but without such consent they are not authorized to alienate any of the property under their care. 4 Viner Abr. 526.

All peers of the realm, clergymen, counsellors, attorneys, clerks in court, physicians, surgeons, and apothecaries, are exempt from serving the office of churchwardens; as is every dissenting teacher or preacher, in holy orders, or pretended holy orders.

By 2 Geo. III. c. 20. no serjeant, corporal, drummer, or private man, personally serving in the militia, during the time of such service, shall be liable to serve as churchwarden.

By the 10 and 11 Wm. c. 23. s. 2. persons who have prosecuted a felon to conviction, and the first assignee of the certificate thereof, are exempted.

No person living out of the parish may be chosen churchwarden. Gibs. 215.

CHYLE, in the animal economy, a milky fluid, secreted from the aliments by means of digestion. See PHYSIOLOGY.

CICATRIX, in surgery, a little seam or elevation of callous flesh rising on the skin, and remaining there after the healing of a wound or ulcer. It is commonly called a scar. See SURGERY.

CICADA, the FROG-HOPPER, or flea-locust, a genus of insects belonging to the order of hemiptera. See Plate Nat. Hist. figs. 121, 122, 123. The beak is inflected; the antennæ are setaceous: the four wings are membranaceous and deflected; and the feet in most of the species, are of the jumping kind. The species are fifty-one. The larvæ of several of this genus evacuate great quantities of a frothy matter upon the branches and leaves of plants, in the midst of which they constantly reside, probably for shelter against the search of other animals, to which they would become a prey. Nature has afforded this kind of defence to insects whose naked and soft bodies might otherwise very easily be injured; perhaps also the moisture of this foam may serve to screen it from the sultry beams of the sun. On removing the foam, you discover the larva concealed underneath; but it does not long remain uncovered. It soon emits fresh foam, that hides it from the eye of observation. It is in the midst of this foamy substance that the larva goes through its metamorphosis into a chrysalis and perfect insect. Other larvæ, whose bodies are not so soft, run over plants without any manner of defence; and escape from insects that might hurt them, by the nimbleness of their running, but especially of their leaping.

The chrysalids, and all the larvæ that produce them, differ little from each other, only that the former have the rudiments of wings, a kind of knob at the place where the wings will afterwards be in the perfect insect. In other respects, the chrysalids walk, leap, and run, over plants and trees; as do the larva and the frog-hopper, which they are to produce. At length they throw off their teguments of chrysalids, slip their last slough, and then the insect appears in its utmost state of perfection. The male alone is then endowed with the faculty of singing, which it exercises not with its throat, but with an organ situated under the abdomen. Behind the legs of the male are observed two valvulæ, which, raised up, discover several cavities separated by various membranes. The middle contains a scaly triangle. Two vigorous muscles give motion to another membrane, which alternately becomes concave and convex. The air, agitated by this membrane, is modified within the other cavities; and by the help of this sonorous instrument, he amorously solicits his female. By pulling the muscles of a frog-hopper lately dead, it may be made to sing. This insect begins its song early in the morning, and continues it during the heat of the noontide sun. Its lively and animated music is, to the country people, a presage of a fine summer, a plenti-

fel harvest, and the sure return of spring. The cicadæ have a head almost triangular, an oblong body, their wings fastigiated or in form of a roof, and six legs with which they walk and leap pretty briskly. In the females, at the extremity of the abdomen, are seen two large lamina, between which is enclosed, as in a sheath, a spine, or lamina, somewhat serrated, which serves them for the purpose of depositing their eggs, and probably to sink them into the substance of those plants which the young larvæ are to feed upon.

CICCA, a genus of the tetrandria order, in the monœcia class of plants. The male calyx is tetraphyllous; there is no corolla; the female calyx triphyllous; no corolla; four styles; the capsule quadricoccous, or four-berried. There is one species, a shrub of the East Indies.

CICER, the *chick-pea*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is quinquepartite, as long as the corolla, with its four uppermost segments incumbent on the vexillum; the legumen is rhomboidal, turgid, and dispermous. There is but one species, which produces peas shaped like the common ones, but much smaller. They are cultivated in Spain, where they are natives, being one of the ingredients in their olios, as also in France; but are rarely known in Britain.

CICHORIUM, *succory*, a genus of the polygamia æqualis order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is a little paleaceous; the calyx calyculated; the pappus almost quinquedentated, and indistinctly hairy. There are three species, viz.

1. Cichorium endivia, or common endive, with broad crenated leaves, differs from the wild sort (No. 2.) in its duration, being only annual, whereas the wild sort is perennial. This species may be considered both as an annual and biennial plant. If sown early in the spring, or even any time before the beginning of June, the plants very commonly fly up to seed the same summer, and perish in autumn. If sown in June and July they acquire perfection in autumn, continue till the next spring, then shoot up stalks for flower and seed, and soon after perish. The inner leaves are the useful parts. These when blanched white to render them crisp and tender, and reduce them from their natural strong taste to an agreeable bitter one, are then fit for use. They are valued chiefly as ingredients in autumn and winter salads, and for some culinary uses.

2. Cichorium intybus, wild succory, grows naturally by the sides of roads, and in shady lanes. It sends out long leaves from the roots, from between which the stalks arise, growing to the height of three or four feet, and branching out into smaller ones. The flowers come out from the sides of the stalks, and are of a fine blue colour. They are succeeded by oblong seeds covered, inclosed in a down. The roots and leaves are articles of the materia medica. The former have a moderately bitter taste, with some degree of roughness; the leaves are somewhat less bitter; and the darker-coloured and more deeply jagged they are, the bitterer is their taste. Wild succory is an useful detergent, aperient, and attenuating medicine, acting without much irritation, tending rather to cool than to heat the body; and, at the same time, corroborating the tone of the intestines. All the parts of the plant, when wounded, yield a milky saponaceous juice. This, when taken in large quantities, so as to keep up a gentle diarrhœa, and continued for some weeks, has been found to produce excellent effects in scorbutic and other chronical disorders.

3. Cichorium spinosum, with a prickly forked stalk, grows naturally on the sea-coast in Sicily, and the islands of the Archipelago. The flowers are of a pale blue colour, and are succeeded by seeds shaped like those of the common sorts.

CICINDELA, the *sparkler*, in zoology, a genus of insects belonging to the order of coleoptera. The antennæ are setaceous; the jaws are prominent, and furnished with teeth; the eyes are a little prominent; and the breast is roundish and marginated. There are 14 species. The campestris (see Plate Nat. Hist. fig. 124), or field sparkler, is one of the most beautiful of the genus. The upper part of its body is of a fine green colour, rough, and rather bluish. The under side, as also the legs and antennæ, are of a shot colour, gold and red, of a copperish cast. The eyes are very prominent, and give the head a broad appearance. The thorax is angular, and narrower than the head, which constitutes the character of the cicindela. It is rough, and of a green colour tinged with gold, as well as the head. The elytra are delicately and irregularly dotted. Each of them has six white spots, viz. one on the top of the elytrum, at its outward angle; three more along the outward edge, of which the middlemost forms a kind of lunula; a fifth on the middle of the elytra, opposite the lunula; and that one is broader, and tolerably round; lastly, a sixth at the extremity of the elytra. There is also sometimes seen a black spot on the middle of each elytrum, opposite to the second white spot. The upper lip is also white, as is the upper side of the jaws, which are very prominent and sharp. This insect runs with great swiftness, and flies easily. It is found in dry sandy places, especially in the beginning of spring. In the same places its larva is met with, which resembles a long, soft, whitish worm, armed with six legs, and a brown scaly head. It makes a perpendicular round hole in the ground, and keep its head at the entrance of the hole to catch the insects that fall into it; a spot of ground is sometimes entirely perforated in this manner. The insects belonging to this genus are in general very beautiful, and merit the attention of the curious in their microscopic observations; some are minute, though not inferior in splendour, therefore best suited for the experiment. Living subjects are ever preferable to dead ones. The larvæ of all this genus live under ground; and are, as well as the perfect insects, tigers in their nature, attacking and destroying all they can overcome.

CICUTA, *water hemlock*, a genus of the order digynia, in the pentandria class of plants, and ranking in the natural method under the 45th order, umbellatæ. There are three species, viz.

1. Cicuta bulbifera;
2. Cicuta maculata; and
3. Cicuta virosa. This species is the only one remarkable, and that from the poisonous qualities of its roots, which have been often known to destroy children who eat them for parsnips.

CIDARIS, in antiquity, the mitre used by the Jewish high-priests. The rabbis say, that the bonnet used by the priests in general, was made of a piece of linen cloth sixteen yards long, which covered their heads like a helmet or a turban; and they allow no other difference between the high-priest's bonnet, and that of other priests, than this: that one is flatter, and more in the form of a turban; whereas that worn by ordinary priests rose something more in a point. A plate of gold was an ornament peculiar to the high-priest's mitre.

CILIARE, or *ligamentum ciliare*, or *ciliaris processus*, in anatomy, a range of black fibres disposed circularly, having their rise in the inner part of the uvea, and terminating in the prominent part of the chrystalline humour of the eye, which they surround. See ANATOMY.

CIMEX, or *bug*, in zoology, a genus of insects belonging to the order of hemiptera. (See Plate Nat. Hist. figs. 125, 126, 127.) The rostrum is inflected. The antennæ are longer than the horax. The wings are folded together crosswise; the upper ones are coriaceous from their base towards their middle. The back is flat; the thorax margined. The feet are formed for running. This genus is divided into different sections, viz. 1. Those without wings. 2. Those in which the escutcheon is extended so far as to cover the abdomen and the wings. 3. The coleoptrati, whose elytra are wholly coriaceous. 4. Those whose elytra are membranaceous: these are very much depressed like a leaf. 5. In which the thorax is armed on each side with a spine. 6. Those which are of an oval form, without spines on the thorax. 7. In which the antennæ become setaceous towards their point. 8. Those of an oblong form. 9. Those whose antennæ are setaceous, and as long as the body. 10. Those that have their thighs armed with spines. 11. Those whose bodies are long and narrow. Linnæus enumerates no fewer than than 121 species, to which several have been added by other naturalists. A very peculiar species was discovered by Dr. Sparman at the Cape, which he has named cimex paradoxus. He observed it as at noontide he sought for shelter among the branches of a shrub from the intolerable heat of the sun. "Though the air (says he) was extremely still and calm, so as hardly to have shaken an aspen leaf, yet I thought I saw a little withered, pale, crumpled leaf, eaten as it were by caterpillars, flittering from the tree. This appeared to me so very extraordinary, that I thought it worth my while suddenly to quit my verdant bower in order to contemplate it: and I could scarcely believe my eyes, when I saw a live insect, in shape and colour resembling the fragment of a withered leaf, with the edges turned up, and eaten away as it were by caterpillars, and at the same time all over beset with prickles. Nature, by this peculiar form, has certainly extremely well defended and concealed, as in a mask, this insect from birds and its other diminutive foes; in all probability with a view to preserve it, and employ it for some important office in the system of her economy; a system with which we are too little acquainted, in general

too little investigated; and which, in every part of it, can never sufficiently admire with that respect and veneration which we owe to the great Author of Nature and ruler of the universe."

The larvæ of bugs only differ from the perfect insect by the want of wings: they run over plants; and grow and change to chrysalids, without appearing to undergo any material difference. They have only rudiments of wings, which the last transformation unfolds, and the insect is then perfect. In the first two stages they are unable to propagate their species. In their perfect state, the female, fecundated, lays a great number of eggs, which are often found upon plants, placed one by the side of another; many of which, viewed through a glass, present singular varieties of configuration. Some are crowned with a row of small hairs, others have a circular fillet; and most have a piece which forms a cap; this piece the larva pushes off when it forces open the egg. Released by nature from their prison, they overspread the plant on which they feed, extracting, by the help of the rostrum, the juices appropriated for their nourishment: even in this state, the larvæ are not all peaceably inclined; some are voracious in an eminent degree, and spare neither sex nor species they can conquer. In their perfect state they are mere cannibals, glutting themselves with the blood of animals; they destroy caterpillars and flies; and even the coleopterous tribe, whose hardness of elytra one would imagine was proof against their attacks, have fallen an easy prey to the sharp piercing nature of the rostrum of the bug, and the incautious naturalist may even experience a feeling severity of its nature. The cimex lectularius, or house bug, is particularly acceptable to the palate of spiders in general, and is even sought after by wood-bugs; which is not indeed surprising, when the general voracity of this genus is considered. Trials have been made of various methods of destroying house-bugs, with oil of turpentine, camphor, solutions of sublimate, &c.

CIMICIFUGA, in botany, a genus of the polyandria order, in the diœcia class of plants. The male calyx is almost pentaphyllous; there is no corolla; the stamina are 20 in number: the female calyx is almost pentaphyllous; no corolla: the stamina 20, and barren; the capsules from four to seven, polyspermous. There is but one species; of which Messerschmidius, in the Isis Siberica, gives the following character and name: cimicifuga fœtida, with the leaves of the herb Christopher, bearing a thyrsus of yellow male flowers with a red villous seed, the seed-vessel in form of a horn. This whole plant so resembles the actea racemosa, that it is difficult to distinguish them when not in flower; but in the fructification it greatly differs from it, the cimicifuga having four pistils, the actea but one. Jacquin says, that it is a native of the Carpathian mountains. It has obtained the name of cimicifuga, or bugbane, both in Siberia and Tartary, from its property of driving away those insects: and the botanists of those parts of Europe which are infested by them, have long desired to naturalize it in their several countries. Gmelin mentions, that in Siberia the natives also use it as an evacuant in dropsy; and that its effects are violently emetic and drastic.

CIMOLIA *alba*, the name of the earth of which tobacco-pipes are made. Its distinguishing characters are, that it is a dense, compact, heavy earth, of a dull colour, and very close texture; it will not easily break between the fingers, and slightly stains the fingers in handling. It adheres to the tongue, melts slowly in the mouth, and is not readily diffusible in water. It is found in the Isle of Wight, Dorsetshire, and Staffordshire.

CIMOLIA *nigra*, is of a dark lead-colour, hard, dry, and heavy; it does not stain the hands, and is not acted upon by the acids. It burns perfectly white, and acquires a great degree of hardness. It is found in Northamptonshire, where it is used in the manufacture of pipes.

CIMOLITE, a species of white earth, found in some of the Grecian islands, where it is used for whitening stuffs. It is mentioned by Pliny under the name of cimolia, and in more modern authors it is called cimolia terra. Colour pearl-grey; when exposed to the air it becomes reddish. Texture earthy, fracture uneven, opaque, does not stain, but adheres strongly to the tongue. It is soft, and broken with difficulty: specific gravity is 2.000; and it becomes white before the blowpipe. It is composed, according to Klaproth, of

63.00 silica,
23.00 alumina,
1.25 iron,
12.00 water.

99.25

CINCHONA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking with those plants, the order of which is dubious. The corolla is funnel-shaped, with a woolly summit; the capsule inferior, bilocular, with a parallel partition. There are nine species. The principal are,

1. Cinchona corymbifera, corymb-bearing cinchona, or white Peruvian bark, with oblong lanceolate leaves and axillary corymbs. This species particularly abounds in the hilly parts of Quito, growing promiscuously in the forests, and is spontaneously propagated from its seeds.

2. Cinchona caribæa, a native of the West India islands. In Jamaica it is called the sea-side beech, and grows from 20 to 40 feet high. The white, furrowed, thick, outer bark, is not used; the dark-brown inner bark has the common flavour, with a mixed taste, at first of horse-radish and ginger, becoming at last bitter and astringent. It seems to give out more extractive matter than the cinchona officinalis. Some of it was imported from St. Lucia, in consequence of its having been used with advantage in the army and navy during the last war.

3. Cinchona officinalis, or coloured Peruvian bark, with elliptic leaves, downy underneath, and the leaves of the corolla woolly. Both the corymbifera and officinalis are natives of Peru, where they attain the height of from 15 to 20 feet. The bark has an odour, to some people not unpleasant, and very perceptible in the distilled water; in which floating globules, like essential oil, have been observed. Its taste is bitter and astringent, accompanied with a degree of pungency, and leaving a considerably lasting impression on the tongue. For its properties and preparations, see PHARMACY.

CINCTURE, or *ceinture*, in architecture, a ring, list, or orlo, at the top and bottom of the shaft of a column, separating the shaft at one end from the base, and at the other from the capital. That at the bottom is particularly called apophyge, as if the pillar took its rise from it; and that at top colarin, collar, or collier, and sometimes annulus.

CINERARIA, a genus of the class and order syngenesia polygamia superflua. The calyx is simple, many-leaved, equal; pappus simple; receptacle naked. There are 41 species, most of them ornamental plants, and natives of the Cape; of which the C. cruenta, and the C. amelloides and lanata, are old and elegant ornaments of our greenhouses. The last has only one unpleasant property, that it is apt to be lousy.

CINNABAR. See CHEMISTRY.

CINNAMON-TREE. See LAURUS.

No cinnamon can be imported into Britain except from the East Indies. That which comes thence pays a duty of 3*s*. $\frac{86}{100}$*d*. a pound, and draws back on exportation, 3*s*. $\frac{29\frac{1}{3}}{100}$*d*. at the rate of 6*s*. 8*d*.

Cinnamon is an astringent in the *primæ viæ*, but in the more remote seats of action it operates as an aperient and alexipharmic. It stops diarrhœas, strengthens the viscera, assists concoction, dispels flatulencies, and is a very pleasant cardiac. It affords an oil which will sink in water; and is in great esteem, and much prescribed in extemporaneous practice. As it is much adulterated on account of its dearness, the best way to know it is by dropping it upon sugar, and then dissolving it in small spirit. This oil has been made genuine in England from the common cinnamon of the shops, so as to exceed that brought from Holland.

CINNAMON-WATER is made by distilling the bark first infused in spirit of wine, brandy, or white wine.

CINQUE-FOIL. See POTENTILLA.

CINQUE-PORTS were thus called by way of eminence, on account of their superior importance, as having been thought to merit a particular regard by the kings of England, for their preservation against invasion. Hence they have a particular policy; and are governed by a keeper, with the title of lord warden of the cinque ports. The five ports are, Hastings, Romney, Hythe, Dover, and Sandwich. Thorn tells us, that Hastings provided 21 vessels, and in each vessel 21 men. To this port belong Seaford, Pevensey, Hedney, Winchelsea, Rye, Hamine, Wakesbourne, Creneth, and Forthclipe. Romney provided five ships, and in each 24 men. To this belong Bromhal, Lyde, Oswarstone, Dangemares, and Romenhal. Hythe furnished five ships, and in each 21 seamen. To this belongs Westmeath. Dover the same number as Hastings. To this belong Folkstone, Feversham, and Marge. Sandwich furnished the same number with Hythe. To this belong Fordiwic, Reculver, Serre, and Deal. The privileges granted to them in consequence of these services were very great. Amongst others, they were each of them to send two barons to represent them in parliament; their deputies were to bear the canopy over the king's head at the time

of his coronation, and to dine at the uppermost table in the great hall on his right hand; to be exempted from subsidies and other aids; their heirs to be free from personal wardship, notwithstanding any tenure; to be impleaded in their own towns only, and not to be liable to tolls, &c.

Certioraris, to remove indictments taken in the cinque-ports, must be directed to the mayor and jurats before whom they were taken, and not to the lord warden; because they hold plea of it as justices of the peace, by virtue of their commission, and not by their antient character.

CIPHER, denotes certain secret characters disguised and varied, used in writing letters that contain some secret, not to be understood but by those between whom the cipher is agreed on. There are several kinds of ciphers, according to lord Bacon; as the simple, those mixed with non-significants, those consisting of two kinds of characters, wheel-ciphers, key-ciphers, word-ciphers, &c. They ought all to have these three properties, 1. They should be easy to write and read. 2. They should be trusty and undecipherable. 3. Clear of suspicion.

There is a new way of eluding the examination of a cipher, viz. to have two alphabets, the one of significant, and the other of non-significant letters; and folding up two writings together, the one containing the secret, while the other is such as the writer might probably send without danger: in case of a strict examination, the bearer is to produce the non-significant alphabet for the true, and the true for the non-significant; by which means the examiner would fall upon the outward writing, and finding it probable, suspect nothing of the inner. No doubt the art of ciphering is capable of great improvement. It is said that king Charles I. had a cipher consisting only of a straight line differently inclined: and there are ways of ciphering by the mere punctuation of a letter, whilst the words of a letter shall be non-significants, or sense that leaves no room for suspicion. Those who desire a fuller explanation of ciphering may consult Bacon, where they will find a cipher of his invention; bishop Wilkin's Secret and Swift Messenger; and Mr. Falconer's Cryptomenysis Patefacta.

CIPPUS, in antiquity, a low column, with an inscription, erected in the high roads, or other places, to shew the way to travellers, to serve as a boundry, to mark the grave of a deceased person, &c. Those erected in the highways to mark the miles were called miliary columns.

CIRCÆA, *enchanter's nightshade*, a genus of the monogynia order, in the diandria class of plants, and in the natural method ranking under the 48th order, aggregatæ. The corolla is dipetalous; the calyx diphyllous, superior, with one bilocular seed. There are two species, one of which is a native of Britain, and the other of Germany. They are low herbaceous plants with white flowers, and possessed of no remarkable property.

CIRCLE, in geometry, a plane figure comprehended by a single curve line, called its circumference; in which right lines drawn from a point in the middle, called the centre, are equal to each other.

The area of the circle is found by multiplying the circumference by the fourth part of the diameter; or half the circumference by half the diameter: for every circle may be conceived to be a polygon of an infinite number of sides, and the semidiameter must be equal to the perpendicular of such a polygon, and the circumference of the circle equal to the periphery of the polygon: therefore half the circumference multiplied by half the diameter, gives the area of the circle.

Circles, and similar figures inscribed in them, are always as the squares of the diameters; so that they are in a duplicate ratio of their diameters, and consequently of their radii.

A circle is equal to a triangle, the base of which is equal to the periphery, and its altitude to its radius: circles therefore are in a ratio compounded of the peripheries and the radii.

To find the proportion of the diameter of a circle to its circumference. Find, by continual bisection, the sides of the inscribed polygon, till you arrive at a side subtending any arch, howsoever small; this found, find likewise the side of a similar circumscribed polygon; multiply each by the number of the sides of the polygon, by which you will have the perimeter of each polygon. The ratio of the diameter to the periphery of the circle will be greater than that of the same diameter to the perimeter of the circumscribed polygon, but less than that of the inscribed polygon. The difference of the two being known, the ratio of the diameter to the periphery is easily had in numbers very nearly, though not justly, true. Thus Archimedes fixed the proportion at 7 to 22.

Wolfius finds it as 10000000000000000 to 31415926535897932; and the learned Mr. Machin has carried it to one hundred places, as follows: if the diameter of a circle be 1, the circumference will be 3.14159, 26535, 89793, 23846, 26433, 83279, 50288, 41971, 69399, 37510, 58209, 74944, 59230, 78164, 05286, 20899, 86280, 34825, 34211, 70679, of the same parts. But the ratios generally used in practice are that of Archimedes, and the following; as 106 to 333, as 113 to 355, as 1702 to 5347 as 1815 to 5702, or as 1 to 3.14159.

A variety of series have been discovered for obtaining the length of the circumference of a circle, such as the following, viz. If the diameter be 1, the circumference c will be variously expressed thus,

$$c = 4 \times (1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \frac{1}{13} - \frac{1}{15} \text{ &c}),$$

$$c = \sqrt{8} \times (1 + \frac{1}{3} - \frac{1}{5} - \frac{1}{7} + \frac{1}{9} + \frac{1}{11} - \frac{1}{13} - \frac{1}{15} \text{ &c}),$$

$$c = \sqrt{12} \times (1 - \frac{1}{3.3} + \frac{1}{5.3^2} - \frac{1}{7.3^3} + \frac{1}{9.3^4} \text{ &c}),$$

$$c = 8 \times (\frac{1}{1.1.3} + \frac{1}{1.3.5} - \frac{1}{3.5.7} + \frac{1}{5.7.9} - \frac{1}{7.9.11} \text{ &c}),$$

$$c = 8 \times (\frac{2}{3} - \frac{1}{5} - \frac{1}{4.7} - \frac{1.3}{4.6.9} - \frac{1.3.5}{4.6.8.11} \text{ &c}),$$

$$c = 4\sqrt{2} \times (\frac{2}{3} - \frac{1}{5.2} - \frac{1}{4.7.2^2} - \frac{1.3}{4.6.9.2^3} - \frac{1.3.5}{4.6.8.11.2^4} \text{ &c}),$$

$$c = 4 \times (1 - \frac{1}{2.3} - \frac{1}{2.4.5} - \frac{1.3}{2.4.6.7} - \frac{1.3.5}{2.4.6.8.9} \text{ &c}).$$

The quadrature of the circle, or the manner of making a square whose surface is perfectly and geometrically equal to that of a circle, is a problem that has employed the geometricians of all ages.

Many maintain it to be impossible; Des Cartes, in particular, insists on it, that a right line and a circle being of different natures, there can be no strict proportion between them; and in effect we are at a loss for the just proportion between the diameter and circumference of a circle.

Archimedes is the person who has come nearest the truth: all the rest have made paralogisms. Charles V. offered a reward of one hundred thousand crowns to the person who should solve this celebrated problem.

Dr. Wallis has given in his Arithmetic of Infinites, a series for expressing the ratio of a circle to the square of its diameter, as

$$1 : \frac{3 \times 3 \times 5 \times 5 \times 7 \times 7}{2 \times 4 \times 4 \times 6 \times 6 \times 8} \text{ &c.}$$

$$\text{or as } 1 : \frac{9}{8} \times \frac{25}{24} \times \frac{49}{56} \text{ &c.}$$

CIRCLE of the higher kind, an expression used by Wolfius, and some others, to denote, for the most part, a curve expressed by the equation $y^m = ax^{m-1} - x^m$; which indeed will be an oval when m is an even number; but when m is an odd number, the curve will have two infinite legs.

CIRCLES, *druidical*, in British topography, a name given to certain ancient inclosures, formed by rude stones, circularly arranged.

These, it is now generally agreed, were temples, and many writers think also places of solemn assemblies for councils or elections, and seats of judgment. These temples, though generally circular, occasionally differ as well in figure as magnitude: with relation to the first, the most simple were composed of one circle. Stonehenge consisted of two circles and two ovals, respectively concentric; whilst that at Bottalch near St. Just in Cornwall is formed by four intersecting circles. The great temple at Abury in Wiltshire, it is said, described the figure of a seraph or fiery flying serpent, represented by circles and right lines. Some, besides circles, have avenues of stone pillars. Most, if not all of them, have pillars or altars within their penetralia or centre. In the article of magnitude and number of stones, there is the greatest variety; some circles being only twelve feet diameter, and formed only of twelve stones; whilst others, such as Stonehenge and Abury, contained, the first one hundred and forty, the second six hundred and fifty-two, and occupied many acres of ground. All these different numbers, measures, and arrangements, had their pretended reference, either to the astronomical divisions of the year, or some mysteries of the druidical religion.

CIRCONCELLIONES, a race of fanatics, so called because they were continually rambling round the houses in the country. They took their rise among the donatists in the reign of the emperor Constantine. It is incredible what ravages and cruelties these vagabonds committed in Africa through a long series of years. They were illiterate, savage peasants, who understood only the Punic

language. Intoxicated with a barbarous zeal, they renounced agriculture, professed continence, and assumed the title of "vindicators of justice, and protectors of the oppressed." To accomplish their mission, they enfranchised slaves, scoured the roads; forced masters to alight from their chariots, and run before their slaves, whom they obliged to mount in their place; and discharged debtors, killing the creditors if they refused to cancel the bonds. The counts Ursacius and Taurinus were employed to quell them: they destroyed a great number of them, of whom the donatists made as many martyrs. Ursacius, who was a good catholic, and a religious man, having lost his life in an engagement with the barbarians, the donatists did not fail to triumph in his death, as an effect of the vengeance of heaven. Africa was the theatre of these bloody scenes during a great part of Constantine's life.

CIRCUIT, or CIRCUITY, in law, signifies a longer course of proceedings than is needful to recover the thing sued for: in case a person grants a rent-charge of 10*l.* a year of his manor, and afterwards the grantee disseises the grantor, who thereupon brings an assise, and recovers the land, and 20*l.* damages; which being paid, the grantee brings his action for 10*l.* of the rent, due during the time of his disseisin. This is termed circuity of action, because as the grantor was to receive 20*l.* damages, and pay 10*l.* rent, he might only have received 10*l.* for the damages, and the grantee might have retained the other 10*l.* for his rent, and by that means saved his action.

CIRCUIT also signifies the journey or progress which the judges take twice every year through the several counties of England and Wales, to hold courts and administer justice, where recourse cannot be had to the king's courts at Westminster. Hence England is divided into six circuits, viz. the home circuit, Norfolk circuit, midland circuit, Oxford circuit, western circuit, and northern circuit. In Wales there are but two circuits, north and south Wales: two judges are assigned by the king's commission to every circuit. In Scotland there are three circuits, viz. the southern, western, and northern, which are likewise made twice every year, viz. in spring and autumn.

CIRCULAR *sailing*, is the method of sailing by the arch of a great circle. See NAVIGATION.

CIRCULAR *velocity*, in astronomy, signifies the velocity of any planet or revolving body, which is measured by the arch of a circle.

CIRCULATION *of the blood.* See PHYSIOLOGY.

CIRCUMFERENCE, the curve line which bounds a circle; and otherwise called a periphery, the boundary of a right-lined figure being expressed by the term perimeter. Any part of the circumference is called an arch, and a right line drawn from one extreme of the arch to the other is called a chord. The circumference of every circle is supposed to be divided into 360 degrees. The angle at the circumference of a circle is double that at the centre.

CIRCUMFERENTOR, an instrument used by surveyors for taking angles. See SURVEYING.

CIRCUMSCRIBED, in geometry, is said of a figure which is drawn round another figure, so that all its sides or planes touch the inscribed figure.

CIRCUMSCRIBED *hyperbola*, one of sir Isaac Newton's hyperbolas of the second order, that cuts its asymptotes, and contains the parts cut off within its own space.

CIRCUMSCRIBING, in geometry, denotes the describing a polygonous figure about a circle, in such a manner that all its sides shall be tangents to the circumference. Sometimes the term is used for the describing a circle about a polygon, so that each side is a chord; but in this case it is more usual to say the polygon is inscribed, than the circle is circumscribed.

CIRCUMSTANTIBUS, in law, a term used for supplying and making up the number of jurors (in case any impannelled appear not; or appearing, are challenged by either party), by adding to them so many of the persons present as will make up the number, in case they are properly qualified.

CIRCUMVALLATION, or line of circumvallation, in military affairs, implies a fortification of earth, consisting of a parapet and trench, made round the town intended to be besieged, when any molestation is apprehended from parties of the enemy, which may march to relieve the place. Care is to be taken to have the most exact plan of it possible; and upon this the line of circumvallation and the attack are projected. This line, being a fortification opposed to an enemy that may come from the open country to relieve the besieged, ought to have its defences directed against them; that is, so as to fire from the town; and the besiegers are to be encamped behind this line, and between it and the place. The camp should be as much as possible out of the reach of the shot of the place; and the line of circumvallation, which is to be farther distant from the place than the camp, ought still more to be out of the reach of its artillery.

As cannon are never to be fired from the rear of the camp, this line should be upwards of 1200 fathoms from the place; we will suppose its distance fixed at 1400 fathoms from the covert-way. The depth of the camp may be computed at about 30 fathom; and from the head of the camp to the line of circumvallation 120 fathoms, that the army may have room to draw up in order of battle at the head of the camp, behind the line. This distance added to the 30 fathoms makes 150 fathoms, which being added to the 1400, makes 1550 fathoms to constitute the distance of the line of circumvallation from the covert-way. The top of this line is generally 12 feet broad, and seven feet deep. The parapet runs quite round the top of it, and at certain distances is frequently strengthened with redoubts and small forts: the base 18 feet wide, the height within six, and on the outside five feet, with a banquette of three feet wide and one and a half high.

CIRCUS, in antiquity, a great building of a round or oval figure, erected by the antients, to exhibit shows to the people. The Roman circus was a large oblong edifice, arched at one end, encompassed with porticoes, and furnished with two rows of seats placed ascending over each other. In the middle was a kind of foot-bank, or eminence, with obelisks, statues, and posts, at each end. This served them for the courses of their bigæ and quadrigæ. Those that have measured the circus say that it was 2187 feet long, and 960 broad; so that it was the greatest building in Rome. Some say it would contain 150,000 people, others 260,000 or 300,000. The circus was dedicated to the sun, as a little temple of the sun in the middle denoted. Some say that there were eight circuses in Rome, of which several were, either through vanity or devotion, built for the ornament of the city.

CIRRI, among botanists, fine strings or thread-like filaments, by which some plants fasten themselves to walls, trees, &c. Such are those of ivy.

CIRRI in ichthyology, certain oblong and soft appendages, not unlike little worms, hanging from the under-jaws or mouths of some fishes. These cirri, commonly translated beards, afford marks to distinguish the different species of the fish on which they are found. Their use may be to give notice of approaching danger or prey; since by their hanging position, as well as by their soft texture, they must be more sensible of any motion in the water than any other part.

CIRSOCELE, or HERNIA VARICOSA. See SURGERY.

CISSAMPELOS, a genus of the monadelphia order, in the dioecia class of plants; and in the natural method ranking under the 11th order, sarmentaceæ. The male calyx is tetraphyllous; no corolla; the nectarium wheel-shaped; four stamina with their filaments grown together. The female calyx is monophyllous and ligulated, roundish, or like a piece of garter a little roundish. There is no corolla; three styles, and a monospermous berry. There are five species: the

Cissamplos caapeba is a native of the warmest parts of America. The root applied externally is said to be an antidote against the bites of venomous serpents. The plant being infused in water, quickly fills the liquor with a mucilaginous substance, which is as thick as jelly; whence the name of freezing wyth, by which this genus of plants has been distinguished by the Brazilians.

CISSOID, in geometry, a curve of the second order, first invented by Diocles, whence it is called the cissoid of Diocles.

Sir Isaac Newton, in his appendix de æquationum constructione lineari, gives the following elegant description of this curve; and at the same time shews how, by means of it, to find two mean proportionals, and the roots of a cubic equation, without any previous reduction. Let A G (Plate Miscel. fig. 14) be the diameter, and F the centre of the circle belonging to the cissoid; and from F draw F D, F P, at right angles to each other, and let F P be = A G; then if the square P E D be so moved that one side E P always passes through the point P, and the end D of the other side E D slides along the right line F D, the middle point C of the side E D will describe one leg G C of the cissoid; and by continuing out F D on the other side F, and turning the square about by a like operation, the other leg may be described.

This curve may likewise be generated by points in the following manner. Draw the indefinite right line B C (Plate fig. 15) at right angles to A B the diameter of the semicircle A O B, and draw the right lines A H, A F, A C, &c. then if you take A M = L H, A O = O F, Z C = A N, &c. the points M O C, &c. will form the curve A M O Z of the cissoid.

Properties of the Cissoid.—It follows from the genesis, that drawing the right lines PM, KL, perpendicular to AB, the lines AK, PN, AP, PM, as also AP, PN, AK, KL, are continual proportionals, and therefore that AK=PB, and PN=IK. If the diameter AB=a, the abscis AP=x, and the ordinate PM=y, then is $x : a-x :: y^2 : x^2$ or $x^3 = \overline{a-x} \times y^2$, which is the equation of the curve. After the same manner it appears that the cissoid AMO, bisects the semicircle AOB. Sir Isaac Newton, in his last letter to Mr. Leibnitz, has shewn how to find a right line equal to one of the legs of this curve, by means of the hyperbola, but suppressed the investigation, which however may be seen in his Fluxions. The cissoidal space contained under the diameter AB, the asymptote BC, and the curve AOZ of the cissoid, is triple that of the generating circle AOB. See Dr. Wallis's mathematical works, Vol. I. p. 545, et seq.

CISSUS, the wild grape, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 46th order, hederaceæ. The berry is monospermous, surrounded by the calyx, and a quadripartite corolla. There are 15 species, natives of Jamaica, and some of the other islands in the warmest parts of America and the East Indies. They send out slender branches, having tendrils at their joints; by which they fasten to the neighbouring trees, bushes, and any other support, mounting to a considerable height. The fruit of some of the species is eaten by the negroes.

CISTERCIANS, in church-history, a religious order founded in the eleventh century by St. Robert, a benedictine. They became so powerful, that they governed almost all Europe, both in spirituals and temporals. Cardinal de Vitri describing their observances says, they neither wore skins nor shirts, nor ever ate flesh except in sickness; and abstained from fish, eggs, milk, and cheese. They lay upon straw beds, in their tunics and cowls: they rose at midnight to prayers; they spent the day in labour, reading, and prayer; and in all their exercises observed a continual silence. The habit of the Cistercian monks is a white robe, in the nature of a cassock, with a black scapulary and hood, and is girt with a woollen girdle. The nuns wear a white tunic, and a black scapulary and girdle.

CISTUS, rockrose, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking under the 20th order, rotaceæ. The corolla is pentapetalous; the calyx pentaphyllous, with two of its leaves smaller than the rest. The seeds are contained in a capsule. There are 66 species, most of them natives of the southern parts of Europe, but many of them hardy enough to bear the open air in this country. They are beautiful evergreen shrubs, generally very branchy quite from the bottom, and forming diffused heads. They are very ornamental in gardens: not only as evergreens, making a fine variety at all seasons with the leaves of different figures, sizes, and shades of green and white; but also as first-rate flowering shrubs, being very profuse in most elegant flowers of white, purple, and yellow colours. These flowers last only for one day; but there is a continual succession of new ones for a month or six weeks on the same plant; and when there are different species, they exhibit a constant bloom for near three months. They are propagated either by seeds or cuttings, and thrive best in a dry soil. Their proper situation in shrubbery works should be towards the front of the clumps and other compartments, in assemblage with the choicest shrubs of similar growth, disposing them so as to make a variety, and to have shelter from the other plants, but they ought by no means to be crowded. Gum labdanum is found upon a species of cistus which grows naturally in the Levant, and is therefore called labdaniferus.

CITADEL, a place fortified with four, five, or six bastions, built on a convenient ground near a city, that it may command it in case of a rebellion. The city therefore is not fortified on the part opposite to the citadel, though the citadel is against the city. The best form for a citadel is a pentagon, a square being too weak, and a hexagon too large.

CITATION, in ecclesiastical courts, is the same with summons in civil courts. A person is not to be cited out of the diocese where he lives, unless it be by the archbishop in default of the ordinary, or where the ordinary is party to the suit, and in cases of appeal,

CITHAREXYLUM, fiddle-wood, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is quinquedentated, campanulated, wheel-shaped, with its segments villous, on the upper side equal. The fruit is a dispermous berry; the seeds bilocular. There are five species, natives of the warmer parts of America, where they grow to be large trees, and are adorned with white flowers growing in spikes. In Britain they appear only as shrubs, and must be constantly retained in the stove, where they make a fine appearance, being beautiful evergreens. They may be propagated either by seeds or cuttings.

CITRINUS, in natural history, a peculiar species of sprig crystal, which is of a beautiful yellow. Many of the common crystals, when in the neighbourhood of lead mines, are liable to be accidentally tinged yellow, by an admixture of the particles of that metal; and all these, whether finer or coarser, have been too frequently confounded together under the name citrine; but Dr. Hill has ascertained this to be a peculiar species of crystal different from all the others in form as well as in colour; and distinguished by the name of ellipomacrostylum lucidum flavescens, pyramido brevi. It is never found colourless like the other crystals, but has great variety of tinges, from that of the deeper ochres to a pale lemon-colour. It is sometimes found in Bohemia. The pyramid of this crystal is always finer than the column.

CITRUS, the citron, orange, and lemon tree, a genus of the polyadelphia class and the icosandria order of plants. The calyx is quinquefid; the petals oblong, and five in number; the anthers are 20, filaments united into various bodies; fruit nine-celled. There are five species, with many varieties, viz.

1. Citrus aurantium, the orange: of which the varieties are, 1. Seville orange. This is a very handsome tree, and the hardiest of any; as in this country it shoots freely, produces large and beautiful leaves, flowers stronger, &c. The fruit is large, rough-rinded, and sour, of excellent quality for economical uses. 2. The China orange. This tree has moderately-sized leaves, and a smooth, thin-rinded, sweet fruit, of which there are several varieties in warm countries, whey they grow in the open ground. 3. The forbidden-fruit tree, in trunk, leaves, and flowers, very much resembles the common orange-tree; but the fruit when ripe is larger and longer than the biggest orange. See Plate. It has somewhat the taste of shaddock, but far exceeds that, as well as the best orange, in its delicious taste and flavour. 4. The horned orange is a tree of moderate size, producing fruit which divide, and the rind runs out into divisions like horns. 5. The hermaphrodite orange is a common sized tree, producing fruit shaped partly like an orange and partly like a citron. 6. The dwarf orange tree, or nutmeg orange, has a long stem and small bushy head, growing two or three feet high; small oval leaves in clusters; and numerous flowers in clusters, covering the branches, succeeded by very small fruit.

2. Citrus medica, the citron-tree. The varieties are, 1. citron-tree with sour fruit; 2. with sweetish fruit; 3. with long fruit; 4. with warted fruit; 5. with recurved fruit; and 6. with blotched leaves.

The lemon-tree is accounted a variety of the citron. The varieties of lemon are, 1. the lemon-tree with sour fruit; 2. with sweetish fruit; 3. with very large fruit, called imperial lemon; 4. with pear-shaped fruit; 5. with furrowed fruit; 6. with clustered fruit; 7. with childing fruit; 8. with whitish fruit; 9. with tricolar striped fruit; 10. with silver-striped leaves; and 11. with double flowers.

These are the most remarkable varieties of the species of citrus; but besides these there are a great number of others; and indeed in those countries where they grow naturally, the varieties may be multiplied without end, like those of our apples and pears. The flowers of all the species and varieties are formed each of five spreading petals, appearing here principally in May and June, and the fruit continues setting in June and July, and ripens the year following.

3. Citrus trifoliata, is a thorny shrub growing naturally in Japan, where it is likewise known by the names of gees, and karatals banna. The trunk acquires by age and culture the thickness of a tree. The flowers, which resemble those of the medlar, proceed singly from the arm-pits of the leaves, are white, possessed of no great degree of fragrance, and consist of five petals. The fruit is equally beautiful with a middle-sized orange; their internal structure is also pretty much the same; only the pulp is glutinous, of an unpleasant smell, and a harsh disagreeable taste. The seeds have the same taste with the pulp, and are shaped exactly like those of the orange.

4. Citrus decumana, or shaddock, which derives its name from captain Shaddock, who brought it from the East to the West Indies.

5. Citrus japonica, the fruit of which is no larger than a cherry, but very sweet and pleasant.

CITIES, *imperial*, an appellation given to those cities of Germany immediately subject to the emperor: they make a part of the Germanic body, are governed by their own magistrates, have the privilege of coining money, and assist at the diet of the empire. They are 48 in all, and are distinguished in general by their prosperity and opulence.

CIVET. See VIVERRA.

CIVIL LAW, is properly the peculiar law of each state, country, or city; but what is usually meant by the civil law, is a body of laws composed out of the best Roman and Grecian laws, compiled from the laws of nature and nations, and for the most part received and observed throughout all the Roman dominions for above 1200 years.

The Romans took the first grounds of this law from the twelve tables; which were abridgments of the laws of Solon, at Athens, and of other celebrated cities of Greece; to which they added their own antient customs of the city of Rome. These written laws were subject to various interpretations, whence controversies arising, they were determined by the judgment of the learned; and these determinations were what they first called jus civile, after their several cases were composed, which, lest the people should make them at pleasure, were fixed, certain, and solemn; and this part of their law they called actiones juris, cases at law. The Romans had also their plebiscita, which were laws made by the commons, without the authority of the senate. The jus honorarium was an edict of some particular magistrate, the senatus consultum an ordinance made by the sole authority of the senate, and the principalis constitutio was enacted by the prince or emperor. These laws grew by degrees to a vast number of volumes, and therefore the emperor Justinian commanded his chancellor Trebonianus, with the assistance of some other eminent lawyers, to reduce them to a perfect body.

The body of the civil law is divided into three volumes, which are still remaining, viz. the pandects or digests, the code, and the institutes: to these were afterwards added the authentics or constitutions of Justinian, called also novellæ, or novels. See CODE,&c.

The civil law is not received at this day in any one nation, without some addition or alteration. For sometimes the feudal law is mixed with it, or general or particular customs; and often ordinances and statutes cut off a great part of it. In Turkey the Justinian Greek code is only used. In Italy, the canon law and customs have excluded a good part of it. In Venice, custom has almost an absolute government. In the Milanese, the feudal law and particular customs bear sway. In Naples and Sicily, the constitutions and laws of the Lombards are said to prevail. In Germany and Holland, the civil law is esteemed to be the municipal law; but yet many parts of it are there grown obsolete, and others are altered, either by the canon law, or a different usage. In Friezland it is observed with more strictness; but in the northern parts of Germany, the jus Saxonicum, Lubecense, or Culmense, is preferred to it. In Denmark and Sweden it has scarcely any authority at all. In France only a part of it is received, and that part is in some places as a customary law; and in those provinces nearest to Italy, the municipal written law. In criminal cases the civil law is more regarded in France: but the manner of trial is regulated by ordinances and edicts. The civil law in Spain and Portugal is corrected by the jus regium, and custom. In Scotland the statutes of the sederunt, part of the regiæ majestatis, and their customs, controul the civil law. In England it is used in the ecclesiastical courts, in the courts of the admiralty, and in the two universities: yet in all these it is restrained and directed by the common law.

CIVIL YEAR is the legal year, or annual account of time, which every government appoints to be used within its own dominions; and is so called in contradistinction to the natural year, which is measured by the revolution of the heavenly bodies.

CIVILIAN, in general, denotes something belonging to the civil law, but more especially the doctors and professors of it are called civilians. Of these we have a college or society in London, known by the name of doctors'-commons.

CLACK, among countrymen. To clack wool is to cut off the sheep's mark, which makes the weight less, and yields less custom to the king.

CLAIM, in law, a challenge of interest in any thing that is in the possession of another, or at least out of a man's own; as claim by charter, by descent, &c. By stat. 4 Anne c. 16. sect. 16. no claim or entry shall be of force to avoid any fine levied with proclamation in the common-pleas, or in the court of session in the counties palatine, or of grand session in Wales, or shall be a sufficient entry to claim within the statute of limitation, 21 Jac. 1. c. 16. unless upon such entry or claim, an action be commenced within one year after making such entry or claim, and prosecuted with effect. Plowd. 359.

CLAMP, *in a ship*, denotes a piece of timber applied to a mast or yard, to prevent the wood from bursting; and also a thick plank lying fore and aft under the beams of the first orlop, or second deck, and is the same that the rising timbers are to the deck.

CLAMP is likewise the term for a pile of unburnt bricks built up for burning.

CLAMPING, in joinery, is the fitting a piece of board with the grain, to another piece of board cross the grain. Thus the ends of tables are commonly clamped, to prevent their warping.

CLANS, in history, and particularly in that of Scotland. The nations which overran Europe were originally divided into many small tribes; and when they came to parcel out the lands which they had conquered, it was natural for every chieftain to bestow a portion, in the first place, upon those of his own tribe or family. These all held their lands of him; and as the safety of each individual depended on the general union, these small societies clung together, and were distinguished by some common appellation, either patronymical or local, long before the introduction of surnames or ensigns armorial. But when these became common, the descendants and relations of every chieftain assumed the same name and arms with him. Other vassals were proud to imitate their example; and by degrees they were communicated to all those who held of the same superior. Thus clanships were formed; and in a generation or two that consanguinity which was at first in a great measure imaginary, was believed to be real. An artificial union was converted into a natural one. Men willingly followed a leader, whom they regarded both as the superior of their lands and the chief of their blood, and served him not only with the fidelity of vassals, but the affection of friends. Against such men a king contended with great disadvantage; and that cold service which money purchases, or authority extorts, was not an equal match for their ardour and zeal. Some imagine the word clan to be only a corruption of the Roman colonia; but Mr. Whitaker asserts it to be purely British, and to signify a family.

CLARENCIEUX, the second king at arms, so called from the duke of Clarence, to whom he first belonged; for Lionel III. son to Edward III. having by his wife the honour of Clare, in the county of Thomond, was afterwards declared duke of Clarence; which dukedom afterwards escheating to Edward IV. he made this earl a king at arms. His office is to marshal and dispose of the funerals of all the lower nobility, as baronets, knights, esquires, on the south side of the Trent; whence he is sometimes called Surroy, or South-roy, in contradistinction to Norroy.

CLARENDON. The constitutions of Clarendon are certain ecclesiastical laws drawn up at Clarendon, near Salisbury. They were sixteen in number, all tending to restrain the power of the clergy; and readily assented to by all the bishops and barons, the archbishop Becket excepted, who opposed them at first, but was afterwards prevailed upon to sign them. The pope Alexander III. declared against and annulled most of them.

CLARIFICATION, in chemistry, the act of clearing and fining any fluid from all heterogeneous matter or feculancies. See CHEMISTRY.

CLARION, a kind of trumpet, the tube of which is narrower, and its tone acuter and shriller, than that of the common trumpet. It is said that the clarion, now used among the Moors, and Portuguese who borrowed it from the Moors, served antiently for a treble to several trumpets, which sounded tenor and bass.

CLARION, in heraldry, a bearing as represented: he bears ruby, three clarions topaz, being the arms of the earl of Bath, by the name of Granville. Guillim is of opinion, that these three clarions are a kind of old-fashioned trumpets; but others say that they rather resemble the rudder of a ship, others a rest for a lance.

CLARO-OBSCURO, or CLAIR-OBSCURE, in painting, the art of distributing to advantage the lights and shadows of a piece, both with regard to the easing of the eye, and the effect of the whole piece. See PAINTING.

CLASS, an appellation given to the most general subdivisions of any thing: thus, in the Linnæan system, animals are divided into six classes, viz. mammalia, aves, amphibia, pisces, insecta, and vermes; these are again subdivided in orders, and these last into genera. See NATURAL HISTORY.

CLATHRUS, in botany, a genus of roundish fungi; the substance of which is reticulated, or full of holes, somewhat like the meshes of a net, with continuous ramification. There are seven species.

CLAVA, a genus of vermes mollusca, having one common aperture, dilatable, vertical, surrounded by club-shaped tentacula. There is only one species.

CLAVARIA, club-top, a genus of the cryptogamia class of plants, and of the order of fungi; the 58th in the natural method. The fungus is smooth and oblong. Mr. Miller asserts, that the whole genus of clavaria belongs to the tribe of zoophytes, that is, to the animal, and not to the vegetable kingdom. According to his method, he ranks them among the vermes, under a subdivision which he terms fungosa osculis atomiferis; supposing them to be compound animals with many orifices on their surface, from which are protruded atoms or animalcules, which have a visible spontaneous motion, something similar to what is now acknowledged to be a fact, with regard to a numerous class of marine bodies, termed corallines. This motion, however, has not been observed by other naturalists. Schæffer has figured the seeds of several clavariæ as they appeared to him through the microscope; and none of these fungi, when burnt, emit the strong disagreeable smell peculiar to animal substances.

1. Clavaria hemotades, or the oak leather club-top, exactly resembles tanned leather, except that it is thinner and softer. It is of no determinate form. It grows in the clefts and hollows of old oaks, and sometimes on ash in Ireland and in some places of England, &c. In Ireland it is used to dress ulcers, and in Virginia to spread plasters upon, instead of leather.

2. Clavaria militaris, and one or two other species, are remarkable for growing only on the head of a dead insect in the nympha state.

CLAVARIUM, in antiquity, an allowance the Roman soldiers had for furnishing nails to secure their shoes with. They frequently raised mutinies, and demanded largesses of the emperors, under this pretence.

CLAVES INSULÆ, a term used in the Isle of Man, where all weighty and ambiguous causes are referred to a jury of twelve, who are called claves insulæ, the keys of the island.

CLAVICLES. See ANATOMY.

CLAUSE-ROLLS, in the Tower, contain all such matters as were committed to close writ.

CLAVUS, in antiquity, an ornament upon the robes of the Roman senators and knights, which was more or less broad, according to the dignity of the person. Hence the distinction of tunica angusticlavia and laticlavia.

CLAW, among zoologists, denotes the sharp-pointed nails with which the feet of certain quadrupeds and birds are furnished.

CLAY, is a mixture of alumina and silica in various proportions. The alumina is in the state of an impalpable powder; but the silica is almost always in small grains, large enough to be distinguished by the eye. Clay therefore exhibits the character of alumina, and not of silica, even when this last ingredient predominates. The particles of silica are already combined with each other; and they have so strong an affinity for each other, that few bodies can separate them; whereas the alumina, not being combined, readily displays the characters which distinguish it from other bodies. Besides alumina and silica, clay often contains carbonat of lime, of magnesia, barytes, oxyd of iron, &c. and as clay is merely a mechanical mixture, the proportion of its ingredients is exceedingly various. Its specific gravity is 1.8 to 2.68. Adheres slightly to the tongue. Often feels greasy. Fails to powder in water. Colour, when pure, white, often tinged blue or yellow.

The specific gravity of potter's clay is 1.8 to 2. Stains the fingers slightly. Acquires some polish by friction. Colour white; often with a tinge of yellow or blue; sometimes brownish, greenish, reddish. Totally diffusible in water; and when duly moistened, very ductile. A specimen from Dreux, analysed by Vauquelin, contained

43.5 silica
33.2 alumina
3.5 lime
1.0 iron
18.0 water

99.2

Very common in strata. Tobacco-pipe clay is a variety of this sub-species.

Indurated clay does not diffuse itself in water, but falls to powder. Discovers but little ductility. Colours grey, yellowish, blueish, greenish, reddish, brownish.

The structure of shistose clay is slaty. Specific gravity from 2.6 to 2.68. Feels smooth. Streak white or grey. Colour commonly bluish, or yellowish grey; sometimes blackish, reddish, greenish. Found in strata, usually in coal-mines. This variety is sometimes impregnated with bitumen. It is then called bituminous shale.

CLAYTONIA, in botany, a genus of the pentandria monogynia class of plants, the flower of which consists of five ovato-oblong, erect, large petals; the fruit is a roundish unilocular capsule, containing three roundish seeds. There are two species.

CLEAT, on ship-board, a piece of wood fixed to the yard-arm, to keep the ropes from slipping off.

CLECHE, in heraldry, a kind of cross, charged with another cross of the same figure, but of the colour of the field.

CLEF, or CLIFF, in music, a mark set at the beginning of the lines of a song, which shews the tone or key in which the piece is to begin; or it is a letter marked on any line, which explains the rest.

CLEMATIS, virgin's bower, in botany, a genus of the polyandria polygynia class of plants, the flower of which consists of four oblong lax petals. There is no pericarpium, but a small receptacle contains several roundish compressed seeds, crowned with a slender filament, somewhat like a feather. There are 21 species, chiefly climbing shrubs. See Plate Nat. Hist. fig. 128.

CLEOME, a genus of the siliquosa order, in the tetradynamia class of plants, and in the natural method ranking under the 25th order, putamineæ. There are three nectariferous glandules, one at each sinus of the calyx, except the lowest; the petals all rising upwards; the siliqua unilocular and bivalved. There are 15 species; all natives of warm climates, except two. They are herbaceous plants, rising from one to two feet high; and are adorned with flowers of various colours, as red, yellow, flesh-colour, &c. They are propagated by seeds, and require no other care than what is common to other exotics which are natives of warm countries.

CLEPSYDRA, a water-clock, or instrument to measure time by the fall of a certain quantity of water.

The construction of a CLEPSYDRA. To divide any cylindrical vessel into parts, to be emptied in each division of time; the time wherein the whole, and that wherein any part is to be evacuated, being given:—

Suppose a cylindrical vessel, whose charge of water flows out in twelve hours, was required to be divided into parts, to be evacuated each hour. 1. As the part of time 1 is to the whole time 12, so is the same time 12 to a fourth proportional 144. 2. Divide the altitude of the vessel into 144 equal parts: here the last will fall to the last hour; the three next above to the last part but one; the five next to the tenth hour; and so the twenty-three last will fall to the first hour. For since the times increase in the series of the natural numbers 1, 2, 3, 4, 5, &c. and the altitudes, if the numeration be in a retrograde order from the twelfth hour, increase in the series of the unequal numbers 1, 3, 5, 7, 9, &c. the altitudes computed from the twelfth hour will be as the squares of the times 1, 4, 9, 16, 25, &c. Therefore the square of the whole time, 144, comprehends all the parts of the altitude of the vessel to be evacuated. But a third proportional to 1 and 12 is the square of 12, and consequently it is the number of equal parts in which the altitude is to be divided, to be distributed according to the series of the unequal numbers, through the equal intervals of hours.

There were many kinds of clepsydræ among the antients; but they all had this in common, that the water ran generally through a narrow passage, from one vessel to another; and in the lower was a piece of cork or light wood, which, as the vessel filled, rose up by degrees, and shewed the hour. The reader may see a description of a very curious clepsydra given by Mr. Hamilton, in No. 479 of the Philosophical Transactions.

CLERGY. The privileges of the English clergy, by the antient statutes, are very considerable: their goods are to pay no toll in fairs or markets; they are exempt from all offices but their own; from the king's carriages, posts, &c. from appearing at sheriffs' tourns, or frankpledges; and are not to be fined or amerced according to their spiritual, but their temporal means. A clergyman acknowledging a statute, his body is not to be imprisoned. If he is convicted of a crime for which the benefit of clergy is allowed, he shall not be burnt in the hand; and he shall have the benefit of clergy in infinitum, which no layman can have more than once. The clergy, by common law, are not to be burdened in the general charges of the laity nor to be troubled nor encumbered, unless expressly named and charged by the statute; for general words do not affect them. Thus if a hundred is sued for a robbery, the minister shall not contribute; neither shall they be assessed to the highway, to the watch, &c.

The revenues of the clergy were antiently more considerable than at present. Ethelwolf, in 855, gave them a tythe of all goods, and a tenth of all the lands in England, free from all secular services, taxes, &c. The charter whereby this was granted them was confirmed by several of his successors: and

William the Conqueror, finding the bishoprics so rich, created them into baronies, each barony containing thirteen knight's fees at least: but since the Reformation the bishoprics are much impoverished. The revenues of the inferior clergy, in general, are small; a third part of the best benefices being antiently, by the pope's grant, appropriated to monasteries, upon the dissolution thereof became a lay-fee.

CLERGY, *benefit of*, is an antient privilege, whereby one in orders claimed to be delivered to his ordinary, to purge himself of felony. This purgation was to be by his own oath, affirming his innocence, and the oath of twelve compurgators, as to their belief of it, before a jury of twelve clerks: if the clerk failed in his purgation, he was deprived of his character, whereby he became a mere layman, or he was to be kept in prison till a pardon was obtained; but if he purged himself, he was set at liberty. This was formerly admitted, even in cases of murder; but the antient course of the law is much altered upon this head. By the statute of 18 Eliz. cap. vii. clerks are no more committed to their ordinary to be purged; but every man to whom the benefit of clergy is granted, though not in orders, is put to read at the bar, after he is found guilty and convicted of such felony, and so burnt in the hand, and set free for the first time, if the ordinary or deputy standing by, do say, Legit ut clericus: otherwise he shall suffer death.

It appears by our law-books, that laymen that could read had the privilege of the clergy ever since 25 Edw. III. which allowance never was condemned in parliament, but rather approved of.

CLERK, a word originally appropriated to the clergy, from the Greek κληρος (chosen), whence it was afterwards applied to denote a learned man, or man of letters: in law it is still the designation of a clergyman, or a person in holy orders; in former times the nobility and gentry being usually bred up to the exercise of arms, and none left but the ecclesiastics to cultivate the sciences.

CLERK *of the acts*, an officer in the navy office, appointed for recording all orders, contracts, bills, warrants, &c. transacted by the lords of the admiralty and commissioners of the navy.

CLERK *of the affidavits*, the officer, in the court of chancery, who files all affidavits made use of in court.

CLERK *of the assise*, the person who writes all things judicially done by the justices of assize in their circuits.

CLERK *of the bails*, an officer in the court of king's bench, whose business it is to file all bail-pieces taken in that court, where he always attends.

CLERK *of the crown*, an officer, in the king's bench, who frames, reads, and records, all indictments against offenders, there arraigned or indicted of any public crime. He is likewise termed clerk of the crown-office, in which capacity he exhibits informations by order of the court, for divers offences.

CLERK *of the crown*, in chancery, an officer whose business it is constantly to attend the lord-chancellor, in person or by deputy, to write and prepare for the great seal, special matters of state by commission, both ordinary and extraordinary, viz. commissions of lieutenancy, of justices of assise, oyer and terminer, gaol-delivery, and of the peace; all general pardons, granted either at the king's coronation, or in parliament: the writs of parliament, with the names of the knights, citizens, and burgesses, are also returned into his office. He also makes out special pardons, and writs of execution on bonds of statute-staple forfeited.

CLERK *of the declarations*, he that files all declarations after they are engrossed, in causes depending in the court of king's bench.

CLERK *of the deliveries*, an officer of the Tower, whose function is to take indentures for all stores and ammunition issued from thence.

CLERK *of the errors*, in the court of common pleas, an officer who transcribes and certifies into the king's bench, the tenor of the record of the action on which the writ of error, made out by the cursitor, is brought there to be determined. In the king's bench, the clerk of the errors transcribes and certifies the records of causes, by bill in that court, into the exchequer. And the business of the clerk of the errors in the exchequer, is to transcribe the records certified thither out of the king's bench, and to prepare them for judgment in the exchequer-chamber.

CLERK *of the essoins*, in the court of common pleas, keeps the essoin-roll, or enters essoins: he also provides parchment, cuts it into rolls, marks the number on them, delivers out all the rolls to every officer, and receives them again when written.

CLERK *of the estreats*, an officer in the exchequer, who every term receives the estreats out of the lord-treasurer's remembrancer's office, and writes them out, to be levied for the crown.

CLERK *of the hamper* or *hanaper*, an officer in chancery, whose business is to receive all money due to the king for the seals of charters, letters patent, commissions, and writs; also the fees due to the officers for enrolling and examining them.

CLERK *of the enrolments*, an officer of the court of common pleas, that enrols and exemplifies all fines and recoveries, and returns writs of entry.

CLERK *of the juries*, an officer of the common pleas, who makes out the writs called habeas-corpus and distringas, for juries to appear either in that court, or at the assizes, after the pannels are returned upon the venire facias. He likewise enters into the rolls the awarding these writs, and makes all the continuances till verdict is given.

CLERK *controler of the king's household*, an officer of the king's court, authorized to allow or disallow the charges of poursuivants, messengers of the green cloth, &c. to inspect and control all defects of any of the inferior officers; and to sit in the counting-house with the lord-steward and other officers of the household, for regulating such matters.

CLERK *of the king's silver*, an officer of the common pleas, to whom every fine is brought, after it has passed the office of the custos brevium; and who enters the effect of writs of covenant, into a book kept for that purpose, according to which all the fines of that term are recorded in the rolls of the court.

CLERK *of the king's great wardrobe*, an officer who keeps an account of all things belonging to the wardrobe.

CLERK *of the market*, an officer of the king's house, to whom is given the charge of the king's measures and weights, the standards of those that ought to be used all over England.

CLERK *of the nichils*, or *nihils*, an officer of the exchequer, who makes a roll of all such sums as are nichilled by the sheriffs upon their estreats of green wax, and delivers them in to the remembrancer of the treasury, to have execution done upon them for the king.

CLERK *of the ordnance*, an officer that registers all orders concerning the king's ordnance in the Tower.

CLERK *of the outlawries*, an officer of the common pleas, and deputy to the attorney-general, for making out all writs of capias utlegatum after outlawry, to which there must be the king's attorney's name.

CLERK *of the paper-office*, an officer belonging to the king's bench, whose business is to make up the paper-books of special pleadings in that court.

CLERK *of the parliament-rolls*, an officer in the house of lords, and likewise in the house of commons, who records all transactions in parliament, and engrosses them fairly in parchment rolls.

CLERK *of the peace*, an officer belonging to the sessions of the peace, whose business is to read indictments, enrol the proceedings, and draw the process; he likewise certifies into the king's-bench, transcripts of indictments, outlawries, attainders, and convictions, had before the justices of peace, within the time limited by statute, under a certain penalty. This office is in the gift of the custos rotulorum, and may be executed by deputy.

CLERK *of the pells*, an officer that belongs to the exchequer, whose business is to enter every teller's bill into a parchment roll called pellis receptorum, and to make another roll of payments, called pellis exituum.

CLERKS *of the petty bag*, officers of the court of chancery, of which there are three, the master of the rolls being the chief: their business is to record the return of all inquisitions out of every shire, to make out patents of customers, gaugers, controlers, &c. liberates upon extents of statute-staple, congé-d'elires for bishops; summons of the nobility, clergy, and burgesses to parliament; and commissions directed to knights and others, of every shire, for assessing subsidies and taxes.

CLERK *of the pipe*, an officer of the exchequer, who having the accounts of all debts due to the king, delivered out of the remembrancer's office, charges them in a great roll, folded up like a pipe. He writes out warrants to sheriffs, to levy the said debts on the goods and chattels of the debtors; and if they have no goods, then he draws them down to the treasurer's remembrancer, to write estreats against their lands.

CLERK *of the pleas*, an officer of the exchequer, in whose office all the officers of the court, having special privilege, ought to sue, or be sued, in any action. In this office also actions at law may be prosecuted by other persons, but the plaintiff ought to be tenant or debtor to the king, or some way accountable to him. The under-clerks are attorneys in all suits.

CLERKS *of the privy-seal*, four officers that attend the lord privy seal, for writing and making out all things that are sent by warrant from the signet to the privy seal, and to be passed the great seal; and likewise to make out privy seals, upon special occasions of his majesty's affairs, as for loan of money, or the like.

CLERK *of the rolls*, an officer of the chancery, whose business is to make searches after, and copies of, deeds, offices, &c.

CLERK *of the rules*, an officer of the court of king's bench, who draws up and enters all the rules and orders made in court, and gives rules of course in divers writs.

CLERK *of the sewers*, an officer who writes and records the proceedings of the commissioners of the sewers.

CLERK *of the signet*, an officer continually attending upon his majesty's principal secretary, who has the custody of the privy signet, as well for sealing the king's private letters, as those grants which pass the king's hand by bill signed. There are four of these officers, who have their diet at the secretary's table.

CLERKS, *six*, officers in chancery, next in degree below the twelve masters; whose business is to enrol commissions, pardons, patents, warrants, &c. which pass the great seal: they were antiently clerici, and forfeited their places if they married. They are also attorneys for parties in suits depending in the court of chancery.

CLERK *of the supersedeas*, an officer of the common pleas, who makes out writs of supersedeas, forbidding the sheriff to return the exigent upon a defendant's appearing thereto on an outlawry.

CLERK *of the treasury*, an officer belonging to the court of common pleas, who has the charge of keeping the records of the court, makes out all records of nisi prius, and likewise all exemplifications of records being in the treasury. He has the fees due for all searches; and has under him an underkeeper, who always keeps one key of the treasury-door.

CLERK *of the warrants*, an officer of the common pleas, whose business is to enter all warrants of attorney for plaintiffs and defendants in suit; and to enrol deeds of bargain and sale, that are acknowledged in court, or before a judge. His office is likewise to estreat into the exchequer all issues, fines, estreats, and amercements, which grow due to the crown in that court.

CLERODENDRUM, a genus of the didynamia angiospermia class of plants, the flower of which consists of only one petal, with a slender and long tube; its upper lip is concave, erect, obtuse, and divided into two segments; and the under lip, being of the length of the upper, is divided into three reflex and obtuse segments: the fruit is a roundish drupe; and the seed is roundish and single. There are eight species, natives of the East Indies.

CLETHRA, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 18th order, bicornes. The calyx is quinquepartite; the petals five; the stigma trifid; the capsule trilocular and three-valved. There are four species, of which the most remarkable is,

Clethra alnifolia, a native of Virginia and Carolina, where it grows in moist places, and near the sides of rivulets, rising near eight or ten feet high. The leaves are shaped like those of the alder, but longer; the flowers are produced in close spikes at the extremities of the branches: they are white. This plant bears the open air in Britain, and is one of the most beautiful flowering shrubs. Its season is commonly about the beginning of July; and, if not very hot, there will be part of the spikes in beauty till the middle of September. It thrives best in moist land, and requires a sheltered situation, where it may be defended from strong winds, which frequently break off the branches where they are too much exposed to their violence. It is propagated by layers, but they are generally two years before they take root.

CLEW *of a sail*, in naval affairs, is the lower corner of it, to which are made fast the sheets and tacks: a square sail has no clew.

CLEW-GARNET, a rope made fast to the clew of the sail, and running thence to the block, seized to the middle of the main and fore yard; which, in furling, hales up the clew of the sail close to the middle of the yard.

CLEW-LINE, the same to the top-sails, top-gallant-sails, and sprit-sails, that the clew-garnet is to the main-sail and fore-sail, and of the same use.

CLIBADIUM, a genus of the monoecia pentandria class and order. The male calyx is imbricate; corolla of the disk five-cleft. The female, common calyx the same; corolla of the ray female three or four; seed an umbilicate drupe. There is one species, a native of Surinam.

CLIFFORTIA, a genus of the polyandria order, in the dioecia class of plants: and in the natural method ranking under the 38th order, tricoccæ. The male calyx is triphyllous, no corolla; the stamina near 30 in number; the female calyx triphyllous, superior to the receptacle of the fruit; no corolla; two styles, with a bilocular capsule, and a single seed. There are 19 species, all natives of Africa; so require to be kept in a greenhouse when cultivated in this country. Their flowers make no great appearance; but the plants themselves are very ornamental evergreens. They grow to the height of four or five feet; and are propagated by cuttings, which must be young shoots of five or six inches long. If planted in pots in spring or summer, and plunged in a hotbed, they will readily take root. They must be watered plentifully in summer, but very sparingly in winter.

CLIMACTERIC, among physicians and natural historians, a critical year in a person's life, in which he is supposed to stand in great danger of death. According to some, every seventh year is a climacteric; but others allow only those years produced by multiplying seven by the odd numbers, 3, 5, 7, and 9, to be climacterical. These years, they say, bring with them some remarkable change with respect to health, life, or fortune: the grand climacteric is the sixty-third year; but some, making two, add to this the eighty-first: the other remarkable climacterics are the seventh, twenty-first, thirty-fifth, forty-ninth, and fifty-sixth. The credit of climacteric years can only be supported by the doctrine of numbers introduced by Pythagoras, and is probably nothing but superstitious nonsense.

CLIMATES, in geography, spaces upon the surface of the terrestrial globe, contained between two parallels, so far distant from each other, that the longest day on one parallel differs half an hour from the longest day on the other. See GEOGRAPHY.

CLINCH, in the sea-language, that part of a cable which is bent about the ring of the anchor, and then seized, or made fast.

CLINCHING, in the sea-language, a kind of slight caulking used at sea, in a prospect of foul weather, about the ports: it consists in driving a little oakum into their seams, to prevent the water's coming in at them.

CLINIC MEDICINE, particularly used for the method of visiting and treating sick persons in bed, and the more exact discovery of all the symptoms of their disease.

CLINOPODIUM, field-basil, a genus of the gymnospermia order, in the didynamia class of plants; and in the natural method ranking under the 41st order, asperifoliæ. The involucrum consists of many small bristles under the verticillus or whorl of flowers. There are five species, all herbaceous plants growing from one to two feet high. They are remarkable only for their strong odour, being somewhat between marjoram and basil.

CLIO, in zoology, a genus of insects belonging to the vermes mollusca. The body is oblong and fitted for swimming: it has two membranaceous wings placed opposite to each other. There are three species, principally distinguished by the shape of the vagina, and all natives of the ocean. See Plate Nat. Hist. fig. 118.

CLITORIA, a genus of the decandria order in the diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ. The corolla is supine, or turned down-side up; with the vexillum or flag-petal very large, patent, and almost covering the alæ or wing-petals. There are five species, all herbaceous perennials, or annuals, of the kidney-bean kind, growing naturally in both the Indies. The stalk is climbing, slender, and of the height of a man. The leaves are winged. The flowers, which are elegant, stand singly, each on its proper footstalk. They are very large, and generally of a deep blue, but sometimes of a white colour. From the fruit of this plant is distilled an eye-water.

CLOACA, in Roman antiquity, the common sewer, by which the filth of the city of Rome was carried away. It was built with great stones, in the form of an arch, so well fastened and cemented together, that the continual running of water and filth had not damaged it in the space of 700 years. There were many sinks in the city, which all fell into this common sewer; and the officers appointed to take care of this work, and to see it repaired, were called curatores cloacarum urbis.

CLOATHED, in the sea-language. A mast is said to be cloathed, when the sail is so long as to reach down to the gratings of the hatches, so that no wind can blow below the sail.

CLOCK, a kind of movement, or machine, serving to measure and strike time.

The usual chronometers are watches and clocks: the former are such as shew the parts of time; the latter, such as publish it

by striking: though the name *watch* is commonly appropriated to pocket-clocks; and that of *clock* to larger machines, whether they strike or no.

Clocks, *invention of.* The invention of clocks with wheels is ascribed to Pacificus, archdeacon of Verona, who lived in the time of Lothair son of Lewis the Debonnair, on the credit of an epitaph quoted by Ughelli, and borrowed by him from Panvinius. They were at first called *nocturnal dials*, to distinguish them from sun-dials, which showed the hour by the sun's shadow. Others ascribe the invention to Boethius, about A. D. 510. Mr. Derham makes clock-work of a much older standing; and ranks Archimedes's sphere mentioned by Claudian, and that of Posidonius mentioned by Cicero, among the machines of this kind: not that either their form or use was the same with those of ours, but that they had their motion from some hidden weights or springs, with wheels, or pulleys, or some such clock-work principle. But be this as it may, it is certain the art of making clocks, such as are now used, was either first invented, or at least revived, not more than 200 years ago. The clepsydræ, or water-clocks, and sun-dials, have a much better claim to antiquity. The French annals mention one of the former kind sent by Aaron, kalif of Persia, to Charlemagne, about A. D. 807, which seemed to bear some resemblance to the modern clocks. It was of brass, and showed the hours by 12 little balls of the same metal which fell at the end of each hour, and in falling struck a bell and made it sound. There were also figures of 12 cavaliers which at the end of each hour came forth at certain apertures or windows in the side of the clock, and shut them again, &c. The invention of pendulum clocks is owing to the happy industry of the century before last: the honour of it is disputed by Huygens and Galileo. The former, who has written a volume on the subject, declares it was first put in practice in 1657, and the description thereof printed in 1658. Becher, *de Nova Temporis dimetiendi Theoria*, A. D. 1680, contends for Galileo: and relates, though at second-hand, the whole history of the invention; adding that one Tresler, clock-maker to the then father of the grand duke of Tuscany, made the first pendulum clock at Florence, by direction of Galileo Galilei; a pattern of which was brought into Holland. The Academy del Cimento says expressly, that the application of the pendulum to the movement of a clock was first proposed by Galileo, and first put in practice by his son Vincenzo Galilei, in 1649. Be the inventor who may, it is certain the invention never flourished till it came into Huygens's hands, who insists, that if ever Galileo thought of such a thing, he never brought it to any degree of perfection. The first pendulum clock made in England was in 1662, by Mr. Fromantil, a Dutchman. Before the invention of the pendulum a balance was used resembling the fly of a jack.

In Plate fig. 1 is the profile of a clock: P is a weight that is suspended by a rope that winds about the cylinder or barrel C, which is fixed upon the axis *aa*; the pivots *bb* go into holes made in plates TS, TS, in which they turn freely. These plates are made of brass or iron, and are connected by 4 *pillars* ZZ; and the whole together is called the *frame*. The weight P, if not restrained, would necessarily turn the barrel C with an uniform accelerated motion, in the same manner as if the weight was falling freely from a height. But the barrel is furnished with a ratchet wheel KK, fig. the right side of whose teeth strikes against the click, which is fixed with a screw to the wheel D, so that the action of the weight is communicated to the wheel D, the teeth of which act upon the teeth of the small wheel *d* which turns upon the pivots *c c*. The communication or action of one wheel with another is called the *pitching*; a small wheel like *d* is called a *pinion*, and its teeth are leaves of the pinion. Several things are requisite to form a good pitching, the advantages of which are obvious in all machinery where teeth and pinions are employed. The teeth and pinion leaves should be of a proper shape, and perfectly equal among themselves; the size also of the pinion should be of a just proportion to the wheel acting into it; and its place must be at a certain distance from the wheel, beyond or within which it will make a bad pitching. The wheel EE is fixed upon the axis of the pinion *d*; and the motion communicated to the wheel D D by the weight is transmitted to the pinion *d*, consequently to the wheel EE, as likewise to the pinion *e* and wheel FF, which moves the pinion upon the axis of which the crown or balance wheel G H is fixed. The pivots of the pinion *f* play in holes of the plates L, M, which are fixed horizontally to the plates TS. The motion begun by the weight is transported from the wheel G H to the palettes I K, and by means of the fork X U rivetted on the palettes, communicates motion to the pendulum A B, which is suspended upon the hook A. The pendulum A B describes, on the point A, an arc of a circle alternately going and returning. If then the pendulum is once put in motion by a push of the hand, the weight of the pendulum at B will make it return upon itself, and it will continue to go alternately backward and forward till the resistance of the air upon the pendulum, and the friction at the point of suspension at A, destroys the original impressed force. But at every vibration of the pendulum, the teeth of the balance wheel, G H, act so upon the palettes I K (the pivots upon the axis of these palettes play in two holes of the potence *s t*), that after one tooth H has communicated motion to the palette K, that tooth escapes; then the opposite tooth G acts upon the palette I, and escapes in the same manner; and thus each tooth of the wheel escapes the palettes I K, after having communicated their motion to the palettes in such a manner that the pendulum, instead of being stopped, continues to move. The wheel E E revolves in an hour; the pivot *c* of this wheel passes through the plate, and is continued to *r*; upon the pivot is a wheel N N with a long socket fastened in the centre: upon the extremity of this socket *r*, the minute-hand is fixed. The wheel N N acts upon the wheel O; the pinion of which *p* acts upon the wheel *q q*, fixed upon a socket, which turns along with the wheel N. This wheel *q q* makes its revolution in 12 hours, upon the socket of which the hour-hand is fixed. Thus it is plain, 1. That the weight P turns all the wheels, and at the same time continues the motion of the pendulum: 2. That the quickness of the motion of the wheels is determined by that of the pendulum. 3. That the wheels point out the parts of time divided by the uniform motion of the pendulum. When the cord upon which the weight is suspended is entirely run down from off the barrel, it is wound up again by a key, which goes on the square end of the arbor at Q, by turning it in a contrary direction to that in which the weight descends. For this purpose, the inclined side of the teeth of the wheel R, fig. 2, removes the click C, so that the ratchet-wheel R turns while the wheel D is at rest; but as soon as the cord is wound up, the click falls in between the teeth of the wheel D, and the right side of the teeth again acts upon the end of the click, which obliges the wheel D to turn along with the barrel; and the spring A keeps the click between the teeth of the ratchet-wheel R.

To explain how time is measured by the motion of the pendulum; and how the wheel E, upon the axis of which the minute-hand is fixed, makes but one precise revolution in an hour; we must observe, that the vibrations of a pendulum are performed in a shorter or longer time in proportion to the length of the pendulum itself. A pendulum of 3 feet 8½ French lines in length, makes 3600 vibrations in an hour: *i. e.* each vibration is peformed in a second of time, and for that reason it is called a *second pendulum*. But a pendulum of 9 inches 2¼ French lines makes 7200 vibrations in an hour, or two vibrations in a second of time, and is called *a half-second pendulum*. Hence, in constructing a wheel whose revolution must be performed in a given time, the time of the vibrations of the pendulum which regulates its motion, must be considered. Supposing, then, that the pendulum A B makes 7200 vibrations in an hour, let us consider how the wheel E shall take up an hour in making one revolution. This entirely depends on the number of teeth in the wheels and pinions. If the balance wheel consists of 30 teeth, it will turn once in the time that the pendulum makes 60 vibrations: for at every turn of the wheel, the same tooth acts once on the palette I, and once on the palette K, which occasions two separate vibrations in the pendulum; and the wheel having 30 teeth, it occasions twice 30, or 60, vibrations. Consequently, this wheel must perform 120 revolutions in an hour; because 60 vibrations, which it occasions at every revolution, are contained 120 times in 7200, the number of vibrations performed by the pendulum in an hour. To determine the number of teeth for the wheels E E, and their pinions *e*, *f*, it must be remarked, that one revolution of the wheel E must turn the pinion *e* as many times, as the number of teeth in the pinion is contained in the number of teeth in the wheel. Thus, if the wheel E contains 72 teeth, and the pinion *e*, 6, the pinion will make 12 revolutions in the time that the wheel makes 1; for each tooth of the wheel drives forward the tooth of the pinion; and when the six teeth of the pinion are moved, a complete revolution is performed; but the wheel E has by that time only advanced 6 teeth, and has still 66 to advance before its revolution is completed, which will occasion 11 more revolutions of the pinion. For the same reason, the wheel F having 60 teeth, and the pinion *f* 6, the pinion will make 10 revolutions while the wheel performs one. Now, the wheel F, being turned

by the pinion *e*, makes 12 revolutions for one of the wheel E: and the pinion *f* makes 10 revolutions for one of the wheel F; consequently the pinion *f* performs 10 times 12 or 120 revolutions in the time the wheel E performs one. But the wheel G, which is turned by the pinion *f*, occasions 60 vibrations in the pendulum each time it turns round; consequently the wheel G occasions 60 times 120 or 7200 vibrations of the pendulum while the wheel E performs one revolution; but 7200 is the number of vibrations made by the pendulum in an hour; and consequently the wheel E performs but one revolution in an hour, and so of the rest. From this reasoning, it is easy to discover how a clock may be made to go for any length of time without being wound up: 1. By increasing the number of teeth in the wheels; 2. By diminishing the number of teeth in the pinions; 3. By increasing the length of the cord that suspends the weight; 4. By increasing the length of the pendulum; and, 5. By adding to the number of wheels and pinions. But, in proportion as the time is augmented, if the weight continues the same, the force which it communicates to the last wheel, G H, will be diminished. It only remains to take notice of the number of teeth in the wheels which turn the hour and minute hands. The wheel E performs one revolution in an hour; the wheel N N, which is turned by the axis of the wheel E, must likewise make one revolution in the same time; and the minute-hand is fixed to the socket of this wheel. The wheel N has 30 teeth, and acts upon the wheel O, which has likewise 30 teeth, and the same diameter; consequently the wheel O takes one hour to a revolution: now the wheel O carries the pinion *p*, which has 6 teeth, and which acts upon the wheel *qq* of 72 teeth; consequently the pinion *p* makes 12 revolutions, while the wheel *qq* makes one; and of course the wheel *qq* takes 12 hours to one revolution, and upon the socket of this wheel the hour-hand is fixed. All that has been said here concerning the revolutions of the wheels, &c. of clocks, is equally applicable to the general movements of watches.

Dr. Franklin contrived a clock to show the hours, minutes, and seconds, with only three wheels and two pinions in the whole movement. The dial-plate, fig. 3. has the hours engraved upon it in spiral spaces along two diameters of a circle containing four times 60 minutes. The index A goes round in 4 hours, and counts the minutes from any hour which it has passed to the next following hour. The time, therefore, in the position of the index shown in the figure, is either 30 minutes past XII, IV, or VIII; and so in every other quarter of the circle it points to the number of minutes after the hours which the index last left in its motion. The small hand B, in the arch at top, goes round once in a minute, and shews the seconds. The wheel-work of this clock may be seen in fig. 4. A is the first or great wheel containing 160 teeth, and going round in four hours with the index A in fig. 3 let down by a hole on it axis. The wheel turns a pinion of 10 leaves, which therefore goes round in a quarter of an hour. On the axis of this pinion is the wheel C of 120 teeth; which goes round in the same time, and turns a pinion D of 8 leaves round in a minute, with the second-hand B of fig. 3 fixed on its axis, and also the common wheel E of 30 teeth for moving a pendulum (by palettes) that vibrates seconds, as in a common clock. This clock is wound up by a cord going over a pulley on the axis of the great wheel, like a common thirty-hours clock. Many of these admirably simple machines have been constructed, which measure time exceedingly well. It is subject, however, to the inconvenience of requiring frequent winding by drawing up the weight, and likewise to some uncertainty as to the particular hour shown by the index A. Mr. Ferguson has proposed to remedy these inconveniences by the following construction: In the dial-plate of his clock, fig. 5, there is an opening, *a b c d*, below the centre; through which appears part of a flat plate: on this the 12 hours, with their divisions into quarters, are engraved. This plate turns round in 12 hours: and the index A points out the true hour, &c. B is the minute-hand, which goes round the large circle of 60 minutes whilst the plate *a b c d* shifts its place one hour under the fixed index A. There is another opening, *e f g h*, through which the seconds are seen on a flat moveable ring at the extremity of a fleur-de-lis engraved on the dial-plate. A in fig. 6 is the great wheel of this clock, containing 120 teeth, and turning round in 12 hours. The axis of this wheel bears the plate of hours, which may be moved by a pin passing through small holes drilled in the plate, without affecting the wheel-work. The great wheel A turns a pinion B of ten leaves round in an hour, and carries the minute-hand B on its axis round the dial-plate in the same time. On this axis is a wheel C of 120 teeth, turning round a pinion D of 6 leaves in three minutes; on the axis of which there is a wheel E of 90 teeth, that keeps a pendulum in motion, vibrating seconds by palettes, as in a common clock, when the pendulum-wheel has only 30 teeth, and goes round in a minute. In order to show the seconds by this clock, a thin plate must be divided into 3 times 60, or 180 equal parts, and numbered 10, 20, 30, 40, 50, 60, three times successively; and fixed on the same axis with the wheel of 90 teeth, so as to turn round near the back of the dial-plate; and these divisions will show the seconds through the opening *e f g h*, fig. 5. This clock will go a week without winding, and always show the precise hour; but this clock, as Mr. Ferguson candidly acknowledges, has two disadvantages of which Dr. Franklin's clock is free. When the minute-hand B is adjusted, the hour-plate must also be set right by means of a pin; and the smallness of the teeth in the pendulum wheel will cause the pendulum ball to describe but small arcs in its vibrations: and therefore the momentum of the ball will be less, and the times of the vibrations will be more affected by any unequal impulse of the pendulum wheel on the palettes. Besides, the weight of the flat ring on which the seconds are engraved will load the pivots of the axis of the pendulum wheel with a great deal of friction, which ought by all possible means to be avoided. To remedy this inconvenience, the second-plate might be omitted. A clock similar to Dr. Franklin's was made in Lincolnshire many years ago.

Thus far refers to what is usually called clock-work; but watches are so far on a different construction that they are set in motion by a spring. The manner that a weight acts upon the cylinder, about which the line or cord to which it hangs is wound, is easy to be understood by all; but the action of the spring coiled up within the cylindric barrel, or box of a clock or watch, is somewhat more nice and mysterious; and the manner how it acts upon the fusee always with an equal force, by means of the chain and the proper figure of the fusee for that purpose, is next to be explained.

The chain being fixed at one end of the fusee, and at the other to the barrel; when the machine is winding up, the fusee is turned round, and of course the barrel; on the inside of which is fixed one end of the spring, the other end being fixed to an immovable axis in the centre. As the barrel moves round, it coils the spring several times about the axis, thereby increasing its elastic force to a proper degree: all this while the chain is drawn off the barrel upon the fusee; and then, when the instrument is wound up, the spring, by its elastic force endeavouring constantly to unbend itself, acts upon the barrel, by carrying it round, by which the chain is drawn off from the fusee, and thus turns the fusee, and consequently the whole machinery. Now as the spring unbends itself by degrees, its elastic force, by which it affects the fusee, will gradually decrease; and therefore, unless there was some mechanical contrivance in the figure of the superficies of the fusee, to cause, that, as the spring grows weak, the chain shall be removed farther from the centre of the fusee, so that what is lost in the spring's elasticity is gained in the length of the lever: was it not for this contrivance, the spring's force would always be unequal upon the fusee, and thus would turn the fusee and consequently the whole machinery, unequally. All this is remedied by the conical figure of the fusee. The fusee being acted upon, or put in motion, by an uniform force, the great wheel, which is fixed to it, is put into motion, and that drives the pinion of the centre-wheel, which centre-wheel drives the pinion of the third wheel, and this drives the pinion of the contrate wheel, and this the pinion of the balance-wheel, which plies the two palettes on the axis of the balance, and keeps the balance in motion.

The balance in a watch is instead of the pendulum in a clock, both serving to govern the motion of the whole machinery. To this balance is fixed a small steel spiral spring, which regulates its motions, and makes it equable: whence it has its name of regulator.

When the watch is wound up, the chain from the spring exerts a force upon the fusee, which gives motion to all the parts of the machine, in the following manner; as will be easy to understand, when the number of teeth in each wheel, and leaves in the pinions which they drive, are specified, and these in modern thirty-hour watches are as follows:

	Teeth.	Leaves.
Great wheel	48	12
Centre-wheel	54	6
Third wheel	48	6
Contrate-wheel	48	6
Balance-wheel	15	2 pallets.

Hence it is easy to conceive how often any

one wheel moves round in the time of one revolution of that which drives it.

Thus the great wheel on the fusee, having 48 teeth, and driving the centre-wheel by a pinion of 12, must cause the centre-wheel to move round four times in one turn of the fusee, and so for all the rest, as follows:

12) 48 (4 = turns of the centre
6) 54 (9 = turns of the third
6) 48 (8 = turns of the contrate
6) 48 (8 = turns of the balance
} wheel.

Whence it follows, that the turns of each of these wheels respectively, in one turn of the fusee, will be had by multiplying those several quotients together successively, as follows:

	1	Turns of the	fusee-wheel.
$4\times1=$	4		centre wheel.
$9\times4\times1=$	36		third wheel.
$8\times9\times4\times1=$	288		contrate-wheel.
$8\times8\times9\times4\times1=$	2304		balance-wheel.

But all that has been hitherto said shews only the minutes of an hour, and seconds or quarter-seconds of a minute; for nothing has been yet mentioned relating to the mechanism for shewing the hour of the day. This part of the work lies concealed from sight, between the upper plate of the watch-frame and the dial-plate. In this work, ABC (Plate fig. 7.) is the uppermost side of the frame-plate, as it appears when detached from the dial-plate: the middle of this plate is perforated with a hole, receiving that end of the arbor of the centre wheel which carries the minute-hand; near the plate is fixed a pinion *ab* of ten teeth: this is called the pinion of report; it drives a wheel *cd* of forty teeth; this wheel *cd* carries a pinion *ef* of twelve teeth; and this drives a wheel *gh* with thirty-six teeth.

As in the body of the watch the wheels every where divide the pinions, here, on the contrary, the pinions divide the wheels, and by that means decrease the motion, which is here necessary; for the hour-hand, which is carried on a socket fixed on the wheel *gh*, is required to move but once round, while the pinion *ab* moves twelve times round. To this end the motion of the wheel *cd* is $\frac{1}{4}$ of the pinion *ab*: again, while the wheel *cd*, or the pinion *ef*, goes once round, it turns the wheel *gh* but $\frac{1}{3}$ part round; consequently the motion of *gh* is but $\frac{1}{3}$ of $\frac{1}{4}$ of the motion of *ab*; but $\frac{1}{3}$ of $\frac{1}{4} = \frac{1}{12}$, that is, the hour-wheel *gh* moves once round in the time that the pinion of report, on the arbor of the centre or minute-wheel, makes twelve motions, as required.

CLOCK-WORK, properly so called, is that part of the movement which strikes the hours, &c. on a bell; in contradistinction to that part of the movement of a clock or watch which is designed to measure and exhibit the time on a dial-plate, and which is termed watch-work. The wheels composing the clock part are: the great or first wheel E (see Plate fig. 8), which is moved by the weight or spring at the barrel D: in sixteen or thirty-hour clocks, this has usually pins, and is called the pin-wheel; in eight-day pieces the second wheel L is commonly the pin-wheel, or striking wheel, which is moved by the former. Next the striking wheel is the detent wheel, or hoop wheel *m*, having a hoop almost round it, wherein is a vacancy at which the clock locks. The next is the third or fourth wheel, according to its distance from the first, called the warning wheel, *n*. To these must be added the pinion of report, 2, which drives round the locking wheel, called also the count wheel; ordinarily with eleven notches in it, unequally distant, to make the clock strike the hours. Besides the wheels, to the clock part belong the rash or ratch; a kind of wheel with twelve large fangs, running concentrical to the dial wheel, and serving to lift up the detents every hour, and make the clock strike: the detents or stops, which being lifted up and let fall, lock and unlock the clock in striking; the hammer, as S, which strikes the bell R; the hammer-tails, as T, by which the striking pins draw back the hammers; latches, whereby the work is lifted up and unlocked; and lifting pieces, as P, which lift up and unlock the detent O. The method of calculating the numbers of a piece of clock-work has something in it very entertaining, and at the same time easy and useful. We therefore shall here give the rules: 1. Regard here needs only be had to the count wheel, striking wheel, and detent wheel, which move round in this proportion: the count wheel commonly goes round once in twelve or twenty-four hours; the detents wheel moves round every stroke the clock strikes, or sometimes but once in two strokes: wherefore it follows, that, 2. As many pins as are in the pin wheel, so many turns has the detent wheel in one turn of the pin wheel; or, which is the same, the pins of the pin wheel are the quotients of that wheel divided by the pinion of the detent wheel. But if the detent wheel move but once round in two strokes of the clock, then the said quotient is but half the number of pins. 3. As many turns of the pin wheel as are required to perform the strokes of 12 hours (which are 78), so many turns must the pinion of report have to turn round the count wheel once: or thus, the quotient of 78, divided by the number of striking pins, shall be the quotient for the pinion of report and the count wheel; and this is in case the pinion of report be fixed to the arbor of the pin wheel, which is commonly done. An example will make all plain: the locking wheel being 48, the pinion of report 8, the pin wheel 78, the striking pins are 13, and so of the rest. Note also, that 78 divided by 13 gives 6, the quotient of the pinion of report. As for the warning wheel and fly wheel, it matters little what numbers they have; their use being only to bridle the rapidity of the motion of the other wheels.

8) 48 (6.
6) 78 (13.
6) 60 (10.
6) 48 (8.

The watch part of a clock or watch is that part of the movement which is designed to measure and exhibit the time on a dial-plate; in contradistinction to that part which contributes to the striking of the hour, &c. The several members of the watch parts are, 1. The balance, consisting of the rim, which is its circular part; and the verge, which is its spindle; to which belong two palettes, or leaves, that play in the teeth of the crown wheel. 2. The potence, or pottance, which is the strong stud in pocket-watches, whereon the lower pivot of the verge plays, and in the middle of which one pivot of the balance wheel plays; the bottom of the pottance is called the foot, the middle part the nose, and the upper part the shoulder. 3. The cock, which is the piece covering the balance. 4. The regulator, or pendulum spring, which is the small spring, in watches, underneath the balance. 5. The pendulum (see Plate fig. 8), whose parts are, the verge, palettes 5,5, cocks, the rod, the fork, the flat, the bob or great ball, and the corrector or regulator, being a contrivance for bringing the pendulum to its nice vibrations. 6. The wheels, which are the crown wheel F, in pocket pieces, and swing wheel in pendulums; serving to drive the balance or pendulum. 7. The contrate wheel E, which is that next the crown wheel, &c. and whose teeth and hoop lie contrary to those of other wheels; whence the name. 3. The great, or first wheel C; which is that which the fusee immediately drives, by means of the chain or string of the spring box or barrel D; after which are the second wheel, third wheel, &c. Lastly, between the frame and dial-plate is the pinion of report, which is that fixed on the arbor of the great wheel; and serves to drive the dial wheel, as that serves to carry the hand. The method of calculation is easily understood: for suppose the great wheel E goes round once in 12 hours; then if it is a royal pendulum clock, swinging seconds, we have $60\times60\times12=43200$ seconds or beats in one turn of the great wheel: but because there are sixty beats or seconds in one minute, and the seconds are shewn by an index on the end of the arbor of the swing wheel, which in those clocks is an horizontal position; therefore it is necessary that the swing wheel should have 60 teeth; whence $\frac{43200}{60}=720$, the number to be broken into quotients for finding the number of teeth for the other wheels and pinions.

In the year 1803 the Society for the Encouragement of Arts, &c. presented to Mr. John Prior, of Nessfield, Yorkshire, a reward of thirty guineas, on account of his contrivance for the striking part of an eight-day clock. It consists of a wheel and fly, with six turns of a spiral line, cut upon the wheel for the purpose of counting the hours. The pins below this spiral elevate the hammer, and those above are for the use of the detent. This single wheel serves the purpose of count-wheel, pin-wheel, detent-wheel, and the fly-wheel, and has six revolutions in striking the twelve hours. If we suppose a train of wheels and pinions used in other striking parts to be made without error, and that the wheels and pinions would turn each other without shake or play; then allowing the above supposition to be true (though every mechanic knows it is not), Mr. Prior's striking part would be found six times superior to others, in striking the hours one, two, five, seven, ten, eleven; twelve times superior in striking, four, six, eight; and eighteen times, in striking three, nine, and twelve. In striking two, the inventor purposely made an imperfection equal to the space of three teeth of the wheel; and, in striking three, an imperfection of nine or ten teeth; and yet both these hours are struck perfectly correct.

CLOCKS, *table and rules for regulating*. By the following table, clocks and watches

may be so regulated as to measure true equal time.

D.	H.	M.	S.	D.	H.	M.	S.
1	0	3	56	16	1	2	54
2	0	7	52	17	1	6	50
3	0	11	48	18	1	10	46
4	0	15	44	19	1	14	42
5	0	19	39	20	1	18	38
6	0	23	35	21	1	22	34
7	0	27	31	22	1	26	30
8	0	31	27	23	1	30	26
9	0	35	23	24	1	34	22
10	0	39	19	25	1	38	17
11	0	43	15	26	1	43	13
12	0	47	11	27	1	46	9
13	0	51	7	28	1	50	5
14	0	55	3	29	1	54	1
15	0	58	58	30	1	57	57

The stars make 366 revolutions from any point of the compass to the same point again in 365 days and one minute; and therefore they gain a 365th of a revolution every 24 hours of mean solar time, near enough for regulating any clock or watch. This acceleration is at the rate of 3 min. 55 sec. 53 thirds, 59 fourths, in 24 hours; or, in the nearest round numbers, 3 min. 56 sec. by which quantity of time every star comes round sooner than it did on the day before. Therefore if you mark the precise moment shown by a clock or watch when any star vanishes behind a chimney, or any other object, as seen through a small hole in a thin plate of metal, fixed in a window-shutter; and do this for several nights successively (as suppose twenty); if at the end of that time the star vanishes as much sooner than it did the first night, by the clock, as answers to the time denoted in the table for so many days, the clock goes true, otherwise not. If the difference between the clock and the star be less than the table shows, the clock goes too fast; if greater, it goes too slow, and must be regulated accordingly, by letting down or raising the ball of the pendulum, by little and little, by turning the screw-nut under the ball, till you find it keeps true equal time. Thus, supposing the star should disappear behind a chimney any night when it is 12 by the clock, and that on the 20th night afterward the same star should disappear when the time is 41 min. 22 sec. past 10 by the clock, which being subtracted from 12 hours, 0 min. 0 sec. leaves remaining 1 hour 18 min. 38 sec. for the time the star is then faster than the clock; look in the table, and against 20, in the left hand column, you will find the acceleration of the star to be 1 hour, 18 min. 38 sec. agreeing exactly with what the difference ought to be between the clock and star; which shows that the clock measures true equal time, and agrees with the mean solar time, as it ought to do.

CLOCK-WORK, *extraordinary pieces of.* Amongst the modern clocks, those at Strasburg and Lyons are very eminent for the richness of their furniture, and the variety of their motions and figures. In the former, a cock claps his wings, and proclaims the hour; and the angel opens a door, and salutes the Virgin, and the Holy Spirit descends on her, &c. In the latter, two horsemen encounter, and beat the hour on each other; a door opens, and there appear on the theatre the Virgin, with Jesus Christ in her arms; the magi, with their retinue, marching in order, and presenting their gifts, two trumpeters sounding all the while to proclaim the procession. These, however, are excelled by two which were lately made by English artists, and sent as a present from the East India company to the emperor of China. These clocks are in the form of chariots, in which are placed, in a fine attitude, a lady, leaning her right hand upon a part of the chariot; under which is a clock of curious workmanship, little larger than a shilling, that strikes and repeats, and goes eight days. Upon her finger sits a bird finely modelled, and set with diamonds and rubies, with its wings expanded in a flying posture, and actually flutters for a considerable time on touching a diamond button below it; the body of the bird (which contains part of the wheels that in a manner give life to it) is not the bigness of the 16th part of an inch. The lady holds in her left hand a gold tube, not much thicker than a large pin, on the top of which is a small round box, to which a circular ornament set with diamonds not larger than a sixpence is fixed, which goes round near three hours in a constant regular motion. Over the lady's head, supported by a small fluted pillar no bigger than a quill, are two umbrellas: under the largest of which a bell is fixed, at a considerable distance from the clock, and seeming to have no connection with it; but from which a communication is secretly conveyed to a hammer, that regularly strikes the hour, and repeats the same at pleasure by touching a diamond button fixed to the clock below. At the feet of the lady is a gold dog, before which, from the point of the chariot, are two birds, fixed on spiral springs; the wings and feathers of which are set with stones of various colours, and appear as if flying away with the chariot, which, from another secret motion, is contrived to run in a straight, circular, or any other direction. A boy that lays hold of the chariot behind seems also to push it forward. Above the umbrella are flowers and ornaments of precious stones, and it terminates with a flying dragon set in the same manner. The whole is of gold, most curiously executed, and embellished with rubies and pearls.

CLOCKS, *statutes respecting.* By stat. 9 and 10. W. III. cap. 28. § 2. no person shall export, or endeavour to export, out of this kingdom, any outward or inward box, case, or dial-plate, of gold, silver, brass, or other metal, for clock or watch, without the movement in or with every such box, &c. made up fit for use, with the maker's name engraved thereon; nor shall any person make up any clock or watch without putting his name and place of abode or freedom, and no other name or place, on every clock or watch, on penalty of forfeiting every such box, case, and dial-plate, clock and watch, not made up and engraved as aforesaid; and 20*l.*; one moiety to the king, the other to those that shall sue for the same. By stat. 17. Geo. III. cap. 108. an annual duty must be paid of 5*s.* for every clock or time-keeper, of 10*s.* for every gold watch, and 2*s.* 6*d.* for every silver or metal watch, by the respective proprietors; under the penalty of 10*l.* for neglecting to deliver lists of these articles, of double duty for omissions in such lists, and of 10*l.* more for not giving in a declaration respecting them within 14 days after receiving notice from the assessors. Duties on clocks let with houses are to be paid by the occupiers, but when these are empty, by the landlords. These duties do not extend to such householders as are not liable to the house and window tax, for one clock, or one silver or metal watch. Clocks not worth more than 20*s.* are also exempted, to occupiers of houses not exceeding ten windows. The royal family, foreign ambassadors, hospitals, churches, servants in husbandry, soldiers, marines, sailors, and licensed watchmakers, pawn-brokers, and dealers in clocks and watches, are also exempted. These last must pay 2*s.* 6*d.* annually for their licences within London and Westminster, and 1*s.* elsewhere, under a penalty of 5*l.* This act has been since repealed.

CLOFF, that in which any goods are put for the convenience of carriage; as the bags of pepper or hops, the barrels of butter, soap, &c.

CLOSE, in heraldry. When any bird is drawn in a coat of arms with its wings close down about it, and in a standing posture, they blazon it by this word *close*; but if it is flying they call it volant.

CLOSE-FIGHTS, in the sea-language, such bulk-heads as are in a close fight put up fore and aft in ship, for the men to stand behind them secure, and fire upon the enemy; and if the ship is boarded, to secure and clear the decks.

CLOTH, in commerce, a manufacture made of wool wove on the loom.

The term is applicable also to other manufactures made of hemp, flax, &c. but in a more particular sense it implies the web or tissue of woollen threads interwoven; some whereof, called the warp, are extended in length from one end of the piece to the other: the rest, called the woof, disposed across the first, or breadthwise of the piece.

The best wool for the manufacturing of cloths are those of England and Spain, especially those of Lincolnshire and Segovia. To use those wools to the best advantage, they must be scoured, by putting them into a liquor somewhat more than lukewarm, composed of three parts fair water, and one of urine. After the wool has continued long enough in the liquor to soak, and dissolve the grease, it is drained and well washed in running water. When it feels dry, and has no smell but that of the sheep, is said to be duly scoured. After this it is hung to dry in the shade, the heat of the sun making it harsh and inflexible; when dry, it is beaten with rods upon hurdles of wood, or on cords, to cleanse it from dust and the grosser filth; the more it is thus beaten and cleansed, the softer it becomes, and the better for spinning. After beating, it must be well picked, to free it from it the rest of the filth that had escaped the rods. It is now in a proper condition to be oiled, and carded on large iron cards, placed slopewise. Olive-oil is esteemed the best for this purpose: one-fifth of which should be used for the wool intended for the woof, and a ninth for that designed for the warp. After the wool has been oiled, it is given to the spinners; who first card it on the knee, with small cards, and then spin it on the wheel; observing to make the thread of the warp smaller by one-third than that of the woof, and much compacter-twisted. The thread being thus spun, reeled, and made into skeins, that designed for the woof is wound on little tubes, pieces of paper, or rushes, so disposed as that they may be easily put into the eye of the shuttle.

When warped, it is stiffened with size, the best of which is that made of shreds of parchment, and when dry, is given to the weavers; who mount it on the loom.

The warp being thus mounted, the weavers, who are two to each loom, one on each side, tread alternately on the treadle, first on the right step, and then on the left, which raises and lowers the threads of the warp equally; between which they throw transversely the shuttle from the one to the other: and every time that the shuttle is thus thrown, and a thread of the woof inserted within the warp, they strike it conjunctly with the same frame, to which is fastened the comb or reed, between whose teeth the threads of the warp are passed, repeating the stroke as often as is necessary. The weavers having continued their work till the whole warp is filled with the woof, the cloth is finished; it is then taken off the loom by unrolling it from the beam whereon it had been rolled in proportion as it was woven; and now given to be cleansed of the knots, ends of threads, straws, and other filth, which is done with iron nippers.

In this condition it is carried to the fullery, to be scoured with urine; or a kind of potter's clay, well steeped in water, put along with the cloth in the trough wherein it is fulled. The cloth, being again cleared from the earth or urine, is returned to the former hands to have the lesser filth, small straws, &c. taken off as before: then it is returned to the fuller to be beaten and fulled with hot water, wherein a suitable quantity of soap has been dissolved; after fulling it is taken out to be smoothed, or pulled by the lists lengthwise, to take out the wrinkles, crevices, &c. The smoothing is repeated every two hours till the fulling is finished, and the cloth brought to its proper breadth: after which it is washed in clear water, to purge it of the soap, and given wet to the carders to raise the hair or nap on the right side with the thistle or weed. After this preparation the cloth-worker takes the cloth, and gives it its first cut or sheering: then the carders resume it, and, after wetting, give it as many more courses with the teazle, as the quality of the stuff requires, always observing to begin against the grain of the hair, and to end with it; as also to begin with a smoother thistle, proceeding still with one sharper and sharper, as far as the sixth degree.

The cloth next is sent to the dyer: when dyed it is washed in fair water, and the worker takes it again wet as it is, lays the nap with a brush on the table, and hangs it on the tenters; where it is stretched both in length and breadth sufficiently to smooth it, set it square, and bring it to its proper dimensions, without straining it too much; observing to brush it afresh, the way of the nap, while a little moist, on the tenters. When quite dry the cloth is taken off the tenters, and brushed again on the table, to finish the laying of the nap; after which it is folded, and laid cold under a press, to make it perfectly smooth and even, and give it a gloss.

Lastly, the cloth being taken out of the press, and the papers, &c. for glossing it removed, it is in a condition for sale or use. With regard to the manufacture of mixt cloths, or those wherein the wools are first dyed and then mixt, spun and woven of the colours intended, the process, except what relates to the colour, is mostly the same with that just represented.

CLOUD, in physiology, a collection of vapours visibly suspended in the atmosphere; being a congeries chiefly of watry particles, drawn up from the sea and land by the solar or subterraneous heat, or both, in vapour. See METEOROLOGY.

CLOVE-TREE. See CAROPHYLLUS.

CLOVE, a term used in weights. Seven pounds of wool make a clove.

In Essex eight pounds of cheese and butter go to the clove.

CLOVER-GRASS. See TRIFOLIUM.

CLOUGH, or *draught*, among traders, an allowance of two pounds to every three hundredweight, for the turn of the scale, that the commodity may hold out when sold by retail.

CLUPEA, or *herring*, in ichthyology, a genus belonging to the order of abdominales. The upper jaw is furnished with a serrated mystacne; the branchiostege membrane has eight rays; a scaly serrated line runs along the belly from the head to the tail: and the belly-fins have frequently nine rays. There are 11 species, viz.

1. The clupea harengus, or common herring, has no spots, and the under jaw is longer than the upper one. A herring dies immediately after it is taken out of the water; whence the proverb, As dead as a herring. Herrings are found from the highest northern latitudes yet known, as low as the northern coasts of France; none are found more southerly. They are met with in vast shoals on the coast of America, as low as Carolina. In Chesapeak-bay is an annual inundation of these fish, which cover the shore in such quantities as to become a nuisance. The great winter rendezvous of the herring is within the arctic circle: there they continue for many months, in order to recruit themselves after the fatigue of spawning; the seas within that space swarming with insect food in a far greater degree than those of our warmer latitudes. An immense number of them begin to appear off the Shetland isles in April and May; but these are only the forerunners of the grand shoal which comes in June; and their appearance is marked by certain signs, by the numbers of birds which follow to prey on them; but when the main body approaches, its breadth and depth are such as to alter the appearance of the very ocean. It is divided into distinct columns of five or six miles in length, and three or four in breadth, and they drive the water before them with a kind of rippling: sometimes they sink for the space of 10 or 15 minutes, and then rise again to the surface; and in fine weather reflect a variety of splendid colours.

The first check this army meets with in its march southward is from the Shetland isles, which divide it into two parts; one wing takes to the east, the other to the western shores of Great Britain, and fill every bay and creek with their numbers; others pass on towards Yarmouth, the great and antient mart of herrings: they then pass through the British Channel, and after that in a manner disappear. Those which take towards the west, after offering themselves to the Hebrides, where the great stationary fishery is, proceed to the north of Ireland: here they meet with a second interruption, and are obliged to make a second division; one party takes to the western side, and is scarcely perceived, being soon lost in the immensity of the Atlantic; but the other, that passes into the Irish sea, rejoices and feeds the inhabitants of most of the coasts that border on it. These brigades, as we may call them, which are thus separated from the greater columns, are often capricious in their motions, and do not shew an invariable attachment to their haunts.

They are full of roe in the end of June, and continue in perfection till the beginning of winter, when they deposit their spawn. The young herrings begin to approach the shores in July and August, and are then from half an inch to two inches long: those in Yorkshire are called *herring fite*. Though we have no particular authority for it, yet as very few young herrings are found in our seas during winter, it seems certain that they must return to their paternal haunts beneath the ice, to repair the vast destruction of their race during summer by men, fowl, and fish. Some of the old herrings continue on our coast the whole year: the Scarborough fishermen never put down their net but they catch a few; but the numbers that remain are not worth comparison with those that return. The Dutch are extravagantly fond of pickled herrings, but the art of curing them was invented in Flanders. There is as much joy in Holland on receiving the first buss of herrings (for which a premium is given), as the Egyptians shew on the overflowing of the Nile.

2. The clupea sprattus, or sprat, has 13 rays in the back fin. It is a native of the European seas, and has a resemblance to the herring, but is smaller. They come into the river Thames in November, and leave it in March.

3. The clupea encrasiolus, or anchovy, has the upper jaw longer than the under one, and is about three inches long. They are taken in the Mediterranean, and brought here and pickled. The principal fishery is at Georgia, a small island west of Leghorn.

4. Clupea alosa, the shad, has a forked snout, and black spots on the sides. According to Belonius and Hasselquist, this is a fish of passage in the Nile. The latter says it is found in the Mediterranean near Smyrna, and on the coast of Egypt near Rosetta; and that in the months of December and January it ascends the Nile as high as Cairo, where the people stuff it with pot-marjoram; and when dressed in that manner, it will very nearly intoxicate the eater. In Great Britain the Severn affords this fish in higher perfection than any other river. It makes its first appearance there in May, but in very warm seasons in April; for its arrival sooner or later depends much on the temperature of the air. It continues in the river about two months, and then is succeeded by the variety called the twaite. The Severn shad is esteemed a very delicate fish about the time of its first appearance, especially in that part of the river that flows by Gloucester, where they are taken in nets, and usually sell dearer than salmon: some are sent to London, where the fishmongers distinguish them from those of the Thames by the French name alose. Whether they spawn in this river and the Wye is not determined; for their fry has not yet been ascertained. The old fish come from the sea into the river in

CLOCK-WORK &c.

Profile of a Clock.

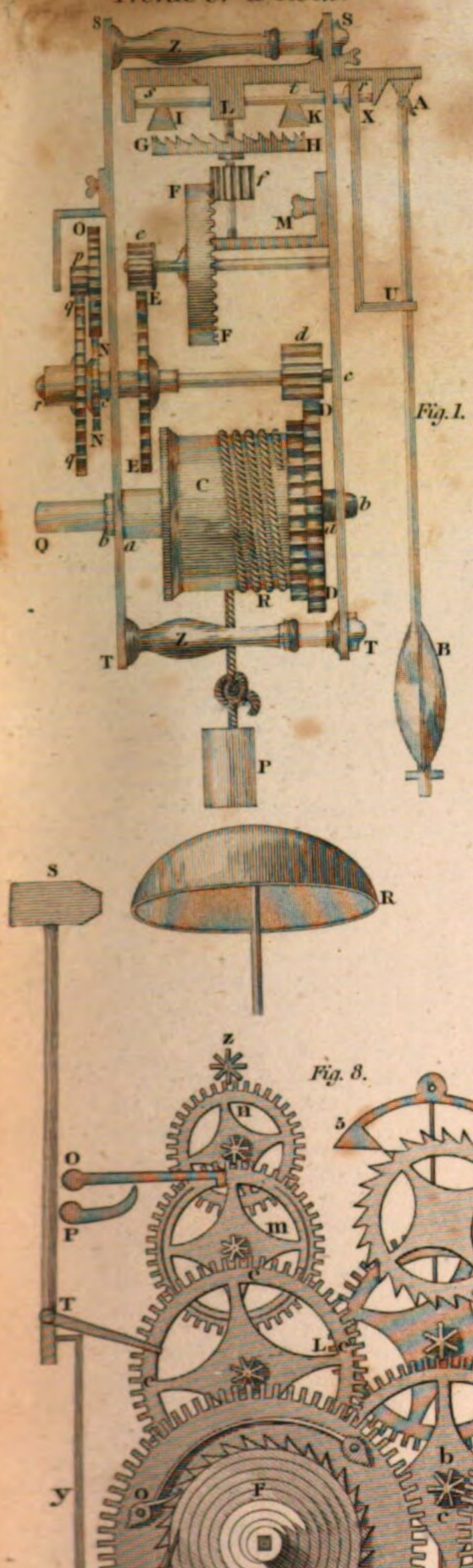


Fig. 1.

Dr. Franklin's Clock.

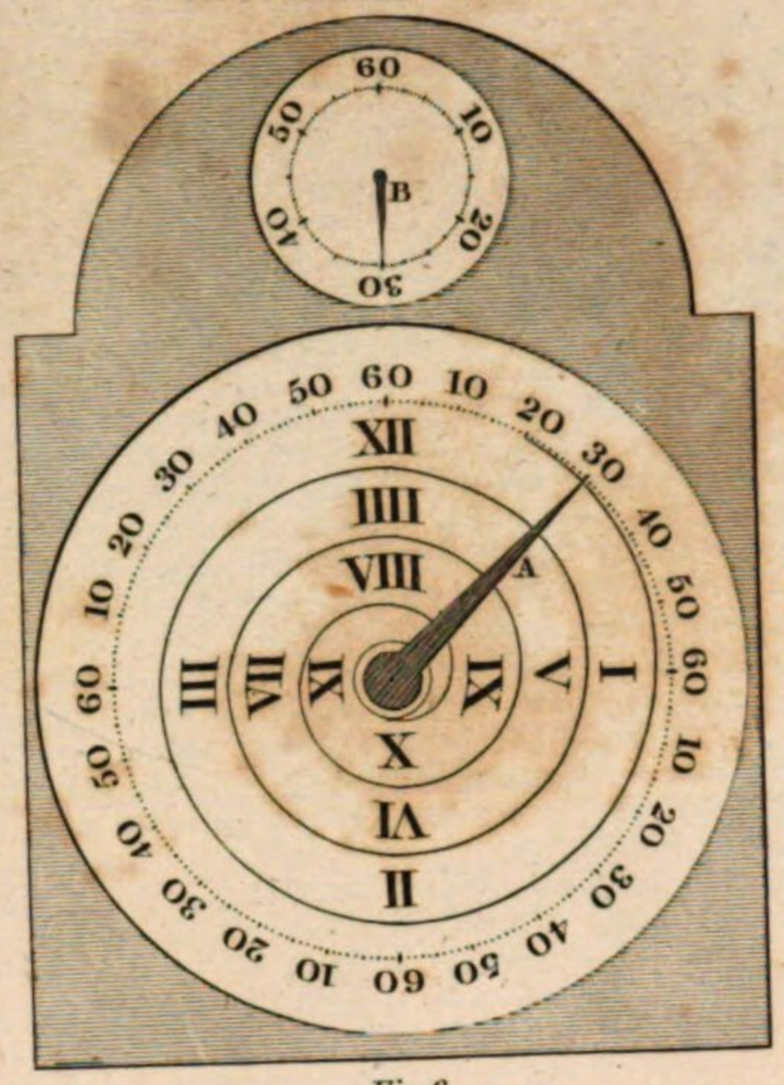


Fig. 3.

Mr. Ferguson's Improvement.

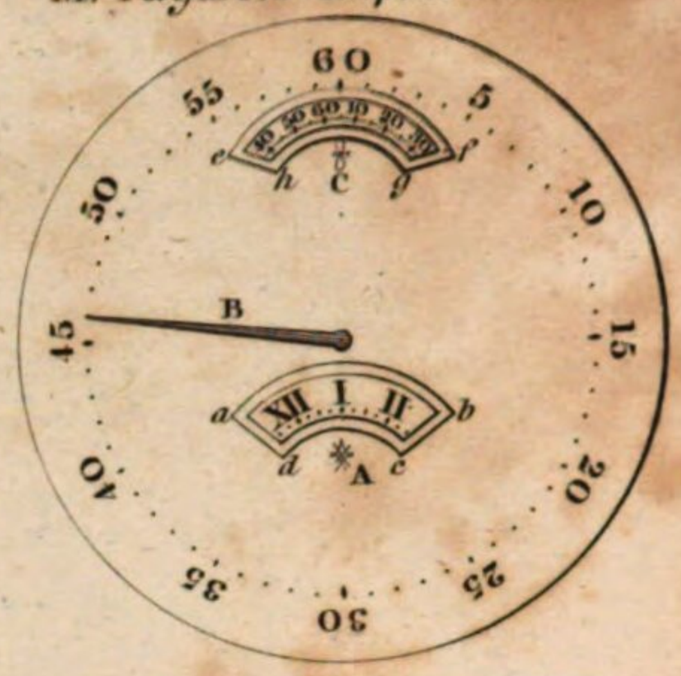


Fig. 5.

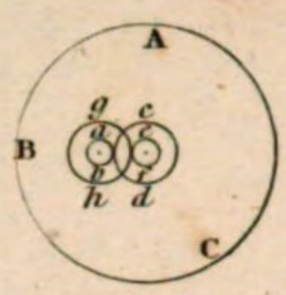


Fig. 7.

Fig. 2.

Coining.

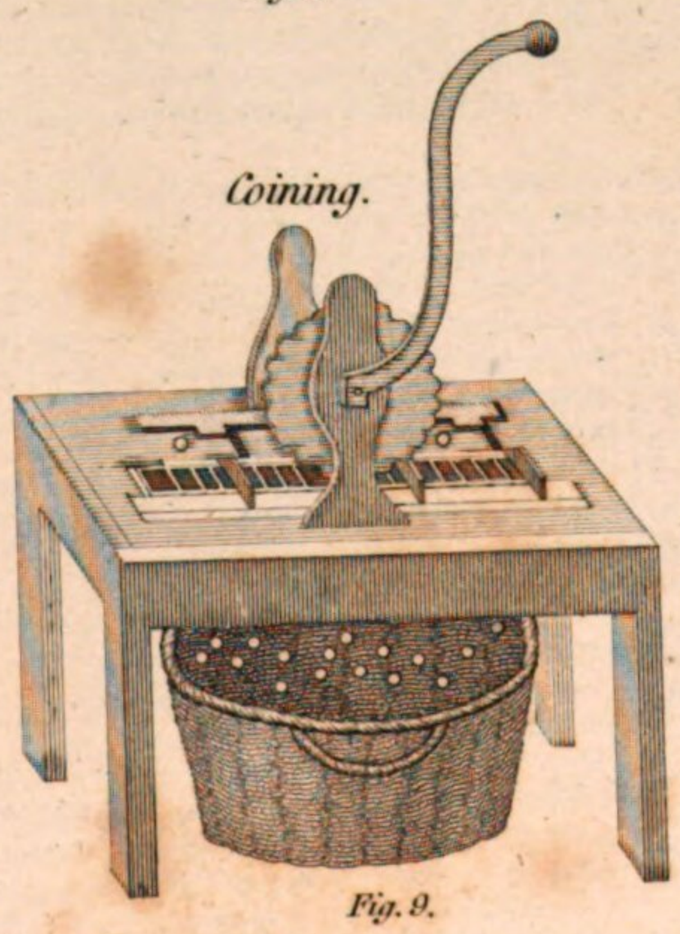


Fig. 9.

Fig. 6.

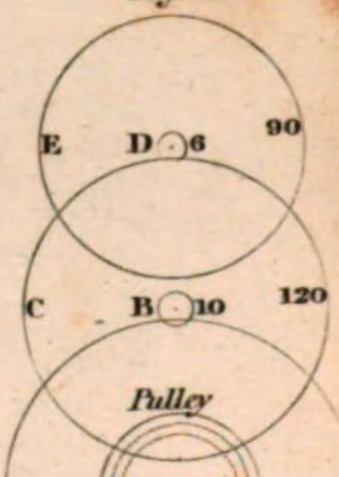
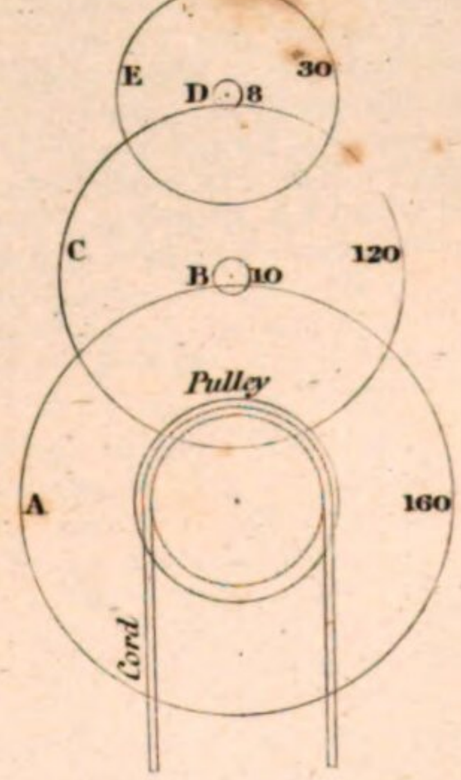


Fig. 4.



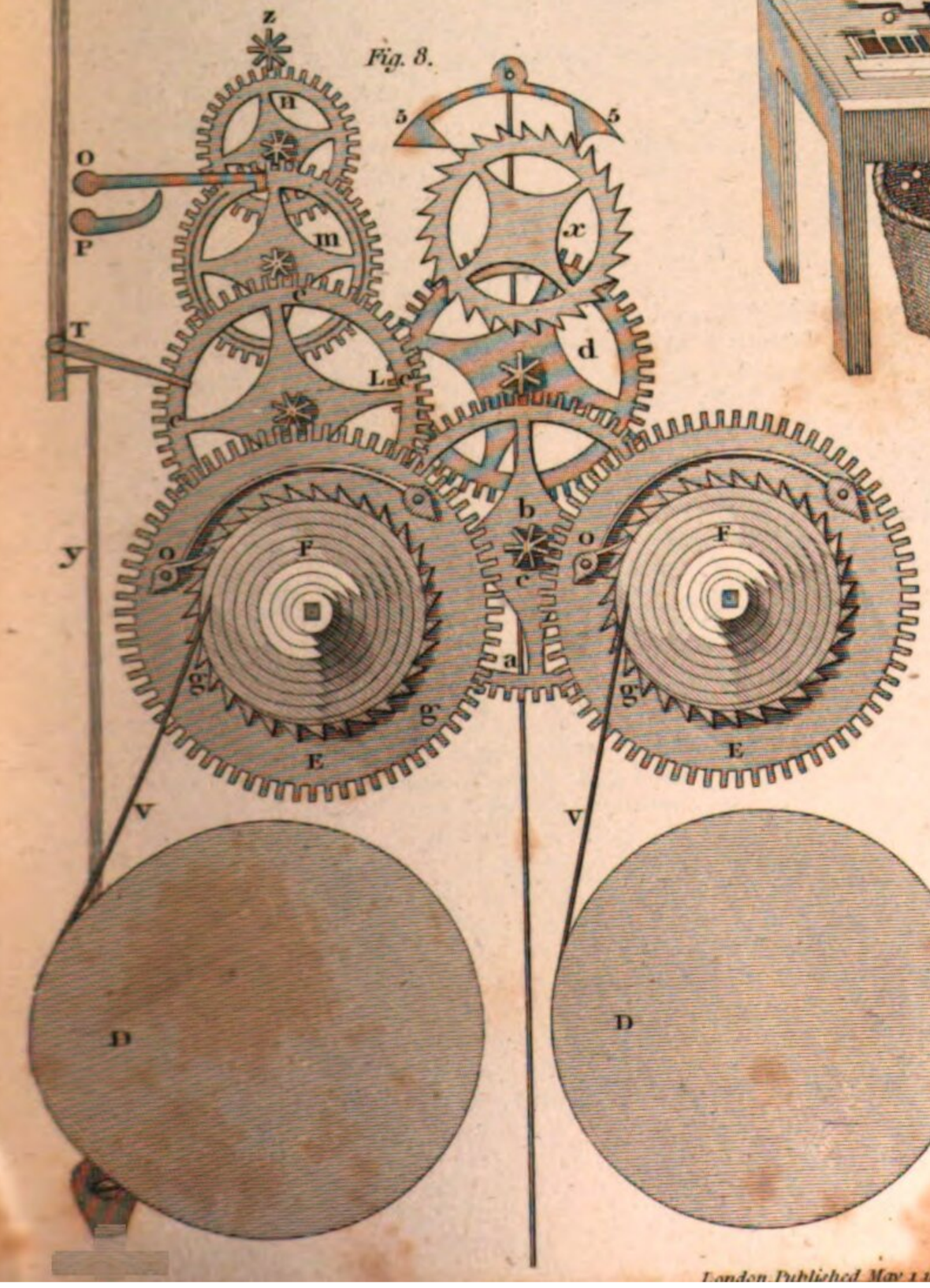


Fig. 8.

Coining.

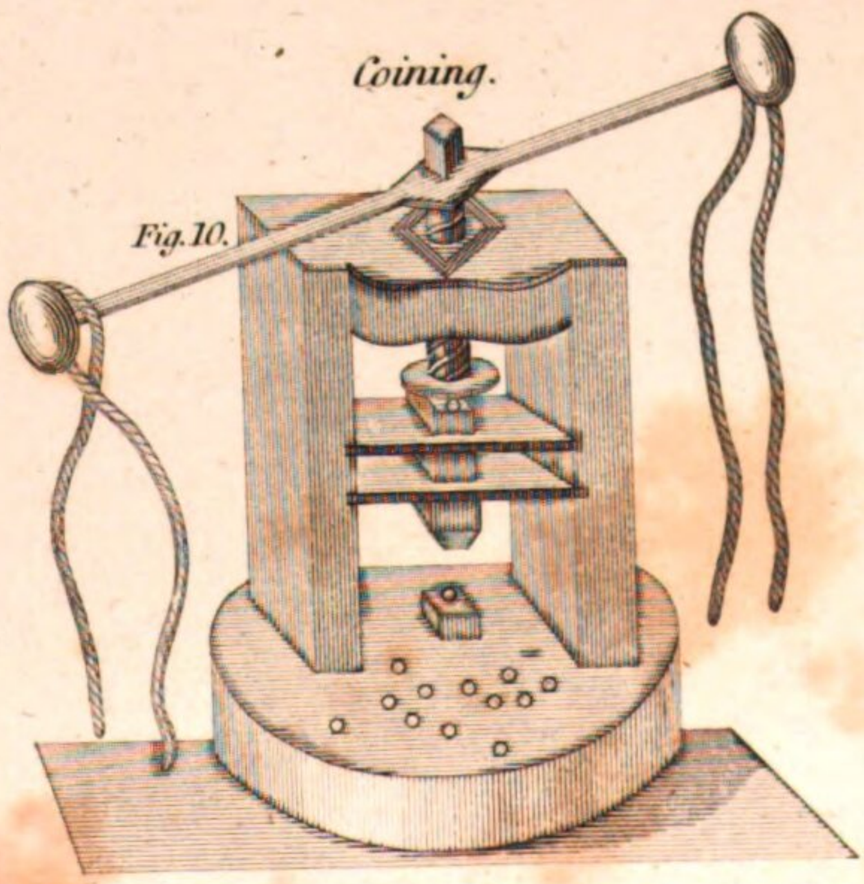


Fig. 10.

Figs. 11.

London Published May 1 1808 by [illegible] Bridge Street Blackfriars

full roe. In July and August multitudes of bleak frequent the river near Gloucester; some of them are as big as a small herring, and these the fishermen erroneously suppose to be the fry of the shad. Numbers of these are taken near Gloucester, in those months only, but none of the emaciated shad are ever caught in their return. The Thames shad does not frequent that river till the end of May or beginning of June, and is esteemed a very coarse and insipid sort of fish. The Severn shad is sometimes caught in the Thames, though rarely, and called allis by the fishermen in that river. About the same time, or rather earlier, the variety called, near Gloucester, the twaite, makes its appearance. It is taken in great numbers in the Severn, and is held in as great disrepute as the shad of the Thames. The differences between each variety are as follow: the true shad weighs sometimes 8 lb. but their general size is from 4 to 5 lb. The twaite, on the contrary, weighs from half a pound to 2 lb. which it never exceeds. The twaite differs from the shad only in having one or more round black spots on the sides; if only one, it is always near the gill; but commonly there are three or four, placed one under the other.

5. Clupea atherinoides has a shining line on each side, and small belly-fins. It is a native of Surinam.

6. Clupea mystus is shaped like a sword, and the fins at the anus are united. It is found in the Indian ocean.

7. Clupea sima has yellow fins, those of the belly being very small. The mouth is flat; the upper jaw is very short; the body is of a shining silver colour; and the fins are yellow. It is a native of Asia.

8. Clupea Sinensis is very like the common herring, but broader. It is a native of China, and has no teeth.

9. Clupea sternicla has no belly fins, and the body is broad. It is a native of Surinam.

10. Clupea thrissa has 28 rays in the fin at the anus. It is found in the Indian ocean.

11. Clupea tropica has a wedge-like tail, and a white, broad, compressed body. It is found at Ascension island.

CLUSIA, the *balsam-tree*, a genus of the polygamia monoecia class of plants, and in the natural method ranking under those plants the order of which is doubtful. The male calyx is tetraphyllous or hexaphyllous, with its leaflets opposite and imbricated; the corolla tetrapetalous or hexapetalous; the stamina numerous. The calyx and corolla of the female as in the male; the nectarium of antheræ or glandules coalited, including the germen. The capsule is quinquelocular, quinquevalved, and full of pulp. There are six species, all natives of America. The most remarkable is the

Clusia flava. It is pretty common in the British American islands, where the trees grow to the height of 20 feet, and shoot out many branches on every side, furnished with thick, round, succulent leaves placed opposite. The flowers are produced at the ends of the branches, each having a thick succulent cover. They are succeeded by oval fruit. From every part of these trees there exudes a kind of turpentine, which is called in the West Indies hog gum; because they say, that when any of the wild hogs are wounded, they repair to these trees, and rub their wounded parts against the stem till they have anointed themselves with this turpentine, which heals all wounds. The plants are very tender, and in this country must be kept constantly in a stove.

CLUYTIA, a genus of the gynandria order, in the diœcia class of plants, and in the natural method ranking under the 38th order, triccocæ. The male calyx is pentaphyllous; the corolla pentapetalous; the calyx and corolla of the female as in the male; the styles are three; and the capsule is trilocular with a single seed. There are 10 species, all natives of warm climates. They are evergreen shrubby plants, rising six or eight feet, with simple leaves, and greenish-white quinquepetalous flowers. They are propagated by cuttings in spring or summer, planting them in pots of light earth, plunged in a hotbed. The plants must always be kept in a stove.

Cluytia elutheria. Dr. Wright in his account of the medicinal plants of Jamaica, says, that this species is the same as the cascarilla and elutheria of the shops. Other medical writers have supposed them to be distinct barks, and they are sold in the shops as different productions. Linnæus's croton cascarilla, Dr. Wright observes, is the wild rosemary shrub of Jamaica, the bark of which has none of the sensible qualities of the cascarilla.

CLYPEOLA, *treacle-mustard*, a genus of the siliculosa order, in the tetradynamia class of plants, and in the natural method ranking under the 39th order, siliquosæ. The silicula is emarginated, orbiculated, compressed plane, and deciduous. There are three species, natives of France, Italy, and the warm parts of Europe, but hardy enough to bear the winters in this country. One of them is an annual, and the others perennial plants; they are low and herbaceous, bearing spikes of white flowers.

CLYSTER. See MEDICINE.

CNEORUM, *widow-wail*, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking under the 38th order, tricoccæ. The calyx is tridentated; there are three equal petals, and a tricoccous berry. There is but one species, a little evergreen and very ornamental shrub, adorned with simple leaves, and tripetalous flowers of a pale yellow colour. It is propagated from seeds, and requires only to be kept free from weeds.

CNICUS, *blessed thistle*, a genus of the polygamia æqualis order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The calyx is ovate, imbricated with spinous branched scales, and encircled with bracteæ. The florets are equal. There are nine species, of which the only remarkable one is that used in medicine under the name of carduus benedictus. This is an annual plant cultivated in gardens: it flowers in June and July, and perfects its seeds in autumn. For medical purposes it should be gathered when in flower, dried in the shade, and kept in a very dry airy place, to prevent its rotting or growing mouldy, which it is very apt to do. The leaves have a penetrating bitter taste, not very strong or durable, accompanied with an ungrateful flavour, which they are in a great measure freed from by keeping. Water extracts in a little time, even without heat, the lighter and more grateful parts of this plant; if the digestion is continued for some hours the disagreeable parts are taken up; a strong decoction is very nauseous and offensive to the stomach. Rectified spirit gains a very pleasant bitter taste, which remains uninjured in the extract. The virtues of this plant are little known in the present practice. The nauseous decoction is sometimes used to provoke vomiting; and a strong infusion to promote the operation of other emetics.

COACH. Hackney-coaches; commissioners are appointed to license and regulate them: the proprietor of each coach to pay 10*s*. per week. Each coach is to be numbered on both sides, the altering of which incurs a penalty of 5*l*. The same penalty is incurred by driving or letting to hire a coach without a licence. Mourning-coaches and hearses are within the act. The horses in hackney-coaches must be fourteen hands high. Coachmen compellable to go in the day ten miles; after dark, but two miles and a half on turnpike-roads; to have check-strings, under the penalty of 5*l*.

The rate for a mile or less is 1*s*.; from that to a mile and a half 1*s*. 6*d*; and for each additional half-mile entered upon, 6*d*.

In reckoning by time, three-quarters of an hour or less is 1*s*; between that and an hour 1*s*. 6*d*.; one hour and twenty minutes 2*s*.; and for each additional twenty minutes entered upon, 6*d*. For a delay of twelve hours 14*s*. 6*d*.; and 6*d*. for each twenty minutes over.

A coachman refusing to go, or exacting more than his fare, forfeits from 10*s*. to 3*l*. By misbehaviour or impudence he incurs the same penalty, and subjects his licence to be revoked, and himself to be committed to the house of correction. Persons refusing to pay the fare, or defacing the coach, may be compelled by a justice to make satisfaction. The penalties may be recovered before the aldermen of the city, as justices of the peace, as well as before the commissioners. 4, 7, 10, 11, 12, 24, 26, and 32 Geo. III.

Stage-coaches. Every person keeping any public stage-coach shall pay annually 5*s*. for a licence; and keeping any such public stage without a licence, he shall forfeit for every time such carriage is used 10*l*. No person licensed shall, by virtue of one licence, keep more than one carriage, on penalty of 10*l*. Every licensed stage-coach shall pay twopence halfpenny for every mile it travels. Every person licensed shall paint, on the outside pannel of each door, his christian and surname, with the name of the place whence he sets out, and to which he is going, on pain of 10*l*. Should he discontinue such carriage, he shall give seven days previous notice; and have such notice indorsed upon his licence, and thenceforth shall be no longer chargeable.

Drivers of stage-coaches are not to admit more than one outside passenger on the box, and four on the roof of the coach, on the penalty of 5*s*. for each passenger at every turnpike-gate.

COACHMAKER. The wares of coachmakers shall be examined by persons appointed by the sadlers' company. 1 Jac. c. 22. And every coachmaker shall take out an annual licence from the excise-office, and pay a duty of 20*s*. for every four-wheeled

carriage, and 10*s.* for every two-wheeled carriage, built by him for sale.

COACHMAN opening and partly destroying a parcel left in his coach, is guilty of felony.

COAK is used for exciting intense heats, for chemical purposes, or for smelting iron ore, and for operations in which common coal would be detrimental, as the drying malt. Coak is fossil coal previously charred by an operation similar to that by which charcoal is made.

COAL, or *pit-coal*, in mineralogy. The substances belonging to this genus are composed chiefly of carbon and bitumen. There are six species, (1.) *Jet:* this substance is found in France, Spain, Germany, Britain, and other countries. It is found in detached kidney-form masses, of various sizes, from an inch to seven or eight feet in length. The colour is full black: internal, glossy, opaque: not so brittle as asphaltum: texture striated; fracture conchoidal. Specific gravity 1.259. It has no smell except when heated, and then it resembles asphaltum in its odour. It melts in a strong heat, burns with a greenish flame, and leaves an earthy residuum. Becomes electric by friction; and when distilled it yields a peculiar acid.

(2.) *Cannel coal* is found in Lancashire, and in different parts of Scotland. The colour is black, opaque: structure sometimes slaty: texture compact: fracture conchoidal: brittle. Specific gravity 1.232 to 1.426. Does not stain the fingers.

Kindles easily, and burns with a bright white flame like a candle, which lasts but a short time. It does not cake. See AMPELITES.

A specimen of Lancashire cannel coal, analysed by Mr. Kirwan, contained

75.20 charcoal
21.68 maltha
3.10 alumina and silica

99.98

A specimen of the slaty kind from Ayrshire, called splent coal, was composed of

47.62 charcoal
32.52 maltha
20.00 earths

100.14

Cannel coal is susceptible of polish, and, like jet, is often wrought into trinkets.

3. *Common coal.* This very useful combustible is never found in the primitive mountains, but only in the secondary mountains, or in plains formed of the same materials with them. It is always in strata, and generally alternates with clay, sandstone, or limestone.

The colour is black, more or less perfect. Lustre usually greasy or metallic. Opaque. Structure generally slaty. Texture often foliated. Fracture various. Specific gravity 1.25 to 1.37. Usually stains the fingers. Takes fire more slowly, and burns longer, than the last species. Cakes more or less during combustion.

Of this species there are many varieties, distinguished in Britain by the names of caking coal, rock coal, &c. These are too well known to require any description.

Mr. Kirwan analysed a variety of different kinds of coal. The result of the experiments may be seen by the following table:

	Whitehaven coal.	Wigan.	Swansey.	Leitrim.	
charcoal.	57.0	61.73	73.53	71.43	
maltha and asph.	41.3	36.7	23.14	23.37	
earths.	1.7	1.57	3.33	5.20	
	100.00	100.00	100.00	100.00	

(4.) *Spurious coal* is generally found amidst strata of genuine coal. It is also called parrot coal in Scotland.

The colour is greyish black. Structure usually slaty. Texture earthy. Specific gravity 1.5 to 1.6. Generally explodes, and bursts when heated.

Composed of charcoal, maltha, and asphalt, and above .20 of stony matter.

(5.) *Anthracite.* This substance, as Dolomieu informs us, is found exclusively in the primitive mountains. It is commonly amorphous, sometimes crystallized in short hexagonal prisms. Colour black, or brownish black. Structure slaty. Fragments rhomboidal. Specific gravity 1.300. Often stains the fingers.

Burns precisely like the last species, and leaves .40 of white ashes. According to Dolomieu, it is composed of about

64.0 charcoal
32.5 silica
3.5 iron

100.0

(6.) *Kilkenny coal.* This mineral has been found in Hungary, Italy, France, Ireland, and Wales. It occurs in stratified masses, or in lumps nested in clay. The colour is black. Opaque. Texture foliated. Specific gravity 1.4 to 1.526. Often stains the fingers. Insoluble in acids. Deflagrates with nitre. Does not burn till wholly ignited, and then consumes slowly without emitting flame or smoke. It consists almost entirely of charcoal.

COAL, *small*, a sort of charcoal prepared from the spray and brushwood stripped off from the branches of coppice-wood, sometimes bound in bavins for that purpose, and sometimes charred without binding, and then it is called coming it together.

The wood they dispose on a level floor, and setting a portion of it on fire, they throw on more and more, as fast as it kindles, whence arises a sudden blaze, till all is burnt that was near the place. As soon as all the wood is thrown on, they cast water on the heap from a large scoop, and thus keep plying the heap of glowing coals, which stops the fury of the fire; while with a rake they spread it open, and turn it with shovels till no more fire appears. Then they shovel them up into great heaps, and when thoroughly cold, put them up in sacks, to be used by divers artificers to temper and anneal their several works. Small-coal was formerly much used in kindling fires, but there is now no demand for it for this purpose.

COAL-LAWS. Sea-coal brought into the Thames shall be sold by the chaldron, containing 36 bushels heaped up, according to the bushel sealed for that purpose at Guildhall.

Coals within the bills shall be carried in linen sacks, sealed by the proper officer, which shall be at least four feet four inches in length, and twenty-six inches in breadth; and sellers of coals by the chaldron, or less quantity, shall put three bushels of coals into each sack. 3 and 32 Geo. II. c. 26. and 27.

All sellers of coals are to keep a lawful bushel, which bushel and other measures shall be edged with iron and sealed; and using others, or altering them, incurs a forfeiture of 50*l.*

Any purchaser dissatisfied with the measure of any coals, may, on delivery to him of the meter's ticket, have the same remeasured, by sending notice thereof to the seller, and to the land coal-meter's office for the district in which the coals were sold; on which a meter (not being the same under whose inspection the coals were originally measured) must, within two hours, attend to remeasure the coals, and shall remeasure the same sack by sack, in the presence of the seller and purchaser (if they attend), and also in the presence of a meter from the two other districts (whose attendance within London and Westminster is enforced by a penalty of 5*l.* but not in Surry); for this attendance the purchaser is to pay each coal-meter attending 6*d.* per chaldron. If the coals prove deficient measure, the seller shall forfeit 5*l.* for every bushel deficient, and also forfeit the coals to the poor. The meter under whose inspection the coals were measured at the wharf, shall also forfeit 5*l.* per bushel deficient, to be recovered (if not in five days) of the principal coal-meter; and coal-porters 2*s.* 6*d.* per bushel. The carman is to be paid 2*s.* 6*d.* for his horses, &c. for each hour, whilst the coals are remeasuring.

Any coal-factor receiving, or coal-owner giving, any gratuity for buying or selling any particular sort of coals, and selling one kind of coals for and as a sort which they really are not, shall forfeit 500*l.* 3 Geo. II. c. 26.

Owners or masters of ships shall not enhance the price of coals in the river Thames, by keeping turn in delivering coals there, under the penalty of 100*l.* 4 Geo. II. c. 30. Contracts between coal-owners, &c. and merchants of ships for restraining the buying of coals are void, and the parties shall forfeit 100*l.* 9 Ann. c. 28.

Wilfully and maliciously setting on fire any mine, pit, or delph of coal, or cannel-coal, is felony without benefit of clergy. 10 Geo. II. c. 32.

Setting fire to, demolishing, or otherwise damaging, any engine or any other thing belonging to coal-mines, is felony and transportation for seven years. 9 Geo. III. c. 29.

COAMINGS, in ship-building, are those

planks which raise up the hatches higher than the rest of the deck, in which loop-holes for muskets to shoot out are usually made, in order to clear the deck when the ship is boarded by an enemy.

COASTING, that part of navigation where the places assigned are not far distant, so that a ship may sail in sight of land, or within soundings, between them. In this there are only required a good knowledge of the land, and the use of the compass and lead, or sounding-line.

COAT, or *coat of arms*, in heraldry, a habit worn by the antient knights over their arms, both in war and tournaments, and still borne by heralds at arms. It was a kind of surcoat, reaching as low as the navel, open at the sides with short sleeves, sometimes furred with ermine and hair, upon which were applied the armories of the knights embroidered in gold and silver, and enamelled with beaten tin, coloured black, green, red, and blue: whence the rule never to apply colour on colour, or metal on metal.

Coats of arms and banners were never allowed to be worn by any but knights and antient nobles.

COATS, in a ship, are pieces of tarred canvass put about the masts at the partners to keep out water. They are also used at the rudder's head, and about the pumps at the decks, that no water may go down there.

COBALT, in mineralogy, a mineral of a grey colour, first discovered by Brandt, the celebrated Swedish chemist, in 1733.

Bergman confirmed and extended the discovery of Brandt in the year 1780. In the year 1800 a new set of experiments were made upon it by the school of mines at Paris, in order to procure it perfectly pure, and to ascertain its properties when in that state. And in 1802 a new set of experiments were published by Thenard, which throw considerable light on its combinations with oxygen.

I. 1. Cobalt is of a grey colour with a shade of red, and by no means brilliant. Its texture varies according to the heat employed in fusing it. It is composed of plates, sometimes of grains, and sometimes of small fibres adhering to each other. It has scarcely any taste or smell. 2. Its specific gravity, according to Bergman and the school of mines at Paris, is 7.7; but Tassaert makes it 8.5384. 3. It is brittle, and easily reduced to powder; but if we believe Leonhardi it is somewhat malleable when red-hot. Its tenacity is unknown. 4. When heated to the temperature of 130 degrees Wedgewood it melts; but no heat which we can produce is sufficient to cause it to evaporate. When cooled slowly in a crucible, if the vessel is inclined the moment the surface of the metal congeals, it may be obtained crystallized in irregular prisms. 5. Like iron, it is attracted by the magnet; and from the experiments of Wenzel it appears, that it may be converted into a magnet precisely similar in its properties to the common magnetic needle.

II. When exposed to the air it undergoes no change, neither is it altered when kept under water; its affinity for oxygen is not sufficiently strong to occasion a decomposition of the water. When kept red-hot in an open vessel it gradually imbibes oxygen; and is converted into a powder at first blue, but which gradually becomes deeper and deeper, till at last it becomes black, or rather of so deep a blue, that it appears to the eye black. If the heat is very violent the cobalt takes fire, and burns with a red flame. From the experiments of Thenard it follows, that cobalt is capable of combining with three doses of oxygen at least, and of forming three distinct oxides, which may be exhibited in a separate state.

1. The protoxide of cobalt has a blue colour. It may be obtained by dissolving cobalt in nitric acid, and precipitating the cobalt from the solution by means of potass. The precipitate has a blue colour; but when dried in the open air it gradually becomes black. This black powder is to be kept for half an hour in that degree of heat known to manufacturers of iron utensils by the name of cherry-red. This heat expels the oxygen which it had absorbed in drying, and converts it into a fine blue colour. This oxide dissolves in acids without effervescence. The solution of it in muriatic acid, if concentrated, is green; but if diluted with water it is red. Its solution in sulphuric and nitric acids is always of a red colour. 2. When the protoxide of cobalt, newly precipitated from acids by potass, is exposed to the air, it gradually combines with an additional dose of oxygen, as Thenard ascertained by experiment, and assumes an olive-green colour; and by cautiously drying it without the aid of heat, it may be obtained in that state. This is the deutoxide of cobalt. When this oxide is treated with diluted muriatic acid, a moderate heat developes oxymuriatic acid gas, and a red-coloured solution is obtained. Hence we see that the deutoxide of cobalt loses a portion of its oxygen during its solution in muriatic acid. 3. When the protoxide or deutoxide of cobalt, newly precipitated from an acid, is dried by heating it in the open air, it assumes a flea-brown colour, which gradually deepens, till at last it becomes black. This is the peroxide of cobalt. It dissolves with effervescence in muriatic acid, and a great quantity of oxymuriatic acid gas is exhaled. Mr. Thenard considers the brown colour which the oxide of cobalt first assumes before it becomes black, as a tritoxide; but his experiments are not sufficient to decide that point.

With respect to the reddish precipitate which is sometimes obtained by precipitating cobalt from acids, and which has been considered as a peculiar oxide of cobalt, Mr. Thenard suspects, with reason, that it is a combination of the oxide of cobalt with arsenic acid.

III. 1. Cobalt does not combine with carbon nor hydrogen. 2. It cannot be combined with sulphur by fusion. But sulphuret of cobalt may be formed by melting the metal along with sulphur previously combined with potass. It has a yellowish-white colour, displays the rudiments of crystals, and can scarcely be decomposed by heat. 3. Phosphuret of cobalt may be formed by heating the metal red-hot, and then gradually dropping in small bits of phosphorus. It contains about one-fifteenth of phosphorus. It is white and brittle; and when exposed to the air, soon loses its metallic lustre. The phosphorus is separated by heat, and the cobalt is at the same time oxidated. This phosphuret is much more fusible than pure cobalt.

IV. Cobalt does not combine with azotic gas, nor muriatic acid gas.

V. Cobalt seems capable of combining with most of the metals, but its alloys are very imperfectly known. 1. It combines with small portions of gold; but the alloy scarcely differs from pure cobalt in its properties. 2. When two parts of cobalt and one of silver are melted together, the two metals are obtained separately after the process; the silver at the bottom of the crucible, and the cobalt above it. Each of them, however, has absorbed a small portion of the other metal: for the silver is brittle and dark-coloured, while the cobalt is whiter than usual. 3. The alloy of iron and cobalt is very hard, and not easily broken. Cobalt generally contains some iron, from which it is with great difficulty separated. 4. The alloy of tin and cobalt is of a light violet colour, and formed of small grains. 5. It was supposed formerly that cobalt does not combine with lead by fusion; for upon melting equal parts of lead and cobalt together, both metals are found separate; the lead at the bottom, and the cobalt above. Indeed when this cobalt is melted with iron, it appears that it had combined with a little lead; for the iron combines with the cobalt, and the lead is separated. But Gmelin has shown that the alloy may be formed. He put cobalt in powder within plates of lead, and covered them with charcoal to exclude the air. He then applied heat to the crucibles containing the mixtures. Equal parts of lead and cobalt produced an alloy, in which the metals appeared pretty uniformly distributed, though in some places the lead predominated. It was brittle, and received a better polish than lead, which it resembled rather than cobalt; its specific gravity was 8.12. Two parts of lead and one of cobalt produced an uniform mixture, more like cobalt than lead, very little malleable, and softer than the last. Its specific gravity was 8.28. Four parts of lead and one of cobalt formed an alloy still brittle, and having the fracture of cobalt, but the polish of lead. It was harder than lead. Six parts of lead and one of cobalt formed an alloy more malleable, and harder than lead. Its specific gravity was 9.65. Eight parts of lead and one of cobalt was still harder than lead, and it received a better polish. It was as malleable as lead. Its specific gravity was 9.78.

COCCINELLA, in zoology, a genus of insects (see Plate Nat. Hist. fig. 132) of the order of coleoptera, the characters of which are these: the antennæ are subclavated; the palpi are longer than the antennæ, the last articulation heart-shaped; the body is hemispheric; the thorax and elytra are margined; the abdomen is flat. This genus is divided into sections, from the colour of the elytra, and of the spots with which they are adorned. The females, impregnated by the males, deposit their eggs, which turn to small larvæ, slow in their process, and enemies to the plant-louse. Those larvæ are frequently found upon leaves of trees covered with plant-lice. On the point of being metamorphosed they settle on a leaf by the hinder part of their body, then bend and swell themselves, forming a kind of hook. The skin extends, grows hard, and in a fortnight's time the chrysalis opens along the back. The insect in its perfect state receives the impressions of the air, that gives its elytra a greater degree of consistence. It seldom flies, and cannot keep long on the wing. Of all the different larvæ of

the coccinella, the most curious is the white hedgehog; a name given it by M. de Reaumur, on account of the singularity of its figure, and the tufts of hair which render it remarkable. It seeks its food on the leaves of trees. After a fortnight it settles on one spot, and, without parting with its fur, turns to a chrysalis; three weeks after which it becomes a coccinella. The slough appears nowise impaired by its transformation. M. de Reaumur has observed it on a plum-tree. It is likewise found upon the rose-tree. When the coccinella first arrives at the state of perfection, the colours of its elytra are very pale, nearly bordering upon white or cream-colour; and its elytra are very soft and tender, but soon grow hard, and change to very lively brilliant colours. Their eggs are of an oblong form, and of the colour of amber. This is not the cochineal insect: for that see Coccus.

COCCOLOBO, a genus of the trigynia order, in the octandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. The calyx is quinquepartite and coloured; there is no corolla; the berry is formed of the calyx, and is monospermous. There are 19 species: that called uvifera, or sea-side grape (see Plate Nat. Hist. fig. 129). It grows upon the sandy shores of most of the West India islands; where it sends up many woody stems, eight or ten feet high, covered with brown smooth bark, and furnished with thick, veined, shining, orbicular leaves, five or six inches diameter, standing upon short footstalks.

COCCULUS *Indicus*, the name of a poisonous berry, too frequently mixed with malt liquors, in order to make them intoxicating; but this practice is expressly forbidden by act of parliament. It is the fruit of the monospermum cocculus. Fishermen have a way of mixing it with paste; this the fish swallow greedily, and are thereby rendered lifeless for a time, and float on the water. The old women use it with staves-acre, for destroying lice in children's heads.

COCCUS, in zoology, a genus of insects belonging to the order of hemiptera. The rostrum proceeds from the breast; the belly is bristly behind; the wings of the male are erect; and the female has no wings. The species are 22, denominated principally from the plants they frequent. The most remarkable species are,

1. The coccus hesperidum, or greenhouse bug, which is oval, oblong, of a brown colour, covered with a kind of varnish: it has six legs, with a notch and four bristles at the tail. It infests orange-trees and other similar plants in greenhouses. When young it runs upon the trees; but afterwards fixes on some leaf, where it hatches an infinity of eggs, and dies. The male is a very small fly.

2. The coccus phalarides. The male of this species is small; its antennæ are long for its size; the feet and body are of a reddish colour, nearly pink, and sprinkled with a little white powder. Its two wings, and the four threads of its tail, are snow-white; and of those threads two are longer than the rest. It is to be found upon the species of gramen which Linnæus calls phalaris. The female contrives, along the stalks of that dog-grass, little nests, of a white cottony substance, in which she deposits her eggs. The small threads of her tail are scarcely perceptible.

3. The coccus cacti (see Pl. Nat. Hist. fig. 130, 131), a native of the warmer parts of America, is the famous cochineal animal, so highly valued in every part of the world for the incomparable beauty of its red colour, which it readily communicates to wool and silk, but with much more difficulty to linen and cotton. This insect, like others, is of two sexes, but exceedingly dissimilar in their appearance. The female, which alone is valuable for its colour, is ill-shaped, tardy, and stupid: its eyes, mouth, and antennæ, are fixed so deep, and are so concealed in the folds of the skin, that it is impossible to distinguish them without a microscope. The male is very scarce, and is sufficient for 300 females or more: it is active, small, and slender, in comparison with the female; its neck is narrower than the head, and still narrower than the rest of the body.

The cochineal insect may, in some circumstances, be compared to the silkworm, particularly in the manner of depositing its eggs. The insects destined for this purpose are taken at a proper time of their growth, and put into a box well closed, and lined with a coarse cloth, lest any of them should be lost; and in this confinement they lay their eggs and die. The box is kept close shut till the time of placing the eggs on the nopal, when, if any motion is perceived, it is a sufficient indication that the animalcule has life, though the egg is so minute as hardly to be perceived; and this is the seed placed on the foliage of the cactus cochenilifer, or Indian fig, known to the Spaniards by the name of nopal, the quantity contained in the shell of a hen's egg being sufficient for covering a whole plant. At Oaxaca cochineal insects are gathered in large quantities, and form a branch of commerce; the cultivation of these little creatures being there the chief employment of the Indians. In trade four sorts of cochineal are distinguished, mastique, campeschane, tetraschale, and sylvester; of which the first is accounted the best, and the last the worst. Its principal consumption is among the dyers.

4. The coccus ilicis, or that forming the kermes grains, inhabits the quercus coccifera of the southern parts of Europe. Both antients and moderns seem to have had very confused notions concerning the origin and nature of the kermes; some considering it as a fruit, without a just knowledge of the tree which produced it; others taking it for an excrescence formed by the puncture of a particular fly, the same as the common gall observed upon oaks; but it was finally discovered that the kermes is in reality nothing else but the body of an insect transformed into the resemblance of a grain, berry, or husk, according to the course of nature. The progress of this transformation must be considered at three different seasons. In the first stage, at the beginning of March, an animalcule, no larger than a grain of millet, scarcely able to crawl, is perceived sticking to the branches of the tree, where it fixes itself, and soon becomes immoveable: at this period it grows most, and appears to swell and thrive with the sustenance it draws in by degrees. At the second stage, in April, its growth is completed; its shape is then round, and about the size of a pea: it has then acquired more strength, and the down which covered it is changed into dust; and seems to be nothing but a husk or a capsule, full of a reddish juice, not unlike discoloured blood. Its third state is towards the end of May, when the husk appears replete with small eggs, less than the seed of a poppy. These are properly ranged under the belly of the insect, progressively placed in the nest of down that covers its body, which it withdraws in proportion to the number of eggs. After this work is performed it soon dies, though it still adheres to its position, rendering a further service to its progeny, and shielding them from the inclemency of the weather, or the hostile attacks of an enemy. In a good season they multiply exceedingly, laying from 1800 to 2000 eggs, which produce the same number of animalcules. In France poor people gather the kermes, letting their nails grow in order to pick them off with greater facility.

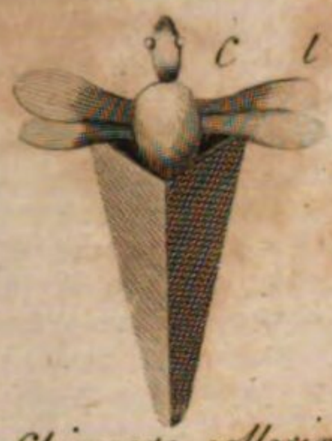
5. The coccus lacca, or gum-lac animal, is a native of the East Indies. This species traverse the branches of the trees upon which they were produced, for some time, and then fix themselves upon the succulent extremities of the young branches. By the middle of January they are all fixed in their proper situations; and appear as plump as before, but show no other marks of life. The limbs, antennæ, and setæ of the tail, are no longer to be seen. Around their edges they are environed with a spissid subpellucid liquid, which seems to glue them to the branch: it is the gradual accumulation of this liquid which forms a complete cell for each insect, and is what is called gum-lac. About the middle of March the cells are completely formed, and the insect is in appearance an oval, smooth, red bag, without life, about the size of a small cochineal insect, emarginated at the obtuse end, full of a beautiful red liquid. In October and November we find about 20 or 30 oval eggs, or rather young grubs, within the red fluid of the mother. When this fluid is all expended the young insects pierce a hole through the back of their mother, and walk off one by one, leaving their exuviæ behind, which is that white membranous substance found in the empty cells of the stick-lac. The insects are the inhabitants of four trees: 1. Ficus religiosa, Linnæi; 2. Ficus indica, Linnæi; 3. Plaso, Hortus Malabaricus; and 4. Rhamnus jujuba, Linnæi. The insects generally fix themselves so close together, and in such numbers, that scarcely one in six can have room to complete her cell: the others die, and are eaten up by various insects. The extreme branches appear as if they were covered with a red dust, and their sap is so much exhausted, that they wither, and produce no fruit; the leaves drop off, or turn to a dirty black colour. A red medicinal gum is produced by incision from the plaso tree, so similar to the gum-lac, that it may readily be taken for the same substance. Hence it is probable that those insects have little trouble in animalizing the sap of these trees in the formation of their cells. The gum-lac of this country is principally found upon the uncultivated mountains on both sides the Ganges, where the only trouble in procuring it is in breaking down the branches, and carrying them to market. The lac is of a deep red colour.

114
Chaetodon lanceolatus

115
Chaetodon Chirurgus

116
Chætodon rhomboides

Clio



118

Chiton

117

119
Chimaera collorinchus

120
Chrysis lucidula

121
Cuada aurita

122
Cicada sanguinolenta

128
Clematis

128

123
Cicada plebeia

124
Cicindela campestris

125
Cimex paradoxus

126
Cimex spinicornis

128

128

129
Coccoloba uvifera

130
Coccus
Cochineal Insect

131.
Cacti
Male & Female

127
Cimex zosterae

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6. Coccus polonicus, an insect which may properly enough be called the cochineal of the northern part of the world. As the cochineal loves only the hot climates, this creature affects only the cold ones. Though collected for the use of the dyers, it is greatly inferior to the true cochineal. It is commonly known by the name of the scarlet grain of Poland. It is to be met with not only in Poland, but in many of the northern countries. It is found affixed to the root of a plant, and usually to plants of that species thence called polygonum cocciferum. Towards the end of June the coccus is in a fit state to be gathered. Every one of these creatures is then nearly of a spherical form, and of a fine violet colour. Some of them, however, are not larger than poppy-seeds, but others are the size of a pepper corn; and each of them is lodged, either in part or entirely, in a sort of cup like that of an acorn. On some plants are found only one or two of these, and on others more than forty; and they are sometimes placed near the origin of the stalks of the plants.

COCCYX, or *coccygis os*, in anatomy, a bone situated at the extremity of the os sacrum. See ANATOMY.

COCHINEAL. See COCCUS.

With us this article pays no duty; and is esteemed a great cordial, sudorific, alexipharmic, and febrifuge; and much used by dyers and painters, the high crimson colour it affords being scarcely equalled by any thing; and making, according to their different management of it, all the degrees and kinds of red.

COCHLEA, in anatomy, the third part of the labyrinth of the ear. See ANATOMY.

COCHLEARIA, *scurvy-grass*, a genus of the siliculosa order, in the tetradynamia class of plants; and in the natural method ranking under the 39th order, siliquosa. The silicula is emarginated, turgid, and scabrous; with the valves gibbous and obtuse. There are eight species; the most remarkable of which are,

1. Cochlearia Anglica, or garden scurvy-grass, it grows naturally on the sea shore, in the north of England and in Holland, but is cultivated for use in the gardens near London. It has a fibrous root, from which arise many round succulent leaves, which are hollowed like a spoon; the stalks rise from six inches to a foot high. The flowers are produced in clusters at the end of the branches, consisting of four small white petals. This plant is propagated by seeds, which should be sown in July: in spring they will be fit for use. Scurvy-grass is a pungent stimulating medicine, capable of dissolving viscid juices, opening obstructions of the viscera and the more distant glands, and promoting the more fluid secretions. It is particularly celebrated in scurvies, and is the principal herb employed in these disorders in the northern countries.

2. Cochlearia armoracia, or horse-radish, is so well known as to need no description. It is propagated by cuttings or buds from the sides of old roots. The root has a quick pungent smell, and penetrating acrid taste; it nevertheless contains in certain vessels a sweet juice, which sometimes exudes on the surface. By drying it loses all its acrimony, becoming first sweetish, and then almost insipid: if kept in a cool place, in sand, it retains its qualities for a considerable time. The medical effects of it are, to stimulate the solids, attenuate the juices, and promote the fluid secretions: it seems to extend its action through the whole habit, and to affect the minutest glands. It has frequently done service in some kinds of scurvies, and other chronic disorders proceeding from a viscidity of the juices or obstructions of the excretory ducts. Sydenham recommends it likewise in dropsies, particularly those which follow intermittent fevers. Both water and rectified spirit extract the virtues of this root by infusion, and elevate them in distillations: along with the aqueous fluid an essential oil rises, possessing the whole taste and pungency of the horse-radish.

COCHLITES, in natural history, an appellation given to the petrified shells of snails.

COCK. See PHASIANUS.

COCK-BOATS, those used only in rivers, or near the shores.

COCK'S-COMB. See CELOSIA.

COCK-PIT, in a ship of a war, a place on the lower floor or deck, abaft the main-capstan, lying between the platform and the steward's room, where are partitions for the purser, surgeon, and his mates.

COCK-SWAIN, or *coxon*, an officer on board a ship of war, who has the care of the barge and all things belonging to it, and must be also ready with his crew to man the boat on all occasions: he sits at the stern of the boat, and steers.

COCK-WATER, among miners, a stream of water, brought into a trough, to wash away the sand from tin ore, while stamping in the middle.

COCKETT, *cockettum*, *cocketum*. The custom-house seal, or the office where goods to be wooden shivers, to keep them from splitting and galling by the pin of the block.

COCKETT, *cockettum*, *cocketum*. The custom-house or the office where goods to be transported are first entered, and pay their custom; and are to have a cockett, signifying that their merchandises are customed, and may be discharged. See CUSTOM-HOUSE.

COCOS, in botany, a genus belonging to the natural order of palmæ. It is of the monoecia hexandria. The calyx of the male is tripartite; the corolla tripetalous, with six stamina. The calyx of the female quinquepartite; the corolla tripetalous; the stigmata three; and the plum coriaceous. There are five species. The principal is,

Cocos nucifera, the cocoa-nut tree. See Plate. It is supposed to be a native of the Maldive, and some desert islands in the East Indies, and thence to have been transported to all the warm parts of America: for it is not found in any of the inland parts, nor any where far distant from settlements. It frequently rises 60 feet high. The body of the trunk, which generally leans to one side, occasioned by the great weight of nuts it sustains when young, is the exact shape of an apothecary's large iron pestle, being of an equal thickness at top and at bottom, but somewhat smaller in the middle; its colour is of a pale brown throughout, and the bark smooth. The leaves or branches are often 14 or 15 feet long, about 28 in number, winged of a yellow colour, straight and tapering. The pinnæ are green, often three feet long next the trunk, but diminishing in length toward the extremity of the branches, which are fastened at top by brown stringy threads that grow out of them, of the size of ordinary packthread, and are interwoven like a web. The nuts hang at the top of the trunk, in clusters of a dozen each. Each nut, next the stem, has three holes closely stopped; one being wider and more easily penetrated than the rest. When the kernel begins to grow it incrusts the inside of the nut in a bluish, jelly-like substance: as this grows harder the inclosed liquid, distilled into the nut from the roots, becomes somewhat acid; and the kernel, as the nut ripens, becomes still more solid, and at length lines the whole inside of the nut for above a quarter of an inch thick, being as white as snow, and of the flavour of a filberd. The quantity of liquor in a full-grown nut is frequently a pint and upwards. The husky tegument of the nut consists of strong, tough, stringy filaments, which, when removed from the fruit, resemble coarse oakum. The leaves are wrought into brooms, hammocks in form of nets, mats, sacks, and other useful utensils. The tree is propagated by planting the nuts, which in six or eight weeks will come up, provided they are fresh and thoroughly ripe; but this is what few of them are when brought into this country: for they are always gathered before they are ripe, that they may keep during the passage. The best way, therefore, would be to gather such nuts as are thoroughly ripe in their native country, and plant them in a tub of dry sand, to keep them from the vermin during the passage. Here they will frequently sprout, which will be an advantage, as they may then be immediately planted in pots of earth, and plunged in the bark-stove.

COCTION, a general term for all alterations made in bodies by the application of fire or heat: of this there are various species, as maturation, friction, assation, elixation, ustion, &c. See FRICTION, &c. and also the articles PHARMACY and DECOCTION.

COD. See GADUS.

CODE, a collection of the laws and constitutions of the Roman emperors, made by order of Justinian. The code is accounted the second volume of the civil law, and contains 12 books, the matter of which is nearly the same with that of the digests, especially the first eight books; but the style is neither so pure, nor the method so accurate, as that of the digests: and it determines matters of daily use, whereas the digests discuss the more abstruse and subtile questions of the law, giving the various opinions of the antient lawyers.

CODICIL. See WILL.

COECUM. See ANATOMY.

COEFFICIENTS, in algebra, such numbers, or given quantities, as are put before letters; or unknown quantities, into which letters they are supposed to be multiplied: thus, in $3a$, of bx, or cxx; 3 is the coefficient or $3a$, b of bx, and c of cxx. When no number is prefixed, unity is supposed to be the coefficient; thus 1 is the coefficient of a or of b. See ALGEBRA.

COEFFICIENT *of any generating term in fluxions*, is the quantity arising from the division of that term by the generated quantity.

COELIAC ARTERY. See ANATOMY.

COELIAC PASSION. See MEDICINE.

COELIAC VEIN, in anatomy, that running through the intestinum rectum, along with the cœliac artery. See ANATOMY.

COENOBITE, in church history, an order of monks in the primitive christian church. They were so called απο του κοινου βιου, from living in common, in which they differed from the anachorites, who retired from society.

COEUR, in heraldry, a short line of partition in pale, in the centre of the escutcheon, which extends but a little way, much short of the top and bottom, being met by other lines, which form an irregular partition of the escutcheon.

COFFEA, the *coffe-tree:* a genus of the monogynia order, in the pentandria class of plants: and in the natural method ranking under the 47th order, stellatæ. The corolla is funnel-shaped; the stamina above the tube; the berry inferior, dispermous; the seeds arillated, or having a proper exterior covering dropping off of its own accord. There are 10 species, but that which is most worthy of attention is supposed to be a native of Arabia Felix. (See Plate Nat. Hist. fig. 133.) The coffea Arabica seldom rises more than 16 or 18 feet in height; the main stem grows upright, and is covered with a light-brown bark; the branches are produced horizontally and opposite, crossing each other at every joint. The leaves also stand opposite; and when fully grown are about four or five inches long, and two broad in the middle, decreasing toward each end; the borders are waved, and the surface is of a lucid green. The flowers are produced in clusters at the root of the leaves, sitting close to the branches; they are tubulous, and spread open at the top, where they are divided into five parts: they are of a pure white, and have a grateful odour, but are of short duration. The fruit, which is the useful part, resembles a cherry. It grows in clusters, and is ranged along the branches under the axillæ of the leaves, of the same green as the laurel, but something longer. When it comes to be of a deep red, it is gathered for exportation.

The coffee-tree is cultivated in Arabia, Persia, the East Indies, the isle of Bourbon, and several parts of America. It is also raised in botanic gardens in several parts of Europe. It delights particularly in hills and mountains, where its root is almost always dry, and its head frequently watered with gentle showers. It prefers a western aspect, and ploughed ground without any appearance of grass. The plants should be placed at eight feet distance from each other, and in holes twelve or fifteen inches deep. If left to themselves, they would rise to the height of 16 or 18 feet; but they are generally stinted to five for the convenience of gathering their fruit with the greater ease. Thus dwarfed, they extend their branches so, that they cover the whole spot round about them. They begin to yield fruit the third year, but are not in full bearing till the fifth. With the same infirmities that most other trees are subject to, these are likewise in danger of being destroyed by a worm or by the scorching rays of the sun. The hills where the coffee-trees are found have generally a gravelly or chalk bottom. In the last, it languishes for some time and then dies, in the former its roots, which seldom fail of striking between stones, obtain nourishment, and keep the tree alive and fruitful for 30 years. This is nearly the period for plants of the coffee-tree. The proprietor, at the end of that time, not only finds himself without trees, but has his land so reduced, that it is not fit for any kind of culture; and unless he is so situated that he can take a spot of virgin land, to make himself amends for that which is totally exhausted by the coffee-trees, his loss is irreparable.

The coffee-tree is sometimes cultivated in European gardens; but it requires a stove. It makes a fine appearance at all seasons of the year, but especially when in flower, and when the berries are red, which is generally in the winter, so that they continue a long time in that state. It is propagated from the berries; but they must be planted immediately when gathered from the tree, for they loose their vegetative quality in a very short time.

COFFER, in fortification, a hollow lodgment across a dry moat, from six to seven feet deep, and from 16 to 18 broad, the upper part being made of pieces of timber, raised two feet above the level of that moat; which little elevation has hurdles, laden with earth, for its covering, and serves as a parapet with embrasures. The besieged generally make use of these coffers to repulse the besiegers, when they attempt to pass the ditch: they are distinguished only by their length from the caponiers, which are likewise somewhat less in breadth; and differ from the traverse and gallery, in that these are made by the besiegers, and the coffer by the besieged. To save themselves from the fire of these coffers the besiegers epaule, or throw up the earth, on that side towards the coffer.

COFFERER *of the king's household*, next under the comptroller, who superintends and pays the other officers of the household their wages.

COGGSHALL'S *sliding-rule*. See SLIDING-RULE.

COGNATION, in the civil law, a term for that line of consanguinity which is between males and females, both descended from the same father; as agnation is for the line of parentage between males only descended from the same stock. In France, for the succession to the crown, they follow agnation; in England, Spain, &c. cognation: women coming to the succession according to the degree of proximity, in default of males, or their descendants, from branch to branch.

COGNISOR, or *connusor*, he that passeth or acknowledgeth a fine of lands or tenements to another. Cognisee, or conusee, is he to whom the fine is acknowledged.

COGNISANCE, sometimes signifies an acknowledgment of fine, and sometimes a power or jurisdiction; as cognisance of pleas is an ability to call a cause or plea out of another court, which no one can do but the king, except he can shew charters for it.

COGNITIONIBUS MITTENDIS, a writ to one of the king's justices of the common pleas, or other that has power to take a fine, and who having taken it, delays to certify the same, commanding him to certify it.

COGNOVIT ACTIONEM, is an acknowledgment by a defendant, or confession that the plaintiff's cause of action is just; and who, to save law expences, suffers judgment to be entered against him; in this case the confession generally extends to no more than is contained in the declaration, with costs.

COHABITATION, in the civil law, denotes the state of a man and a woman who live together like husband and wife, without being legally married. By the common law of Scotland, cohabitation for a year and day, or a complete twelvemonth, is deemed equivalent to matrimony.

COHESION. The force called cohesion is inherent in the particles of all bodies, except caloric and light: for all bodies except these constantly exist in masses composed of an indefinite number of particles united together. This force possesses all the characters of affinity. 1. It acts only at insensible distances; for whenever we remove the particles of a body to a perceptible distance from each other, they cease to cohere altogether. 2. Cohesion is exceedingly various in different bodies: though in the same body, if other things be equal, it is always the same. Thus an iron rod is composed of particles of iron cohering so strongly, that it requires an enormous force to separate them. A smaller force is necessary to overcome the cohesion of lead, and a still smaller to separate the particles of chalk from each other. In short, there are scarcely two bodies whose particles cohere with the same force. The force of cohesion in solid bodies is measured by the weight necessary to break them, or rather to pull them asunder. Thus if a rod of glass is suspended in a perpendicular direction, and weights attached to its lower extremity till the rod is broken by them, the weight attached to the rod just before it broke is the measure of the cohesive force of the rod. We are indebted to Muschenbroeck for the most complete set of experiments hitherto made upon the cohesive force of solid bodies. Sickengen also has examined the cohesion of several of the metals with much accuracy. The results of the labours of the first of these philosophers, with regard to metals and wood, may be seen in the following table, in which the numbers denote the pounds avoirdupois which are just sufficient to tear asunder a rod of each of the bodies, whose base is an inch square.

I. METALS.			
Steel, bar	—	—	135,000
Iron, bar	—	—	74,500
Iron, cast	—	—	50,100
Copper, cast	—	—	28,600
Silver, cast	—	—	41,500
Gold, cast	—	—	22,000
Tin, cast	—	—	4,440
Bismuth	—	—	2,900
Zinc	—	—	2,600
Antimony	—	—	1,000
Lead, cast	—	—	860.
II. WOODS.			
Locust-tree	—	—	20,100
Jujeb	—	—	18,500
Beech, oak	—	—	17,300
Orange	—	—	15,500
Alder	—	—	13,900
Elm	—	—	13,200
Mulberry	—	—	12,500
Willow	—	—	12,500
Ash	—	—	12,000
Plum	—	—	11,800
Elder	—	—	10,000
Pomegranate	—	—	9,750
Lemon	—	—	9,250

Tamarind	—	—	8,750
Fir	—	—	8,330
Walnut	—	—	8,130
Pitch-pine	—	—	7,656
Quince	—	—	6,750
Cypress	—	—	6,000
Poplar	—	—	5,500
Cedar	—	—	4,880.

3. The nature of cohesion has been more happily explained by Boscovich than by any other philosopher. Indeed it forms the most beautiful and satisfactory part of his theory. According to him, the particles of bodies cohere together when they are placed in the limit of repulsion and attraction. Two particles, when situated at a certain distance from each other, repel each other mutually; this repulsion gradually diminishes as the distance between the particles increases, till at last when the distance reaches a certain magnitude, the repulsion ceases altogether. If the distance is increased ever so little, the particles now, instead of repelling, attract each other; and this attraction increases with the distance till at last it reaches its maximum. From this point it gradually diminishes, till at last, when the particles have acquired a certain distance, it vanishes altogether. If the distance is increased ever so little beyond that distance, the particles now again repel each other. He supposes that the insensible distance between two particles is divided into an indefinite number of portions of alternate repulsions and attractions.

Boscovich supposes, that in all cases of cohesion the particles of the cohering body are so situated as to be in these limits of cohesion with respect to each other. According to this very ingenious theory, cohesion is not, properly speaking, a force, but the interval between two forces. And even if we were to modify the theory a little, still we must consider cohesion as the balancing of two opposite forces, either of which becomes prevalent according as the cohering particles are urged nearer each other or forced to a greater distance. Consequently if we were to speak with precision, cohesion is not itself a force, but the absence of a force. What has been hitherto called the force of cohesion, is the attraction which prevents the cohering particles from separating from each other, and which begins to act, or more precisely, which becomes prevalent, when the particles are urged to a greater distance from each other.

4. Boscovich has shewn, in a very satisfactory manner, how all the varieties of cohesion may be produced by the differences in the size, figure, and density, of the cohering particles. It deserves attention, that in most cases the cohesive force of simple bodies is greater than that of compound bodies. To this indeed there are a great number of exceptions, but the observation holds in a variety of instances. All the metals cohere very strongly; the diamond probably coheres with no less force, if we can judge from its hardness; and the cohesion of sulphur is also very considerable. Thus if we except phosphorus, all the simple substances are remarkable for cohesion. Those of them which are in the state of elastic fluids must be excluded altogether; because in that particular state the particles, instead of being in the limit of cohesion, are actually repelled. In the earths, too, such of them at least are found crystallized in a state of purity, the cohesion is very strong. Thus the sapphire or crystallized alumina, and rock crystal or crystallized silica, are always very hard, and exhibit a much stronger cohesion than limestone, or magnesian stones, which are composed of heterogeneous bodies. This remark, however, by no means applies to the metals; for in them the cohesion is very often increased considerably by alloying them together. Thus the cohesion of copper is doubled by alloying with one-sixth of its weight of tin, though the cohesion of the tin is scarcely one-sixth of that of the copper.

The cohesion of metals is greatly increased by forging them, and by drawing them out into wire. By this last operation gold, silver, and brass, have their cohesion nearly tripled; copper and iron more than doubled.

5. There are three states in which bodies exist exceedingly distinct from each other: the state of solids, of liquids, and of elastic fluids. In the first two states the particles cohere with more or less force; but the cohesion produces in them very different effects. In the first it prevents all relative motion among the particles themselves; in the second, this relative motion is left at full liberty. Hence in solid bodies the motion of one particle is followed by the motion of the whole mass; or if that is impossible, the cohesion is destroyed altogether. In liquids, on the contrary, the motion of one particle is not necessarily followed by that of the rest, neither does that motion destroy the cohesion. Boscovich has shewn, that solidity and fluidity are the consequence of the figure of the cohering particles. If that figure is such that the particles may change their position without altering their relative distances, the consequence must be fluidity; because in that case there is nothing to oppose the motion of any individual particle. This happens when the particles are spherical; but if the figure is such that the particles cannot change their position without altering their relative distances, the bodies which they compose must be solids, because all relative motion of an individual particle is opposed by the attractions and repulsions of all the surrounding particles; for every motion must bring the particle out of the former limit of cohesion. This happens when the particles have the figure of parallelopipeds, or any other figure except that of spheres.

This explanation is exceedingly ingenious; but it would not be an easy task to explain by means of it all the phenomena of solidity and fluidity. How comes it, for instance, that the addition of a certain dose of caloric renders a body fluid which was before solid? If it be answered, that it acts by combining with the particles of the solid in such a manner as to render them spherical; how comes it, in that case, that gold and platina, metals which are ductile and malleable, properties which indicate a kind of approach to fluidity, and of course sphericity, in the particles of these metals,—how comes it that they require so much more caloric to render them fluid than bismuth or sulphur, which are altogether brittle? We must rather consider fluidity as a kind of solution in caloric, analogous to the solution of salts in water. But this explanation, though it would do very well in many instances, would lead us in others to difficulties as great as those which we are endeavouring to avoid.

The cohesion of liquids is often very considerable. According to sir Isaac Newton, it is nearly proportional to the density of the liquid. This holds pretty accurately in several instances: but it is not easy to ascertain the cohesion of a liquid with precision, because the particles slide upon each other; and the column of the liquid, whose cohesion we are measuring, always becomes smaller and smaller, till at last it consists only of a very small number of particles.

Viscid bodies have particles approaching to a spherical form; but deviating from it so far as to occasion a certain resistance to the relative motion of the particles.

Solid bodies are of two kinds: they may either resist all change of distance in their particles so strongly as not to be capable of compression or dilatation without a breach of cohesion; or they may admit of both to a certain degree with facility. The first of these constitutes hardness; the second constitutes softness if the particles retain their new situation, or elasticity if they return again to their old position when the external force is removed. Ductility and malleability depend upon the same state as softness, only the particles require a greater force to make them change their situation, and assume a new one.

6. When a solid body is plunged into a liquid, if the particles of the liquid attract those of the solid with a greater force than these last particles attract each other, they are gradually carried off by the fluid, and combine with its particles, that is to say, the solid is gradually dissolved. Thus sugar is dissolved by water, and sulphur by oil. The particles of the solid thus dissolved are each of them surrounded and combined with a certain number of the particles of the liquid. Hence they must be arranged in the liquid in regular order, and at regular distances from each other. The greater the number of particles thus dissolved by the liquid, the smaller is the affinity by which each of them is retained, because it is surrounded by a smaller number of particles of the liquid. But the greater must be the force with which these particles are attracted towards each other, and of course tend to form the solid again by cohesion; because the greater the number of the particles of the solid dissolved in the fluid, the nearer they are to each other.

Thus it appears that the affinity between the fluid and solid diminishes with the quantity dissolved; but that the tendency to cohesion increases with that quantity. Consequently if the solution is supposed to go on, these two opposite forces must at last balance one another; and whenever that happens, the liquid can dissolve no more of the solid. If it did, the particles of the solid would in part cohere, and form a new portion of the solid again. Whenever this happens, the fluid is said to be saturated. The saturation of a fluid then does not mean that its affinity for the solid is satisfied, but that it is not greater than the tendency of the combined particles to cohere. Now when a liquid is saturated with a solid, if by any means we can abstract part of that liquid, the cohesive force of the particles of the solid must gain the superiority; and the consequence will be, that they

will unite and form solid bodies anew, till their number is so much diminished, that their mutual attraction is again counterbalanced by the affinity of the liquid. Hence the reason that evaporation occasions the crystallization of those bodies which are held in solution by these liquids.

7. These different solid bodies differ excessively from each other in their tendency to cohesion; and this difference can only be ascertained by experiment. Thus the tendency to cohesion, and the force of cohesion, in silica, is so strong, that when it has been precipitated from a solution by evaporation, it cannot be dissolved again in the same liquid.

This tendency to cohesion, and the consequent insolubility of the compound, produce many of the most important phenomena of chemistry, as they occasion the various precipitations and decompositions which so often take place when different substances are mixed together. See ATTRACTION, and MECHANICS.

COHORT, *cohors*, in Roman antiquity, the name of part of the Roman legion, comprehending about six hundred men. There were ten cohorts in a legion, the first of which exceeded all the rest, both in dignity and number of men. When the army was ranged in order of battle, the first cohort took the right of the first line, and the rest followed in their natural order; so that the third was in the centre of the first line of the legion, and the fifth on the left, the second between the first and third, and the fourth between the third and fifth: the five remaining cohorts formed a second line, in their natural order.

COIF. The serjeants at law are otherwise called serjeants of the coif, from the lawn coif they wear on their heads, under their caps, when they are created, and always after.

COIN denotes all the several stamps and species of money in any nation. In earlier times, when the necessity of traffic put men upon the expedient of having money; and metals, on account of their firmness, cleanliness, and durableness, were chosen for that end; each person cut his metal into pieces of different sizes and forms, according to the quantity to be given for any merchandize, or according to the demand of the seller, or the quantity stipulated between them. It was usual then to go to market laden with metal, in proportion to the purchase to be made; and furnished with instruments for proportioning it, and with scales for dealing it out, according as occasion required. By degrees it was found more convenient to have pieces ready weighed; and as there were different weights required, all those of the same weight were distinguished with the same mark or figure. At length the growing commerce of money beginning to be disturbed with frauds, both in the weights and the matter, the public authority interposed; and hence arose the first stamps, or impressions of money, to which succeeded the names of the moneyers, and at length the effigies of the prince, the date, legend, and other precautions to prevent the alteration of the specie: thus were coins completed, and gradually brought to their present perfection. See COINAGE.

The following are Tables of the most remarkable Coins, both ancient and modern.

The Jewish COINS, and their value in English Money, are as follow:

									£.	s.	d.	q.
								Gerah	-	-	-	-
							10	Bekah	-	-	-	-
						20		2 Shekel	-	-	-	-
					1000		100	50 Maneh, Mina hebraica	-	-	-	-
				60000		6000		3000 60 Talent	342	3	9	
									-	-	-	-
								Solidus aureus, or sextula, worth	0	12	0	$\frac{1}{4}$
									-	-	-	-
								Siclus aureus, worth	1	16	6	
									-	-	-	-
								A talent of gold, worth	5475	0	0	

The Grecian coins, with their value and proportion.

													£.	s.	d.	q.
													-	-	-	-
													-	-	-	-
													-	-	-	-

the others were in proportion; accordingly their mark was 13*s.* 4*d.* Scots, current in England at 13½*d.*; their noble in proportion.

Beside these they had their tornorer, pence, and half-pence; their penny 1-12th of that of England; besides base money of achisons, bawbees, and placks; the bodle 1-6th of the penny, ¼ of the achison, ⅓ of the bawbee, and ½ of the plack.

In Ireland the coins are as in England, viz. guineas, shillings, &c. with this difference, that the English shilling passes for twenty-six half-pence, which are the only coin peculiar to that country.

Coins of the French Empire.

The current coins of France were formerly the double louis (gold), the louis (gold), the piece of six livres (silver), that of three livres, the ecu (silver), twenty-four sols piece (silver), the twelve (silver), the six sols piece (silver), the large or double sol (of copper), the sol (of copper), and the half and quarter sol, or pieces of two and one liard. There are also ancient pieces made of copper and silver, denominated pieces of six liards, value one sol and a half.

According to the new system, an attempt has been made, with partial success, to introduce the following currency. The denomination of livre has been changed into that of franc, with an alteration, in the small proportion of only three pence to the louis. The franc is then assumed as the basis or unit of all their computations; and all values are reckoned upwards by tens, hundreds, and thousands of francs, and downwards by tenth parts and hundredth parts of francs.

Some coins have been put into circulation agreeably to this new system, viz. in silver pieces of 5 francs, in pieces of 30 sols, being the fourth of the franc, and in pieces of 15 sols, being the eighth of the franc; in copper pieces of 5 centimes (five hundredths) equal to the old sol, and of 10 centimes (ten hundredths) or 1 decime, equal to the double sol.

Value of the coinage of both nations.—As a primary principle, the traveller must recollect, that whenever the course of exchange between the two countries is at par, the French louis is to be considered as of equal value to the English pound sterling.

Existing English Coins.		*French Value.*
The guinea	is equal to	One louis and one 24 sols piece.
The crown piece	—	The six livre piece.
The half-crown	—	The three livre piece.
The shilling	—	The 24 sols piece.
The sixpence	—	The 12 sols piece.
The penny	—	The double sol.
The halfpenny	—	The sol.
The farthing	—	The deux liards.

Existing French Coins.		*French Value.*
The louis, containing 24 livres or francs		One pound sterling.
The six livre piece	—	Five shillings.
The five franc piece	—	Four shillings and two pence.
The livre piece	—	Half-crown.
The 30 sol piece	—	Fifteen pence.
The 24 sol piece	—	One shilling.
The 15 sol piece		Seven pence half-penny.
The 12 sol piece	—	Six pence.
The 6 sol piece	—	Three pence.
The double sol	—	A penny.
The 6 liard piece	—	Three farthings.
The sol	—	One halfpenny.
The two liard piece	—	One farthing.
The liard	—	Half a farthing.

The livre or franc is a nominal value, equal to ten-pence English. The tenth part of a franc is called a decime, and the hundredth part of a franc is called a centime.

Coins, Spanish. In Spain, and the states depending upon it, the gold coin is the pistole; above which are the double pistole and piece of four pistoles, and under it the half-pistole; to which must be added the castillans of gold. The silver money is the piastre, or piece of eight rials, and its diminutions; as also the simple rial, with its diminutions. The copper coins are the ochavos, or octavos, which are of two kinds: the one equal to only four maravedis, and ordinarily called quarta; the other double this, and called double quarta: and lastly the maravedis. It must be observed, that in Spain they have new money and old; the old current in Sevil, Cadiz, Andalusia, &c. is worth 25 per cent. more than the new current at Madrid, Bilboa, St. Sebastian, &c. This difference is owing to their king Charles II. who, to prevent the exportation of money, raised it 25 per cent. which however he was able to effect only in part, several provinces still retaining the ancient rate.

Value and proportion of the Spanish coin.

	l.	*s.*	*d.*
Quarta, 4 maravedis			
Octavo, or double quarta, 8 maravedis			
Rial, old plata, equal to	0	0	6¾
Piece of eight, or piastre	0	4	6
Pistole	0	16	9.3

Coins, Portuguese. Those of gold are the moeda d'oro, or as we call it, moidore, which is properly their pistole; above this are doppio moedas or double pistoles, and quadruple species equal to five pistoles. The silver coins are the crusada, pataca, or piece of eight, and vintem, of which they have two sorts, the one silver and the other billon. The ree is of copper, which serves them in accompts as the maravedis do the Spaniards.

Res, ree, or rez, equal to three-fifths of a farthing sterling			
Vintem. 20 res			
Cruzada, 26 vintems.			
	l.	*s.*	*d.*
Mi-moeda, or half-pistole	0	13	6
Moeda d'oro, or pistole	1	7	0
Doppio moeda, or double pistole	2	14	0
Ducat of fine gold	6	15	0

Besides the above, they have also pieces of gold of the value of 3*l.* 12*s.*, 1*l.* 16*s.*, and other subdivisions.

Coins, Dutch. Those of silver are crowns or dollars, ducatoons, florins, and schellings, each of which has its diminution. The stiver is of billon: the duyt and penny, of copper.

	l.	*s.*	*d.*
Ducat of Holland	0	9	3.2
Ducatoon	0	5	5.59
Patagon, or rix dollar	0	4	4.28
The three-guilder piece, or sixty stivers	0	5	2.46
The guider-florin, or twenty stivers	0	1	8.08
The lion dollar	0	3	7.07

The schelling goes for six stivers, and the ortke is the fourth part of a stiver.

Coins, Flemish. Those of gold are imperials, rides or philips, alberts, and crowns; those of silver are philips, rix dollars, patagons, schellings, and guldens; and those of copper, patards.

	l.	*s.*	*d.*
Groat, 8 patards			
Single stiver	0	0	1½
Schelling	0	0	7¼
Gulden	0	2	0
Rix dollar, dollar, patagon	0	4	6
Imperial	0	11	9

The German, Dutch, and French coins are current here.

Coins, German. Those of gold are ducats, which are of various kinds, oboli of the Rhine, and florins: of this last kind there are some likewise of silver, besides rix dollars and izelottes, which are all of that metal.

	s.	*d.*
Ducat of the bishop of Bamberg	9	3.2
Ducat of Hanover	9	2.7
Ducat of Brandenburg	9	3.2
Ducatoon of Cologn	5	5.02
Rix dollar or patagon of Cologn	4	4.53
Rix dollar or patagon of Liege	4	7.48
Rix dollar of Mentz	4	7.27
Rix dollar of Frankfort	4	6.53
Rix dollar of the Palatinate of Nuremberg	4	7.55
Rix dollar of Lunenburg	4	6.65
Old rix dollar of Hanover	3	6.03
Old bank dollar of Hamburgh	4	6.92
Rix dollar of Lubec	4	7.54
Gulden of Hanover	2	4.14
Gulden of Zell	2	3.07
Gulden of Brandenburg	2	3.81
Gulden of Saxony	2	4.12

Coins, Italian. The several states of Italy have several current moneys, though there are some common to all, such as the pistole of gold, and the ducatoon and florin of silver, which are of various weights, fineness, &c. The coins peculiar to Rome are the julios of silver, the pignatelle of billon, and the bayoco, demi-bayoco, and quadrine, of copper. Venice has its sequins of gold; its justins, or ducatoons, and derlingues, of silver: Naples, its carlins: Genoa its croisats; Savoy and Piedmont, lys, all silver: this last state has its papiroles and cavales of billon.

Gold coins of Italy.

	s.	*d.*
The sequin of Venice	9	5.7
The old Italian pistole	16	7.6
Pistole of Rome, Milan, Venice, Florence, Savoy, Genoa	16	6.7
Double ducat of Genoa, Venice, and Florence	18	7.7
Single ducat of the same places	9	3.8

Silver coins.

The old ducat of Venice	3	4.50
The ducat of Naples	3	4.43
The ducat of Florence or Leghorn	5	4.62
The tarin, or fifth part of the ducat, of Naples	0	8.09
The carlin, or tenth part	0	4.04
The escudi, or crown, of Rome, or piece of ten julios, or one hundred bayocos	5	1
The teston of Rome, or piece of three julios	1	6.32
The julio of Rome	0	6.10
The croisat of Genoa	6	6.74
Justine of Venice	4	9
Derelingue, one-fourth of the justine	1	2

COINS, Swiss, are ratzes and blazes of billon; the ratze equal to $\frac{7}{8}$ of a penny sterling: and the blaze of Berne, nearly equal to the ratze.

The German, French, and Italian coins, are current here.

COINS, Polish.

	s.	d.	
The golden ducat	9	2	.1
The old silver dollar of Dantzic	4	6	.27
The old rix dollar of Thorn	4	5	.85
The rix dollar of Sigismund III. and Uladislaus IV. kings of Poland	4	6	.4
Abra	1	0	$\frac{1}{5}$
Roup	0	4	$\frac{3}{4}$
Groch	0	0	$\frac{5}{6}$

COINS, Danish, are,

	s.	d.	
The gold ducat	9	3	.2
The horse	1	1	$\frac{1}{2}$
The four-mark piece	2	8	.23
Marc lubs	1	6	
Schesdal, or two marks	3	0	
Rix mark	0	11	
Slet mark	0	9	

COINS, Swedish. Those of copper are the roustique, alluvre, mark, and money.

	s.	d.	
A gold ducat is equal to	9	3	.2
An eight-mark piece of silver	7	2	
A four-mark piece	2	7	
A christine	1	1	$\frac{1}{2}$
Caroline	1	5	$\frac{1}{4}$

The Swedish money properly so called, is a kind of copper, cut into little square pieces, or plates, about the thickness of three English crowns, and stamped at the four corners with the Swedish arms; and current in Sweden for a rix dollar, or piece of eight.

COINS, Muscovite. The proper coins of Muscovy are,

	s.	d.	
The copec of gold, worth	1	6	$\frac{1}{11}$
Copec of silver, or denaing	0	1	
Polusk	0	0	$\frac{1}{2}$
Motofske	0	0	$\frac{1}{4}$
The ruble of silver, valued at	4	6	
The cheroonitz of gold, called ducat by foreigners	9	6	

COINS, Turkish. The gold coins are zingerlees, worth two dollars two-thirds; and tomilees, worth two dollars and a half, reckoning each dollar at 108 aspers; the sultani, xeriff, and chequeens, each worth about 9*s*. 4*d*., 5*d*., or 6*d*., sterling.

The silver ones are the asper, worth a trifle more than a farthing sterling; and the para, or medin, worth three aspers.

COINS of the coast of Barbary. Though the general currency in these parts is Spanish dollars, French crowns, Hungarian ducats, and the Turkish golden sultanins, there are some coins struck by the kings or deys in their different territories.

At Morocco, the metacals are a sort of gold ducats made by the Jews at their pleasure, so that their standard is very uncertain.

There are also the blanquille of silver, worth $2\frac{1}{4}d$.; and the filours of copper, eight of which go to a blanquille.

At Algiers, the gold coins are sultanins and aspers; and burbas, of which six go to an asper. The dubla is silver, and worth about 4*s*. 6*d*. The rubie, median, and zian, are of gold, the first equal to 35 aspers, or 1*s*. 9*d*. and the last 100 aspers.

At Tunis, they have sultanins of gold, but heavier by one-third than those of Constantinople: the nasura of silver, cut nearly square: and dublas and burbas, of the same value with those of Algiers.

COINS, Persian, are either of silver or copper: of the first kind are the

	s.	d.	
Abassi, equal to	1	4	$\frac{1}{2}$
Mamoudi	0	8	$\frac{1}{4}$
Shakee	0	4	$\frac{1}{8}$

The copper coins are the casbequi, or cabsequi, equal to 5-12ths of a penny sterling. The telac, or cherasis, is of gold, but it has no currency among the merchants, being only a medal struck by every king of Persia upon his accession to the crown.

COINS, Chinese. Throughout the kingdom of China and Tonquin there are not properly any coins struck; instead of these they cut their gold and silver into little pieces, of different weights: those of gold are called goltschuts; those of silver the natives call leam, the Portuguese taels. Beside these they have a small money of lead mixed with the scum of copper, having holes in the middle to string them on for the ease of numbering; this species is called caxa, cas, and pitis; and the string, which usually holds 200, is called santa. There are two sorts of goltschuts, the one of 32 and 1-7th ounces, and the other but half as much. The tael, or leam, is equal to 6*s*. 8*d*. sterling. The caxa, cas, or pitis, is one-third of a farthing; 300,000 of them are only worth about 56 guilders and 5 stivers of Holland.

COINS of Japan. The Japanese strike coupants both of gold and silver; and copper pieces with holes in the middle, like those of China, six hundred of which make the tael. The other moneys, which they cut, like the Chinese, of different weights, are chiefly three: the largest of the weight of six reals, viz. 48 taels, the tael equivalent to 75 Dutch stivers; the second equal to 6 and a half, and the third to 1 and 1-16th.

Coupant of gold, weighs one ounce six drachms; its figure is a long oval, the longest diameter about four inches, and the shortest half an inch: worth 6*l*. 12*s*. 6*d*.

Other coupants of gold, near one-third of the former, amounting to about 2*l*. 4*s*. 2*d*. Coupant of silver current at 4*s*. 6*d*.

Copper money, seven-twelfths of a farthing.

COINS of Siam. In the dominions of Siam are struck gold pieces five or six grains heavier than the half-pistole of Spain: but these are rather pieces of curiosity, than of use in commerce. Their silver coin is the tical or baat: the diminutions of which are the mayon or seling, $\frac{1}{4}$ of the tical; the fouang, $\frac{1}{2}$ of the mayon; the page, $\frac{1}{4}$ of the fouang; and clam $\frac{1}{2}$ of the page; there are also sompays, in value $\frac{1}{2}$ a fouang. The tical weighs 3 gross and 23 grains, which, reckoning the ounce of silver at $3\frac{1}{2}$ louis tournois, is 32 sols and 4 deniers of that money, as it weighs near half an ounce.

COINS of the coasts and islands of the Indies. The principal, and those most generally current, are pagodos, rupees, larins, fanos or fanoms, and coupans, each of which are struck both of gold and silver. Besides these, there are also particular coins: as at Goa, St. Thomases of gold; at Surat, Agra, and the rest of Indostan, the pecha, or pessa, and doudus, all of copper; the basarucos and chedas, of tin. The gold pagodo is common on all the coasts of Coromandel, and almost the only one in use in the trade carried on there. The English make them at Fort St. George, and the Dutch at Negapatnam, of the same standard and weight with those of the country. The value is 5*s*. The value of the silver pagodo is very different: the smallest are worth eight tangas, reckoning the tanga at 90 or 100 basarucos, 8*s*.

The gold rupee is worth 1*l*. 11*s*. 6*d*.

Silver-rupee varies in fineness and value. There are three kinds current, viz. rupee sicca, worth at Bengal, 2*s*. 11*d*.

Rupee of Madras, 2*s*. $5\frac{1}{2}d$.

Rupee of Surat, 2*s*. 3*d*.

This is to be understood of the new rupees; for as to the old ones of each kind, their value is less; those of Madras are but equal to 1*s*. 11*d*. those of Surat 2*s*. and the siccas 2*s*. 4*d*.

Larin, in form of a cylinder, bent in two, and flatted at each end, worth 9*d*.

Fanoms of gold are of different fineness, weight, and value. The heaviest are not worth above 5*d*. or $5\frac{1}{2}d$. and the lighest little more than five farthings.

The silver fanoms are not worth at most above 2*d*.

St. Thomas, equal to 9*s*.

Pecha or pessa of copper, worth about $\frac{1}{2}d$.

Doudou, somewhat less than $\frac{1}{2}d$.

Basaruco, 1-5th of a farthing.

Cheda of pewter is of two kinds: the one octagonal, current at $1\frac{3}{4}d$.

The other round, at $\frac{1}{3}d$.

In the dominions of the Great Mogul are roupees, mamoudas, and pechas; the first, both of gold and silver; the second of silver alone; and the third, of copper. There are others struck by the princes tributary to him, particularly a silver piece of the king of Matoucha, worth $\frac{1}{2}d$. a silver piece of the king of Ogden, worth 6*d*. a gold piece of the king of Achem, worth 1*l*. 3*s*. a gold piece of the king of Macasser, taken for a guilder.

Shells current for coins are, 1. Cowries, brought from the Maldives, and pass for $\frac{1}{1360}$ of a penny sterling. The natives of the coast of Africa call them bouges. 2. Porcelaine, in America, a shell nearly on the same footing with the cowrie. 3. Zimbi, current particularly in the kingdoms of Angola and Congo.

Fruits current for coins are, 1. Cacao, among the Americans, fifteen of which are esteemed equivalent to a Spanish rial. 2. Maize, which has ceased to be current since the discovery of America by the Europeans. 3. Almonds, used in the East Indies, where cowries are not current. The value of these is higher or lower, according as the year is more or less favourable to this fruit; in a common year, an almond is worth about 1-20th part of a farthing.

For real utility the following very short table will answer almost all practical purposes with regard to coins as far as relates to Europe:

	French money.		English money.		
	Frs.	*Cts.*	*L.*	*s.*	*d.*
A florin of Germany	2	20	0	1	10
Austria	2	65	0	2	2

	Frs.	*Cts.*	*l.*	*s.*	*d*
Rix dollar of Prussia	4	0	0	3	4
Dollars of North America	5	40	0	4	6
Guinea of England	25	0	1	1	0
Rix dollar of Denmark	5	70	0	4	9
Piastre of Spain	5	30	0	4	5
Lere of Italy	0	85	0	0	8½
Scuds of Rome	5	53	0	4	7
Ducat of Naples	4	30	0	3	7
Rouble of Russia	4	5	0	3	4
Rix dollar of Sweden	5	80	0	4	10½

COIN, in architecture, a kind of dye cut diagonal-wise, after the manner of a flight of a stair-case, serving at bottom to support columns in a level, and at top to correct the inclination of an entablature supporting a vault.

COIN is also used for a solid angle composed of two surfaces inclined towards each other: whether that angle be exterior, as the coin of a wall, a tree, &c. or interior, as the coin of a chamber or chimney.

COINAGE, or COINING, the art of making money, as performed either by the hammer or mill. Formerly the fabric of coins was different from what it is at present. They cut a large plate of metal into several little squares, the corners of which were cut off with sheers. After having shaped these pieces, so as to render them perfectly conformable in point of weight to the standard piece, they took each piece in hand again, to make it exactly round, by a gentle hammering. This was then called a planchet, and it was fit for immediate coining. The engravers then prepared, as they still do, a couple of steel masses in form of dyes, cut and terminated by a flat surface, rounded off at the edges. They engraved or stamped on them the hollow of a head, a cross, a scutcheon, or any other figure, according to the custom of the times, with a short legend. As one of these dyes was to remain dormant, and the other moveable, the former ended in a square prism; that it might be introduced into the square hole of the block, which, being fixed very fast, kept the dye as steady as any vice could have done. The planchet of metal was horizontally laid upon this inferior mass, to receive the stamp of it on one side, and that of the upper dye, wherewith it was covered, on the other. This moveable dye, having its round engraved surface resting upon the planchet, had at its opposite extremity a flat, square, and larger surface, upon which they gave several heavy blows, with a hammer of an enormous size, till the double stamp was sufficiently in relievo, impressed on each side of the planchet. The strong tempering which was and is still given to the two dyes, rendered them capable of bearing those repeated blows.

This art, however, has been improved and rendered very expeditious, by several ingenious machines, and by a wise application of the surest physical experiments to the methods of fining, dyeing, and stamping the different metals. The three finest instruments the mint-men use, are the laminating engine; the machine for making the impressions on the edges of coins; and the mill. After they have taken the laminæ, or plates of metal, out of the mould into which they are cast, they do not beat them on the anvil as was formerly done, but make them pass and repass between the several rollers of the laminating engine, which being gradually brought closer and closer to each other, at last give the lamina its uniform and exact thickness. Instead of dividing the lamina into small squares, they at once cut clean out of it as many planchets as it can contain, by means of a sharp steel trepan, of a roundish figure, hollow within, and of a proportionable diameter to shape and cut off the piece at one and the same time. After these planchets have been prepared and weighed with standard pieces, filed or scraped to get off the superfluous part of the metal, and then boiled and made clean, they arrive at last at the machine (Plate Clockwork, &c. fig. 9.), which marks them upon the edge; and finally at the mill (fig. 10.), which squeezing each of them singly between two dyes, brought near each other with one blow, forces the two surfaces or fields of the piece to fill exactly all the vacancies of the two engraved figures.

The principal pieces of the machine (fig. 9.) to stamp coins on the edge, are two steel laminæ, about a line thick. One half of the legend, or of the ring, is engraven on the thickness of one of the laminæ, and the other half on the thickness of one of the other; and these two laminæ are straight, although the planchet marked with them is circular. When they stamp a planchet, they first put it between the laminæ in such a manner, as that these being each of them laid flat upon a copper-plate, which is fastened upon a very thick wooden table, and the planchet being likewise laid flat upon the same plate, the edge of the planchet may touch the two laminæ on each side, and in their thick part. One of these laminæ is immoveable, and fastened with several screws; the other slides by means of a dented wheel, which takes into the teeth that are on the surface of the lamina. This sliding lamina makes the planchet turn in such a manner, that it remains stamped on the edge, when it has made one turn. Only crown and half-crown pieces are thick enough to bear the impression of letters on their edge.

The coining engine or mill (fig. 10.) is so convenient, that a single man may stamp 20,000 planchets in one day. Gold, silver, and copper planchets, are all of them coined with a mill, to which the coining squares (fig 11.) commonly called dyes are fastened; that of the face under, in a square box furnished with male and female screws, to fix and keep it steady; and the other above in a little box with similar screws, to fasten the coining square. The planchet is laid flat on the square of the effigy, which is dormant; and then they immediately pull the bar of the mill by its cords, which causes the screws set within it to turn. This enters into the female screw, which is in the body of the mill; and turns with so much strength, that by pushing the upper square upon that of the effigy, the planchet, violently pressed between both squares, receives the impression of both at one pull, and in the twinkling of an eye. The planchet thus stamped and coined, goes through a final examination of the mint wardens, from whose hands it comes into circulation.

In the coining of medals, the process is the same in effect with that of money; the principal difference consisting in this: that money, having but a small relievo, receives its impression at a single stroke of the engine; whereas for medals, the height of this relievo makes it necessary that the stroke be repeated several times: to this end the piece is taken out from between the dyes, heated, and returned again; which process, in medallions and large medals, is repeated fifteen or twenty times before the full impression is given: care must be taken every time the planchet is removed, to take off the superfluous metal, stretched beyond the circumference, with a file. Medallions, and medals of a high relievo, are usually first cast in sand, on account of the difficulty of stamping them in the press, where they are put only to perfect them; because the sand does not leave them smooth, clear, and accurate enough.

COINAGE, British. It was only in the reign of William III. that the hammer-money ceased to be current in England, where till then it was struck in that manner as in other nations. Before the hammer-specie was called in, the English money was in a wretched condition; having been filed and clipped by natives as well as foreigners, insomuch that it was scarcely left of half its value. The British coinage is now wholly performed in the Tower of London, where there is an establishment for it under the title of the mint. Formerly there were here, as there are still in other countries, the rights of seignorage and brassage: but since the eighteenth year of king Charles II. there is nothing taken either for the king or for the expences of coining; so that weight is returned for weight, to any person who carries his gold and silver to the Tower. The specie coined in Great Britain is esteemed contraband, and not to be exported: but all foreign specie may be sent out of the realm, as well as gold and silver in bars, ingots, dust, &c.

Counterfeiting the king's money, or bringing false money into the realm counterfeit to the money of England, clipping, washing, rounding, filing, impairing, diminishing, falsifying, scaling, lightening, edging, colouring, gilding; making, mending, or having in one's possession, any puncheon, counter-puncheon, matrix, stamp, dye, pattern, mould, edger, or cutting-engine: all these incur the penalty of high treason. And if any person shall counterfeit any such kind of gold or silver, as is not the proper coin of the realm, but current therein by the king's consent, he shall be guilty of high treason.

If any person shall tender in payment any counterfeit coin, he shall for the first offence be imprisoned six months, for the second offence two years, and for the third offence shall be guilty of felony without benefit of clergy.

Blanching copper or other base metal, or buying or selling the same; and receiving or paying money at a lower rate than its denomination imports; and also the offence of counterfeiting copper half-pence and farthings; incur the penalty of felony, but within clergy. Counterfeiting coin not the proper coin of this realm, nor permitted to be current therein, is misprision of treason. A person buying or selling, or having in his possession, clippings or filings, shall forfeit 500*l.* and be branded in the cheek with the letter R. And any person having in his possession a coining-press, or casting bars or ingots of silver in imitation of Spanish bars or ingots, shall forfeit 500*l.*

A reward of 40*l.* is given for convicting a counterfeiter of the gold or silver coin; and 10*l.* for a counterfeiter of the copper coin. 16 Geo. II. and 13 Geo. III. c. 28 and 77.

COINING, in the tin-works, is the weighing and stamping the blocks of tin with a lion rampant, performed by the king's officer; the duty for every hundredweight being four shillings.

COIX, Job's-tears: a genus of the triandria order, in the monœcia class of plants; and in the natural method ranking under the 4th order, gramina. The male flowers grow in spikes remote from each other; the calyx is a biflorous, beardless glume. The calyx of the female is a biflorous glume; the corolla a beardless glume; the style bipartite; the seed covered with the calyx ossified. There are three species, the principal of which, the coix lacryma, is a native of the East Indies, and frequently cultivated in Spain and Portugal. It is an annual plant, rising two feet from a fibrous root, with two or three jointed stalks, and single, long, narrow leaves at each joint, resembling those of the reed. At the base of the leaves come out the spikes of flowers standing on short footstalks; the seeds greatly resemble those of gromwell, whence the plant has by some writers been called lithospermum. It may be propagated in this country by seeds brought from Portugal, and sown on a hot-bed; after which the young plants should be removed into a warm border, and planted two feet from each other. In Spain and Portugal the poor grind the seeds of this plant in times of scarcity, and make a coarse kind of bread of them. The seeds are inclosed in small capsules about the bigness of an English pea, and of different colours. These are strung upon silk, and used instead of bracelets, by some of the poorer sort in the West Indies, particularly by the negroes.

COLARBASIANS, in church-history, Christian heretics, in the second century, who maintained the whole plenitude and perfection of truth and religion to be contained in the Greek alphabet, and that it was upon this account that Jesus Christ was called the alpha and omega: they rejected the Old Testament; and received only a part of St. Luke's gospel, and ten of St. Paul's epistles, in the New.

COLARIN, in architecture, the little frize of the capital of the Tuscan and Doric columns, placed between the astragal and the annulets; called also hypotrachelium, and sometimes cincture.

COLCHICUM, meadow-saffron: a genus of the trigynia order, in the hexandria class of plants, and in the natural method ranking under the 9th order, spathaceæ. The corolla is sexpartite, with its tube radicated, or having its root in the ground; there are three capsules, connected and inflated. There are three species; all bulbous-rooted perennials, possessing the singular property of their leaves appearing at one time, and their flowers at another; the former rising long and narrow from the root in spring, and decaying in June; the flowers (which are monopetalous, long, tubular, erect, and six-parted) rise naked from the root in autumn, not more than 4 or 5 inches. Their colours afford a beautiful variety; being purple, variegated purple, white, red, rose-coloured, yellow, &c. with single and double flowers. They are all hardy plants, insomuch tha they will flower though the roots lie out of the ground; but by this they are much weakened. The root of this plant is poisonous. When young and full of sap, its taste is very acrid; but when old, mealy and faint. Two drachms of it killed a large dog in 13 hours, operating violently by stool, vomit, and urine. One grain of it swallowed by a healthy man, produced heats in the stomach, and soon after flushing heats in different parts of the body, with frequent shiverings, followed by colicky pains; after which an itching in the loins and urinary passages was perceived; then came on a continual inclination to make water, a tenesmus, pain in the head, quick pulse, thirst, and other disagreeable symptoms. Notwithstanding these effects, however, an infusion of roots in vinegar, formed into a syrup with honey or sugar, proves a safe and powerful pectoral and diuretic, and is often of service in dropsies, &c. The virtues of colchicum seem much to resemble those of squills.

Colchicum variegatum, one of the three species above-mentioned. Its roots are said to afford the hermodactyle of the apothecaries.

COLD. When caloric combines with our bodies, or separates from them, we experience, in the first case, the sensation of heat, in the second cold. When the hand is put upon a hot iron, part of the caloric leaves the iron, and enters the hand; this produces the sensation of heat. On the contrary, when the hand is put upon a lump of ice, the caloric rapidly leaves the hand and combines with the ice; this produces the sensation of cold. The sensation of heat is occasioned by caloric passing into our bodies; the sensation of cold by caloric passing out of our bodies. We say that a body is hot when it communicates caloric to the surrounding bodies; we call it cold when it absorbs caloric from other bodies. The strength of the sensations of heat and cold depends upon the rapidity with which the caloric enters or leaves our bodies; and this rapidity is proportional to the difference of the temperature between our bodies and the hot or cold substance, and to the conducting power of that substance. The higher the temperature of a body is, the stronger a sensation of heat does it communicate; and the lower the temperature, the stronger a sensation of cold; and when the temperature is the same, the sensations depend upon the conducting power of the substance. Thus what in common language is called cold, is nothing else than the absence of the usual quantity of caloric. When we say that a substance is cold, we mean merely that it contains less caloric than usual, or that its temperature is lower than that of our bodies.

There have been philosophers, however, who maintained that cold is produced, not by the abstraction of caloric merely, but by the addition of a positive something, of a peculiar body, endowed with specific qualities. According to them, cold is a substance of a saline nature, very much resembling nitre, constantly floating in the air, and wafted about by the wind in very minute corpuscles, to which they gave the name of frigorific particles. They were induced to adopt this hypothesis, because they could not otherwise account for the freezing of water. According to them, these frigorific particles insinuate themselves like wedges between the molecules of water, destroy their mobility, and thus convert water into ice. Dr. Black, by discovering the cause of the freezing of water, banished the frigorific particles from the regions of philosophy; because the advocates for them never brought any other proof for their existence than the convenience with which they accounted for certain appearances. Of course, as soon as these appearances were explained without their use, every reason for supposing their existence was destroyed. The only fact which gives any countenance to the opinion that cold is a body, has been furnished by the following very curious experiments of Mr. Pictet. Two concave tin mirrors being placed at the distance of 10½ feet from each other, a very delicate air-thermometer was put into one of the foci, and a glass matrass full of snow into the other. The thermometer sunk several degrees, and rose again when the matrass was removed. When nitric acid was poured upon the snow (which increases the cold), the thermometer sunk five or six degrees lower. Here cold seems to have been emitted by the snow, and reflected by the mirrors to the thermometer, which could not happen, unless cold was a substance. The experiment is certainly highly interesting, and deserving a more accurate examination than has been hitherto bestowed on it. In order to explain it, we must recollect that caloric is constantly radiating from all bodies. It is evident that the temperature of the thermometer, like that of all other bodies, is maintained partly by the irradiation of caloric from the surrounding bodies. It must therefore, since it is placed in the focus of one of the mirrors, be affected by whatever body is placed in the focus of the other. If that body is colder than the surrounding bodies, less caloric will be eradiated from it, and thrown upon the thermometer; consequently the thermometer will be depressed till the deficiency is supplied by some other channel. Such nearly is the explanation of this singular fact offered by Prevost and Dr. Hutton; but it cannot be denied that this explanation, ingenious as it is, is very far from being satisfactory.

A very great degree of cold may be produced by mixing together different solids, which suddenly become liquid. But as such mixtures are often employed in chemistry, in order to be able to expose bodies to the influence of a low temperature, it will be worth while to enumerate the different substances which may be employed for that purpose, and the degree of cold which each of them is capable of producing. The first person who made experiments on freezing mixtures was Fahrenheit. But the subject was much more completely investigated by Mr. Walker, in a paper published in the Philosophical Transactions for 1795. Since that time several curious additions have been made by professor Lowitz, particularly the introduction of muriat of lime, which produces a very great degree of cold when mixed with snow. The experiments of Lowitz have been lately repeated and extended by Mr. Walker. The result of all these experiments may be seen in the following table.

Table of freezing-mixtures.

Mixtures.	parts.	Thermometer sinks.
Muriat of ammonia	5	From 50° to 10°
Nitre	5	
Water	16	
Muriat of ammonia	5	From 50 to 4
Nitre	5	
Sulphat of soda	8	
Water	16	
Nitrat of ammonia	1	From 50 to 4
Water	1	
Nitrat of ammonia	1	From 50 to 7
Carbonat of soda	1	
Water	1	
Sulphat of soda	3	From 50 to 3
Diluted nitric acid		
Sulphat of soda	6	From 50 to 10
Muriat of ammonia	4	
Nitre	2	
Diluted nitric acid	4	
Sulphat of soda	6	From 50 to 14
Nitrat of ammonia	5	
Diluted nitric acid	4	
Phosphat of soda	9	From 50 to 12
Diluted nitric acid	4	
Phosphat of soda	9	From 50 to 21
Nitrat of ammonia	6	
Diluted nitric acid	4	
Sulphat of soda	8	From 50 to 0
Muriatic acid	5	
Sulphat of soda	5	From 50 to 3
Diluted sulphuric acid	4	
Snow	1	From 32 to 0
Common salt	1	
Muriat of lime	3	From 32 —to 50
Snow	2	
Potash	4	From 32 to —51
Snow	3	
Snow	1	From 20 to —60
Diluted sulphuric acid	1	
Snow or pounded ice	2	From 0 to —5
Common salt	1	
Snow and diluted nit. acid		From 0 to —46
Muriat of lime	2	From 0 to —66
Snow	1	
Snow or pounded ice	1	From —5 to —18
Common salt	5	
Muriat of ammonia and nitre	5	
Snow	2	From —10 to —56
Diluted sulphuric acid	1	
Diluted nitric acid	1	
Snow or pounded ice	12	From —18 to —25
Common salt	5	
Nitrat of ammonia	5	
Muriat of lime	3	From —40 to —73
Snow	1	
Diluted sulphuric acid	10	From—68to—91.
Snow	8	

In order to produce these effects, the salts employed must be fresh chrystallized, and newly reduced to a very fine powder. The vessels in which the freezing mixture is made should be very thin, and just large enough to hold it, and the materials should be mixed together as quickly as possible.

Cold, in medicine, is found to be productive of inflammatory disorders, as coughs, pleuresies, peripneumonies, rheumatic pains, consumptions, &c. See Medicine.

COLDENIA, a genus of the tetragynia order, in the tetrandria class of plants; and in the natural method ranking among those of the dubious order. The calyx is tetraphyllous; the corolla funnel-shaped; the styles four; the nuts four with a fungous rind. There is but one species, a native of India. It is an annual plant, whose branches trail on the ground, extending about six inches from the root. They are adorned with small blue flowers growing in clusters, which come out from the wings of the leaves.

COLEOPTERA, among zoologists, the first order of insects, comprehending all those with four wings, the external pair of which are hard, rigid, and opake, and form a kind of case for the interior pair: add to this, that the mouth consists of two transverse jaws.

According to the Linnæan system, there are about 56 genera in this order, and in forming them special care is had to the antennæ. They are thus arranged, in Linnæus's general system.

1. A. *a* Club lamellate; scarabæus, lucanus, synodendron.

2. *b.* Club perfoliate; dermestes, melyris, byrrhus, silpha, tritoma, hydrophilus, tetraloma.

3. Club solid or inflated. Hister, bostrichus, anthrenus, nitidula, coccinella, curculio, pausus.

4. B. Antennæ moniliform; brentus, attelabus, erodius, staphylinus, zygia, meloe, tenebrio, cassida, opatrum, mordella, chrysomelia, horia.

5. C. Antennæ filiform; apalus, mantecora, pimelea, gyrinus, cucujus, cryptocephalus, bruchus, ptinus, hispa, buprestes, necydales, lampyris, cantharis, noloxus elater, calopus, alurnus, carabus lytta.

6. D. Antennæ setaceous; serropalpus, cerambyx, septura, rhenomacer, zoniles, cucindela, dytiscus, forficula.

These animals are known, in English, by the general name of beetles; whereof authors have established (as above) 56 genera, from the different figures of their antennæ, or horns, and other general distinctions; such are the scarabæus, or beetle, properly so called, the dermestes, and the several other genera as above noted.

COLIC, a severe pain in the lower venter, so called because the disorder was formerly supposed to be seated in the colon. See Medicine.

COLISEUM, or Colisæum, in antient architecture, an oval amphitheatre at Rome, built by Vespasian, wherein were statues representing all the provinces of the empire; in the middle of which stood that of Rome, holding a golden apple in her hand. This structure was so large, that it would hold near 100,000 spectators. When Titus dedicated it, he sacrificed above 4000 beasts of different kinds.

COLLAR, in Roman antiquity, a sort of chain put generally round the neck of slaves that had run away, after they were taken, with an inscription round it, intimating their being deserters, and requiring their being restored to their proper owners, &c.

Collar, in a modern sense, an ornament consisting of a chain of gold, enamelled, frequently set with cyphers and other devices, with the badge of the order hanging at the bottom; worn by the knights of several military orders over their shoulders, on the mantle, and its figure drawn round their armories. Thus, the collar of the order of the garter consists of SS, with roses enamelled red, within a garter enamelled blue, and the George at the bottom.

Collar *of a ship*, a rope fastened about her beak-head, into which the dead-man's-eye is seized, that holds her main-stay. Also the rope which is wound about the main-mast head, to save the shrouds from galling, is also called a collar. See Dead mans' eye.

Collar-*beam*, in architecture, a beam framed cross betwixt two principal rafters.

Collar *of a plough*, an iron ring fixed on the middle of the beam, wherein are inserted the tow and bridle chains. See Plough.

COLLATERAL *point*, in cosmography, the intermediate points of those between the cardinal points.

Collateral, those relations which proceed from the same stock, but not in the same ascendants or descendants. Thus uncles, aunts, nephews, nieces, and cousins, are collaterals, or in the same collateral line: those in a higher degree, and nearer the common root, represent a kind of paternity with regard to those more remote.

Collateral, in a legal sense, is taken for any thing that hangs by the side of another, to which it relates; as a collateral assurance is that instrument which is made over and above the deed itself, for the performance of covenants between man and man; thus called as being external, and without the nature and essence of the covenant.

COLLATION, in the canon law, the giving or bestowing of a benefice on a clergyman by a bishop, who has it in his own gift or patronage. This differs from presentation; the latter being properly the act of a patron, offering the clerk to the bishop, to be instituted into a benefice, whereas the former is the act of the bishop himself. The collator can never confer a benefice on himself.

Collation, in common law, the comparison or presentation of a copy with its original, to see whether or not it is conformable; or the report or act of the officer who made the comparison. A collated act is equivalent to its original, provided all the parties concerned were present at the collation.

COLLATIONE *facta uni post mortem alterius*, a writ to the justices of the common pleas, commanding them to issue their writ to the bishop, for the admitting of a clerk in the place of another presented by the king; such other clerk, during the suit between the king and the bishop's clerk, being dead.

COLLEGATORY, in the civil law, a person who has a legacy left him in common with one or more other persons. If the thing is bequeathed *in solido*, the portion of the deceased collegatory accrues to the rest.

COLLEGE, an assemblage of several bodies or societies, or of several persons into one society.

College, among the Romans, served indifferently for those employed in the offices of religion, of government, the liberal and even mechanical arts, and trades; so that, with them, the word signified what we call a corporation or company. Each of these colleges had distinct meeting-places or halls; and likewise, in imitation of the state, a treasury and common chest, a register, and one to represent them upon public occasions, and acts of government. These colleges had the privilege of manumitting slaves, of being

legates, and making by-laws for their own body, provided they did not clash with those of the government.

There are various colleges on foot among the moderns, founded on the model of those of the antients. Such are the three colleges of the empire, viz.

COLLEGE *of electors*, or their deputies, assembled in the diet of Ratisbon.

COLLEGE *of princes*, the body of princes, or their deputies, at the diet of Ratisbon.

COLLEGE *of cities* is, in like manner, the body of deputies which the imperial cities send to the diet. See ELECTOR, and DIET.

COLLEGE *of cardinals*, or the sacred college, a body composed of the three orders of cardinals.

COLLEGE is also used for a public place endowed with certain revenues, where the several branches of learning are taught. An assemblage of several of these colleges constitutes an university. The erection of colleges is part of the royal prerogative, and not to be done without the king's licence. The university of Oxford consists of nineteen colleges and six halls; that of Cambridge, of twelve colleges and four halls; and that of Paris, of fifty-four colleges, though, in reality, there are but ten where there is any teaching.

Colleges in the universities are generally lay corporations, although the members of the college may be all ecclesiastical. 2 Salk. 672. And in the government thereof, the king's courts cannot interfere, where a visitor is specially appointed. 1 Blacks. 483.

The two universities, in exclusion of the king's courts, enjoy the sole jurisdiction over all civil actions and suits, except where the right of freehold is concerned; and also in criminal offences or misdemeanors under the degree of treason, felony, or maim. 3 Black. 83. Their proceedings are in a summary way, according to the practice of the civil law. Wood, b. 4. c. 2. But they have no jurisdiction, unless the plaintiff or defendant be a scholar or servant of the university, and resident in it at the time. An appeal lies from the chancellor's court to the congregation, thence to the convocation, and thence to the delegates.

COLLEGE *of civilians*, commonly called *doctors'-commons*, founded by Dr. Harvey, dean of the arches, for the professors of the civil law residing in the city of London. The judges of the arches, admiralty, and prerogative court, with several other eminent civilians, commonly reside here. To this college belong 34 proctors, who make themselves parties for their clients, manage their causes, give licences for marriages, &c.

In the common hall of doctors'-commons are held several courts, under the jurisdiction of the civil law; particularly the high court of admiralty, the court of delegates, the arches court of Canterbury, and the prerogative court of Canterbury: whose terms for sitting are much like those at Westminster, every one of them holding several court-days; most of them fixed and known by preceding holidays, and the rest appointed at the judge's pleasure.

COLLEGE *of physicians*, a corporation of physicians in London, whose number, by charter, is not to exceed 80. The chief of them are called fellows; and the next candidates, who fill up the places of fellows as they become vacant by death or otherwise. Next to these are the honorary fellows; and lastly the licentiates, that is, such as being found capable, upon examination, are allowed to practise physic.

This college has several great privileges granted by charter and acts of parliament. No man can practise physic in or within seven miles of London, without licence of the college, under the penalty of 5*l*. Also, persons practising physic in other parts of England, are to have letters testimonial from the president and three elects, unless they are graduate physicians of Oxford or Cambridge. Every member of the college is authorized to practise surgery in London or elsewhere; and that they may be able at all times to attend their patients, they are freed from all parish offices. The college is governed by a president, four censors, and twelve electors. The censors have, by charter, power to survey, govern, and arrest, all unlicensed physicians or others practising physic in or within seven miles of London; to fine, amerce, and imprison them at discretion; to search apothecaries' shops, &c. in and about London; to see if their drugs, &c. be wholesome, and the compositions according to the form prescribed by the college in their dispensaries; and to burn or otherwise destroy those that are defective or decayed, and not fit for use. They are judges of records, and not liable to action for what they do in their practice but by judicial process; subject, nevertheless, to appeal to the college of physicians. However, the college is not very rigorous in asserting its privileges, there being some of very good abilities who practise in London, &c. without their licence: yet by law, if any person, not expressly allowed to practise, take upon him the cure of any disease, and the patient die under his hand, it is deemed felony in the practiser.

Sion-COLLEGE, or the college of the London clergy, was formerly a religious house, next a spital or hospital, and now it is a composition of both, viz. a college for the clergy of London, who were incorporated in 1631, at the request of Dr. White, under the name of the president and fellows of Sion-college; and an hospital for ten poor men: the first within the gates of the house, and the latter without.

This college consists of a president, two deans, and four assistants, who are annually chosen from among the rectors and vicars in London, subject to the visitation of the bishop. They have one of the finest libraries in England, built and stocked by Mr. Simpson, chiefly for the clergy of the city, without excluding other students on certain terms: they have also a hall with chambers for the students, generally filled with the ministers of the neighbouring parishes.

Gresham COLLEGE, or COLLEGE *of philosophy*, a college founded by sir Thomas Gresham, who built the Royal-exchange; a moiety of the revenue whereof he gave in trust to the mayor and commonalty of London and their successors for ever, and the other moiety to the company of mercers; the first to find four able persons to read in the college divinity, astronomy, music, and geometry; and the last three or more able men to read rhetoric, civil law, and physic; a lecture upon each subject is to be read in term-time, every day except Sundays, in Latin in the forenoon, and the same in English in the afternoon; the lecture on music is to be read alone in English. The lecturers have each 50*l*. per annum, and a lodging in the college.

COLLEGE *of heralds*, commonly called the *heralds' office*, a corporation founded by charter of king Richard the Third, who granted them several privileges; as to be free from subsidies, tolls, offices, &c. They had a second charter from king Edward the Sixth; and a house built near doctors'-commons by the earl of Derby, in the reign of king Henry the Seventh, was given them by the duke of Norfolk in the reign of queen Mary, which house is now rebuilt. This college is subordinate to the earl marshal of England. They are assistants to him in his court of chivalry, usually held in the common-hall of the college, where they sit in their rich coats of his majesty's arms.

COLLEGIATE *church*, a church built and endowed for a society, or a body corporate of a dean or other president, and secular priests, as canons or prebendaries in the same church.

COLLET, in glass-making, is that part of glass vessels which sticks to the iron instrument wherewith the metal was taken out of the melting-pot: this is afterwards used for making green glass.

COLLINSONIA, in botany, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 40th order, personatæ. The corolla is unequal, with its under-lip multifid, and the segments capillary. There are two species, natives of North America, but possessed of no remarkable properties.

COLLUTHIANS, in church history, a religious sect which arose in the sixth century, on occasion of the indulgence shewn to Arius by Alexander, patriarch of Alexandria: they held that God was not the author of the evils and afflictions of this life, &c.

COLLYRIDIANS, in church history, a sect of antient heretics, who paid divine honours to the Virgin Mary, offering her little cakes called *collyrida*.

COLLYRIUM. See PHARMACY.

COLON, in anatomy, the second of the three large intestines. See ANATOMY.

COLON, in grammar, a point or character marked thus (:), shewing the preceding sentence to be perfect or entire; only that some remark, farther illustration, or other matter connected therewith, is subjoined.

COLONEL, in military matters, the commander in chief of a regiment, whether horse, foot, or dragoons.

A colonel may lay any officer of his regiment in arrest, but must acquaint the general with it; he is not allowed a guard, only a sentry from the quarter-guard.

COLONNADE, in architecture, a peristyle of a circular figure, or a series of columns disposed in a circle, and insulated withinside. Such is that of the little park at Versailles, consisting of 32 Ionic columns, all of solid marble, and without incrustation. A polystile colonnade is that whose number of columns is too great to be taken in by the eye at a single view. Such is the colonnade of the palace of St. Peter's at Rome, consisting of 284 columns of the Doric order, each above four feet and a half diameter, all in Tiburtine marble.

COLOPHONY. See PHARMACY.

COLOSSUS, a statue of a gigantic or enormous size. The most famous of this kind was the colossus of Rhodes, made in honour of Apollo, by Chares the disciple of Lysippus. It was 86 feet high, and its thumb so large that few people could embrace it. This statue was placed across the mouth of the harbour at Rhodes, and the ships in full sail passed betwixt its legs.

COLOUR. See OPTICS.

COLOUR, in painting, is applied both to the drugs, and to the tints produced by those drugs variously mixed and applied.

We shall in this article give a brief account of the different pigments or colours which are used either in water or oil for the purposes of drawing or painting.

Red. Lakes. This term is used to denote a species of colours formed by the combination of alumina, or the oxyd of tin, with the colouring matters of vegetables. The lakes chiefly used are red colours; and these are of different qualities, according to the basis and colouring matter employed; such as carmine, Florence-lake, and madder-lake.

Carmine is a very rich bright crimson colour, and stands well in water. For the preparation of carmine, four ounces of finely pulverized cochineal are to be poured into four or six quarts of rain or distilled water, that has been previously boiled in a pewter kettle, and boiled with it for the space of six minutes longer. Eight scruples of Roman alum, in powder, are to be then added, and the whole kept upon the fire one minute longer. As soon as the gross powder has subsided, and the decoction has become clear, it is to be carefully decanted into large cylindrical glasses covered over, and kept undisturbed till a fine powder is observed to have settled at the bottom. The liquor is then to be poured off from this powder, which is to be gradually dried. From the liquor, which is still much coloured, the rest of the colouring matter may be separated by means of the solution of tin, when it yields a carmine little inferior to the former.

Florentine lake is the kind in general use, known by the name of lake. It is used in water and also in oil, but does not stand; which is much to be lamented, as it is a very beautiful colour, and there is no substitute that will completely answer all the purposes of lake. The best sort may be prepared from the sediment of cochineal that remains in the kettle after making carmine, adding to it a small quantity of cochineal or Brazil-wood, and precipitating the colouring matter with a solution of tin.

Madder lake is very little known as a colour. It is not so bright and rich a colour as the last-mentioned lakes, but has this valuable advantage; that it stands much better, and it may answer many of the purposes of Florence lake. It is prepared nearly in the same manner as the foregoing.

Rose-lake. This is generally called rose-pink. It is a lake made by a basis of chalk, coloured by Brazil or Campeachy wood. It does not stand, and is only used for house-painting and paper-hanging.

Vermilion, a bright scarlet pigment, formed from sulphur and quicksilver; when of a coarse kind, it is called cinnabar. Its goodness is known by its brightness, and inclining to a crimson hue. It is a very useful colour in oil, where it stands very well; but in water it is apt to turn black.

Red-lead, or minium, is lead calcined till it acquires a red colour, by exposing it with a large surface to the fire. It is also made from litharge, which is a calx or oxyd of lead; but is not so good as when made directly from metallic lead. This colour is very apt to turn black, both in water and oil, and is therefore seldom used but for very coarse purposes.

Indian-red is a very useful colour, answering some of the purposes of lake: it stands well both in water and oil. It is difficult to procure the genuine kind, which comes from the East Indies. What is sold for Indian-red is said to be chiefly made in this country.

Venetian-red, is a native red-ochre, rather inclining to the scarlet than the crimson hue: it is not far different from the common Indian red, but fouler, and is chiefly used by house-painters.

Spanish-brown is also an earthy substance, found in the same state in which it is used; it is nearly of the same colour as Venetian-red, but coarser. It is used only for the commonest purposes. It does not change.

Light-red, or burnt ochre. This is common yellow-ochre, heated red-hot in the fire, till the colour changes from yellow to a red. It is a very excellent colour, both in water and oil; having the quality in common with all the ochres, of standing perfectly well.

Red-chalk. This is the same substance as is used for drawing on paper, in the manner of a crayon. It is very much like light-red, and is used instead of it for some purposes. It stands perfectly well, and may be used both in water and oil.

Burnt terra di Sienna. This colour is made by calcining raw terra di Sienna till it acquires a red colour. It is of a very rich tint, and is much used both in water and oil. It stands well in both.

Blue. Ultramarine is prepared from lapis lazuli, by calcining and washing it very clean. When genuine, it is an extremely bright blue colour, somewhat transparent both in oil and water, and stands perfectly well. On these accounts it is of the utmost value, being excellent in every kind of painting, even in enamel; but its great price prevents the general use of it.

Ultramarine ashes. This is the residuum, after washing the lapis lazuli, in which a portion of the ultramarine still remains. It is very subject to be adulterated. It is not so bright as ultramarine; being like that colour, with a tint of red and white in it. When genuine it stands well.

Prussian-blue. This colour is iron combined with a peculiar acid, called the prussic acid. It is made in the following manner:

Two parts of purified potass are most intimately blended with three parts of dried and finely pulverized bullock's blood. The mass is first calcined in a covered crucible, and on a moderate fire, until no more smoke or flame appears; and it is after this brought to a complete yet moderate ignition: or equal parts of potass and finely-powdered coals, prepared from bones, horns, claws, &c. are mingled, and heated in a covered crucible to a moderate redness. This done, either of these two calcined masses is, after cooling, lixiviated with boiling water, and the lixivium filtred. Nothing remains now but to make a solution of one part of green vitriol and two parts of alum; and to add to it while yet hot the above lixivium, little by little, however; and to separate the greenish-blue precipitate which then forms, by means of a filtre. If afterwards a slight quantity of diluted muriatic acid is affused upon this precipitate, it assumes a beautiful dark-blue colour. The operation is terminated by edulcorating and drying the pigment thus prepared. Prussian-blue is an extremely beautiful colour when properly prepared, and stands well. Common Prussian-blue is apt to contain some iron, which causes it to turn greenish or olive.

Verditer is a blue pigment, obtained by adding chalk or whitening to the solution of copper in aqua-fortis. The best sort is prepared by the refiners; who employ for this purpose the solution of copper which they obtain in the process of parting, by precipitating, silver from aqua fortis by plates of copper. Common verditer is made from the sulphate of copper or blue, by the manufacturers in Sheffield and Birmingham. Verditer is only used for very coarse purposes, chiefly by the paper-stainers. It has been sometimes called sanders-blue, from ignorance of the meaning of the term *cendres blues*, or blue ashes, which the French call it.

Indigo. This colour is extracted from a plant that grows in the East and West Indies. It is not so bright as Prussian-blue, but it is cooler, and has the advantage of being very durable. It cannot be dissolved by water, but may by the sulphuric acid; and it then forms Scott's liquid blue, so much used for colouring silk stockings, &c.

Smalt. This is glass coloured with cobalt, and ground to a fine powder. Its coarseness prevents its being used much for painting in oil or water. It is employed sometimes by strewing it upon a ground of oil-paint. It is also used in enamel-painting. It stands well.

Bice is only smalt more finely levigated.

Yellow. Indian-yellow. This is the brightest of all yellows for water-colours, and is perfectly durable. It is said to be procured from the urine of the buffalo. In the East Indies it is a very common and cheap colour; the natives there use it commonly for colouring their calicoes, which they do without any mordant; so that the colour is washed out again when the cloth is dirty.

King's-yellow. This colour is orpiment refined; which is a substance dug out of the earth, and consists of sulphur joined to arsenic; or it may be prepared by subliming sulphur with arsenic. It is of a very bright yellow, but does not stand well; and great caution should be used in employing it, as it is a strong poison.

Naples-yellow. This is a very durable and bright yellow; it comes from Naples, and is supposed to be prepared from lead and antimony.

Yellow-ochre. This is an earth coloured by oxyd of iron. It is a cheap colour, and not very bright, but is valuable on account of its standing well. Roman-ochre is a superior kind of yellow-ochre.

Dutch-pink. This pigment is formed of chalk, coloured with the juice of French berries, or other vegetables affording a yel-

low colour. It does not stand, and is chiefly used for common purposes.

Gamboge is a gum brought from the East Indies. It readily dissolves in water, and is a fine bright yellow. It is used only in water, and is very serviceable.

Massicot is an oxyd of lead, prepared by calcining white-lead. It is very little used, the colour not being very bright.

Gall-stones. This is a concretion or hard substance, formed in the gall-bladders of beasts; or it may be obtained from the gall of animals. It is a very rich colour, but does not stand.

Raw terra di Sienna, is a native ocherous earth brought from Italy. It is a fine warm colour, and stands well.

Orange-lake is the tinging part of annotto precipitated together with the earth of alum. It does not stand.

Brown-pink is the tinging part of some vegetable substance precipitated upon the earth of alum. It is of a fine rich greenish yellow, but does not stand.

Green. There are few colours that are useful as greens; accordingly, it is the practice with artists to form their greens by the mixture of blue and yellow colours. By varying these, a vast variety of green tints may be obtained.

Sap-green is the concreted juice of the buckthorn-berries. It is never used in oil. It is employed chiefly in flower-painting and colouring prints, &c.

Verdigris. If plates of copper, moistened from time to time with vinegar, are left exposed to the air, they will be converted into a green oxyd, called verdigris: this is an imperfect oxyd of copper, combined with a small portion of acetic acid, carbonic acid, and water. It is prepared in large quantities, chiefly in France near Montpellier, by stratifying copper-plates with the husks of grapes yet under vinous fermentation, which soon grow acid, and corrode the copper. After the plates have stood in this situation for a sufficient time, they are moistened with water, and exposed in heaps to the air. The verdigris is scraped off from their surface as it forms. Verdigris is of a bluish-green colour, but has no body, and does not stand. It is only used for very coarse purposes. It answers best when used in varnishes.

Distilled verdigris, sometimes called crystals of verdigris, is prepared from common verdigris, by dissolving it in vinegar. It is of a very bright green; and is used chiefly for varnishes, and in colouring maps, &c.

Brown colours. Bistre is the finer part extracted from the soot of burnt wood. It is much used alone for sketches in water-colours, being a transparent warm colour. There is an excellent sort prepared in Ireland.

Cologne-earth is a mineral substance of a blackish brown colour. It is a very useful colour; though what is generally sold in the shops for Cologne-earth, is an artificial mixture of several colours.

Raw-umbre is a native ochreous earth, of a light brown. It stands well.

Burnt-umbre is only the last-mentioned colour calcined in the fire. It then acquires a rich deep brown, and is of great use, being a fine colour, and standing perfectly well.

Asphaltum is used in oil, and is of a very rich deep brown. It is a transparent or glazing colour. It will not work in water; but when dissolved in turpentine, it becomes a useful substance for giving deep and spirited touches to drawings.

White. Flake-white is an oxyd of lead, formed by corroding lead with vegetable acids or vinegar.

White-lead is the same colour as flake-white, only of an inferior quality. It is the only white used in oil-painting, and is a very useful colour; but in water it always turns black, and should never be used.

Pure carbonate of lime is very useful as a white in water-colours, as it stands perfectly well.

Egg-shell white, and oyster-shell white, are only egg-shells or oyster-shells calcined, by which the animal gluten is destroyed, leaving the lime behind, which soon attracts the carbonic acid again from the atmosphere. Well-washed Spanish-white, or common whitening, answers the same purpose.

Black. Lamp-black is the soot of oil, collected after it is formed by burning. It is very generally used, both in oil and water, and stands perfectly well.

Ivory-black is the coal of ivory or bone, formed by giving them a great heat, while they are deprived of all access of air. It is of a more intense black than lamp-black.

Blue-black is the coal from burning vine-stalks in a close vessel. It is like ivory-black, with a tint of blue.

COLOUR, in dyeing. See DYEING.

COLOUR, in heraldry. The colours generally used in heraldry are red, blue, black, green, and purple; which the heralds call gules, azure, sable, vert or sinople, and purpure; tenne or tawny, and sanguine, are not so common: as to yellow and white, called or and argent, they are metals, not colours.

COLOUR, in law, some probable plea, though really false in itself, and only calculated to draw the trial of the cause from the jury to the judge; for which reason it ought to be matter in law or doubtful to the jurors.

COLOUR *of office*, signifies some unjust action done under countenance of an office, and is opposed to *virtute officii*, which implies a man's doing a right and just thing in the execution of his office.

COLOURS, in the Latin and Greek churches, are used to distinguish several mysteries and feasts.

To COLOUR *strangers' goods*, in commerce, is when a freeman allows a foreigner to enter goods at the custom-house in his name.

COLOURING, in painting, is the art of applying and disposing various colours in such a manner as to be productive either of an imitation of the natural hues of the objects represented, of harmonious arrangement of tints, or of force and brightness of effect. See PAINTING.

COLUBER, a genus of serpents. The generic character is, scuta or undivided lamellæ under the abdomen, broad alternate scales under the tail. This is by far the most numerous of all the Linnæan genera of serpents: and the species differ greatly in size and habit, according to their respective tribes; some, as the vipers, having large, flattish, and subcordate heads, with rather short than long bodies and tails; while others, as the major part of the harmless serpents, have, in general, small heads, with longer bodies and tails in proportion. In some few species, exclusive of the usual subcaudal scales, are a few scuta or undivided lamellæ, either at the beginning or towards the tip of the tail. It is to be observed, that in the investigation of this genus the subcaudal scales, though alternate, are reckoned by pairs, so that the number marked under the respective species is always to be understood to mean so many pairs. There are ninety-seven species: the following are the most remarkable.

1. COLUBER BERUS, or common viper (See Plate Nat. Hist. fig. 136), which appears to be pretty generally diffused over the whole antient continent, and which is by no means uncommon in our own island, has been known from times of remote antiquity, though all the particulars relative to its nature and manners are even yet not fully understood.

The general length of the viper is about a foot and half, or two feet, though some have been seen of much greater length, measuring near three feet: the fangs are situated, as in other poisonous serpents, on each side the fore part of the upper jaw; and are generally two in number, with a few smaller ones lying near the principal or large fangs, as if intended by nature to supply the place of the former when lost either by age or accident.

The viper has always been considered as the most poisonous of the European serpents, and innumerable are the cases recorded by medical and other writers of the fatality of its bite; yet the instances, in our own island at least, seem to be far less frequent than generally supposed; and though the bite of this animal produces a painful and troublesome swelling, yet it is rarely of any other bad consequence. No doubt the cases must differ, as in the bite of every other poisonous serpent, according to the nature of the part bitten, the constitution of the person, the strength and vigour of the animal, the season of the year, &c. and if the bite happens directly on a vein, it may perhaps be productive of the most alarming symptoms, and even sometimes prove fatal: yet Fontana, even in the warm of climate of Italy, seems to doubt whether any well-attested instance could be adduced in which the viper had killed any person by its bite. The poison of the viper was in ancient times collected by barbarian nations as a poison for their arrows; the Scythians, according to Pliny, using it for that purpose mixed with human blood: the poison of other serpents is used in a similar manner by savage nations at the present day.

The most established application for the bite of a viper is common olive-oil, thoroughly rubbed on the wounded part, and about a wine-glassful taken internally: this the viper-catchers use, as is pretended, with perfect success; and all other applications, as volatile alkali, &c. seem of far less certain efficacy.

The viper, though so much dreaded on account of its bite, has been very highly esteemed, both by the ancients and moderns, in a medical view, and used as a restorative and strengthening diet. This idea seems to have originated from the animal's casting its skin, like other snakes, and thus appearing, as it were, in a state of renovated youth; and the snake's being made the emblem of health, and consecrated to Æsculapius, must have depended on the same idea. We are

indeed of opinion, that it is possible (could we overcome our reluctance to it), that viper's flesh might prove nutritious food, but that to ascribe any medical virtues to it is a vulgar error.

The viper is viviparous, producing its young towards the close of summer. "On the 4th of August, 1755," says Mr. White, "we surprised a large female viper, which seemed very heavy and bloated, as it lay on the grass, basking in the sun. When we came to cut it up, we found that the abdomen was crowded with young, fifteen in number; the shortest of which measured full seven inches, and were about the size of full-grown earthworms. This little fry issued into the world with the true viper-spirit about them, shewing great alertness as soon as disengaged from the belly of the dam: they twisted and wriggled about, and set themselves up, and gaped very wide when touched with a stick, shewing manifest tokens of menace and defiance; though as yet they had no manner of fangs that we could find, even with the help of our glasses." Mr. White, in another part of his work, informs us, that in the month of May a female viper was opened, which had in it a chain of eleven eggs, about the size of those of a blackbird; but not so far advanced as to shew the rudiments of the young.

"Several intelligent persons," adds Mr. White, "assure me that they have seen the viper open her mouth, and admit her helpless young down her throat on sudden surprises, just as the opossum does her brood into the pouch under her belly upon the like emergencies; and yet the London viper-catchers insist on it to Mr. Barrington that no such thing ever happens.

Sir Thomas Brown, however, seems inclined to believe this circumstance. The young, says he, supposed to break through the belly of the dam, will upon any fright, for protection, run into it; for then the old one receives them in at her mouth: the fright being past, they will return again, which is a peculiar way of refuge, and although it seem strange, it is avowed by frequent experience and undeniable testimony. There is a variety of this species entirely black.

2. The cerastes or horned viper, which commonly grows to the length of about a foot or fifteen inches, and sometimes to a larger size, is distinguished by a pair of horns or curved processes, situated above the eyes, and pointing forwards: these horns have nothing analogous in their structure to the horns of quadrupeds, and are by no means to be considered in the light of either offensive or defensive weapons: they increase, however, the natural antipathy so generally felt against the serpent tribe, and give the animal a more than ordinary appearance of malignity. The cerastes is a native of many parts of Africa, and is principally found in sandy deserts and dry places. Its usual colour is a pale yellowish or reddish brown, with a few rather large, distant, round, or transversely oblong spots of a deeper colour, dispersed along the upper parts of the body, the belly or under part being of a pale lead-colour. In Syria and Arabia the cerastes is particularly frequent, and is also found in many parts of Egypt, &c. It bears a very great affinity to the common viper, and its bite is perhaps still more to be dreaded; since, exclusive of the general danger of treading accidentally on this reptile, and thus irritating it unawares, it is said to possess a propensity of springing with great suddenness to a considerable distance, and assailing without provocation those who happen to approach it.

The celebrated Abyssinian traveller, Mr. Bruce, is of opinion that this was the aspic employed by Cleopatra to procure her death. He adds some incredible stories respecting the power of certain persons in Africa to charm these and other serpents so as to prevent their biting them. If these narratives have any foundation, the animals must in some way have been previously disarmed of their fangs, as the cobra de capello is by the Indian jugglers.

3. Coluber nasicornis, or horn-nose snake, adds to the number of those malignant reptiles whose bite, in the hotter regions of the globe, proves the dreadful forerunner of a speedy and painful death. If at the first glance of most of the serpent tribe an involuntary sort of horror and alarm is so often felt by those who are unaccustomed to the examination of these animals, how much greater dread must the unexpected view of the species here exhibited be supposed to inflict! when to the general form of the creature are superadded the peculiar fierceness and forbidding torvity with which nature has marked its countenance; distinguished by the very uncommon appearance of two large and sharp-pointed horns, situated, not as in the cerastes, above the eyes, but on the top of the nose or anterior part of the upper jaw. These horns stand nearly upright, but incline slightly backwards and a little outwards on each side, and are of a substance not absolutely horny, but in some degree flexible: their shape is somewhat triangular or three-sided; they are about half an inch in length, and at the fore-part of the base of each stands an upright strong scale, of nearly the same shape with the horn itself, and thus giving the appearance of a much smaller pair of horns. The mouth is furnished with extremely large and long fangs or tubular teeth, situated as in other poisonous serpents, and capable of inflicting the most severe wounds: two of these fangs appear on each side of the mouth, the hinder pair being smaller than the others. The length of this animal is about thirty-five inches. Its colour is a yellowish olive-brown, very thickly sprinkled all over with minute blackish specks: along the whole length of the back is placed a series of yellowish-brown oblong spots or marks, each of which is imbedded in a patch of black; and on each side of the body, from head to tail, runs an acutely-flexuous or zigzag line or narrow band of an ochre-colour: the horn-nose snake is supposed to be a native of the interior parts of Africa.

4. The coluber naja, or cobra de capello, (See Plate Nat. Hist. fig. 138.) is a native of India, where it appears to be one of the most common, as well as most noxious, of the serpent tribe; very frequently proving fatal, in the space of a few minutes, to those who unfortunately experience its bite. Its remarkable form and colours are such as to distinguish it with great ease from almost every other snake. Its general length seems to be three or four feet, and the diameter of the body about an inch and a quarter. It has obtained its Portuguese title of cobra de capello, or hooded snake, from the appearance which it presents when viewed in front in an irritated state, or when preparing to bite; at which time it bends the head rather downwards, and seems hooded in some degree by the expanded skin of the neck. In India it is every where exhibited publicly as a show, and is, of course, more universally known in that country than almost any other of the race of reptiles. It is carried about in a covered basket, and so managed by its proprietors as to assume, when exhibited, a kind of dancing motion; raising itself up on its lower part, and alternately moving its head and body from side to side for some minutes, to the sound of some musical instrument which is played during the time. The Indian jugglers, who thus exhibit the animal, first deprive it of its fangs, by which means they are secured from the danger of its bite.

Dr. Russel, in his account of experiments made in India with this serpent, observes, that, as a general standard for a comparison of the effect of its bite with that of other poisonous serpents, he never knew it prove mortal to a dog in less than twenty-seven minutes, and to a chicken in less than half a minute. Thus, fatal as it is, its poison seems not so speedy in operation as that of the rattle-snake, which has been known to kill a dog in the space of two minutes.

5. The coluber aquaticus, or water viper, is called in Carolina the water rattle-snake; not that it has a rattle; but is a large snake, and coloured not much unlike the rattle-snake, and the bite is said to be as mortal. This snake frequents the water, and is never seen at any great distance from it; the back and head are brown; the belly transversely marked with black and yellow alternately, as are the sides of the neck: the neck is small, the head large, and armed with the like destructive weapons as the rattle-snake: it is very nimble, and particularly dextrous in catching fish. In summer great numbers are seen lying on the branches of trees hanging over rivers, from which at the approach of a boat they drop down into the water, and often into the boat on the men's heads: they lie in this manner to surprise either birds or fish, after which last they plunge, and pursue them with great swiftness, and catch some of a large size, which they carry on shore and swallow whole. The tail is small towards the end, and terminates in a blunt horny point about half an inch in length, and which, though harmless, is considered as of dreadful efficacy by the credulous vulgar, who believe that the animal is able, with this weapon, not only to kill men and other animals, but even to destroy a tree by wounding it with it; the tree withering, turning black, and dying.

6. Coluber argus, or argus snake, (See Plate Nat. Hist, fig. 135.) is a large and elegant species, measuring, according to Seba, above five feet in length, and being of a moderate thickness in proportion: the head is large, flattish, covered in front with small scales, and so very protuberant on each side at the hind part as to appear heart-shaped, or rather bilobate: the teeth large and strong: the whole upper surface of the animal is of a dusky chesnut colour, the scales being small, ovate, and each marked by a white

speck; while the body is beautifully marked from head to tail by numerous transverse rows of round red spots; the tail is moderately slender, tapering to a point, and seemingly measuring about a fifth of the whole length. This snake is, according to Seba, a native of Arabia. The appearance of the head seems strongly to indicate a poisonous species.

7. The coluber natrix, or ringed snake (See Plate Nat. Hist. fig. 137.) appears to be pretty generally diffused through all parts of Europe, and is common in our own island, frequenting woods, moist hedges, and shady places; in colour it occasionally varies, but is generally either of a blueish grey or pale olive on the upper parts, marked along the sides by a row of small transverse black streaks, alternating with some smaller spots of the same colour; and on each side the neck is a black and somewhat semilunar patch, the horns or tips pointing forward: this is bounded in front by a second patch of a pale yellow or whitish colour, thus forming a kind of collar on each side the neck. This animal is of an innoxious nature, and may be tamed to a considerable degree. Mr. White, in his History of Selborne, has the following remark on this subject: "I knew a gentleman who kept a tame snake, which was in its person as sweet as any animal; but as soon as a stranger, or a dog or cat, came in, it fell to hissing, and filled the room with such nauseous effluvia as rendered it hardly supportable." The snake chiefly lives by preying on frogs, mice, small birds, insects, worms, &c. It is known to frequent the water occasionally, for the sake of frogs, &c. and is capable of swimming, though not with any great degree of celerity. It deposits its eggs in any warm and moist situation, as under hedges, in dunghills, &c. in the form of a continued chain or necklace of ova, to the number of twelve, fourteen, sixteen, or even twenty, of the size of those of a blackbird, and of a whitish colour: these, according to the observations of Mr. White, do not hatch till the spring following.

During the winter the snake conceals itself in any convenient retreat, and becomes nearly torpid, re-appearing in the spring, when it casts its skin, which cracking or opening on the edges of the lips, is, by the efforts of the animal, gradually thrown off, in an inverted direction, throughout its whole length, to the very terminal scale of the tail; and so complete is the spoil or exuvium, as to exhibit the very coat or membrane of the eyes themselves: the whole skin is entirely transparent.

8. The coluber atrovirens, or French snake, is an animal of a perfectly harmless nature, and, like the former, is capable of being tamed to a considerable degree. The count de Cepede relates, from Mr. Bomare, an anecdote relative to a snake which he supposes to have been of this species, which had been so completely tamed by a lady, as to come to her whenever she called it, follow her in herwalks, wreathe itself round her arms, and sleep in her bosom. One day, when this lady went in a boat, to some distance up a large river, she threw the snake into the water, imagining that it would readily recover the boat by swimming; but the current proving unusually strong, at that juncture, owing to the advance of the tide, the poor animal, in spite of all its efforts to reach the vessel, was unfortunately drowned.

9. The coluber constrictor, or black snake, is a large and very long snake; some being six feet in length: they are all over of a shining black, never changing their colour; and are very nimble and beneficial in killing rats, which they pursue with wonderful agility to the roofs and all parts of houses and barns, where rats are able to run, for which service they are preserved by most of the inhabitants: they are bold and furious, leaping at and biting those that attack them, though no harm ensues; their bite not being venomous: it is commonly said in Carolina that they will attack and swallow rattle-snakes: it is certain that most or all snakes will devour one another, not only of their own but of other kinds. They are the most numerous of all snakes in North America.

"Many ridiculous frights," says Mr. Pennant, "have happened from this innocent reptile. As every one in America is full of the dread of the rattle-snake, they are apt to fly at the sight of any of the serpent kind. This pursues, soon overtakes, and twisting round the legs of the fugitive, soon brings him to the ground; but he happily receives no hurt, but what may result from the fright; all the mischief this species does is to the housewives, for it will skim their milk-pans of the cream, and rob their hen-roosts of all the eggs."

10. The coluber austriacus, or smooth snake, is found in France and several other parts of Europe. It inhabits moist meadows, hedges, watry places, &c. It is of a fierce disposition in its wild state, biting with much eagerness such animals as happen to attack it; but is incapable of producing any injury, being unprovided with poisonous fangs, and is easily tamed, in which state it shows a considerable degree of attachment. It occasionally varies somewhat in colour, the upper parts having a strong tinge of rufous, and the abdomen of dusky brown or even blackish, while the sides have a cast of yellow or green.

11. The coluber gemmatus, or bugle snake, is a beautiful species: length about fifteen or sixteen inches, colour of the upper parts blue, with three narrow equidistant stripes from head to tail; the two lateral stripes being white, the middle one black, marked by a row of small white specks alternately oblong and round, representing a small string of beads and bugles: head large-scaled, and marked on each side by three or four spots forming a band across the eyes, the top spotted with pale blue marks bordered with black: the abdomen is white, each scutum being marked at its edge, near the body, with a small black speck, forming two rows down the abdomen: native country unknown: described by Cepede from a specimen in the royal cabinet.

12. The coluber mycterizans, or long-snouted snake, is in colour grass-green, with a yellow line on each side the abdomen: habit remarkably slender, measuring about three feet and a half in length, and about half an inch in diameter: head moderately large, long, and very sharp-snouted, the upper jaw running far beyond the lower: sometimes this species varies in having an additional pair of yellow abdominal lines, running down the middle of that part: it is an innoxious snake, though erroneously marked as poisonous in the Systema Naturæ, owing to the fang-like appearance of its large and long teeth in the upper jaw. It is a native of many parts of North America, where it is principally seen on trees, moving with great velocity in pursuit of insects, on which it is said principally to feed.

13. The coluber ahætulla, or iridescent snake, is one of the most beautiful of the whole serpent tribe (See Plate Nat. Hist. fig. 134); and in general, easily distinguished by its blue-green gilded tinge, accompanied by iridescent hues: its habit is long and slender, measuring about three feet and a half, or four feet, in length, and about half or three quarters of an inch in diameter: the skin, between the scales, is blackish, and in some parts gives an additional beauty to the general colour: across the cheeks, passing through the eyes, is a jet-black streak: the head is covered above with large scales, and the snout is slightly elongated, but by no means pointed: the abdomen is pale and flattish, as in the mycterizans and some others of this tribe, and the tail is angular, thin, and of very considerable length. This species is entirely innocent, and is a native of several parts of India.

COLUBRINUM LIGNUM, snake-wood. See MATERIA MEDICA.

COLUMBA, in ornithology, the pigeon, a genus belonging to the order of passeres. The characters of this genus are as follow: the bill is straight towards the point; the nostrils are oblong, and half-covered over with a soft tumid membrane; and the tongue is entire, that is, not cloven. There are about 70 species, natives of different countries. The following are the most remarkable:

1. Columba coronata, or great crowned pigeon, a very large species, about the size of a turkey. The bill is black, and two inches long; the irides are red; the head, neck, breast, belly, sides, thighs, and under tail-coverts, cinereous blue; the head is crested; the sex of a deep ash-colour. This species inhabits the Molucca isles and New Guinea, and has been brought to England alive. In size it far exceeds any of the pigeon tribe; but its form and manners tell us it can belong to no other. Its note is cooing and plaintive, like that of other pigeons, only louder in proportion. The mournful notes of these birds alarmed the crew of Bougainville much, when in the neighbourhood of them, thinking they were the cries of the human species. In France they were never observed to lay eggs, nor in Holland, though they were kept for some time.

2. Columba malaccensis, the Malacca pigeon described by Sonnerat, is little larger than the house-sparrow. It is a most beautiful species, and the flesh is said to be extremely delicate. It has been transported into the Isle of France, where it has multiplied exceedingly.

3. Columba migratoria, or pigeon of passage, is about the size of an English wood-pigeon; the bill black: it is red; the head of a dusky blue; the breast and belly of a faint red; above the shoulder of the wing there is a patch of feathers shining like gold; the wing is coloured like the head, having some few spots of black; the tail is very long, and covered with a black feather, under which the rest are white; the legs and feet are red.

They come in prodigious numbers from the north, to winter in Virginia and Carolina. In these countries they roost upon one another's backs in such numbers that they often break down the limbs of oaks which support them, and leave their dung some inches thick below the trees. In Virginia Mr. Catesby has seen them fly in such continued trains for three days successively, that they were not lost sight of for the least interval of time, but somewhere in the air they were seen continuing their flight southward. They breed in rocks by the sides of rivers and lakes far north of St. Laurence. They fly to the south only in hard winters, and are never known to return.

4. Columba œnas, or the domestic pigeon, and all its beautiful varieties, derive their origin from one species, the stock dove; the English name implying its being the stock or stem, whence the other domestic birds have sprung. These birds, as Varro observes, take their Latin name, columba, from their voice or cooing: and, had he known it, he might have added the British also; for k'lommen, kylabmano, kulm, and kolm, signify the same bird. They were, and still are, to be found in most parts of our island in a state of nature; but probably the Romans first taught the Britons how to construct pigeon-houses, and make birds domestic. The characters of the domestic pigeon are these. It is of a deep blueish ash-colour; the breast dashed with a fine changeable green and purple; it weighs fourteen ounces. In the wild state it breeds in holes of rocks and hollows of trees; for which reason some style it columba cavernalis, in opposition to the ring-dove, which makes its nest on the boughs of trees. Nature always preserves some agreement in the manners, characters, and colours, of birds reclaimed from the wild state. This species of pigeon soon takes to build in artificial cavities, and from the temptation of a ready provision becomes easily domesticated. Multitudes of these wild birds migrate into the south of England; and, while the beech-woods were suffered to cover large tracts of ground, they used to haunt them in myriads, reaching a mile in length, as they went out in the morning to feed. They visit Britain the latest of any bird of passage, not appearing till November, and retiring in the spring. Mr. Pennant imagines, that their summer haunts are in Sweden, as Mr. Eckmark makes their retreat thence coincide with their arrival in Britain. Numbers of them, however, breed in cliffs on the coast of Wales, and of the Hebrides. The varieties produced from the domestic breed are numerous, and extremely elegant; they are distinguished by names expressive of their several properties, as tumblers, carriers, jacobines, croppers, pouters, runts, turbites, owls, nuns, &c. The most celebrated of these is the carrier. They are gregarious; lay only two eggs, and breed many times in the year. So quick is their increase, that the author of the Economy of Nature observes, that in the space of four years 14760 pigeons may come from a single pair. The male and female sit, and also feed their young, by turns: they cast provision out of their craw into the young one's mouth; they drink, not by sipping, but by continued draughts like quadrupeds.

5. Columba palumbus, the ring-dove or wood-pigeon, is a native of Europe and Asia. It is the largest pigeon we have, and might be distinguished from all others by its size alone. Its weight is about 20 ounces; its length 18, the breadth 30, inches. The head, back, and covers of the wings, are of a blueish ash-colour: the lower side of the neck and breast are of a purplish red, dashed with ash-colour; on the hind part of the neck is a semicircular line of white; above and beneath that, the feathers are glossy, and of changeable colours. This species forms its nest of a few dry sticks in the boughs of trees. Attempts have been made to domesticate them by hatching their eggs under the common pigeon in dove-houses; but as soon as they could fly, they always took to their proper haunts. In the beginning of winter they assemble in great flocks, and leave off cooing, which they begin in March, when they pair.

6. Columba passerina, or the ground-dove of Carolina, is about the size of a lark. The bill is yellow, and black at the end; the iris red; the breast and whole front of a changeable purple, with dark purple spots; the legs and feet of a dirty yellow; but the whole bird has such a composition of colours in it, that a very particular description is impossible. They fly in great numbers together, and make short flights from place to place, generally lighting on the ground.

7. Columba turtur, or turtle-dove, is a native of India. The length is twelve inches and a half; its breadth twenty-one; the weight four ounces. The irides are of a fine yellow, and the eye-lids encompassed with a beautiful crimson circle. The chin and forehead are whitish; the top of the head ash-coloured, mixed with olive. On each side of the neck is a spot of black feathers prettily tipt with white: the back ash-coloured, bordered with olive-brown: the scapulars and coverts of a reddish brown spotted with black: the breast of a light purplish red, having the verge of each feather yellow; the belly white. In the breeding season these birds are found in Buckinghamshire, and in several parts of the west of England. They are very shy, and breed in thick woods, generally of oak; in autumn they migrate into other countries. See Pl. N. H. fig. 139.

COLUMN, in the military art, a long deep file of troops or baggage. The first and second lines of the army as they are encamped, make generally two columns on a march, filing off either from the right or left: sometimes the army marches in four, six, or eight columns, according as the ground will allow: and each column is led by a general officer.

COLUMN. See ARCHITECTURE.

COLUMNA. See ANATOMY.

COLUMNEA, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The calyx is quinquepartite; the upper lip of the corolla arched and entire; gibbous above the base; the antheræ converted; the capsule bilocular. There are six species, natives of the East and West Indies.

COLURES, in astronomy and geography, two great circles supposed to intersect each other at right angles in the poles of the world, and to pass through the solstitial and equinoctial points of the ecliptic. See GEOGRAPHY.

COLUTEA, bastard-sena; a genus of the decandria order, in the diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ. The calyx is quinquefid; the legumen inflated, opening at the upper part of the base. There are nine species, deciduous flowering shrubs, adorned with many-lobed leaves, and butterfly-shaped flowers, of a deep yellow or red colour. They are propagated both by seeds and layers, and are hardy enough, though they sometimes require a little shelter when the weather is very cold.

COLYMBUS, DIVER, in ornithology, a genus of anseres. The bill has no teeth, is subulated, straight, and sharp-pointed; the teeth are in the throat; the nostrils are linear, and at the base of the bill; and the legs are unfit for walking. This genus includes several species, viz. the divers, guillemots, and grebes; of which the following are the most remarkable.

1. The grylle, or black guillemot, is in length fourteen inches, in breadth twenty-two; the bill is an inch and an half long, straight, slender, and black; the inside of the mouth red; on each wing is a large bed of white, which in young birds is spotted; except those in which the whole plumage is black, the legs are red. These birds are found on the Bass isle in Scotland; in the island of St. Kilda; and, as Mr. Ray imagines, in the Farn islands off the coast of Northumberland. They have also been seen on the rocks of Llandidno, in Caernarvonshire, in Wales. Except in breeding-time, the grylle keeps always at sea; and is very difficult to be shot, diving at the flash of the pan. The Welsh call this bird cascan longur, or "the sailor's hatred," from a notion that its appearance forebodes a storm.

2. The troile, or foolish guillemot, weighs 24 ounces; its length is 17 inches, the breadth 27½; the bill is three inches long, black, straight, and sharp-pointed; the inside of the mouth yellow; the feathers on the upper part of the bill are short and soft like velvet; from the eye to the hind part of the head is a small division of the feathers: the rest is of a deep mouse-colour. The chief places they are known to breed in are the uninhabited isle of Priestholm, near the isle of Anglesey; on a rock called Godreve, not far from St. Ives in Cornwall; the Farn isles, near the coast of Northumberland; and the cliffs about Scarborough in Yorkshire. They are also found in most of the northern parts of Europe.

3. The septentrionalis, or red-throated diver, is more elegantly shaped than the others. It weighs three pounds. The length to the end of the tail is two feet; to the toes two feet four inches; the breadth three feet five inches. This species breeds in the northern parts of Scotland, on the borders of the lakes. It is found also in Russia, Siberia, and Kamtschatka; but does not haunt the inland lakes.

4. The glacialis, or northern diver, is three feet five inches in length; the breadth four feet eight; the bill to the corners of the mouth four inches long, black, and strongly made. This species inhabits several parts of the north of Europe, but is not very frequent on our shores, nor ever seen southward except in very severe winters. It is seldom met with on land, being for the most

part on the open sea, where it is continually diving for fish, which it does with great agility, and flies high and well. It is common in Iceland and Greenland, where it breeds, and at that time frequents the fresh waters. It is sufficiently plentiful in Norway, and all along the arctic coasts, as far as the river Ob, in the Russian dominions. The natives of Greenland use the skins for clothing; and the Indians about Hudson's-bay adorn their heads with circlets of their feathers. At the last place it is known by the name of athinue-moqua. As they are seldom seen on the sea-coasts, but chiefly among the lakes, they are called by the Indians inland loons.

5. The immer, or ember-goose, is superior in size to a common goose. The head is dusky; the back, coverts of the wings, and tail, clouded with lighter and darker shades of the same. The under side of the neck spotted with dusky; the breast and belly silvery; the legs black. They inhabit the seas about the Orkney islands; but in severe winters visit the southern parts of Great Britain. They are found also in Iceland, and most parts of northern Europe; likewise in Kamtschatka; but not in any part of Siberia or Russia. It likewise inhabits Switzerland, particularly on the lake of Constance, where it is known by the name of fluder. It is said to dive wonderfully well, and to rise to an amazing distance from the place where it plunged. The female makes its nest among the reeds and flags, and places it in the water; so that it is continually wet, as in some of the grebe genus. It is difficult to be taken, either on land or swimming on the water; but is not unfrequently caught under the water by a hook baited with a small fish, its usual food.

6. The Chinese diver, supposed to inhabit China. From the various and uncertain accounts of authors, we are not clear what birds the Chinese use for catching fish: the custom, however, of doing it, is manifest, from the relations of many travellers. The bird used for this purpose has a ring fastened round the middle of the neck, in order to prevent its swallowing: besides this it has a slender long string fastened to it; and, thus accoutred, is taken by its master into his fishing-boat, from the edge of which it is taught to plunge after the fish as they pass by.

7. The cristatus, crested diver, or cargoose, weighs two pounds and a half. Its length is 21 inches, the breadth 30; the bill is two inches and a quarter long, red at the base, and black at the point. The cheeks and throat are surrounded with a long pendant ruff, of a bright tawny colour, edged with black; the chin is white; the breast and belly are of a most beautiful silvery-white, glossy as satin; the outside of the legs and the bottom of the feet are dusky; the inside of the legs and the toes of a pale green. These birds frequent the meres of Shropshire and Cheshire, where they breed; and the great fen of Lincolnshire, where they are called gaunts.

8. The urinator, or tippet-grebe, is thought by Mr. Latham not to b a different species from the former, being only somewhat less, and wanting the crest and ruff. The sides of the neck are striped downwards from the head with narrow lines of black and white; in other respects the colours and marks agree with that bird. This species has been shot on Bostern-mere in Cheshire. It is rather scarce in England, but is common in the winter time on the lake of Geneva. They appear there in flocks of ten or twelve; and are killed for the sake of their beautiful skins. The under side of them, being dressed with the feathers on, is made into muffs and tippets; each bird sells for about fourteen shillings.

9. The horned grebe is about the size of a teal; weight, one pound; length, one foot; breadth, sixteen inches. It inhabits Hudson's-bay; and first appears in May, about the fresh waters. It lays from two to four white eggs in June, among the aquatic plants; and is said to cover them when abroad. It retires south in autumn; and appears then at New York, staying till spring, when it returns to the north. For its vast quickness in diving it is called the water-witch. At Hudson's-bay, this bird is mostly known by the name of seekeep.

COMA. See MEDICINE.

COMA BERENICES, Berenice's hair, in astronomy, a constellation of the northern hemisphere, composed of stars near the lion's tail. See ASTRONOMY.

COMARUM, marsh-cinquefoil; a genus of the polygynia order, in the icosandria class of plants; and in the natural method ranking under the 35th order, senticosæ. The calyx is decemfid; the petals five, less than the calyx; the receptacle of the seeds ovate, spongy, and persisting. There is but one species, a native of Britain. It rises about two feet high, and bears fruit somewhat like that of the strawberry.

COMB, an instrument to clean, untangle, and dress, flax, wool, hair, &c. Combs for wool are prohibited to be imported into Britain.

COMB, in a ship, a little piece of timber set under the lower part of the beakhead, near the middle. It has two holes in it, and supplies to the fore-tacks what the chest-trees do to the maintacks; that is, to bring the fore-tacks aboard.

COMB-MAKING. Combs are generally made of the horns of bullocks, or of elephants' and sea-horses' teeth: some are made of tortoise-shell, and others of box or holly woods. Bullocks' horns are thus prepared in order to manufacture combs. The tips are first sawn off; they are then held in the flame of a wood fire; this is called roasting, by which they become nearly as soft as leather. While in that state they are slit open on one side, and pressed in a machine between two iron plates; they are then plunged into a trough of water, from which they come out hard and flat. The comb-maker next saws them into lengths according to the sized combs he wants. To cut the teeth, each piece is fixed in a tool called a clam. The teeth are cut with a fine saw, or rather a pair of saws, and they are finished with a file.

The process used for making ivory combs is nearly the same as that already described, except that the ivory is first sawed into thin slices. About eight years ago Mr. Bundy, of Camden-town, obtained a patent for cutting combs by means of machinery. It will be thought a very singular circumstance, that before this period no method was practised in this country for cutting the teeth of combs, but that in which a pair of saws, rudely fastened in a wooden back, were directed by the human hand. With these implements, however, it is, that the very delicate superfine ivory combs, containing from 50 to 60 teeth in an inch, were manufactured.

By Mr. Bundy's machine the business of comb-making is greatly expedited; the teeth of two combs may be cut in about three minutes. The combs are afterwards pointed by applying them to an arbor or axis clothed with cutters having chamfered edges and teeth.

Tortoise-shell combs are very much used, and there are methods of staining horn so as to imitate tortoise-shell; of which the following is one: The horn to be dyed must be first pressed into a flat form, and then spread over with a paste made of two parts of quick-lime and one of litharge, brought into a proper consistence with soap-ley. This paste must be put over all the parts of the horn, except such as are proper to be left transparent, to give it a nearer resemblance to tortoise-shell. The horn must remain in this state till the paste is quite dry, when it is to be brushed off. It requires taste and judgment to dispose the paste in such a manner as to form a variety of transparent parts, of different magnitudes and figures, to look like nature. Some parts should also be semi-transparent; which may be effected by mixing whiting with a part of the paste, to weaken its operation in particular places; by this means spots of a reddish brown will be produced so as greatly to increase the beauty of the work. Horn thus dyed is manufactured into combs, and these are frequently sold for real tortoise-shell.

COMBATANT, in heraldry, a term for two beasts, as lions, &c. borne in a coat of arms in a fighting posture, with their faces to each other.

COMBINATION, in chemistry, the union of bodies of different natures from which a new compound body results. Thus an acid unites with an alkali, and it is said there is a combination betwixt these two salts, because from the union a neutral salt results. Again, metals unite with oxygen, and form a combination of the metallic oxides. Whether there exists a reciprocal affinity between every species of the particles of bodies, is a point which cannot easily be determined, though it is certainly very probable that there does. But as the particles of bodies are usually found cohering together in masses, it is evident that no heterogeneous bodies can combine unless their affinity for each other be stronger than the cohesive force which unites the respective particles of each. Now whenever two bodies constantly refuse to combine, in whatever situation we place them, we say that they have no affinity for each other; meaning merely that their affinity is not so great as to produce combination. Thus we say that there is no affinity between oil and water, because these two liquids refuse to combine together; yet when oil is united with alkali, and in the state of soap, it dissloves in water; a proof that there does exist an affinity between water and oil, though not strong enough to produce combination. We say also, that there is no affinity between azote and lime, because azotic gas cannot be combined with that earth: yet nitric acid dissolves lime readily, which shews us that the refusal of lime and azotic gas to combine is

not the consequence of the want of an affinity between these two bodies, but of some other cause.

We may present a body to another with which it is capable of combining in two different states, either insulated or already combined with some other body. Thus we may present lime to nitric acid, either in the state of pure lime, or combined with carbonic acid, and consequently in the state of a carbonat.

In the first case the affinity is opposed by the cohesion, and combination does not take place unless that force can be overcome. Hence the reason that combination seldom succeeds well, unless some one of the bodies to be combined is fluid, or is assisted by heat, which has the property of diminishing the force of cohesion. Indeed there are not wanting numerous instances of solid bodies combining together without the assistance of heat; but they are always bodies which have the property of becoming liquid in the act of combination. Thus common salt and snow, muriat of lime and snow, &c. combine rapidly when mixed, and are converted into liquids.

It is to the force of cohesion that the difficulty of dissolving the diamond, the sapphire, and many other natural bodies, is to be ascribed, though composed of ingredients very readily acted on by solvents when their cohesive force is sufficiently diminished. If pure alumina is formed into a paste, and heated sufficiently, it becomes so hard that no acid can act upon it; yet its nature is not in the least changed. By proper trituration it may be again rendered soluble; and when precipitated from this new solution, it has recovered all its original properties. The effect of the fire then was merely to increase the cohesion, by separating all the water, and allowing the particles to approach nearer each other.

Even when the cohesive force of the particles to be combined is not very great, it may be still sufficient to prevent combination from taking place, provided the other body can only approach it in a very small mass. Hence the reason that carbonic acid gas, and other elastic fluids, have scarcely any action on the greater number of bodies, though they combine with them readily when the force of cohesion presents no opposition. Thus the oxygen of the atmosphere does not combine with sulphur in its natural state, though it unites with it readily when the sulphur is combined with hydrogen and potash, bodies which diminish its cohesion very considerably, or when it is converted into its integrant particles by the action of heat.

In the second case, or when the body presented to be combined with another is already in combination with some other body, it does not altogether leave the old body and combine with the new, but it is divided between them in proportion to the mass and the affinity of these bodies. Thus, when lime, already in combination with phosphoric acid, is presented to sulphuric acid, it does not altogether leave the phosphoric to combine with the sulphuric acid; but it divides itself between these two acids, part combining with the one and part with the other, according to the respective quantities of each of these acids, and the strength of their affinity for the lime. Chemists had formerly, in a great measure, overlooked the modification produced on the action of heterogeneous bodies on each other by the different proportions of each; supposing that in all cases a substance A, which has a stronger affinity for C than B has, is capable of taking C altogether from B, provided it be added in sufficient quantity, how great soever the proportion of B exceeds that of A. Several exceptions, indeed, have been pointed out to this general law. Thus Cavendish ascertained, that lime-water is incapable of depriving air completely of carbonic acid. But Berthollet has demonstrated, that this pretended law never holds; that no substance whatever is capable of depriving another of the whole of a third, with which it is combined, except in particular circumstances, however strong its affinity for that third may be, and in how great a proportion soever it be added. Thus no proportion of lime whatever is capable of depriving the carbonat of potash of the whole of its acid. Neither does sulphuric acid decompose phosphat of lime completely, nor ammonia sulphat of alumina, nor potash sulphat of magnesia.

In short, it may be considered as a general law in chemistry, that the smaller the proportion of a body in combination with a given quantity of another body is, with the greater energy is it retained; so that at last the force of its affinity becomes stronger than any direct force that can be applied to separate it. Hence the impossibility of depriving sulphuric acid and several other bodies completely of water.

Berthollet has shown also, that every body, how weak soever its affinity for another may be, is capable of abstracting part of that other from a third, how strong soever the affinity of that third is, provided it be applied in sufficient quantity. Thus potash is capable of abstracting part of the acid from sulphat of barytes, from oxat of lime, phosphat of lime, and carbonat of lime. Soda and lime abstract part of the acid from sulphat of potash, and nitric acid abstracts part of the base from oxalat of lime. Hence it follows that substances are capable of decomposing each other reciprocally, provided they be added respectively in the proper quantity. Indeed this was known formerly to be the case, though it had not been considered as a general law till Berthollet drew the attention of chemists to it. Sulphuric acid decomposes nitrat of potash altogether by the assistance of heat. The nitric acid is driven off, and there remains behind sulphat of potash with an excess of acid. On the other hand, if nitric acid is poured into sulphat of potash in sufficient quantity, it takes a part of the base from the sulphuric acid. In the same manner phosphoric acid decomposes muriat of lead, and muriatic acid on the other hand decomposes phosphat of lead.

COMBINATIONS, in law are persons assembled together unlawfully, with an intent to do unlawful acts; and these offences are punishable before such acts are carried into effect, in order to prevent the consequence of combinations and conspiracies. 9 Rep. 57.

COMBINATIONS denote the alternations or variations of any number of quantities, letters, sounds, or the like, in all possible ways.

Father Merseme gives the combinations of all the notes and sounds in music, as far as 64; the sum of which amounts to a number expressed by 90 places of figures. And the number of possible combinations of the 24 letters of the alphabet, taken first two by two, then three by three, and so on, according to Prestet's caclulation, amounts to

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Father Truchet, in Mem. de l'Acad. shews that two square pieces, each divided diagonally into two colours, may be arranged and combined 64 different ways, so as to form so many different kinds of chequer-work: a thing that may be of use to masons, paviours, &c.

Doctrine of COMBINATIONS.

I. *Having given any number of things, with the number in each combination; to find the number of combinations.*

1. *When only two are combined together.*

One thing admits of no combination.
Two, *a* and *b*, admit of one only, viz. *ab*.
Three, *a*, *b*, *c*, admit of three, viz. *ab*, *ac*, *bc*.
Four admit of six, viz. *ab*, *ac*, *ad*, *bc*, *bd*, *cd*.
Five admit of ten, viz. *ab*, *ac*, *ad*, *ae*, *bc*, *bd*, *be*, *cd*, *ce*, *de*.

Whence it appears that the numbers of combinations, of two-and-two only, proceed according to the triangular numbers 1, 3, 6, 10, 15, 21, &c. which are produced by the continual addition of the ordinal series 0, 1, 2, 3, 4, 5, &c. And if n be the number of things, then the general formula for expressing the sum of all their combinations by twos, will be $\frac{n.n-1}{1.2}$.

Thus, if $n = 2$; this becomes $\frac{2.1}{2} = 1$.

If $n = 3$; it is $\frac{3.2}{2}$ - - $= 3$.

If $n = 4$; it is $\frac{4.3}{2}$ - - $= 6$, &c.

2. *When three are combined together; then*

Three things admit of one order, *abc*.
Four admit of 4; viz. *abc*, *abd*, *acd*, *bcd*.
Five admit of 10; viz. *abc*, *abd*, *abe*, *acd*, *ace*, *ade*, *bcd*, *bce*, *bde*, *cde*. And so on according to the first pyramidal numbers 1, 4, 10, 20, &c. which are formed by the continual addition of the former, or triangular numbers 1, 3, 6, 10, &c. And the general formula for any number n of combinations, taken by threes, is $\frac{n.n-1.n-2}{1.2.3}$.

So, if $n = 3$; it is $\frac{3.2.1}{1.2.3} = 1$.

If $n = 4$; it is $\frac{4.3.2}{6} = 4$.

If $n = 5$; it is $\frac{5.4.3}{6} = 10$, &c.

Proceeding thus, it is found that a general formula for any number n of things, combined by m at each time, is $s = \frac{n.n-1.n-2.n-3 \&c}{1. \quad 2. \quad 3. \quad 4. \&c}$ continued to m factors, or terms, or till the last factor in the denominator be m.

So, in 6 things, combined by 4s, the number of combinations is $\frac{6.5.4.3}{1.2.3.4} = 15$.

3. By adding all these series together, their sum will be the whole number of possible combinations of n things combined both by twos, by threes, by fours, &c. And as the said series are evidently the co-efficients of the power n of a binomial, wanting only the first two, 1 and n; therefore the said sum, or whole number of all such combinations, will be $\overline{1+1}^n - n - 1$, or $2^n - n - 1$. Thus if the number of things be 5; then $2^5 - 5 - 1 = 32 - 6 = 26$.

II. *To find the number of changes and alterations which any number of quantities can undergo, when combined in all possible varieties of ways, with themselves and each other, both as the things themselves, and the order or position of them.*

One thing admits but of one order or position.

Two things may be varied four ways; thus, *aa*, *ab*, *ba*, *bb*.

Three quantities, taken by twos, may be varied nine ways; thus *aa*, *ab*, *ac*, *ba*, *ca*, *bb*, *bc*, *cb*, *cc*.

In like manner four things, taken by twos, may be varied 4^2 or 16 ways; and 5 things, by twos, 5^2 or 25 ways; and, in general, n things, taken by twos, may be changed or varied n^2 different ways.

For the same reason, when taken by threes, the changes will be n^3; and when taken by fours, they will be n^4; and so generally, when taken by ns, the changes will be n^n.

Hence then, adding all these together, the whole number of changes or combinations in n things, taken both by 2s, by 3s, by 4s, &c. to ns, will be the sum of the geometrical series $n + n^2 + n^3 + n^4 - - - - - n^n$, which sum is $= \frac{n^n - 1}{n - 1} \times n$.

For example, if the number of things n be 4; this gives $\frac{4^4 - 1}{4 - 1} \times 4 = \frac{255}{3} \times 4 = 340$.

And if n be 24, the number of letters in the alphabet, the theorem gives

$$\frac{24^{24} - 1}{24 - 1} \times 24 = \overline{24^{24} - 1} \times \frac{24}{23} =$$

1391724288887252999425128493402200. In so many different ways, therefore, may the 24 letters of the alphabet be varied or combined among themselves, or so many different words may be made out of them.

COMBRETUM, a genus of the class and order octandria monogynia. The calyx is five-toothed, bell-shaped, superior corolla four-petalled, stam. very long, seed one, four or five angled, angles membranaceous. There are four species, natives of South America and the West Indies.

COMBUSTION. There is perhaps no phenomenon more wonderful in itself, more interesting on account of its utility, or which has more closely occupied the attention of chemists, than combustion. When a stone or a brick is heated, it undergoes no change except an augmentation of temperature; and when left to itself, it soon cools again, and becomes as at first. But with combustible bodies the case is very different. When heated to a certain degree in the open air, they suddenly become much hotter of themselves; continue for a considerable time intensely hot, sending out a copious stream of caloric and light to the surrounding bodies. This emission, after a certain period, begins to diminish, and at last ceases altogether. The combustible has now undergone a most complete change; it is converted into a substance possessing very different properties, and no longer capable of combustion. Thus when charcoal is kept for some time at the temperature of about 800°, it kindles, becomes intensely hot, and continues to emit light and caloric for a long time. When the emission ceases, the charcoal has all disappeared, except an inconsiderable residuum of ashes; being almost entirely converted into carbonic acid gas, which makes its escape, unless the experiment is conducted in proper vessels. If it is collected, it is found to exceed greatly in weight the whole of the charcoal consumed.

The first attempt to explain combustion was crude and unsatisfactory. A certain elementary body, called fire, was supposed to exist, possessed of the property of devouring certain other bodies, and converting them into itself. When we set fire to a grate full of charcoal, we bring, according to this hypothesis, a small portion of the element of fire, which immediately begins to devour the charcoal, and to convert it into fire. Whatever part of the charcoal is not fit for being the food of fire is left behind in the form of ashes.

A much more ingenious and satisfactory hypothesis was proposed in 1665 by Dr. Hooke. According to this extraordinary man, there exists in common air a certain substance, which is like, if not the very same with, that which is fixed in saltpetre. This substance has the property of dissolving all combustibles; but only when their temperature is considerably raised. The solution takes place with such rapidity, that it occasions both heat and light, which in his opinion are mere motions.

About ten years after the publication of Hooke's Micrographia, his theory was adopted by Mayow, without acknowledgment, in a tract which he published at Oxford on saltpetre. We are indebted to him for a number of very ingenious and important experiments, in which he anticipated several modern chemical philosophers; but his reasoning is for the most part absurd, and the additions which he made to the theory of Hooke are exceedingly extravagant. To the solvent of Hooke he gives the name of spiritus nitro-aereus. It consists, he supposes, of very minute particles, which are constantly at variance with the particles of combustibles, and from their quarrels all the changes of things proceed. Fire consists in the rapid motion of these particles, heat in their less rapid motion. The sun is merely nitro-aerial particles moving with great rapidity. They fill space. Their motion becomes more languid according to their distance from the sun; and when they approach near the earth, they become pointed, and constitute cold.

The attention of chemical philosophers was soon drawn away from the theory of Hooke and Mayow to one of a very different kind, first proposed by Beccher, but new-modelled by his disciple Stahl with so much skill, arranged in such an elegant systematic form, and furnished with such numerous appropriate and convincing illustrations, that it almost instantly caught the fancy, raised Stahl to the highest rank among philosophers, and constituted him the founder of the Stahlian theory of combustion.

According to Stahl, all combustible substances contain in them a certain body, known by the name of phlogiston, to which they owe their combustibility. This substance is precisely the same in all combustibles. These bodies of course owe their diversity to other ingredients which they contain, and with which the phlogiston is combined. Combustion, and all its attendant phenomena, depend upon the separation and dissipation of this principle; and when it is once separated, the remainder of the body is incombustible. Phlogiston, according to Stahl, is peculiarly disposed to be affected by a violent whirling motion. The heat and the light, which make their appearance during combustion, are merely two properties of phlogiston when in this state of violent agitation. Ingenious as this theory was, it wanted the support of demonstration. The existence of phlogiston was gratuitously admitted, and every one was at liberty to attach his own idea to the term. The theory accordingly underwent many changes in the hands of Macquer, Priestley, Crawford, and Kirwan, but difficulties multiplied in proportion to the progress of discovery in other departments of the science. The last of these philosophers took much pains to prove that hydrogen performed the office which the Stahlian theory assigned to phlogiston. This he attempted in a treatise published on purpose, entitled, 'An Essay on Phlogiston, and the Constitution of Acids.'

In 1777 the celebrated Swedish chemist, Scheele, published a treatise, entitled, 'Chemical Experiments on Air and Fire,' which perhaps exhibits a more striking display of the extent of his genius than all his other publications. After a vast number of experiments, conducted with astonishing ingenuity, he concluded, that caloric is composed of a certain quantity of oxygen combined with phlogiston; that radiant heat, a substance which he supposed capable of being propagated in straight lines like light, and not capable of combining with air, is composed of oxygen united with a greater quantity of phlogiston, and light of oxygen united with a still greater quantity. He supposed too, that the difference between the rays depends upon the quantity of phlogiston. The red, according to him, contains the least; the violet, the most phlogiston. By phlogiston Mr. Scheele seems to have meant hydrogen. It is needless therefore to examine his theory, as it is now known that the combination of hydrogen and oxygen forms not caloric but water. The whole fabric, therefore, has fallen to the ground; but the importance of the materials will always be admired, and the ruins of the structure must remain eternal monuments of the genius of the builder.

During these different modifications of the Stahlian theory, the illustrious Lavoisier was assiduously occupied in studying the phenomena of combustion. He seems to have attached himself to this subject, and to have seen the defects of the prevailing theory, as early as 1770. The first precise notions, however, of whatever might be the real nature of combustion, were suggested to him by Bayen's paper on the oxydes of mercury, which he heard read before the Academy of Sciences in 1774. These first notions, or rather conjectures, he pursued with unwearied industry, assisted by the numerous discoveries which were pouring in from all quarters; and by a long series of the most laborious and accurate experiments and disquisitions ever exhibited in chemistry, he fully established the existence of this general law: "In every case of combustion, oxygen combines with the burning body." This noble discovery, the fruit of genius, industry, and penetration, has reflected new light on every branch of chemistry, has connected and explained a vast number of facts formerly insulated and inexplicable, and has new-modelled the whole, and moulded it into the form of a science.

Mr. Lavoisier's explanation of combustion depends upon the two laws discovered by himself and Dr. Black. When a combustible body is raised to a certain temperature, it begins to combine with the oxygen of the atmosphere, and this oxygen during its combination lets go the caloric and light with which it was combined while in the gaseous state. Hence their appearance during every combustion. Hence also the change which the combustible undergoes in consequence of combustion.

Thus Lavoisier explained combustion without having recourse to phlogiston; a principle merely supposed to exist, because combustion could not be explained without it. No chemist had been able to exhibit phlogiston in a separate state, or to give any proof of its existence, excepting only its conveniency in explaining combustion. The proof of its existence consisted entirely in the impossibility of explaining combustion without it. Mr. Lavoisier therefore, by giving a satisfactory explanation of combustion without having recourse to phlogiston, proved that there was no reason for supposing any such principle at all to exist.

But the hypothesis of Mr. Kirwan, who made phlogiston the same with hydrogen, was not overturned by this explanation, because there could be no doubt that such a substance as hydrogen actually exists. But hydrogen, if it is phlogiston, must constitute a component part of every combustible, and it must separate from the combustible in every case of combustion. These were points accordingly, which Mr. Kirwan undertook to prove. If he failed, or if the very contrary of his suppositions holds in fact, his hypothesis of course falls to the ground.

Lavoisier and his associates saw at once the important uses which might be made of Mr. Kirwan's essay. By refuting an hypothesis which had been embraced by the most respectable chemists in Europe, their cause would receive an eclat which would make it irresistible. Accordingly, the essay was translated into French, and each of the sections into which it was divided was accompanied by a refutation. Four of the sections were refuted by Lavoisier, three by Berthollet, three by Fourcroy, two by Morveau, and one by Monge; and, to do the French chemists justice, there never was a refutation more complete. Mr. Kirwan himself, with that candour which distinguishes superior minds, gave up his opinion as untenable, and declared himself a convert to the opinion of Lavoisier.

Thus Mr. Lavoisier destroyed the existence of phlogiston altogether, and established a theory of combustion almost precisely similar to that which had been proposed long ago by Dr. Hooke. The theory of Hooke is only expressed in general terms, that of Lavoisier is much more particular. The first was an hypothesis, or fortunate conjecture which the infant state of the science did not enable him to verify; whereas Lavoisier was led to his conclusions by accurate experiments, and a train of ingenious and masterly deductions.

According to the theory of Lavoisier, which is now almost generally received, and considered by chemists as a full explanation of the phenomena, combustion consists in two things: first, a decomposition; second, a combination. The oxygen of the atmosphere being in the state of gas, is combined with caloric and light. During combustion this gas is decomposed: its caloric and light escape, while its base combines with the combustible, and forms the product. This product is incombustible; because its base, being already saturated with oxygen, cannot combine with any more. Such is a short historical detail of the improvements which have been gradually introduced into this interesting part of the science of chemistry. Let us now take more particular view of the subject.

By combustion is meant a total change in the nature of combustible bodies, accompanied by the copious emission of heat and light. Every theory of combustion must account for these two things; namely, the change which the body undergoes, and the emission of heat and light which accompanies this change.

Mr. Lavoisier explained completely the first of these phenomena, by demonstrating, that in all cases oxygen combines with the burning body; and that the substance which remains behind, after combustion, is the compound formed of the combustible body and oxygen. But he did not succeed so well in accounting for the heat and the light which are evolved during combustion. Indeed this part of the subject was in a great measure overlooked by him. The combination of oxygen was considered as the important and essential part of the process. Hence his followers considered the terms oxygenizement and combustion as synonymous; but this was improper, because oxygen often unites to bodies without any extrication of heat or light. In this way it unites to azote, muriatic acid, and mercury; but the extrication of heat and light is considered as essential to combustion in common language. The union of oxygen without that extrication is very different from its union when accompanied by it, both in the phenomena and in the product; they ought therefore to be distinguished.

To account for the emission of heat and light, which constitutes a part of combustion, Mr. Lavoisier had recourse to the theory of Dr. Crawford. The heat and the light were combined with the oxygen gas, and separated from it when that gas united to the combustible body. But this explanation, though it answers pretty well in common cases, fails altogether in others. Heat and light were supposed to be combined with the oxygen of the atmosphere, because it is in a gaseous state; and to separate from it, because it loses its gaseous state. But as violent combustions take place when the oxygen employed is solid or liquid, as when it is in the state of a gas. Thus if nitric acid be poured upon linseed-oil, or oil of turpentine, a very rapid combustion takes place, and abundance of caloric and light is emitted. Here the oxygen forms a part of the liquid nitric acid, and is already combined with azote; or, according to the language of the French chemists, the azote has undergone combustion. Now in this case the oxygen is not only in a liquid state, but it has also undergone the change produced by combustion. So that oxygen is capable of giving out caloric and light, not only when liquid, but even after combustion, which is directly contrary to the theory.

Farther: gunpowder, when kindled, burns with great rapidity in close vessels, or under an exhausted receiver. This substance is composed of nitre, charcoal, and sulphur; the two last of which ingredients are combustible; the first supplies the oxygen, being composed of nitric acid and potash. Here the oxygen is not only already combined with azote, but forms a component part of a solid; yet a great quantity of caloric and light is emitted during the combustion, and almost the whole product of the combustion is in the state of gas. This appears doubly inconsistent with the theory; for the caloric and light must be supposed to be emitted from a solid body during its conversion into gas, which ought to require more caloric and light for its existence in the gaseous state than the solid itself contained.

Mr. Brugnatelli, the celebrated professor of chemistry at Pavia, seems to have been the first who saw this objection in its proper light. He has endeavoured to obviate it in the following manner. According to this very acute philosopher, the substance commonly called oxygen combines with bodies in two states: 1. Retaining the greatest part of the caloric and light with which it is combined when in the state of gas. 2. After having let go all the caloric and light with which it was combined. In the first state, he gives it the name of thermoxygen, in the second of oxygen. Thermoxygen exists as a component part, not only of gaseous bodies, but also of several liquids and solids. It is only in those cases where thermoxygen is a component part of liquids or solids, that caloric and light are emitted. All metals, according to him, combine with thermoxygen; those substances, on the contrary, which by combustion are converted into acids, combine with oxygen. This ingenious theory obviates the objection completely, provided its truth can be established in a satisfactory manner. But as the evidence for it rests almost entirely upon its convenience in explaining several difficult points in the phenomena of combustion, we must consider it rather in the light of an ingenious conjecture than as a theory fully established.

It was long the general opinion of chemists, that light exists in a fixed state in all combustible bodies. The discoveries of Lavoisier induced the greater number of them to give up this opinion, on the supposition that combustion could be explained in a satisfactory manner without it. Indeed the followers of that illustrious philosopher considered it as incumbent upon them to oppose it with all their might, because the fixed light, which had been supposed to constitute a part of combustibles, had been unfortunately denominated phlogiston, a term which they considered as incompatible with truth. The hypothesis, however, was occasionally revived; first by Richter and Delametherie, and afterwards in a more formal manner by Gren. But little attention has been paid to it in this country till lately. The very curious phenomena observed by Mr. Chenevix in his experiments on the hyperoxymuriatic acid, induced him to incline to the same opinion.

That the light exists combined with the combustible, will appear exceedingly pro-

bable, if we recollect that the quantity which appears during combustion depends altogether upon the combustible. Phosphorus emits a vast quantity, charcoal a smaller, and hydrogen the smallest of all; yet the quantity of oxygen which combines with the combustible during these processes, is greatest in those cases where the light is smallest. Besides, the colour of the light depends in all cases upon the combustible that burns; a circumstance which could scarcely be supposed to take place, unless the light was separated from the combustible. It is well known too, that when vegetables are made to grow in the dark, no combustible substances are formed in them; the presence of light being absolutely necessary for the formation of these substances. These facts, and several others which might be enumerated, give a onsiderable degree of probability to the opinion that light constitutes a component part of all combustible substances; but they by no means amount to a decisive proof. Nor indeed would it be easy to answer all the objections which might be started against this opinion. At the same time, it will be allowed that none of these objections amount to a positive proof of the falsehood of the hypothesis. It is always a proof of the difficulty of an investigation, and of the little progress which has been made in it, when plausible arguments can be brought forward on both sides of the question.

Were we to suppose that the oxygen employed in combustion contains caloric as a component part, while combustibles contain light, it would not be difficult to explain what takes place during combustion. The component parts of the oxygen so employed are two; namely, 1. a base; 2. caloric. The component parts of combustibles are likewise two; namely, 1. a base; 2. light. During combustion the base of the oxygen combines with the base of the combustible, and forms the product; while at the same time the caloric of the oxygen combines with the light of the combustible, and the compound flies off in the form of fire. Thus combustion is a double decomposition; the oxygen and combustible divide themselves each into two portions, which combine in pairs: the one compound is the product, and the other the fire which escapes.

COMET, an opake, spherical, and solid body, like a planet, performing revolutions about the sun in elliptical orbits, which have the sun in one of the foci. See ASTRONOMY, p. 177.

COMETARIUM, a curious machine exhibiting an idea of the revolution of a comet about the sun. It is contrived in such a manner, as by elliptical wheels to shew the unequal motion of a comet in every part of its orbit. See INSTRUMENTS ASTRONOMICAL.

COMETES, a genus of the pentandria monogynia class and order. The involucrum is four-leaved, three-flowered; calyx four-leaved, caps. tricoccous. There is one species, a native of Suratte.

COMITIUM, in Roman antiquity, a large hall in the forum, where the comitia, or assemblies of the people, were ordinarily held. This hall was a long time open at top, for which reason the assemblies were often interrupted by bad weather. It was first covered in the time of the second Punic war; and according to Rosinus, the consuls and tribunes were not created in the comitium, but in the Campus Martius.

COMMA, among grammarians, a point or character marked thus (,); serving to denote a short stop, and to divide the members of a period.

COMMANDING *ground*, in the military art, an eminence overlooking any post or strong place. A commanding ground is of three kinds: first, a front ground, being an height opposite to the face of some post, which plays upon its front. Secondly, a reverse ground, being an eminence that can play upon the back of any post. Thirdly, an enfilade commanding ground, or curtin commanding ground, being an eminence that with its shot can scour all the length of a straight line.

COMMENDAM. When a benefice is void, or to prevent its becoming void, it is commended to the charge of some sufficient clerk, to be supplied till it may be conveniently provided with a pastor. When a parson is made bishop, there is a cession of his benefice by the promotion; but if the king give him power to retain his benefice, he shall continue parson, and is said to hold it in commendam; but it must be always before consecration, for afterwards it comes too late, because the benefice is then absolutely void.

COMMELINA, in botany, a genus of the triandria monogynia class of plants, whose corolla consists of six petals; the exterior three of which are small, oval, and concave, of the dimensions of the perianthium; the three interior and alternate petals are large, roundish, and coloured. The fruit is a naked, roundish capsule, containing three cells, and divided by three valves; the seeds, being two only, are angulated. There are 12 species.

COMMENSURABLE, among geometricians, an appellation given to such quantities as are measured by one and the same common measure: thus if a line A a be equal to 8, and a line B b equal to 4 inches, these two lines will be commensurable, since the same common measure 2, measures them both.

COMMENSURABLE *numbers*, whether integers or fractions, are such as can be measured or divided by some other number, without any remainder. Such are 12 and 18, as being measured by 6 or 3.

COMMENSURABLE *in power*, is said of right lines, when their squares are measured by one and the same space, or superficies.

COMMENSURABLE *surds*, those that being reduced to their least terms, become true figurative quantities of their kind, and are therefore as a rational quantity to a rational one.

COMMERCE, the exchange of commodities for other articles, or for some representative of value for which other commodities can be procured. At first, commerce consisted merely in exchanging the surplus of some particular article of produce which an individual possessed beyond what he found necessary for his own use, for the similar surplus of some other article possessed by another individual,—which kind of traffic is now generally called barter. By the introduction of metallic and paper money, the operations of commerce were much facilitated, while the increase of population rendered them of greater magnitude: improvements in the art of navigation extended their boundaries, the advancement of science and increase of luxury multiplied the objects of trade, and the various duties and regulations established by different governments rendered the subject more complicated to individuals, but at the same time of increased importance to the state.

The advantages of commerce began to engage the attention of mankind at a very early period. About 1300 years after the Flood, the commerce of the Phœnicians had attained to a considerable extent: they possessed manufactures, entered into commercial partnerships, made long voyages, had resident agents in foreign countries, and had adopted the practice of lending money on bottomry.

The Greeks and Romans, particularly the latter, carried on an extensive trade, considering the imperfect state of navigation. The reign of Augustus was particularly favourable to commerce, as the general peace which then prevailed enabled the merchants to pursue their concerns unmolested. At this period, Malta was famous for its number of workmen and its various manufactures, particularly of fine cloth. The inhabitants were the descendants of the antient Phœnicians, and, like them, pursued commerce with avidity. Under Tiberius we find the Romans extending their protection to the north; and the town of Havern, the most antient in Friesland, founded. The cultivation of vines in France, Spain, and Portugal, seems to have increased about this time; and from the inhabitants' neglecting to cultivate corn, and turning much of their arable land into vineyards, we may presume the latter afforded considerable profit. About the year 50, the capital of England was first described as a place famous for merchants and plenty of merchandize.

The establishment of Christianity in the northern parts of Germany, in consequence of the conquests of Charlemagne, produced a connection between those parts and the southern parts of Europe, which naturally led to an interchange of produce, and gradually introduced foreign commerce, in the north. The Germans had, however, previously to this period, cultivated a commercial intercourse with the neighbouring states; which was afterwards much increased by the discovery of valuable mines in Saxony, and the establishment of some manufactures in Flanders.

In the 9th century, the Venetians carried on a very beneficial commerce with the Levant; whence they brought spices, silks, drugs, and fruits from the East in great abundance, and supplied the greater part of Europe with these commodities.

The crusades contributed materially to the revival of commerce during the 12th and 13th centuries, by introducing an acquaintance with the luxuries of the East, which multiplied the objects of foreign trade. About this time, the commercial towns bordering on the coasts of the Baltic, finding their trade much interrupted by pirates, entered into an agreement for mutual support and assistance. This union, which became very celebrated under the title of the Hanseatic league, at first consisted of only twelve towns, but finally of upwards of seventy,

including all the principal commercial towns of Europe, and embracing nearly all the foreign trade then carried on.

The invention of the mariner's compass, which enabled trading vessels to make much longer voyages, and led to the discovery of a passage to the East Indies by the Cape of Good Hope, with the settlements made on the coast of Africa, in Arabia, and in India, affected very materially the commerce of the Mediterranean and of the Hanse towns, and threw the principal part of the foreign trade of Europe into the hands of the Portuguese. The Venetians, however, still carried on a great trade with India by way of Egypt, for spices and other eastern commodities: the Indian goods were first landed at Aden in Arabia, carried across that country on canals to the Red Sea, thence over land to the Nile, down that river to Cairo and Alexandria, and thence transported to Venice, whence the Venetians circulated them through every part of Europe.

The Dutch soon began to rival the Portuguese in trade; and in a little time not only dispossessed them of nearly the whole, but from their industry and skill in navigation, and their attention to the fisheries, acquired an extent of foreign trade considerably greater than had been previously possessed by any European power.

The discovery of America opened a new and extensive field for commercial adventure, while the establishment of manufactures produced new articles of trade. The persecutions of the Spaniards drove great numbers of industrious workmen from the Netherlands into England and other countries, who introduced several manufactures into England, and greatly improved others which were already established. While the different branches of its manufactures were thus improving, its colonial possessions in the East and West Indies were greatly increased, and Great Britain was enabled to rival the Dutch not only in manufactured goods, but also in all the principal articles of colonial produce. During the last century, the trade of Holland has rapidly declined; and since the invasion of that country by the French, has been almost annihilated; while the decided naval superiority long maintained by Great Britain, has extended and secured its commerce, and raised it to a magnitude unparalleled in the history of the world.

The vast extent to which the commerce of this country has expanded, appears astonishing when it is considered how great a proportion of the materials of its manufactures are of foreign produce, and the many duties with which the increase of the national expenditure has loaded most articles of foreign trade. The natural advantages arising from the situation of this country, its formidable navy, and extensive colonial possessions, particularly in the East Indies, have favoured and protected its commercial intercourse; while the accumulated capital of individuals has gradually enabled them to give very considerable credit to their customers, which of late years, while some of the principal European powers have been in a very unsettled state, has been of much importance in increasing the commerce of Great Britain to its present extent.

In the reign of Edward III. the countries with which England had commercial intercourse were chiefly France, Spain, Portugal, Lombardy, Flanders, Brabant, and Germany. The total value of all the commodities exported in one year was reckoned at 294,184*l.*, and of all the imports at only 38,970*l.*, sums that are considerably less than the value of the goods now frequently entered in one day. The exports consisted of wool of the value of 277,606*l.*, leather 96*l.*, and cloths 16,260*l.* The imports were, cloths of the value of 11,083*l.*, wax 815*l.*, wine 3841*l.*, linen cloth, mercery, and grocery, 22,943*l.* The policy of the times was by no means calculated to encourage trade: our merchants were very jealous of foreigners participating in their commercial profits, though it was to such persons they were indebted for the little knowledge of trade they possessed; and the government being at times still more jealous in this respect than individuals, many injudicious restrictive laws were made: among others, an act was passed in 1429, prohibiting persons from selling merchandize to aliens, except for ready money. It was, however, soon found necessary to repeal this prohibition, and permission was then given to sell to aliens, upon giving not more than six months credit.

Charles II. imposed a duty of 5 per cent. on goods exported as well as imported, on domestic manufactures as well as on foreign merchandize, and double taxes on all goods when exported by aliens. In 1672, however, the duties payable by aliens on the exportation of British manufactures were repealed. This salutary principle was still more extended in 1700, by removing the imposts on every kind of woollen goods exported, and on corn, meal, and bread. It was, however, by the law "for the further encouragement of manufactures," passed in 1722, that every one was allowed to export duty-free all kinds of merchandize, the produce of Great Britain, except a few particular articles; whild drugs, and other commodities used for dying, were also permitted to be imported duty-free. This period forms a memorable epoch in commercial policy; and the subsequent increase of trade is the best proof of the wisdom of the regulations then adopted.

The various articles of foreign commerce being subject to great fluctuations in their value, a book of rates was adopted at the custom-house in 1696, for the purpose of valuing uniformly the several articles imported and exported; and consonant to these estimates, the following statement shews the total amount of the imports and exports of Great Britain on an average of four years from the above period, and of each five years subsequent.

Years.	Imports.	Exports.
1700	£ 4,956,975	£ 6,034,724
1705	4,794,071	6,310,945
1710	4,321,717	6,713,246
1715	5,304,343	7,401,946
1720	6,054,800	8,132,669
1725	6,628,280	9,663,528
1730	7,273,342	10,808,213
1735	7,470,454	11,855,227
1740	7,270,743	10,822,696
1745	7,363,079	11,920,982
1750	7,429,739	12,877,129
1755	8,264,834	13,406,530
1760	8,877,145	14,253,377
1765	10,266,644	15,544,627
1770	11,910,778	14,138,469
1775	13,8 3,842	17,420,309
1780	11,663,211	13,337,562.

The American war produced a memorable effect on the foreign trade of this country. Previous to that event, our manufacturers were not much in the habit of exporting on their own accounts. The prohibition in America of importation from this country compelled them to seek new markets, and to improve those already known; and from this date commenced that rapid increase of export to the continent of Europe, which has chiefly enabled us to sustain the burthens of that war, and of those in which we have been since engaged. From the peace of 1783, our manufacturers have almost universally acted as merchants, and shipped their goods on their own account. They have gained possession of the foreign markets in part from the superiority of their skill, but far more from the superiority of their capital, which has enabled them to give a credit considerably greater than the exporters of other countries can allow. The rapid increase of our commerce since that time will appear by the following account.

Years.	Imports.	Exports.
1784	£ 15,272,877	£ 15,734,062
1785	16,279,399	15,117,649
1786	15,786,072	16,300,730
1787	17,804,014	16,870,114
1788	18,027,188	17,472,408
1789	17,821,102	19,340,548
1790	19,130,886	20,120,121
1791	19,669,782	22,731,995
1792	19,659,358	24,905,200
1793	19,256,717	20,390,180
1794	22,288,894	26,748,967
1795	22,736,889	27,312,338
1796	23,187,319	30,424,184
1797	21,013,956	28,917,010
1798	27,857,889	33,591,777
1799	26,837,431	35,991,329
1800	30,570,605	43,152,019
1801	32,795,557	42,301,701
1802	31,442,318	46,120,962
1803	27,992,464	33,792,386
1804	- -	37,471,388.

These accounts, formed from rates of value established above a hundred years ago, must of course give a very inadequate idea of the actual total value of the commerce of this country: the accounts are, however, from the very circumstance of being uniformly made up at the same rates, the more correct in a comparative view, and shew a progressive increase, which has arrived to an amount never before known in the commerce of any nation. During the last twenty years it appears that the amount of the imports has more than doubled, and the amount of the exports has increased in a still greater proportion. The declared value of British produce and manufactures exported during the year ending 5th January 1804, was 40,100,642*l.*; the amount of foreign merchandize exported in the latter year was (after correcting the value of coffee, which is rated too high) 10,515,574*l.*; the actual total value of the exports of Great Britain, in the year ending 5th January 1805, was therefore at least 50,865,216*l.*

Of the total exports of Great Britain, about two-thirds of the corrected official value consists of British produce and manufactures, and one third of foreign merchandize; of the former little more than one-fourth is exported to the continent of Europe, about the same amount to the United States of America, and the remainder to the East and West Indies, and all other parts. The following statement of the exports of the year 1800 will shew the proportions of the commerce of Great Britain with different parts of the world; and the accounts that succeed furnish some particulars of all the principal branches.

	£.	s.	d.
To Ireland - -	3,741,499	19	4
Russia - -	1,025,335	4	0
Denmark - -	540,698	0	9
Prussia - -	794,452	8	6
Germany - -	12,664,591	6	5
Holland - -	3,208,613	9	11
Flanders - -	808,826	13	5
France - -	1,325,419	13	3
Portugal - -	1,011,893	6	4
Italy - -	568,732	6	11
British West Indies -	3,416,972	9	6
United States of America - -	6,885,508	2	9
British America -	975,989	13	1
Asia - -	2,835,063	6	9
Africa - -	1,017,365	11	5
All other parts -	2,331,057	13	2
Total -	£43,152,019	5	6

In the commercial intercourse between Great Britain and Ireland, a very unjust and oppressive species of policy was long exercised, by which the latter country was debarred from the enjoyment and use of its own resources, to make it entirely subservient to the interests and opulence of the former. It was not suffered to share in the bounties of nature or the industry of its citizens, but was shut out from every species of commerce, and restrained from sending the produce of its soil to foreign markets. Under such circumstances it cannot be supposed that its commerce even with the country that monopolized it, could be very great; its amount was as follows:

	Imports.	Exports.
In 1710	£ 310,846	£ 285,424
1720	282,812	328,583
1730	294,156	532,698
1740	390,565	628,288
1750	612,808	1,316,600
1760	904,180	1,050,401
1770	1,214,398	2,125,466.

At an early period in the last century, some little relaxation of the restrictive system had taken place, and something more had been done in the reign of George II.; but it is only since the year 1780 that the system has been completely done away, and Ireland has enjoyed the natural right of exporting its produce to such places as offer the best market. The want of sufficient capital among its manufacturers, and the defective state of cultivation, will however long retard the advancement of Ireland to that degree of commercial importance of which it is capable. In the mean time a considerable proportion of its imports will continue to consist of the manufactures of Britain.

Value of British manufactures exported from Great Britain to Ireland.

	£.	s.	d.
In 1791 -	1,470,972	7	8
1792 -	1,511,844	5	9
1793 -	1,055,276	6	2
1794 -	1,281,316	15	5
1795 -	1,612,270	5	0
1796 -	1,781,789	15	6.

But though Ireland receives a considerable amount of foreign merchandize as well as manufactured goods from Great Britain, the balance of the commercial transactions between the two countries is certainly considerably in favour of the former, owing principally to the increased importation by Great Britain of Irish linens, which has amounted of late to upwards of 36,600,000 yards annually. But this unfavourable balance of trade with respect to Great Britain is probably counteracted by other circumstances. The total value of the imports of Ireland from all parts was, in the year ending 5th January 1805, 5,718,945*l.*, and the total value of exports, 5,063,073; the latter consisted of Irish produce and manufactures 4,902,915*l.*, and of British and foreign articles 160,158*l.* The total number of vessels which entered inwards was 8019, of which number 7055 were from Great Britain; the total number that cleared outwards was 6624, of which number 5808 were to Great Britain.

The trade with Russia is carried on chiefly from the ports of London, Hull, Liverpool, Newcastle, Bristol, Leith, Dundee, and Grangemouth. The principal articles of import are iron, hemp, flax, tallow, pot-ashes, coarse linens, deals and lath-wood, hog's bristles, &c. The exports consist of broad-cloth and woollen stuffs, refined sugar, cotton, lead, tin, iron and steel ware, earthenware and glass, alum, salt, coals, horses, London porter, and various articles of less importance.

Total amount of imports from Russia.

	England.	Scotland.	Total.
In 1800	£ 1,990,295	£ 391,803	£ 2,382,098
1801	2,001,663	245,214	2,246,877
1802	1,834,265	347,864	2,182,430

Exports from Great Britain to Russia.

	British Manufac.	Foreign Merchand.	Total.
In 1800	£ 557,374	£ 467,961	£ 1,025,335
1801	594,617	325,126	919,843
1802	834,412	541,987	1,376,399

The trade with this country is highly beneficial to Russia, as it is from Great Britain only that it receives a large balance in cash, which enables it to import the wines of France, Spain, and Portugal, brandy, oil, indigo, and many other articles of foreign produce. The total number of vessels that entered inwards from Russia in the year 1804 was 859, of which 830 were British ships: the total number that cleared out for Russia was 661, of which 558 were British.

The exports to Denmark and Norway consist chiefly of West India produce, and other foreign merchandize: of the imports, timber and corn are the most considerable.

Years.	Imports.	Exports.
1800	£ 241,563	£ 540,698
1801	208,794	416,475
1802	155,672	537,517.

The total number of vessels that entered inwards from Denmark and Norway, in the year 1804, was 1418, of which 460 were British ships: the total number that cleared outwards was 1684, of which 713 were British.

The trade between Great Britain and Sweden has remained of nearly the same extent for the last 20 years. It is carried on chiefly in ships of that country; the total number of vessels that entered inwards in 1804 being 252, of which only 106 were British; and the total number that cleared outwards 229, of which only 96 were British.

Years.	Imports.	Exports.
1801	£ 295,645	£ 111,254
1802	327,350	108,296
1803	288,651	98,045.

The imports consist principally of iron of a superior quality to that of any other country, pitch, tar, deal boards, and sail-cloth. The exports are chiefly colonial produce.

The trade with Prussia is likewise carried on principally in foreign vessels; the total number of vessels from that country which entered inwards in the ports of Great Britain in the year 1804, being 1911, of which only 720 were British, and the total number that cleared outwards 1622, of which only 390 were British vessels.

Years.	Imports.	Exports.
1801	£ 1,387,149	£ 660,739
1802	1,057,602	1,071,896
1803	831,225	1,916,502.

The export to Prussia is chiefly colonial produce, as the manufactured goods of other countries have of late years been much discouraged by the government, with the view of promoting its own manufactures.

The trade with Germany had not been subject to any great fluctuation with respect to its extent, from the commencement of the last century till the year 1794, when it suddenly became the channel through which the principal part of the continent has since procured the goods which before they had received direct from this country. The following account of exports to Germany shews the rapid increase of trade with that country in the course of a few years.

Years.	British Manufactures.	Foreign Merchandize.
1791	£ 778,213	£ 1,111,532
1792	811,140	1,327,970
1793	718,474	1,764,221
1794	1,634,530	4,308,695
1795	1,760,133	6,311,876
1796	1,591,810	6,582,179.

The produce and manufactures of Great Britain exported to Germany, with the exception of consignments to particular mercantile houses, are sold at the great fairs of Frankfort, Leipzig, Brunswick, and Nuremberg. The Easter fair at Leipzig is greatly celebrated for the immense quantities of British manufactures sold there. Towards the end of March, numberless bales of muslins, calicoes, printed cottons, and other goods, are sent from Glasgow, Paisley, Manchester, &c. to Hamburgh, besides vast quantities of English hardware from Birmingham, as butttons, buckles, sadlery, and a thousand various articles, useful or ornamental: for though the Germans possess many of the

materials of at least equal quality, and the wages of workmen are much lower, it will be long before they can rival this country in such articles, from the superiority we derive from the use of powerful machinery, and a great division of labour.

Total amount of imports from Germany.

	England.	Scotland.	Great Britain.
In 1800	£2,182,927	£169,270	£2,352,197
1801	1,900,936	143,238	2,044,175
1802	1,070,941	121,089	1,192,030

Total exports to Germany.

	Brit. Manufactures.	For. Merchandize.	Total.
In 1800	£4,364,120	£8,300,471	£12,664,591
1801	4,928,617	6,186,687	11,115,304
1802	3,992,601	6,322,765	10,315,366.

The total number of vessels that entered inwards from Germany, in the year 1804, was 189, and the number that cleared outwards 300.

The trade with Holland was formerly the principal branch of our European commerce. It was at its height about the year 1745. On the French taking possession of Holland during the late war, the trade with this country was of course in a great measure suspended, particularly during the years 1795 and 1796. Some little relaxation of the restrictions which had been imposed was afterwards found necessary; and on the peace, its commercial connexion with this country immediately revived, till it was checked again by war.

Years.	Imports.	Exports.
1800	*L.*972,600	*L.*3,208,613
1801	1,025,958	3,496,744
1802	974,537	4,957,997
1803	630,403	1,565,355.

The total number of vessels which entered inwards from Holland, in the year 1804, was 790, and the number which cleared outwards 521.

The export to Flanders was formerly considerable; but of late years the trade with that part of the continent has been carried on through other ports. The value of goods exported to Flanders in 1792 was 1,031,093*l.*, of which 381,287*l.* was British manufactures, and 649,806*l.* foreign merchandize.

Commercial intercourse with France has been so much deranged for some years past, that it would be useless to give any account of the little that remains, which, during the time of war, must be entirely carried on by the vessels of neutral powers. In the year 1792, the exports to France amounted to 1,228,165*l.*, of which 743,280*l.* was British manufactures, and 484,885*l.* foreign merchandize.

The trade with Portugal was formerly a very beneficial branch of our commerce, but has decayed much of late. The balance, which some years ago was greatly in favour of this country, being estimated on an average of thirty years previous to the peace in 1753 at 800,000*l.* per annum, declined to nothing, and has been latterly against this country. The export of grain from Great Britain to Portugal was very much reduced previous to the scarcity in 1800, and the consequent prohibition. The exports consisted almost wholly of British produce and manufactures, the total value of the exports in 1792 being 760,655*l.*, of which 720,984*l.* was British manufactures. The imports from Portugal have increased in cotton-wool, wines, and indigo; but the merchants frequently remit cash and bullion to this country in payment of their debts in trade with other countries, though this has not been the case so much lately as formerly. In 1785, the quantity of gold and silver imported into this country from Portugal was 1,101,700*l.*; but in the year 1795 it was reduced to about 186,000*l.*

The following account of the number of ships which entered inwards from Portugal and cleared out for that country, during twelve years, will give some idea of the present extent of this trade, and of the effect of war with respect to the employment of neutral vessels.

	Inwards.		Outwards.	
Years.	British.	Foreign.	British.	Foreign.
1789	495	7	215	9
1790	505	6	225	11
1791	553	8	267	17
1792	561	9	285	17
1793	300	29	162	26
1794	345	23	224	28
1795	344	35	211	90
1796	254	26	216	106
1797	294	63	185	73
1798	265	61	229	69
1799	374	57	180	75
1800	270	70	203	126.

The total number of vessels which entered inwards in the year 1804 was 372; the number that cleared outwards 314.

The Mediterranean trade has suffered much interruption since the year 1793: Great Britain, however, still retains a considerable share of it, though certainly less than at former periods. In the year 1792, the exports to Italy and Venice amounted to 963,232*l.*; but they have since fallen much below that amount. The goods usually imported from Venice are currants loaded at Zante or Cephalonia, or some port in the Morea, silks, cream of tartar, glass beads for the East and West Indian and African trades, whisks of rice-weeds, sponge, and some Levant drugs, cotton, oil, and vallonea. The exports to Italy and Venice are pilchards and red-herrings, of which the consumption is considerable, a small quantity of salmon, salted ox-guts, of which about 100 or 150 casks are yearly consumed for making salt puddings, tin, lead and litharge, alum, woollens, and hardware; besides sugars, cocoa, pepper, and other foreign articles. The number of vessels which entered inwards from Venice in the year 1800, was only 4, the number that cleared out 12.

The trade with Turkey has been less disturbed than that of any other part of the Mediterranean, particularly since Malta has been in the hands of the English: this branch of trade is by no means equal in importance to what it has formerly been. The exports consist chiefly of lead in pigs, lead-shot, tin, wrought and cast iron, hardware, cloths and stuffs, glass and earthenware, clocks and watches, West India coffee, sugar, pepper, &c. The imports are cotton-wool, cotton-yarn, silk, mohair, madder, galls, figs, raisins, and a few other articles.

Years.	Imports.	Exports.
1801	141,137*l.*	172,198*l.*
1802	182,424*l.*	180,000*l.*
1803	175,427*l.*	155,369*l.*

The number of vessels that entered inwards from Turkey, in the year 1803, was 27; in 1804, 16.

The West India trade is in some respects the most important branch of our commerce. The capital engaged in it has been stated at no less than 70,000,000*l.* The value of the goods exported from Great Britain on an average of four years, ending 5th January 1796, was estimated, according to their real value, at 3,900,000*l.*; but besides the goods sent directly hence to the West Indies, merchandize to a considerable amount is exported to the coast of Africa, for the purchase of slaves. Adding, therefore, the value of the slaves annually imported and retained in the islands, the whole export to the West Indies may be estimated at least at 4,672,000*l.* The value of the imports is considerably greater; and the annual balance is to be considered in part as a remittance of the income or property of persons who possess estates in the West Indies, and who are wholly or occasionally resident here; and of persons who have lent money on mortgage or otherwise in the West Indies, and receive the interest through the medium of these remittances: a further part defrays the freight and other charges in this country of West India produce.

Total imports from the West Indies.

	British West Indies.	Conquered Islands.	Total.
1801	6,759,617*l.*	4,105,839*l.*	10,865,456*l.*
1802	7,293,316	2,699,504	9,992,820
1803	5,786,432	362,014	6,148,436.

The number of British vessels that entered inwards, in the year 1804, was 714, containing 202,974 tons, and navigated by 11,819 seamen. The number of vessels that cleared outwards was 785.

The trade with the United States of America has rapidly advanced to considerable importance; and we now supply them with commodities to a far greater amount than in the most favourable years previous to their separation from this country. The imports consist chiefly of unmanufactured American produce, such as corn, tobacco, rice, &c. of which about four-fifths of the tobacco is re-exported. In the year ending 5th January 1793, the number of British ships in the trade between this country and the Anglo-American ports was only 193, while the American vessels in the same trade were no less than 313. In the year ending 5th January 1805, the number of British vessels which entered inwards was only 72, while the American vessels were 363; and unless the British shipmasters can advantageously maintain a competition with those of America, we shall soon lose this important branch of our carrying navigation. The exports of Britain to America consist of British manufactures only; for which America will in all probability long continue an improving market.

The export to Canada, and the remaining possessions of Britain in North America, amounted, in the year 1792, to 1,120,091*l.*, of which 908,105*l.* was in British manufactures, and 211,886*l.* in foreign merchandize.

it has since been rather under this amount. The imports consist of skins and furs of all kinds. The total number of vessels which entered inwards, in the year 1804, was 270, the number which cleared outwards 384.

The East India trade is a concern of vast magnitude, if considered merely in a commercial point of view. The annual sales of the imports of the company for 16 years preceding 1757, amounted to about 2,055,000*l.* on the average; during the succeeding 10 years, their sales of imports increased to 2,150,000*l.* per annum; in the following 10 years they rose to 3,330,000*l.* per annum. During the American war, the sales of imports fell off about 200,000*l.* per annum; but from that period to 1792, they increased again, and amounted on an average to 4,768,242*l.* The accounts of the following years shew a still greater increase.

Amount of the East India company's sales in the years ending 1st March, 1801, 1802, 1803, and 1804.

	India.	China.	Total.
1801	*L.* 3,978,800	*L.* 3,616,381	*L.* 7,595,181
1802	3,086,943	3,539,404	6,626,347
1803	2,289,274	3,753,252	6,042,526
1804	2,236,396	3,629,677	5,866,073

The exports to India are chiefly woollens, metals, and naval and military stores; for the purchase of teas in China a considerable amount of bullion is annually exported. The investments in India are formed from the proceeds of the exports of the company, from the proceeds of part of the territorial revenues invested in merchandize, and from the fortunes of private individuals and the profits of their trade remitted to this country, which are paid into the company's exchequer, and remitted by the company in merchandize from India.

The trade to Africa is chiefly for the purchase of slaves to supply the West India islands. The total number of vessels which entered inwards from Africa in the year 1804 was 38, the number which cleared outwards was 176.

The vast extent of the foreign commerce of Great Britain has been shewn from the custom-house accounts of the imports and exports: it will be further illustrated by the following statement of the whole number of merchant-vessels, the amount of their tonnage, and the number of men and boys usually employed in navigating them, which belonged to the several ports of the British empire on the 30th September, 1804.

Great Britain.

Ships.	Tons.	Men.
17,794	2,017,240	134,032

Ireland.

Ships.	Tons.	Men.
1,061	58,060	5,176

The Colonies.

Ships.	Tons.	Men.
2,870	196,628	15,091

Total.

Ships.	Tons.	Men.
21,725	2,271,928	154,299.

This number of vessels, great as it appear is still increasing; the number of new vessels each year considerably exceeding the losses to which such an extensive navigation must unavoidably be subject. The number of vessels built and registered in the different ports of the British empire, in the year ending the 5th January, 1804, was 1402; and the amount of their tonnage 135,349 tons.

COMMERSONIA, a genus of the pentagynia order, in the pentandria class of plants. The calyx is a monophyllous, five-parted, corolliferous perianthium, with sharp ovated segments; the corolla has five linear petals; the stamina are five very short filaments at the bases of the petals; the pericarpium a globular, hard, quinquelocular nut, with two ovated seeds in each division. There is one species, a tree of Otahelte.

COMMISSARY, a title of ecclesiastical jurisdiction, appertaining to one who exercises spiritual jurisdiction in places so remote from the chief city, that the chancellor cannot call the subjects to the bishop's principal consistory, without exposing them to great inconvenience.

COMMISSARY *general of the musters*, an officer appointed to muster the army, as often as the general thinks proper, in order to know the strength of each regiment and company, to receive and inspect the muster-rolls, and to keep an exact state of the strength of the army.

COMMISSARY *general of stores*, an officer in the artillery, who has the charge of all the stores, for which he is accountable to the office of ordnance.

COMMISSARY *general of provisions*, an officer who has the inspection of the bread and provisions of the army.

COMMISSION, is taken for the warrant or letters patent, that all men exercising jurisdiction, either ordinary or extraordinary, have for their power to hear or determine any cause or action; thus the judges and most of the great officers judicial and ministerial of this realm, are made by commission.

COMMISSION *of bankruptcy*. See BANKRUPT.

COMMISSION *of delegates*, a commission under the great seal, directed to certain persons usually two or three temporal lords, as many bishops, and two judges of the law, authorising them to sit upon an appeal to the king, in the court of chancery, from a sentence given by the archbishop in any ecclesiastical cause.

COMMISSION *of lunacy* issues out of the court of chancery, to inquire whether a person represented to be a lunatic is so or not.

COMMISSION *of peace*. See JUSTICE *of the peace*.

COMMISSION *of rebellion*, generally termed a *writ of rebellion*, issues where a person, after proclamation made by the sheriff, on a process out of the chancery or exchequer, required, upon pain of his allegiance, to present himself to the court by a day assigned, neglects to appear.

COMMISSION *of sewers* is a commission directed to certain persons, to inspect and see drains and ditches well kept in the marshy and fenny parts of England, for the better conveying of water into the sea, and preserving the grass on the land.

COMMISSION, in commerce. See FACTORAGE.

COMMISSIONER, a person authorised by commission, letters-patent, or other lawful warrant, to examine any matters, or execute any public office, &c. See CUSTOMS, EXCISE, NAVY, TREASURY, &c.

COMMITMENT, is the sending a person to prison by warrant or order, either for a crime or for contumacy. If for a crime the warrant must be until discharged according to law; but for contumacy, until he comply, and perform the thing required. Carth. 153. The commitment should be in writing; otherwise, by the habeas-corpus act, the prisoner may be admitted to bail whatever his offence may have been. 1 Burn. 379.

Who may commit.—Wherever a constable or person may justify the arresting another for a felony, or treason, he may justify the sending him or bringing him to the common gaol. 2 Haw. 116. But it is most advisable, for any private person who arrests another for felony, to cause him to be brought as soon as possible before some justice of the peace, that he may be committed or bailed by him. Dall. c. 118.

The privy-council, or any one or two of them, or a secretary of state, may lawfully commit persons for treason, and for other offences against the state. 2 Haw. 117.

To what place.—All felons shall be committed to the common gaol and not elsewhere. 5 Hen. IV. c. 10. But vagrants and other criminals, offenders and persons charged with small offences, may, for such offences, or for want of sureties, be committed either to the common gaol or house of correction, as the justices in their judgment shall think proper. 6 G. c. 19.

Who may be committed.—All persons who are apprehended for offences not bailable, and those who neglect to offer bail for offences which are bailable, must be committed; and wherever a justice of peace is empowered to bind a person over, or to cause him to do a certain thing, he may commit him, if in his presence he shall refuse to be so bound or do such a thing. 2 Haw. 116.

A commitment must be in writing, either in the name of the king, and only tested by the person who makes it; or it may be made by such person in his own name, expressing his office or authority, and must be directed to the gaoler or keeper of the prison. 2 Haw. 119. The commitment should contain the name and surname of the party committed, if known; if not known, it may be sufficient to describe the person by his age, &c. and to add, that he refuses to tell his name. 1 H. H. 557. It ought to contain the causes, as for treason or felony; and also the special nature of the felony, briefly, as for felony for the death of such a one, or for burglary, in breaking the house of such a one. 2 H. H. 122. A commitment must also have an apt conclusion; as if for felony, till he be thence delivered by due course of law. 2 H. H. 123. All commitments grounded on acts of parliament ought to be conformable to the method prescribed by them. 2. Haw. Not. 33. and where a statute appoints imprisonment, but does not limit the time, in such cases the prisoner must remain at the discretion of the court. Dalt. c. 170.

The duty of a gaoler respecting commitments.—If the gaoler shall refuse to receive

a felon, or take any thing for receiving him, he shall be punished for the same by the justices of gaol-delivery. 4 Ed. III. c. 9. But no person can justify the detaining a prisoner in custody, out of the common gaol, unless there be some particular reason for so doing; as if the party should be so dangerously ill, that it would apparently hazard his life to send him to gaol, or that there is evident danger of a rescue from rebels or the like. 1 Haw. 118. By the 3 Hen. VII. c. 3 the sheriff or gaoler shall certify the commitment to the next gaol-delivery.

By the habeas-corpus act, the charge of conveying an offender is limited not to exceed 12*d.* a mile.

Commitment discharged—A person legally committed for a crime, certainly appearing to have been done by some person or other, cannot be lawfully discharged but by the king, till he is acquitted upon his trial, or has an ignoramus found by the grand jury, or none shall prosecute him, on a proclamation for that purpose by the justices of gaol-delivery. 2 Haw. 121.

COMMITTEE *of parliament,* a certain number of members appointed by the house, for the examination of a bill, making report of an inquiry, process of the house, &c.

When a parliament is called, and the speaker and members have taken the oaths, there are committees appointed to sit on certain days, viz. the committee of privileges and elections, of religion, of trade, &c. which are standing committees.

Sometimes the whole house resolves itself into a committee, on which occasion each person has a right to speak and reply as often as he pleases, which is not the case when the house is not in a committee.

COMMODORE, in maritime affairs, an officer of the British navy, commissioned by the lords of the admiralty, or by an admiral, to command a squadron of men-of-war in chief

COMMON, is a right or privilege which one or more persons claim to take or use, in some part or portion of that, which another man's lands, waters, woods, &c. naturally produce; without having an absolute property in such lands, woods, waters, &c. 2 Inst. 65.

The general divisions of common are, into common of pasture, which is a right or liberty that one or more have to feed or fodder their beasts or cattle in another man's land. Common of turbary, or a liberty of cutting turves in another man's land or soil. Common of piscary, or a right and liberty of taking fish in another's fish-pond, pool, or river. Common of estovers, which is a right of taking trees or loppings, shrubs and underwood, in another's woods, coppices, &c. and lastly, a liberty which the tenants have in some manors, of digging and taking sand, gravel, stone, &c. in the lord's soil. 1 Bac. Abr. 385.

But the word common is usually understood of common of pasture, of which there are four kinds; common appendant, common appurtenant, common in gross, and common by reason of vicinage.

Common appendant, is a right belonging to the owners or occupiers of arable land, to put commonable beasts upon the lord's waste, and upon the lands of other persons within the same manor. Commonable beasts are either beasts of the plough, or such as manure the land 1 Inst. 122.

Common appurtenant, can only be claimed by prescription, and is a right of commonage for beasts, not only commonable, as horses, oxen, cows, and sheep, but likewise for beasts not commonable, as swine, goats, and geese. Co. Lit. 122.

Common in gross, is a right of commonage which must be claimed by deed or prescription, and has no relation to any land belonging to the commoner; it may be for a certain number of cattle, or without number. He that has common in gross for a certain number of cattle, may put in the cattle of a stranger, and use the common with them. 2 Inst. 427. 2 Rol. Abr. 402.

Common by reason of vicinage, is a liberty that the tenants of one lord, in one town, have to common with the tenants of another town. Those who challenge this kind of common (which is usually called intercommoning) may not put their cattle in the common of the other town, for then they are distrainable; but turning them into their own fields, if they stray into the neighbour common, they must be suffered. Cowel.

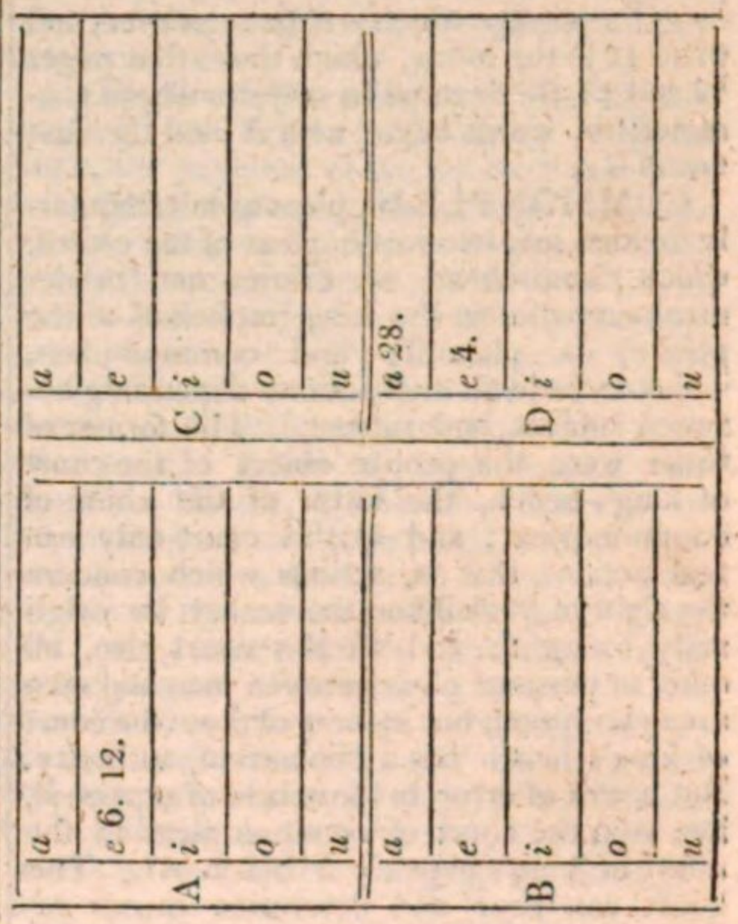
A commoner has only a special and limited interest in the soil, but yet he shall have such remedies as are commensurate to his right, and therefore may distrain beasts damage-feasant, bring an action on the case, &c. but not being absolute owner of the soil, he cannot bring a general action of trespass, for a trespass done upon the common. Nor can he do any thing to the soil which tends to the melioration or improvement of it, as cutting down of bushes, ferns &c. A commoner may abate hedges made on his common; and may drive the beasts of a commoner mixed with the beasts of a stranger to a convenient place to sever them, and may drive the beasts of a stranger out of the common, without any custom. Godb. 123. 2 Mod. 65. 3 Lev. 40. It is a general rule, that a commoner cannot distrain or chase out the cattle of the lord, or terre-tenant, damage-feasant; and if the lord surcharge the common, his proper remedy is an action on the case. Godb. 182.

COMMON INTENDMENT, is common meaning or understanding according to the subject matter, and not strained to an extraordinary or foreign sense.

COMMON LAW. The common law of England, is the common rule for administering justice within the kingdom, and asserts the king's royal prerogatives and likewise the rights and liberties of the subject. It is generally that law by which the determination in the king's ordinary courts are guided. It is distinguished from the statute laws or acts of parliament, as having been the law of the land before any acts of parliament which are now extant were made. Hale's Hist. 24. 44. 45.

COMMON-PLACE BOOK is a sort of register, or orderly collection of things worthy to be noted, and retained in the course of a person's reading; and so disposed, as that among a multiplicity of subjects, any one may be easily found.

In Mr. Locke's method, the first page, or first two pages that front each other of the book, serve as a kind of index to the whole. This part is to be divided by parallel lines into twenty-five equal parts; of which every fifth line is to be distinguished by its colour. These lines are to be cut perpendicularly by others drawn from top to bottom, and in the several spaces of which, the several letters, both small and large, of the alphabet, are to be written. The form of the lines and divisions, both horizontal and perpendicular, with the manner of writing the letters, will be readily understood from the following specimen; in which what is to be done in the book for all the letters of the alphabet, is here shewn in the first four, A, B, C, and D.



The index thus formed, and the pages of the book numbered, every thing is ready for taking down any passage that is worthy of being registered. We will, for example, suppose the reader desirous of inserting in his common-place book, a passage of poetry. He must consider to what particular head it may most naturally be referred, and under which a person would be led to look for such a thing. The prominent idea, in this instance, is death. D then is the initial letter, and *e* the first vowel: looking into the index for the partition D, and the line *e* (which is the place for all words whose first letter is D, and first vowel *e*, as Death, Deity, Dress, &c.) and finding no numbers already down, which direct to any page of the book where words of this characteristic have been entered, he must turn forward to the first blank page, suppose number: 4 here the passage must be written, placing the characteristic word in the margin, thus:

Death. Thou must expire, my soul, ordained to range
Through unexperienced scenes, and mysteries strange,
Dark the event, and dismal the exchange,
&c. &c.

This being done, the page in which it stands must be entered in the space D*e* of the index, from which time the 4th and 5th pages are to be devoted to subjects the characteristic letters of which are D*e*.

Again if the reader wishes to insert an argument against anger, revenge &c. he must determine for himself what is the characteristic of the passage, say anger; he looks for the next vacant page, suppose 6: there he inserts the argument, and in the space A*e* he writes 6, the number of the page in which the

passage stands, and then the 6th and seventh pages are devoted to subjects the characteristic words of which begin with A and the first vowel is *e*, as anger, angel, &c. When these pages are full, and another passage of the same class is to be entered, look for the next vacant leaf of the common-place book, suppose it to be number 12; at the bottom of p. 7 write *t.* p. 12, which signifies to turn to p. 12, then at the top of p. 12, write 7; enter the passage which is to be registered, and write 12 in the index, which shews that pages 12 and 13 are devoted to subjects whose characteristic words begin with A and the first vowel is *e*.

COMMON PLEAS, pleas or suits regularly divided into two sorts; pleas of the crown, which comprehend all crimes and misdemeanours wherein the king (on behalf of the public) is plaintiff; and common-pleas, which include all civil actions depending between subject and subject. The former of these were the proper object of the court of king's-bench, the latter of the court of common-pleas; and in this court only can real actions, that is, actions which concern the right of freehold or the reality, be originally brought; and in this court also, all other or personal pleas between man and man are determined, but in some of these the court of king's bench has a concurrent authority. But a writ of error, in the nature of an appeal, lies from the court of common-pleas to the court of king's bench. 3 Black. 37. This court can hear and determine causes removed out of inferior courts by pone, recordare, or other like writs. They can also grant prohibitions, to keep other courts, as well ecclesiastical as temporal, within due bounds.

In this court are four judges, created by letters patent; the seal of the court is committed to the custody of the chief justice.

COMMON PRAYER. It is the particular duty of a clergyman every Sunday, &c. to use the public form of prayer, prescribed by the book of common prayer. And the 13 and 14 Ch. II. enacts that every incumbent residing upon a living and keeping a curate, shall at least once a month, publicly read the common prayer, and if there be occasion, administer the sacraments, and other rites of the church, on pain of 5*l.* to the poor, on confession or conviction thereof before two justices.

COMMUNICATION *of motion*, the act whereby a body at rest is put into motion by a moving body; or it is the acceleration of motion in a body already moving. See MECHANICS.

COMMUNICATION, *lines of*, in military matters, trenches made to continue and preserve a safe correspondence between two forts or posts; or at a siege, between two approaches, that they may relieve one another.

COMOCLADIA, a genus of the class and order triandria monogynia. The calyx is three-parted; the corolla the same; drupe oblong with a two-lobed nucleus. There are three species, trees of the West Indies.

COMPANY, in a commercial sense, is a society of merchants, mechanics, or other traders, joined together in one common interest.

When there are only two or three joined in this manner, it is called a partnership; the term company being restrained to societies consisting of a considerable number of members, associated together by a charter obtained from the sovereign. The mechanics of all corporations, or towns incorporated, are thus erected into companies, which have charters of privileges and large immunities. Those of London are very numerous. The mercers were incorporated in the 17th of king Richard II. in the year 1393; the grocers, in the 20th Edward III. ann. 1345; the drapers, in the 17th Henry VI. ann. 1430; the fishmongers, in the 28th of Henry VIII. ann. 1536; the goldsmiths, in the 16th of Richard II. ann. 1392; the skinners, in the 1st of Edward III. ann. 1327; the merchant-taylors, in the 17th Henry VII. ann. 1501; the haberdashers, or hurrers, in 26th Henry VI. ann. 1447, and 17th Henry VII. ann. 1501; the salters, in 20th Henry VIII ann. 1530; the ironmongers, in 3d Edward IV. ann. 1462; the vintners, in the reign of Edward III. and 15th Henry VI.; and the clothiers, or cloth-workers, in 22d Henry VIII.

Besides these, which are the twelve principal companies of London, there are other very considerable ones; as the dyers, brewers, leather-sellers, pewterers, barbers, surgeons, armourers, white-bakers, wax-chandlers, cutlers, girdlers, butchers, sadlers, carpenters, cordwainers, painters, curriers, masons, plumbers, innholders, founders, embroiderers, poulterers, cooks, coopers, bricklayers, and tylers; also bowers, fletchers, blacksmiths, joiners, plaisterers, weavers, fruiterers, scriveners, bottle-makers, and horners; likewise stationers, marblers, wool-packers, farriers, paviours, lorimers or loriners, tallow-chandlers, brown-bakers, wood-mongers, upholsterers, turners, glaziers, clerks, watermen, apothecaries, and throwsters.

The word seems now more particularly appropriated to those grand associations set on foot for the commerce of the remote parts of the world, and vested by charter with peculiar privileges. When companies do not trade upon a joint stock, but are obliged to admit any person, properly qualified, upon paying a certain fine and agreeing to submit to the regulations of the company, each member trading upon his own stock, and at his own risk, they are called regulated companies. When they trade upon a joint stock, each member sharing in the common profit or loss in proportion to his share in this stock, they are called joint-stock companies. Such companies, whether regulated or joint-stock, sometimes have, and sometimes have not, exclusive privileges.

However injurious companies with joint stock, and incorporated with exclusive privileges, may at this time be reckoned to the nation in general, it is yet certain that they were the general parents of all our foreign commerce, private traders being discouraged from hazarding their fortunes in foreign countries, until the method of traffic had been first settled by joint-stock companies. But since the trade of this kingdom and the number of traders have increased; and the methods of assurance of shipping and merchandize, and the navigation to all parts of the known world, have become familiar to us; experience has shown, that the trade of the nation has advanced in proportion as these monopolies have been discouraged; all restrictions of trade whatever having been found manifestly prejudicial.

I. Regulated companies resemble, in every respect, the corporations of trades, so common in the cities and towns of all the different countries of Europe; and are a sort of enlarged monopolies of the same kind. As no inhabitant of a town can exercise an incorporated trade, without first obtaining his freedom in the corporation; so in most cases no subject of the state can lawfully carry on any branch of foreign trade, for which a regulated company is established, without first becoming a member of that company. The monopoly is more or less strict according as the terms of admission are more or less difficult; and according as the directors of the company have more or less authority, or have it more or less in their power to confine it to themselves and their particular friends. The regulated companies for foreign commerce, which at present subsist in Great Britain, are, the Hamburgh company, the Russia company, the Eastland company, the Turkey company, and the African company.

1. The Hamburgh company is the oldest trading establishment in the kingdom; though not always known by that name, nor restrained to those narrow bounds under which it is now confined. It was first called the company of merchants trading to Calais, Holland, Zealand, Brabant, and Flanders: then it acquired the general title of merchant-adventurers of England; as being composed of all the English merchants who traded to the Low-countries, the Baltic, and the German ocean. Lastly, it was called the company of merchant-adventurers of England trading to Hamburgh. This company was first incorporated by Edward I. in 1296; and their privileges have been confirmed by many of his successors. The revolutions which happened in the Low-countries towards the end of the sixteenth century, and which laid the foundation of the republic of Holland, having hindered the company from continuing their commerce with their antient freedom, they were obliged to turn it almost wholly to the side of Hamburgh, and the cities on the German ocean; from which the name was changed to that of the Hamburgh, company, though the antient title of merchant-adventurers is still retained in all their writings.

2. The Russia company was first projected towards the end of the reign of king Edward VI. and executed in the first and second years of Philip and Mary; but had not its perfection till its charter was confirmed by act of parliament, under queen Elizabeth, in 1566. It had its rise from certain adventurers, who were sent in three vessels on the discovery of new countries, and to find out a north-east passage to China: these, falling into the White Sea, and making up to the port Archangel, were exceedingly well received by the Muscovites; and at their return, solicited letters patent to secure themselves the commerce of Russia, for which they had formed an association. This company subsisted with reputation almost a whole century, till the time of the civil wars. It is said, the czar then reigning, hearing of the death of king Charles I., ordered all the English in his states to be expelled; of which the Dutch taking advantage, settled in their room. After the Restoration the remains of the company re-established part of their commerce at Archangel,

but never with the same success as before, the Russians being now well accustomed to the Dutch merchants and merchandize. This company subsists still, under the direction of a governor, four consuls, and assistants; and by the 10th and 11th of William III. c. 6. the fine for admission was reduced to 5*l.*

3. The Eastland company was incorporated by queen Elizabeth. Its charter is dated in the year 1579. By the first article the company is erected into a body politic, under the title of the company of merchants of the East; to consist of Englishmen, all real merchants, who have exercised the business thereof, and trafficked thro' the Sound, before the year 1568, into Norway, Sweden, Poland, Livonia, Prussia, Pomerania, &c. excepting Narva, Muscovy, and its dependancies. Most of the remaining articles grant them the usual prerogatives of such companies; as a seal, governor, co. rts, laws, &c.

4. The Turkey or Levant company had its rise under queen Elizabeth, in 1581. James I. confirmed its charter in 1605, adding new privileges. During the civil wars, there happened some innovations in the government of the company; many having been admitted members, not qualified by the charters of queen Elizabeth and king James, or that did not conform to the regulations prescribed. Charles II. on his restoration endeavoured to set it upon its antient basis; to which end, he gave them a charter containing not only a confirmation of their old one, but also several new articles of reformation. By this the company is erected into a body-politic, capable of making laws, &c. under the title of the company of merchants of England trading to the seas of the Levant. The number of members is not limited, but is ordinarily about three hundred. The principal qualification required is, that the candidate be a freeman of London, and a wholesale merchant either by family or serving an apprenticeship of seven years.

5. The company of merchants trading to Africa, established in 1750. Contrary to the former practice with regard to regulated companies, who were reckoned unfit for such sort of service, this company was subjected to the obligation of maintaining forts and garrisons. It was expressly charged at first with the maintenance of all the British forts and garrisons that lie between Cape Blanc and the Cape of Good Hope; and afterwards that of those only which lie between Cape Rouge and the Cape of Good Hope. The act which establishes this company (the 23d of Geo. II. c. 31) seems to have had two distinct objects in view; first, to restrain effectually the oppressive and monopolizing spirit which is natural to the directors of a regulated company; and, secondly, to force them as much as possible to give an attention, which is not natural to them, towards the maintenance of forts and garrisons.

For the first of these purposes, the fine for admission is limited to forty shillings. The company is prohibited from trading in their corporate capacity, or upon a joint stock; from borrowing money upon a common seal; or from laying any restraints upon the trade, which may be carried on freely from all places, and by all persons, being British subjects, and paying the fine. The government is in a committee of nine persons, who meet in London, but who are chosen annually by the freemen of the company at London, Bristol, and Liverpool; three from each place. No committee-man can be continued in office for more than three years together. Any committee-man might formerly be removed by the board of trade and plantations; now by a committee of council, after being heard in his defence. The committee are forbidden to export negroes from Africa, or to import any African goods into Great Britain. But as they are charged with the maintenance of forts and garrisons, they may for that purpose export from Great Britain to Africa goods and stores of different kinds. Out of the money which they shall receive from the company, they are allowed a sum not exceeding eight hundred pounds for the salaries of their clerks and agents at London, Bristol, and Liverpool; the house-rent of their office in London; and all other expences of management, commission, and agency, in England. What remains of this sum, after defraying those different expences, they may divide among themselves, as a compensation for their trouble, in what manner they think proper.

For the second purpose mentioned, the maintenance of the forts and garrisons, an annual sum has been allotted to them by parliament, generally about 13,000*l.* For the proper application of this sum, the committee is obliged to account annually to the cursitor baron of the exchequer; which account is afterwards to be laid before parliament. But it is said great abuses have, notwithstanding, subsisted with regard to this part of the company's engagements.

II. Joint-stock companies, established either by royal charter, or by act of parliament, differ in several respects, not only from regulated companies, but from private copartneries. 1. In a private copartnery no partner, without the consent of the company, can transfer his share to another person, or introduce a new member into the company; each member however may, upon proper warning, withdraw from the copartnery, and demand payment from them of his share of the common stock. In a joint-stock company, on the contrary, no member can demand payment of his share from the company; but each member can, without their consent, transfer his share to another person, and thereby introduce a new member. The value of a share in a joint stock is always the price which it will bring in the market; and this may be either greater or less, in any proportion, than the sum which its owner stands credited for in the stock of the company. 2. In a private copartnery each partner is bound for the debts contracted by the company to the whole extent of his fortune. In a joint-stock company, on the contrary, each partner is bound only to the extent of his share.

The trade of a joint-stock company is always managed by a court of directors. This court indeed is frequently subject, in many respects, to the controul of a general court of proprietors. But the greater part of these proprietors seldom pretend to understand any thing of the business of the company, and give themselves no trouble about it, but receive contentedly such half-yearly or yearly dividend as the directors think proper to make to them. This total exemption from trouble and risk, beyond a limited sum, encourages many people to become adventurers in joint-stock companies, who would upon no account hazard their fortunes in any private copartnery. Such companies, therefore, commonly draw to themselves much greater stocks than any private copartnery can boast of. The principal joint-stock companies at present subsisting in Great Britain are, the South Sea and the East India companies; to which may be added, though of very inferior magnitude, the Hudson's-bay company.

1. The South Sea company. During the long war with France in the reign of queen Anne, the payment of the sailors of the royal navy being neglected, they received tickets instead of money, and were frequently obliged by their necessities to sell these tickets to avaricious men at a discount of 40 and sometimes 50 per cent. By this and other means the debts of the nation unprovided for by parliament, and which amounted to 9,471,321*l.* fell into the hands of these usurers: on which Mr. Harley, at that time chancellor of the exchequer, and afterwards earl of Oxford, proposed a scheme to allow the proprietors of these debts and deficiencies 6 per cent. per annum, and to incorporate them for the purpose of carrying on a trade to the South Sea; and they were accordingly incorporated under the title of "the governor and company of merchants of Great Britain trading to the South Seas, and other parts of America, and for encouraging the fishery," &c.

Some other sums were lent to the government in the reign of queen Anne at 6 per cent. In the third of George I. the interest of the whole was reduced to 5 per cent. and the company advanced two millions more to the government at the same interest. By the statute of the 6th of George I. it was declared, that they might redeem all or any of the redeemable national debts; in consideration of which the company were empowered to augment their capital according to the sums they should discharge; and for enabling them to raise such sums for purchasing annuities, exchanging for ready money new exchequer-bills, carrying on their trade, &c. they might, by such means as they should think proper, raise such sums of money as in a general court of the company should be judged necessary. The company were also empowered to raise money on contracts, bonds, or obligations, under their common seal, on the credit of their capital stock. But if the sub-governor, deputy-governor, or other members of the company, should purchase lands or revenues of the crown upon account of the corporation, or lend money by loan or anticipation on any branch of the revenue, other than such part only on which a credit of loan was granted by parliament, such sub-governor, or other member of the company, should forfeit treble the value of the money so lent. The fatal South Sea scheme, transacted in the year 1720, and the particulars of which are very generally known, was executed upon the last-mentioned statute.

The South Sea company never had any forts or garrisons to maintain, and therefore were entirely exempted from one great expence, to which other joint-stock companies for foreign trade are subject. But they had an immense capital divided among an immense number of proprietors. It was natu-

rally to be expected, therefore, that folly, negligence, and profusion, should prevail in the whole management of their affairs. Their stock-jobbing speculations were succeeded by mercantile projects, which, Dr. Smith observes, were not much better conducted. At length, in the year 1722, this company petitioned parliament to be allowed to divide their immense capital of more than 33,800,000*l.* the whole of which had been lent to government, into two equal parts: the one half, or upwards of 16,900,000*l.* to be put upon the same footing with other government annuities, and not to be subject to the debts contracted, or losses incurred, by the directors of the company, in the prosecution of their mercantile projects; the other half to remain as before, a trading stock, and to be subject to those debts and losses. The petition was too reasonable not to be granted. In 1733 they again petitioned the parliament, that three-fourths of their trading stock might be turned into annuity-stock, and only one-fourth remain as trading stock, or exposed to the hazards arising from the bad management of their directors. Both their annuity and trading stocks had, by this time, been reduced more than 2,000,000*l.* each, by several different payments from government; so that this fourth amounted only to 3,662,784*l.* 8*s.* 6*d.* In 1748 all the demands of the company upon the king of Spain, in consequence of the Assiento contract, were, by the treaty of Aix-la-Chapelle, given up for what was supposed an equivalent; an end was put to their trade in the Spanish West Indies, the remainder of their trading stock was turned into annuity stock, and the company ceased in every respect to be a trading company.

This company is under the direction of a governor, sub-governor, deputy-governor, and 21 directors; but no person is qualified to be a governor, his majesty excepted, unless such governor has, in his own name and right, 5000*l.* in the trading stock; the sub-governor is to have 4000*l.* the deputy-governor 3000*l.* and a director 2000*l.* in the same stock. In every general court every member having, in his own name and right, 500*l.* in trading-stock, has one vote; if 2000*l.* two votes; if 3000*l.* three votes; and if 5000*l.* four votes.

2. The East India company. The first, or, as it is called, the old East India company, was established by a charter from queen Elizabeth in 1600; but for some time the partners seem to have traded with separate stocks, though only in the ships belonging to the whole company. In 1612 they joined their stocks into one common capital; and though their charter was not as yet confirmed by act of parliament, it was looked upon in that early period to be sufficiently valid, and nobody ventured to interfere with their trade. At this time their capital amounted to about 740,000*l.* and the shares were as low as 50*l.* Their trade was in general successful, notwithstanding some heavy losses, chiefly sustained through the malice of the Dutch East India company. In process of time, however, it came to be understood that a royal charter could not by itself convey an exclusive privilege to traders; and the company was reduced to distress by the multitude of interlopers, who carried off most of their trade. This continued during the latter part of the reign of Charles II. the whole of that of James II. and part of William III when, in 1698, a proposal was made to parliament for advancing the sum of 2,000,000*l.* to government, on condition of erecting the subscribers into a new company with exclusive privileges. The old company endeavoured to prevent the appearance of such a formidable rival, by offering government 700,000*l.*, nearly the amount of their capital at that time; but such were the exigencies of the state at that time, that the larger sum, though at eight per cent. interest, was preferred to the smaller at one-half the expence.

Thus were two East India companies erected in the same kingdom, which could not but be very prejudicial to each other. Through the negligence of those who prepared the act of parliament also, the new company were not obliged to unite in a joint stock. The consequence of this was, that a few private traders, whose subscriptions scarcely exceeded 7200*l.* insisted on a right of trading separately at their own risk. Thus a kind of third company was established; and by their mutual contentions with one another, all the three were brought to the brink of ruin. Upon a subsequent occasion, in 1700, a proposal was made to parliament for putting the trade under the management of a regulated company, and thus laying it in some measure open. This, however, was opposed by the company; who represented in strong terms the mischiefs likely to arise from such a proceeding. In 1702 the companies were in some measure united by an indenture tripartite, to which the queen was the third party; and in 1708, they were, by act of parliament, perfectly consolidated into one company by their present name of "the united company of merchants trading to the East Indies." Into this act it was thought worthy to insert a clause, allowing the separate traders to continue their traffic till Michaelmas 1711; but at the same time empowering the directors, upon three years notice, to redeem their capital of 7200*l.* and thereby convert the whole capital of the company into a joint stock. By the same act the capital of the company, in consequence of a new loan to government, was augmented from 2,000,000*l.* to 3,200,000*l.* In 1743 another million was advanced to government; but this being raised, not by a call upon the proprietors, but by selling annuities and contracting bond-debts, it did not augment the stock upon which the proprietors could claim a dividend. Thus, however, their trading stock was augmented; it being equally liable with the other 3,200,000*l.* to the losses sustained and debts contracted by the company, in the prosecution of their mercantile projects. From 1708, or at least from 1711, this company, being freed from all competitors, and fully established in the monopoly of the English commerce to the East Indies, carried on a successful trade; and from their profits made annually a moderate dividend to their proprietors. Unhappily, however, in a short time, an inclination for war and conquest began to take place among its servants; which, though it put them in possession of extensive territories and vast nominal revenues, yet embarrassed their affairs in such a manner, that they have not to this day been able to recover themselves. During the war of 1755, indeed, they acquired the revenues of a rich and extensive territory, amounting, as was then said, to near 3,000,000*l.* per annum.

For several years they remained in quiet possession of the revenue arising from this territory, though it certainly never answered the expectations that had been formed concerning it. But in 1767 the British ministry laid claim to the territorial possessions of the company, and the revenue arising from them, as of right belonging to the crown; and the company, rather than yield up their territories in this manner, agreed to pay government a yearly sum of 400,000*l.* They had before this gradually augmented their dividend from about six to ten per cent. that is, on their capital of 3,200,000*l.* they had raised it from 192,000*l.* to 320,000*l.* a year. About this time also they were attempting to raise it still further, viz. from ten to twelve and a half per cent. but from this they were prevented by two successive acts of parliament, the design of which was to enable them to make a more speedy payment of their debts, at this time estimated at more than six or seven millions sterling. In 1769 they renewed their agreement with government for five years more, stipulating, that during the course of that period they should be allowed gradually to augment their dividend to twelve and a half per cent. never increasing it, however, more than one per cent. annually. Thus their annual payments could only be augmented by 608,000*l.* beyond what they had been before their late territorial acquisitions. By accounts from India in the year 1768, this revenue, clear of all deductions and military charges, was stated at 2,048,747*l.* At the same time they were said to possess another revenue, arising partly from lands, but chiefly from the customs established at their different settlements, amounting to about 439,000*l.* The profits of their trade, too, according to the evidence of their chairman before the house of commons, amounted to at least 400,000*l.* per annum; their accountant made it 500,000*l.* and the lowest accountant stated it at least equal to the highest dividend paid to their proprietors. Notwithstanding this apparent wealth, however, the affairs of the company from this time fell into disorder; insomuch that, in 1773, their debts were augmented by an arrear to the treasury in the payment of the 400,000*l.* stipulated; by another to the custom-house for duties unpaid; by a large sum borrowed from the Bank; and by bills drawn upon them from India to the amount of more than 1,200,000*l.* Thus they were not only obliged to reduce their dividend all at once to six per cent. but to apply to government for assistance. Here it may be mentioned in general, that the event proved very unfavourable to the company, as they were now subjected to an interference of government altogether unknown before. Several important alterations were made in their constitution both at home and abroad. The settlements of Madras, Bombay, and Calcutta, which had hitherto been entirely independent of one another, were subjected to a governor-general, assisted by a council of four assessors. The nomination of the first governor and council, who were to reside at Calcutta, was assumed by parliament; the power of the court of Calcutta, which had gradually extended its jurisdiction over the rest, was now reduced and confined to the

trial of mercantile causes, the purpose for which it was originally instituted. Instead of it, a new supreme court of judicature was established; consisting of a chief justice and three judges, to be appointed by the crown. Besides these alterations, the stock necessary to entitle any proprietor to vote at the general courts was raised from 500*l.* to 1000*l.* To vote on this qualification, too, it was necessary that he should have possessed it, if acquired by his own purchase and not by inheritance, for at least one year, instead of six months, the term requisite formerly. The court of 24 directors had before been chosen annually; but it was now enacted that each director should for the future be chosen for four years; six of them, however, to go out of office by rotation every year, and not to be capable of being rechosen at the election of the six new directors for the ensuing year. It was expected that in consequence of these alterations the courts, both of the proprietors and directors, would be likely to act with more dignity and steadiness than formerly. But this was far from being the case. The company and its servants shewed the utmost indifference about the happiness or misery of the people who had the misfortune to be subjected to their jurisdiction. This indifference, too, was more likely to be increased than diminished by some of the new regulations. The house of commons, for instance, had resolved, that when the 1,600,000*l.* lent to the company by government should be paid, and their bond-debts reduced to 1,500,000*l.* they might then, and not till then, divide eight per cent. upon their capital; and that whatever remained of their revenues and nett profits at home should be divided into four parts; three of them to be paid into the exchequer for the use of the public, and the fourth to be reserved as a fund, either for the further reduction of their bond-debts, or for the discharge of other contingent exigencies which the company might labour under. But it could scarcely be expected that if the company were bad stewards and bad sovereigns when the whole of their nett revenue and profits belonged to themselves, they would be better when three-fourths of these belonged to other people. The regulations of 1773, therefore, did not put an end to the troubles of the company. Among other institutions it had been at this time enacted, that the presidency of Bengal should have a superiority over the other presidencies in the country; the salary of the chief justice was fixed at 8000*l.* per annum, and those of the other judges at 6000*l.* each. In consequence of this act sir Elijah Impey, who was created a baronet on the occasion, set sail, with three other judges, for India in the year 1774. The powers with which they were invested were very extraordinary. They had the title of his majesty's supreme court of judicature in India. Civil law, common law, ecclesiastical, criminal, and admiralty jurisdiction, belonged of right to them. They were empowered to try Europeans on personal actions, and to assess damages, without a jury. Every native, either directly or indirectly in the service of the company, or in their territories, was made subject to their jurisdiction, with a view to prevent the Europeans from eluding justice under the pretence of employing natives in the commission of their crimes: so that in fact they were absolute lords and sovereigns of the whole country.

Such excessive and unlimited powers conferred on any small number of men, could not but be extremely disagreeable to the Europeans, who had been accustomed to enjoy a liberty almost equally unbounded before; nor was it to be supposed that the judges, thus suddenly raised from the rank of subjects to the height of despotism, would always use their power in an unexceptionable manner. The design of the establishment was to preserve the commerce and revenues of the company from depredation, by subjecting its servants to the controul of the court; to relieve the subject from oppression by facilitating the means of redress; and to fix a regular course of justice for the security of liberty and property. Instead of considering the circumstances of the country, however, or the manners and customs of the natives, the judges now precipitately introduced the British laws in their full extent, without the least modification to render them agreeable to the Asiatics, who had been accustomed to others of a quite different nature; nor did they even pay the least regard to the religious institutions or habits to which the Indians are so obstinately attached, that they would sooner part with life itself than break through an article of them.

To remedy these and other abuses, in the year 1783 Mr. Fox, then secretary of state, brought in a bill "for vesting the affairs of the East India company in the hands of certain commissioners, and also for the better government of the territorial possessions and dependancies in India." The bill vested the principal power for four years in seven directors, with nine assistant directors, being proprietors, to be nominated in the first instance by parliament; and all future vacancies among the directors to be filled up by his majesty; and all vacancies among the assistant directors to be filled up by the proprietors of India stock, by open poll. The bill passed the commons; but a clamour being raised against it, was rejected by the lords; and the ministry was dismissed. In the following year Mr. Pitt, who succeeded to the administration, brought in a bill, which was afterwards passed into a law, authorising his majesty to appoint certain commissioners from the members of the privy council, to check, superintend, and controul, all concerns, civil and military, of the India company; and in this, which is now called the board of controul, rests the principal direction of the company's affairs; though the court of directors still conduct the commercial business of the company.

In conclusion of this detail we shall only mention the petition last presented to the house of commons by the company. This stated certain pecuniary embarrassments which they apprehended to take place on the 1st of March, 1790, owing to the arrears of the war, to the government claim of 500,000*l.*, to the debt incurred in China, and to the advances necessary to be made for the purposes of the China trade. In compliance with their petition, the chancellor of the exchequer moved, on the following day, that they should be empowered to borrow a sum not exceeding 1,200,000*l.* He at the same time observed, that in all probability the company in 1791 would have upwards of 3,000,000*l.* sterling more than sufficient to discharge their debts. We are sorry to add, this prediction has not been verified.

3. Hudson's-bay company. The vast countries which surround Hudson's-bay abound with animals whose furs and skins are excellent, being far superior in quality to those found in less northerly regions. In 1670 a charter was granted to a company, which does not consist of above nine or ten persons, for the exclusive trade to this bay; and they have acted under it ever since with great benefit to themselves. The company employ four ships, and 130 seamen. They have several forts, viz. Prince of Wales's fort, Churchill river, Nelson, New Severn, and Albany, which stand on the west side of the bay, and are garrisoned by 186 men. The French, in May 1782, took and destroyed these forts, and the settlements, &c. valued at 500,000*l.* They export commodities to the value of 16,000*l.* and bring home returns to the value of 29,340*l.* which yield to the revenue 3734*l.* This includes the fishery in Hudson's-bay. This commerce, small as it is, affords immense profits to the company, and even some advantages to Great Britain in general: for the commodities we exchange with the Indians for their skins and furs, are all manufactured in Britain; and as the Indians are not very nice in their choice, such things are sent of which we have the greatest plenty; and which, in the mercantile phrase, are drugs with us: and although the workmanship happens to be in many respects so deficient, that no civilized people would take it off our hands, it may be admired among the Indians. On the other hand, the skins and furs we bring from Hudson's-bay, enter largely into our manufactures, and afford us materials for trading with many nations of Europe to great advantage. These circumstances tend to prove incontestably the immense benefit that would result to Great Britain, by throwing open the trade to Hudson's-bay, since even in its present restrained state it is so advantageous. This company, it is probable, do not find their trade so advantageous now as it was before we got possession of Canada. The only attempt made to trade with Labrador has been directed towards the fishery, the annual produce of which exceeds 49,000*l.*

COMPANY, in military affairs, a small body of foot, commanded by a captain, who has under him a lieutenant and ensign.

The number of sentinels, or private soldiers, in a company, may be from 50 to 80; and a battalion consists of 13 such companies, one of which is always grenadiers, and posted on the right; next them stand the eldest company, and on the left the second company; the youngest one being always posted in the centre. Companies not incorporated into regiments are called irregulars, or independant companies.

COMPARATIVE ANATOMY has been defined, "that branch of anatomy which considers the secondary objects, or the bodies of other animals; serving for the more accurate distinctions of several parts, and supplying the defects of human subjects."

From the general view, however, which we are about to present of this science, it will appear that the above is by no means a correct definition. Comparative does not, in strict propriety, stand in contradistinction to

human anatomy; but, on the contrary, while it embraces the whole circle of animated existence, considers man as the standard of its comparisons, and the primary object of its enquiries.

To ascertain the differences among animals in their several organs, is the proper object of comparative anatomy. In treating of this subject, therefore, it is our intention to describe, in the first place, the most important of those varieties; which will lead to a classification or division of animals, founded on the whole of their organization, those being connected in one class which have the nearest resemblance to each other in anatomical characters; we shall then select two individuals of the first classes for the more particular description of the internal organs, especially of the thoracic and abdominal viscera; and conclude by taking a general survey; first of the structure of animal bodies, as it relates to their loco-motive powers; and secondly, in reference to the external form and relative quantity of brain or encephalon, as connected with a gradation of the sentient principle and intellectual faculties.

General differences which animals exhibit in their organs of sense and motion.

As the principal characteristics of animal life are sensation and loco-motion, we are naturally led to enquire into the differences of those organs in which the former faculty is found to reside, and likewise into those by which the latter is exerted, for the purpose of establishing a general and obvious classification of the objects of comparative anatomy: accordingly we find the variations of the internal part of the nervous system to present three well-marked divisions; the first of which, commencing with the lowest order of animals, comprehends those in which neither vessels nor nerves have hitherto been discovered; such are the zoophytes, or polypi, which perhaps may be regarded as preferring but an equivocal claim to the denomination of animals. The second division consists of those in which there is only the brain above the alimentary canal, while the remaining portion of the common-bundle of nerves is situated beneath it, and is contained in the same cavity with the other viscera: these form the class of mollusca, crustacea, insects, and some of the articulated worms. The third division comprehends animals in which the common fasciculus of nerves is placed entirely in the back, and above the alimentary tube, being inclosed within a canal which passes through the vertebral column: these are the vertebral animals, in which man is included.

With respect to the external senses, we shall find the difference to consist in the number, and degree of energy, which appertain to each.

All vertebral animals possess the same senses as man.

Sight appears to be wanting in the zoophytes, in several kinds of articulated worms, in many of the insects, and in the acephalous mollusca. The organ of hearing has not been discovered in some of the mollusca and insects. The remaining three senses, but particularly those of taste and touch, appear in no instance to be wanting.

The organs of motion present likewise the three following important and primary distinctions. 1st. The bones either form an internal skeleton, articulated, and covered by muscles; or, 2dly, these last are placed externally, and enveloped by scales or shells: in the last division there is not any hard part that can serve as a lever or fulcrum for motion.

Animals of the first kind have the whole body supported by a bony column formed of distinct pieces, which is called the spine, vertebral column, or back-bone: these, therefore, are the vertebral animals.

The animals destitute of vertebræ, according as they are entirely soft, have their bodies covered with scales, or are enclosed in shells, belong to the classes of soft worms, insects, or crustacea.

Besides, however, the leading distinctions above pointed out from varieties in animal organization and functions, we shall find important differences likewise in those that are called vital and natural functions, and in the organs appropriated to each.

Varieties in the organs of digestion and assimilation.

The organs of digestion afford two leading differences in their general dispositions. In the major part of the zoophytes the intestines form a sac, which has but a single aperture, serving at once for the entrance of the aliment and discharge of the excrement: all other animals have two distinct openings for these purposes (mouth and anus), placed at the two extremities of what is called the alimentary canal.

The chyle, formed by the action of the digestive organs, is transmitted to the several parts of the body in two different ways. It either simply transudes through the sides of the alimentary canal, thus in a manner bathing all the interior of the body, as in the zoophytes, and perhaps in insects; or it is received by a distinct system of vessels, through the medium of which it is conveyed into the mass of blood. Some of those animals that have absorbent vessels, as man, and other of the vertebral class, have the contents of these vessels white, while the blood is red; in others the chyle, lymph, and blood, are of the same colour.

Differences in the organs of circulation, respiration, and voice.

The circulation of the blood itself is accompanied with very considerable differences.

In the first place, there are animals, viz. the insects and zoophytes, which have no circulation; others have a single, and others a double circulation. The reptiles afford an example of a single circulation; while in man, indeed in all the mammalia, as likewise in birds, fishes, and many of the mollusca, it is double.

Where the circulation is single, a great part of the venous blood re-enters the arteries without passing through the lungs: in this manner the blood is distributed in the amphibia. Here there is only one heart; when the circulation is double, there are sometimes one heart at the base of the pulmonary artery, and another at the base of the aorta, or principal artery of the body; and these two hearts are either united, as in man, some other of the mammalia, and birds; or they are separate, and placed at a distance, as in the genus sepia, or cuttle-fish.

Where there is only one ventricle, it is sometimes placed at the base of the aorta, as in snails and other molluscula, or at the root of the pulmonary artery, as in fishes.

Great varieties are also observable in the organs subservient to respiration. When the element that acts on the blood is atmospheric air, it penetrates the interior of the respiratory organ; while it simply glides over a multiplied surface, when that element is water: in this latter case the lamellæ of which the organ is composed are called gills, or branchiæ; these are common to fishes, and many of the mollusca; in some instances, in place of branchiæ, we meet with fringes, or tufts.

The air penetrates into the interior of the body, either by a single aperture, or by several: the former is observed in all animals which have lungs, properly so called. When there are several apertures, which is the case only in insects, the vessels that receive the air are ramified ad infinitum, and convey it to every part of the body. This last is called respiration by tracheæ.

Lastly, scarcely any of the zoophytes have perceptible organs of respiration.

The organs of voice present but two general differences. In birds the glottis is situated at the inferior, in quadrupeds and reptiles it is placed at the superior, extremity of the trachea, and at the root of the tongue. It is only the above three classes of animals that are furnished with a glottis. Sounds are produced in other animals by different means. Sometimes the friction of certain elastic parts is employed for this purpose; sometimes the animal beats the air with other parts, or occasions a rapid motion in certain portions of that air which is retained in its body.

Varieties in the generative organs.

Generation essentially differs both in its mechanism and produce. This function is performed in some of the zoophytes without copulation; and the young animal grows on the body of the parent like the shoots of vegetation. In other animals the sexual organs are either found united in the same individual, as in the mollusca, and some of the zoophytes, or are placed in two separate individuals, as in insects, and all the vertebral class of animals.

Some hermaphrodites, as the bivate shell fish, generate singly; in others of this class a conjunction of two individuals is absolutely necessary for the production of offspring; each individual performing, at the same time, the function of both male and female: this is the case with snails, and other species of mollusca that crawl upon the belly.

The product of generation is either a bud projecting from the parent like the branch of a tree, till completely developed; or a fœtus, which arrives at maturity in the womb of its mother, and from which it issues a living animal; or, finally, it is an embryo, inclosed in a shell, with a substance adhering to, and connected with, it by vessels; which substance it absorbs and converts into nutriment before it is completely hatched. The above varieties form the three modes of generation denominated gemmiparous, viviparous, and oviparous. The first is confined to a few zoophytes and articulated worms; the second takes place in man and other mammalia only; the third is common to all other animals, with the partial exception of those which,

although in reality oviparous, are actually generated living animals, on account of the eggs being hatched in the oviduct of the mother. This is the case for instance, with the viper. Some animals have at birth the same form which they afterwards retain. Others vary considerably in their perfect state from the form which they received at birth, and are said therefore to undergo a metamorphosis. Hitherto this change has only been observed in insects, and in reptiles without scales, that is, in frogs and lizards.

Organs of secretion.

The organs of secretion likewise vary materially in different animals: in the zoophytes secretory vessels have not been detected; in insects secretion is effected by tubes of different length; and in the vertebral animals, as likewise in some of the mollusca, this function is performed by glands, or at least vascular expansions.

CLASSIFICATION OF ANIMALS, FOUNDED ON THE WHOLE OF THEIR ORGANIZATION.

The comparative anatomist divides the whole animal kingdom into two great families: the first comprehends those animals which have vertebræ and red blood: the second is composed of those which are destitute of vertebræ, and which, for the most part, have white blood.

The general anatomy of the first class is the following.

Anatomy of vertebral animals with red blood.

The skeleton is invariably covered by fleshy substance, and is articulated. Its principal support is the vertebral column, which always joins the head at its anterior extremity, and is frequently prolonged at its posterior extremity to form the tail. The ribs, which are constantly met with in animals of this class, are attached to both sides of the spine. There are never more than four limbs; two, or all of which, are sometimes wanting. The brain is always contained in the cranium; the senses are invariably five in number; the eyes are two; the ear has at least three semicircular canals; the sense of smell has always its seat in the cavities at the anterior part of the head.

The circulation is maintained by a heart consisting of at least one ventricle: if there are two, these are never separate. The absorbent is distinct from the venous system.

The two jaws are situated horizontally: the mouth always opens by their separation from above downwards. The intestinal canal is continued from the mouth to the anus, which is uniformly found at the posterior part of the pelvis. The intestines are surrounded by a peritoneum. A liver, pancreas, and spleen, are always met with.

The kidneys are placed on each side the spine and without the peritoneum. The testicles are two in number. Above the kidneys two bodies are found, the use of which has not hitherto been discovered.

This first class is again subdivided into two branches, consisting 1st of animals with warm blood, and 2dly of animals with cold blood.

Vertebral animals with warm blood.

The first of these have invariably two ventricles and a double circulation. Animals of this class cannot exist without respiration. Their brain occupies the whole cavity of the cranium. Their eyes close by palpebræ. The tympanum of the ear is sunk in the scull. The labyrinth of this organ is enveloped by the bone; and there is always observed in it, besides the semicircular canal, an organ resembling the shell of a snail (cochlea). Their nostrils have a communication with the back of the mouth. Their trunk is invariably surrounded with ribs; the greater number of this class of animals have four limbs.

With cold blood.

The second subdivision of this first class, the vertebral animals with cold blood, are frequently without ribs; some have no articulated limbs. Their brain never fills up the whole cavity of the cranium. The eyes are seldom furnished with moveable palpebræ. When there is a tympanum to the organ of hearing, it is always level with the head. The cochlea is wanting. The various parts of the ear are not attached closely to the cranium; sometimes they are at liberty in the same cavity with the brain.

Each of these two branches of vertebral animals, is again subdivided into two classes; the two divisions of the first branch are the mammalia and birds.

First class of vertebral animals with warm blood—THE MAMMALIA.

The mammalia are viviparous: they nourish their young with milk which is furnished by their mammæ; they have always an uterus with two cornua; the males have a penis, which in copulation is introduced into the genital organ of the female.

The head of the mammalia is joined to the first vertebra by two eminences: the cervical vertebræ are never less than six, nor more than nine; the brain is extremely complicated: it has parts which are not met with in other classes of animals, such as the corpus callosum, fornix, pons Varolii, &c. See ANATOMY.

The eyes of the mammalia have only two palpebræ; their ears have four articulated bones, and a spiral cochlea; their tongue is soft and fleshy: the skin is in a great number of instances covered with hair, and there is some hair on all of them.

The lungs are enclosed within the thorax: there is always a diaphragm: there is only one larynx, which is situated at the base of the tongue, and covered by the glottis during deglutition.

The inferior maxilla only is moveable; both jaws are furnished with lips.

The biliary and pancreatic ducts are inserted at the same point: the lacteal vessels contain a milky chyle, and pass through the mesenteric glands. The epiploon covers the anterior portion of the intestines.

The spleen is invariably situated on the left side; between the stomach, ribs, and diaphragm.

Second class—AVES.

Birds are oviparous; they have but one ovarium and one oviduct, a structure peculiar to this class. The head is connected with the vertebræ by one eminence only: the vertebræ of the neck are very numerous. The sternum is much expanded: the anterior members are only used in flying, the posterior in walking.

The eyes of birds have three palpebræ; they have no external ear: the tympanum has only one bone: the cochlea is in the form of a cone slightly twisted; the tongue has a bone internally; the body is covered with feathers; the lungs are attached to the ribs; in the act of inspiration air is communicated to all the body, as birds have no diaphragm. The windpipe has a larynx at each extremity; the upper extremity is without an epiglottis. Their mouth is formed by a bill or beak of a horny consistence, the two mandibles of which are moveable.

Several ducts pass out from the pancreas and liver, and penetrate the intestinal canal at different parts. The chyle is transparent, and there are neither mesenteric glands nor omentum. The spleen is in the centre of the mesentery.

The urinary ducts (ureters) terminate in a cavity called the cloaca, which is the receptacle both of the excrements and eggs. Birds have no urinary bladder.

General anatomy of animals with cold blood belonging to the vertebral class; these are, reptiles and fishes; third class of animals—REPTILES.

There is less uniformity in the organization of reptiles than in that of any other class; some walk, some fly, others swim, and many can merely crawl. Their organs of sensation, particularly the ear, exhibit nearly as many varieties as those of motion. Reptiles are however universally without cochlea; their skin is either naked, or enveloped with a scaly covering: their brain is invariably small; the lungs are contained in the same cavity with the other viscera, but they do not admit the air to pass beyond them. The pulmonary cells are very capacious; there is only one larynx which has an epiglottis: both the jaws are moveable; they are without omentum or mensenteric glands; the spleen, as in birds, is in the centre of the mesentery. The female has two ovaries and two oviducts; reptiles have an urinary bladder.

Fourth class—PISCES.

Fishes respire by organs in the shape of gills situated on either side of the neck, between which they transmit the water; they have therefore no trachea, larynx, nor voice; their bodies are formed for swimming, but they have sometimes no fins. Besides the four which represent the extremities, they have vertical fins on the back, under the tail, and at its extremity.

Their nostrils do not assist them in respiration: their ear is concealed within the cranium: their skin is either without any covering, or is scaly; their tongue is bony; each jaw is moveable; the intestinula cœca often occupy the place of the pancreas; they have an urinary bladder: their ovaries are double.

General anatomy of animals without vertebræ.

The organization of the second family of animals, the invertebral, presents a less regular series to assist the comparative anatomist in his classification. If animals of this class have an articulated and hard skeleton, it is for the most part external. Their nervous system, instead of being enclosed in a bony case, floats in the same cavity with the other viscera. The brain furnishes two branches which envelope the œsophagus; the continuation of these branches forms the remainder of the common mass of nerves.

Animals without vertebræ never respire by cellular lungs; and in no instance have they voice: their jaws have various directions, and often their mouths are merely suckers; they have neither kidneys nor urine; if they have articulated members they are always at least six in number. The invertebral animals may be divided into five classes; the mollusca, crustacea, insects, worms, and polypi or zoophytes.

First order of invertebral animals, forming the fifth general class—MOLLUSCA.

The body of the mollusca is soft, fleshy, and destitute of articulated members: sometimes they have hard parts situated internally. They respire by branchiæ. Their brain is a distinct mass, from which proceed the nerves and a medulla oblongata. They have ganglions. Their external senses vary with respect to number. In some the eyes and ears are perceptible, while in others we are not capable of detecting any other senses than those of taste and touch. Many of the mollusca can masticate, while others can merely swallow. This class of animals has a voluminous liver, which secretes a large quantity of bile. Their generative organs are exceedingly various.

Sixth class—CRUSTACEA.

In the crustacea the body is covered with scales: these animals have often a considerable number of articulated members; their nervous system is composed of a long knotted cord, from the ganglions of which all the nerves are distributed. The crustacea have hard moveable eyes; their ears are very imperfect in their organization: the sense of touch is furnished by antennæ and feelers, as in insects: they have a heart with arterial and venous vessels, and they respire by branchiæ: their jaws are transverse, strong, and numerous; teeth are found in the stomach; a number of intestinula cœca afford a brown fluid, which appears to supply the office of bile. The male of the crustacea has two penes, the female two ovaria.

Seventh class—INSECTA.

Insects have antennæ and articulated members, like the crustacea. Some of these animals have wings, in which case they have existed in different forms, and in certain stages of their existence have been entirely motionless. Insects have a nervous system, like that of the crustacea; they have, however, neither heart nor vessels, and respire only by tracheæ. Not only the liver, but all the secretory glands, are in insects replaced by long vessels, which float in the abdomen. As the animal passes through its different states of existence, the form of the intestinal canal varies considerably in the same individual.

Eighth class—VERMES.

These animals, which greatly resemble the insect tribe, might be joined with insects, but they do not undergo a metamorphosis. Some of them have a distinct vascularity, and they may be regarded as forming an intermediate class between the mollusca, crustacea, and insects; such are the terrestrial worms, and leeches.

Ninth class—ZOOPHYTA.

The parts of the body in this class of equivocal animals are formed like the radii of a circle, in the centre of which the mouth is placed. The anatomist has not hitherto been able to trace in the zoophytes, heart, blood-vessels, brain, or nerves.

The following table will present at one view, without the necessity of detail, the various subdivisions of the classes of animals above described. To render this description more intelligible, the Linnæan classification and generic names of animals have been connected with the anatomical divisions and nomenclature.

MAMMALIA.

A. With nails.

a. Having each kind of teeth.

I. Thumbs only separate on the superior extremities.—Genus homo; of the primates of Linnæus.—*Bimana.*

II. Thumbs separate on all four feet.—Genera simia, lemur; primates Linnæi.—*Quadrumana.*

III. On the fore feet, no thumbs separate.

1. Hands elongated; membranes from the neck to the anus.—Gen. vespertilio, galeopithecus; primates Lin.—*Chiroptera.*
2. The whole of the soles of the feet resting on the ground.—G. erinaceus, sorex, talpa, ursus; feræ Lin.—*Plantigrada.*
3. Feet resting only on the toes.—G. mustela, viverra, felis, canis; feræ Lin.—*Carnivora.*
4. Thumbs separate on the hind feet.—Genus didelphis; feræ Lin.—*Pedimana.*

b. Without some kinds of teeth.

IV. Without canine teeth.—G. kangarus, hystrix, lepus, cavia, castor, sciurus, cheiromys, mus; glires Lin.—*Rodentia.*

V. With no incisive or canine teeth.—Gen. myrmecophaga, orycteropus, dasypus; bruta Lin.—*Edentula.*

VI. Without incisive teeth.—G. bradypus; bruta Lin.—*Tardigrada.*

B. With hoofs.

VII. More than two toes and two hoofs.—G. elephas; bruta Lin. Sus, hippopotamus, hyrax, and rhinoceros; belluæ Lin.—*Pachodermia.*

VIII. With two toes and hoofs.—Pecora Lin.—*Ruminantia.*

IX. One toe and one hoof.—G. equus; belluæ Lin.—*Solipeda.*

C. With finny feet.

X. Four feet.—G. phoca; feræ Linnæi: and trichecus, bruta Lin.—*Amphibia.*

AVES.

I. Feet short, toes with long claws, beak hooked.—Accipitres Lin. except lanius.—*Accipitres.*

II. Four toes, three anterior and one behind; external toes entirely or partially joined.—G. laneus; passeres Lin. except columba, and some of the picæ.—*Passeres.*

III. Two anterior toes and two behind.—Part of the G. picæ Lin.—*Scansores.*

IV. Anterior toes united at their base by a short membrane.—Gallinæ, and some of the grallæ, Lin.—*Gallinæ.*

V. Legs long and naked.—Most of the grallæ Lin.—*Grallæ.*

VI. Toe united by extensive membranes.—Anseres Lin.—*Anseres.*

REPTILES.

A. Heart with two auricles.

I. Upper part of the body enveloped by shell, jaws covered with horn.—G. testudo; reptiles pedati Lin.—*Chelonii.*

II. Body covered with scales, teeth.—Reptiles pedati Lin.—*Saurii.*

B. Heart with only one ventricle.

III. Body covered with scales, no feet, no branchiæ at any period.—Serpentes apodes Lin.—*Ophidii.*

IV. Skin naked, feet, branchiæ in the first period.—Reptiles pedati Lin.—*Batrachii.*

PISCES.

A. Skeleton cartilaginous.

I. Branchiæ fixed. Part of the amphibia nantia Lin.—*Chondropterygii.*

II. Branchiæ loose. Part of the amph. nan. Lin.—*Branchiostegi.*

B. Skeleton bony.

III. No ventral fins.—Apodes Lin.—*Apodes.*

IV. With ventral fins anterior to the pectoral.—Jugulares Lin.—*Jugulares.*

V. Ventral fins below the pectoral.—Thoracici.—*Thoracici.*

VI. Ventral fins behind the pectoral.—Abdominales Lin.—*Abdominales.*

MOLLUSCA.

I. Head with tentacula supplying the place of feet.—Sæpia belonging to the mollusca, and argonauta and nautilus to the cochleæ, Lin.—*Cephalopoda.*

II. Head free, and which crawl on the belly.—Cochleæ Lin.—*Gasteropoda.*

III. Without a distinct head.—Principally conchæ Lin.—*Acephala.*

CRUSTACEA.

I. *Monuculus.*

II. *Cancer.*

INSECTA.

A. With jaws.

I. No wings.—*Gnathaptera.*

II. Four reticulated wings.—*Neuroptera.*

III. Four veined wings.—*Hymenoptera.*

IV. Four wings, superior hard, inferior folded transversely.—*Coleoptera.*

V. Four wings, superior hard, inferior folded longitudinally.—*Orthoptera.*

B. Without jaws.

VI. Four wings much crossed, rostrum articulated.—*Hemiptera.*

VII. Four wings covered with scales, trunk spirally convoluted.—*Lepidoptera.*

VIII. Two wings only.—*Diptera.*

IX. No wings.—*Aptera.*

VERMES.

I. With external organs of respiration, and hairs on the sides of their bodies.—Some of the mollusca, and some of the testacea, Lin.

II. Without external organs of respiration.

1. Hairs on the sides of the body.—Nais, lumbricus, thallaserna.
2. No hairs on the side of the body.—Hirudo, fasciola, planaria, gordius.

Animals bearing a resemblance to the vermes, the organization of which is not sufficiently known to determine whether they belong to that order, or ought to form one contiguous to the zoophyta.

1st family.—Tenia, hydatigenia, ligula, linguatiula.

2d family.—Ascaris, and some other intestinal worms.

ZOOPHYTA.

A. Not attached.

I. With a calcareous or coriaceous envelope, and intestines floating in the interior cavity.—*Echinodermia.*

II. With a fleshy or gelatinous envelope, intestines hollow, and adhering in the mass of the body.—*Urticaria.*

III. Very small, swimming in fluids.—*Infusoria.*

IV. Gelatinous bodies, increasing by buds.—*Polypi.*

B. Attached to a solid trunk.

V. In which the medullary substance crosses a corneous axis, and terminates in polypi on its branches.—*Zoophyta.*

VI. In which each polypus is inclosed in a horny or calcareous shell, and is not connected by a medullary axis.—*Eschara.*

VII. In which a solid axis is covered with a sentient flesh, from cavities in which the polypi issue.—*Ceratophyta.*

VIII. In which a stony axis or base serves for the receptacle of the polypi.—*Lithophyta.*

IX. In which the base is spongy, friable, or composed of fibres.—*Spongia.*

ANATOMY OF A COW.

Class 1st, order 2d, genus 8th, species ruminantia.

Fœtal state.

For the production of the fœtus in this animal, as well as in the human species, something is necessarily derived from the ovaria. The uterus of the cow has large cornua, in which a portion of the secundines is contained; consisting principally of the allantois, with the contained liquor. The muscular fibres of the uterus are plainly marked. Upon its internal surface are found a number of glandular bodies, which are formed by the termination of the uterine vessels. When the womb is in an impregnated state, a kind of mucilaginous liquor may be pressed out of these glandular bodies. These are called the papillæ of the uterus. The mouth of the womb (os uteri) is entirely closed by a mucilaginous substance, that is common to the females of all animals when in a state of pregnancy. The first of the proper membranes of the fœtus is the chorion; on the external surface of which are spread a number of fleshy bodies, called cotyledones, or placentulæ, which answer the same purpose with the placenta in the human subject. These, though indented among the papillæ, have no vascular connection with them.

The allantois, or allantoides, is the second membrane of the uterus. This is extremely fine and transparent; it is not an entire involucrum of the fœtus, but is chiefly lodged in the cornua uteri. In mares, bitches, and rabbits, it envelopes the amnios. In sheep and goats, the form and comparative extent of this membrane, are nearly the same as in the animal we are now describing, while in swine and in rabbits it covers still less of the amnios. A quantity of urine is commonly found in the sac, which this membrane forms, probably by the dilatation of the urachus, which is connected at its other extremity to the fundus of the bladder. This membrane is exceedingly vascular; its existence in the human female has been a subject of much dispute. See MIDWIFERY.

The third proper involucrum of the fœtus is the amnios. This membrane is thinner and firmer than the chorion. Ramifications of the umbilical arteries and veins are spread out upon it, by the terminations of which, at its lateral parts, a liquor is secreted into the cavity of the membrane. This liquor is, in the first instance, in a small quantity; it afterwards increases; and again, towards the end of pregnancy, decreases. The amnios does not enter the cornua uteri.

We find in the fœtus of this animal two venæ umbilicales, the circulation of which is performed in the following manner. The blood from the placenta of the mother is conveyed into the capsula glissoniana, where it becomes blended with the blood of the vena portarum. Part of this blood proceeds immediately to the cava by the ductus venosus; the rest circulates through the liver. The whole is transmitted from the cava into the right auricle, whence part is sent by the foramen ovale into the left auricle: the rest passes directly into the pulmonary artery, through the right ventricle. A small portion of this last circulates through the lungs, while the greater part is conveyed immediately from the pulmonary artery through the medium of the canalis arteriosus into the descending aorta.

Adult state.

There are no dentes incisores in the upper jaw of this animal; but the gums are hard, and the tongue remarkably rough; its substance being covered by long sharp-pointed papillæ, which are turned towards the throat, for the purpose of retaining the received aliment. The œsophagus of this animal is composed of a double row of spiral fibres, which decussate each other. In common with all the ruminating animals, the cow has more than one stomach. Some of the ruminantia have two, some three; while the subject under examination has four stomachs, or rather ventricles; the first of these is the largest; it is vulgarly called the paunch; this lies upon the left side, and immediately receives the aliment. Upon the internal surface of this ventricle, there are a great number of small blunted processes, which give the whole a general roughness and considerable extent. By the force of the muscular coat of the paunch, aided by the gastric liquors, the food is in this cavity sufficiently macerated; after which it is returned through the œsophagus into the mouth, where it is now masticated. This process is what is called chewing the cud, or rumination. After rumination the food is sent down into the second stomach, into which the œsophagus opens directly, as well as into the first. This second stomach is smaller than the first; it is situated anteriorly: the cells on its internal surface cause it to assume the appearance of a honeycomb. Here the food is further macerated, and is hence protruded into the third; the interior surface of which forms a number of plicæ or folds; from this stomach it passes into the fourth, the structure and function of which greatly resemble the human stomach. This perhaps ought, in strict propriety, to be alone denominated the stomach. It is worthy of remark, that in consequence of the elaboration of the aliment in ruminating animals, much less food is required by them than by others, who have only one stomach. In the horse there is but one ventricle for the maceration of the ingesta, from which a liquor for nourishment is extracted, and the remainder discharged, by the anus, very little altered.

The intestinal canal of the cow is of considerable length; there is scarcely any difference in the diameters of the large and small guts. The cœcum is capacious and long; the spleen is attached to the diaphragm; the liver is not divided into so many lobes as in man; the vesica urinaria is of a pyramidal shape; it is exceedingly capacious; the cornua of the uterus are contorted in the form of a snail; the heart differs in form from that of man principally in having a more acute point, which point is composed only of the left ventricle; the aorta is properly, in this animal, divided into ascending and descending.

ANATOMY OF A DOMESTIC FOWL.

Class 2d, genus 4th, species gallinæ.

This animal, like all others of the same class, is oviparous. The œsophagus of this creature passes down its neck, inclining somewhat to the right side: it terminates in a large membranous sac, which is the ingluvies or crop, where the aliment is macerated and dissolved; then passing out, it proceeds down the remaining portion of the œsophagus into what has been called the ventriculus succentarius, formed by a continuation of the gullet, with more numerous glands. These glands separate a liquor, by which the food is still more diluted, before it enters the true stomach, gizzard, or ventriculus callosus.

The duodenum begins nearly at the same place where the œsophagus enters; the two orifices are however divided by means of a protuberance, called septum medium. The duodenum is chiefly situated in the right side; its two extremities are attached to the liver; the ductus choledochus enters near its termination, and discharges its contents into the gut, contrary to the course of the food.

The small intestines are of considerable length. At the termination of the ilia, there are two large cœca, one on each side proceeding in an ascending direction from the side of the rectum. The excretories of the urine have already been described, as discharging their contents into the cloaca. See general anatomy of the class aves.

The pancreas lies between the two folds of the duodenum; the spleen sends its blood into the vena portarum; the liver is divided into two equal lobes by a pellucid membrane. The principal peculiarity to be observed in the heart, is the want of the valvulæ tricuspides, and their place being supplied by one fleshy substance: the form and mechanism of the lungs are the same as in the other genera of the class. Cells are found in every part of the body, which communicate with those of the lungs; and, as before remarked, are filled with air, which even penetrates into the cavities of the bones. The trachea at its division is very much contracted. Hence, in part, the shrillness of voice peculiar to this class of animals. That birds are without diaphragm has already been remarked. In the animal we are now describing, the whole thorax and abdomen are divided by a longitudinal membrane, or mediastinum, attached to the lungs, pericardium, liver, stomach, and likewise covering the stomach and intestines; this is analogous to the omentum in the human species.

The lacteals pass from the intestines upon the mesenteric vessels; those of the duo-

denum run along the side of the pancreas; afterwards they arrive upon the cœliac artery: here they receive the lymphatics from the liver and gizzard, and shortly after another from the inferior part of the œsophagus. At the root of the cœliac artery they are joined by the lymphatics of the renal glands; and near the same part by the lacteals of the small intestines. A particular branch passes from the rectum, which receives some small vessels from the kidneys at the root of the cœliac artery. The lymphatics of the inferior extremities appear to unite with those from the intestines. At the root of the cœliac artery the junction of the lymphatics forms a kind of net-work, from which arise two thoracic ducts, one lying on each side of the spine, which terminate near the angle formed by the jugular and subclavian veins. The ducts are joined by the lymphatics of the neck, and probably by those of the superior members or wings, at the place of their entrance into the jugulars. The chyle, it has already been observed, in all birds is like the lymph, transparent and colourless.

The kidneys lie in the hollow of the backbone, from which the ureters pass into the cloaca. The testicles are placed on each side of the spine, and are remarkably large in this animal: the seminal vessels pass from these at first in a straight direction, but afterwards are convoluted, like the epididymis of the human subject. These convolutions partly supply the want of vesiculæ seminales; the coition however of these animals is very short; the vasa seminifera terminate in the penes, of which, in the cock, there are two. Birds in general are without prostate gland. From the large size of the testes this animal is remarkably salacious, and is capable of impregnating many females. Impregnation is effected in the following manner: The racemus vitellorum of the female being analògous to the human ovaria, is attached by a membrane to the spine, which membrane is continued down to the uterus. The orifice of the womb is averse in respect to the ovaria; notwithstanding, by the force of the venereal orgasm, it turns round and grasps the vitellus: the substance from the racemus, in its passage through the duct, receives a gelatinous liquor, by which, with what it afterwards receives in the uterus itself, the white of the egg is formed. The shell is lined with a membrane, and in the larger end there is a bag filled with air, for which there is no outlet.

When the egg is completed, it is pushed out from the uterus, through an aperture at the side of the common cloaca. When the hen lays eggs that are not impregnated, the semen of the male has not been applied to the vitelli. These eggs appear to be complete, with the exception of a small black spot, which is that from which the rudiments of the chick are formed.

General view of the organs subservient to animal motions.

FIRST, OF THE SKELETON.

The bones of which the skeleton is composed are for the most part articulated, so as to form a whole. To this rule, however, there are exceptions. In birds and in quadrupeds, the bones which support the tongue are only connected by soft parts with the general skeleton. In those quadrupeds which have no clavicles, all the osseous parts of the anterior extremities are only attached by muscles; in other quadrupeds they are merely joined to the sternum by single clavicles, and by double ones in the class aves.

In fishes they are connected with the vertebral column by a bony girdle. In this class of animals the posterior extremities are generally free, and simply fixed in the muscular substance, while in other animals they have a firm connection with the rest of the skeleton through the medium of the pelvis.

There are three primary divisions of the skeleton; the head, the trunk, and the extremities.

The first is in no instance wanting. In serpents, and in some fishes, the extremities are totally wanting. In those fishes that are without ventral fins (apodes Linnæi), and in the cetacea among the mammalia (cete Lin.), the posterior extremities are wanting. The anterior extremities only are wanting in one species of lizard.

No vertebral animal has more than four extremities, unless we include the kind of wing which belongs to the flying-dragon, a small animal nearly similar to our lizard.

The trunk is formed by the vertebræ, ribs, and sternum; the number of the vertebræ is variable. The sternum is absent in serpents and fishes. The ribs are wanting in frogs, rays, sharks, and a number of cartilaginous fishes.

It is but a small number of the vertebral animals that are without coccyx: these are the ternate bats, and the frog kind. Several fishes have no neck. The false ribs are always posterior in quadrupeds. In birds they are both before and behind. In the crocodile, and some other animals, there are ribs which proceed from the sternum, but which do not join the vertebræ: others come from the vertebræ, and unite anteriorly with the corresponding ribs, without any intermediate sternum, as in the cameleon. The head is invariably placed at the anterior extremity of the vertebral column. It is divided into three parts, which, although they differ in relative proportions, are never wanting. These parts are, 1st, The cranium, in which the brain is contained, and in the partitions of which the cavities of the internal ear, and frequently those of the nose, are situated. 2. The face, which contains the orbits of the eyes, and the nasal cavities, and which terminates inferiorly by the upper jaw. 3. The lower jaw, which in all animals is moveable, even in the crocodile. The upper jaw is immoveable in man, in quadrupeds, and in some reptiles, as the tortoise, the crocodile, and others; it is more or less moveable in birds, serpents, and fishes. The extremities, when perfect, are divided into four parts: those which belong to the anterior members are the shoulder, the arm, the fore-arm, and the hand; those of the posterior are the hip, the thigh, the leg, and the foot. These distinctions do not obtain among fish, whose extremities are merely formed of osseous rays, or bones, constituted like a fan, and articulated to parts corresponding with the shoulder or hip. The shoulder is formed of the scapula placed against the back, and the clavicle attached to the sternum. The last is wanting in some quadrupeds and the cetacea; it is double in birds, tortoises, frogs, and many lizards. Where extremities exist, the scapula is always found. The arm is constituted by one bone; the fore-arm has almost always two; even when this last part consists of only one bone, there generally appears a kind of separating furrow. The hand, as it respects the number of its bones, considerably varies, but the osseous portions of which it consists always form a carpus, metacarpus, and fingers. This is the case even in birds, the fingers of which are enveloped in a skin covered by feathers. This organization likewise obtains in the cetacea, in which the whole anterior member is reduced to the figure of an oar or fin.

The various parts of the skeleton are usually disposed with a strict attention to symmetry; so that when divided by a longitudinal section, the two halves are counter-proofs of each other. In one kind of fish, however, called pleuronectes, which comprehends soles, plaice, turbots, &c. the head is so constituted, that the two eyes and the two nostrils are on the same side.

It may be proper to remark, before we conclude this general account of the skeleton, that although an animal of one class may appear similar to that of another, the resemblance is merely outward; and affects the skeleton, not in the number or arrangement of its bones, but merely in its total proportions. Bats, for instance, appear to have wings; but an anatomical examination demonstrates these to be in reality hands, the fingers of which are merely somewhat lengthened. In like manner, although dolphins appear to have fins, composed of an entire piece, we find under the external covering all the bones that compose the anterior extremities of the other mammalia, short, and nearly immoveable.

OF THE FORMS AND ACTIONS OF MUSCLES.

While the form and number of bones, and the mode in which they are articulated, determine the number, kind, and direction, of motions they are capable of, the number and situation of the muscles determine the number, kind, and direction, of the motions that are actually performed.

Muscles are attached to the bones by tendons. The tendons, like the muscles, are composed of fibres, but they are more close and firm, and have a silver whiteness. The form of the tendon varies as much as that of the muscle. Heavy birds, that walk much, have the tendons of their limbs ossified at a very early period. The same thing takes place in the jerboa, and other animals, that always leap with their posterior extremities.

The tendons of the crustacea and insects are frequently articulated with the scaly case they have to move, in the same manner as one bone is articulated with another; with this case they are connected by a membranous ligament. This structure is particularly observable in the great claws of cray-fish.

The tendons of the mollusca are not perceptible; but this is in consequence of the tendinous and fleshy parts, both having the same colour. The muscles are divided into simple and compound. the first comprehend those in which the fibres have one direction only; the most common are the ventriform, the fibres of which are nearly parallel, and compose a long bundle of a round shape; their fleshy portions swell in

the centre, which is called the belly of the muscle. The second kind of simple muscle is flat, and has parallel fibres. These form a sort of fleshy membrane, which, instead of terminating in small tendons, ends by aponeurosis, or a kind of tendinous membrane.

In the action of muscles it appears that the elementary fibres, all individually, exercise the same power at the moment of contraction; but the sum total of force is directed by the manner in which these fibres are disposed, or the situation of the whole muscle. It is obvious then, that in either kind of these simple muscles above described, the total action is equal to the sum of all the particular actions, which however is not the case with the two other kinds of simple muscles, the radiated and penniform. Muscles are said to be radiated, when the fibres of which they are composed are disposed like the radii of a circle, which, proceeding from a base of a greater or less magnitude, incline towards each other, and are inserted in a small tendon.

Penniform muscles have their fibres arranged in two rows, which unite in a middle line, and form with each other angles more or less obtuse, assuming the appearance of the feathers of a quill. Their tendon is a prolongation of this central line.

In these two last kinds of muscles the resulting force must necessarily be less than the collective sum of the component forces: it is only equal to the sum of the diagonals of the parallelograms, which are formed from every two fibres that unite in the production of one angle.

Compound muscles are produced by the union of several in one common tendon. Sometimes these uniting muscles are of a similar nature: at others the compound muscle is formed by an assemblage of various kinds, as the radiated, the ventriform, and others.

There are some muscles with only one belly with divided tendons; others have several fleshy parts and tendons interlaced in various ways. These last may be denominated complicated muscles.

Muscular origin and insertion may be considered as of eight distinct kinds. A muscle, or muscles, may be destined to compress the soft parts contained in a cavity, which is then enveloped by the muscular fibres in different directions, in the form of membranes or bands. Such is the arrangement in the abdominal muscles and diaphragm of the human species; such is the disposition of the muscles of slugs, other mollusca, and naked worms, which can contract themselves in every direction. When a number of such muscles act in conjunction, it is for the purpose of expelling some matter from the body, as excrement, or ova; their more usual action however is alternate, and then their effect is to increase one of the diameters of the cavity they surround, and diminish the other. Thus, for example, during every inspiration the abdomen becomes wider and shorter, while exactly the contrary takes place on each expiration. In like manner slugs and leeches lengthen and shorten themselves, by first moving their annular, and then their longitudinal muscles.

Upon this principle likewise, those muscles act which are destined to lengthen or shorten, and to relax or compress, any soft part; such as the tongue of man, or the horns of snails. The heart, the arteries, the intestines, and other organs, are furnished with muscles of this kind.

Some muscles are calculated to enlarge or diminish a soft aperture; of these some surround the orifice as the sphincters; others are inserted more or less directly in the margins of the apertures. When they are uniformly extended round the orifice, such orifice preserves its figure, and is always dilated or contracted in the same manner. The eyelid of the moon-fish, and the anus of the snail, present examples of this species of muscular motion. When these muscles are inserted in different directions, the form of the aperture is very variable; as for instance, in the lips of man. The expressive variety of the human physiognomy arises in a great measure from the great mobility of this part.

Another employment of the muscles is to extend and fold back in the manner of curtains, membranes that furnish coverings to certain parts; such as the eyelids of man, quadrupeds, and birds. When such muscles are in the bodies of these membranes, their descriptions are the same as above described; but when their situation is external, they form complicated pulleys.

Again, muscles are employed in the act of turning or rolling a globular mass, which, although free, is supported on every side, as the human eye in the orbit, or the mouth of a snail in its head. The muscles surround such parts in the form of a hoop, and the body which they move is turned to that part in which the muscle contracts with most vigour.

These four modes of action may all be referred to that of the sphincters or circular muscles.

The following mode in which the muscles perform their action may be compared to the action of ropes, drawing a resisting object; the muscular fibres pulling in the direction in which the motion of the part operated upon is to be performed; or if the muscles diverge, an equal quantity of action is produced on either side, and the resulting force is employed to still more advantage. Of the first kind of action, the sterno-hyoideus and genio-hyoideus form examples, and the motions of the mylo-hyoideus and scapulo-hyoideus are instances of the second.

When the bone on which the muscular agency is displayed, cannot be elevated or depressed all at once, it must then be regarded as a lever, the articulation affording the fulcrum.

When the articulation is between the two extremities, and the muscles are situated at one of them, the bone forms a lever of the first rank; such is the case in the mandible of the cray-fish; an example of a similar kind is likewise furnished by the olecranon and os calcis, with their respective muscles; but the most remarkable is, the tibia of those birds called grebes and divers; the long apophysis of which, raised above the knee, serves as a substitute for the patella.

But the most common case of muscular attachment is, that in which the articulation is at one extremity of the bone; then the most favourable position of the muscle is, when it originates from another bone parallel to that which it has to move, or when it forms with the latter only a very small angle; such is the case with the intercostales, interspinales, and intertransversi; and the muscles which draw together bones of a fan-like shape, as the wings of the flying dragon.

The muscles which close the mouth of man and the bill of birds may be also compared to the preceding; these however are inserted nearer to the point of support, and by consequence their force is diminished.

The last and most usual mode of insertion is, when a muscle united with one bone is inserted into another, which last is articulated with the first, and may be extended so as to form together a right line, or bent into a very small angle; this mode is the most disadvantageous, on account of the extreme obliquity of the insertion when the moveable bone is extended, and because of its proximity to the fulcrum; this inconvenience, however, is in some measure obviated by the heads of bones, or enlargements of their articular extremities; so that the tendons, turning round a convexity in order to be inserted below it, form more obtuse angles.

It was necessary that the fulcrum of motion should be near, to prevent the members from being inordinately large, and likewise for the production of a ready and complete flexion, as the muscular fibre loses only a determinate fraction of its length in contraction. Examples are afforded of muscles inserted at a great distance from the fulcrum: birds have one which extends from the top of the shoulder near to the carpus; this however happens because all the angle formed by the radius and ulna is, in these animals, occupied by a membrane intended to augment the surface of the wing.

It is in consequence of the small contraction of the muscular fibre, that the short bones in which complete inflexion is required, are moved by muscles attached to bones at a distance: the vertebræ and phalanges of the fingers are in this situation. Muscles extended from one to the other of these small bones could not have produced a sufficient flection: besides, in the phalanges they would have made the fingers disproportionately thick: it is also necessary that the tendons of these muscles be fixed down to the bones over which they pass; otherwise whenever the phalanges were bent, the muscles and tendons would remain in a straight line like the string of a bow; hence the utility of the carpal ligaments, the sheaths, and perforations. In animals that have but three phalanges, as in man, there is but one perforation; but birds, which have one toe with four and another with five phalanges, have two perforations and consequently three muscles,—one perforated, one perforating and perforated, and one perforating.

Those vertebræ which have much motion, for example, those of the neck in birds, and of the tail in quadrupeds, have likewise very distant muscles; but their long tendons are enclosed in sheaths, which continue to bind them, until they arrive opposite the place of termination.

External form as an indication of the nature of the sentient organization.

In the general description which we have already given of the skeleton, the head of vertebral animals was said to be capable of

division into three parts, viz. the cranium, face, and inferior maxilla; as it relates however to the sentient organization, the head will only admit of two primary divisions: the cranium, containing the brain; and the face, in the cavities of which are lodged the organs of sight, smell, and taste. The organs of hearing are situated on the sides of the cranium. A capacious cranium and a small face are the indices of a large brain and less developed senses of smell and taste.

The relative proportion of the cranium and the face, also indicates a greater or less degree of perfection in those faculties which are generally denominated intellectual or reflective, compared with the external or sensitive. In man the cranium is relatively the largest, and the face the smallest; and animals, as they depart from these proportions, become in the same ratio more stupid and ferocious. To this general rule, however, there are some exceptions. See the article PHYSIOGNOMY.

One of the most simple means of ascertaining these proportions is by means of the facial line of Camper, and the angle which it forms with the basis of the cranium. The facial line is supposed to pass in contact with the upper incisores teeth, and the most prominent part of the forehead; and the basilar line of the cranium is that which bisects longitudinally a plane passing through the external openings of the ear, and along the lower edge of the anterior aperture of the nostrils. In proportion as the forehead projects or the cranium is enlarged, the angle made by these lines must necessarily increase; on the contrary, as the cranium diminishes in size, or the forehead recedes, the facial line will incline further back and diminish the angle. In man the facial angle is wider than in any other animal, and it becomes always more acute in the different animals as they are removed from man.

In the European, it is 85°; negro, 70°; orang-outang, 67°; pug-dog, 35°; polecat, 31°, &c.

Still more important relations, however, are discovered by means of a vertical and longitudinal section of the head. In the European the area of the section of the cranium is nearly four times as large as that of the face, exclusive of the inferior maxilla. In the negro the face is increased about one-fifth. The proportion of the cranium is still less in the orang-outang; in the sapajous the face is nearly one-half of the cranium; in most of the carnivora it is nearly equal. In the rodentia, pachydermata, ruminantia, and solipedia, the area of the section of the face is larger than that of the cranium. Of the rodentia, the hare and marmot have it one-third larger. In the porcupine it is more than double, a little more than double in hogs, nearly triple in the hippopotamus, and almost quadruple in the horse. (N. B. The above proportions are given on the authority of M. Cuvier.)

These remarks are particularly interesting in relation to the mammalia order of animals, as in these the cavity of the cranium is occupied entirely by brain; so that the description of the osseous part, indicates pretty accurately the external form of the whole encephalon.

The proportion which the cranium bears to the face in birds, does not authorise the same inductions as in the mammalia; and with respect to reptiles and fishes (the remaining class of vertebral animals) no important inferences can be made from the magnitude and form of the cranium, as the brain only occupies a small part of its cavity. In the nervous system of the mollusca, crustacea, and insects, the utmost irregularity obtains; and it has already been stated that in the zoophytes, which occupy the lowest rank in the scale of animal life, a distinct sentient organization has not hitherto been detected. For the internal organization and functions of the nervous system, consult the article PHYSIOLOGY.

COMPARISON, in rhetoric, a figure that illustrates and sets off one thing, by resembling and comparing it with another, to which it bears a manifest relation and resemblance, as in the following figure in Shakspeare:

> She never told her love,
> But let concealment, like a worm,
> Feed on her damask cheek: she pined in thought,
> And sat like Patience on a monument,
> Smiling at Grief.

COMPASS, or mariner's compass, an instrument by which the ship's course is determined. See MAGNETISM, and NAVIGATION.

COMPASSES, or pair of compasses, a mathematical instrument for describing circles, or measuring figures. See INSTRUMENTS MATHEMATICAL.

COMPENSATION, in the civil law, a sort of right, whereby a debtor, sued by his creditor for the payment of a debt, demands that the debt may be compensated with what is owing him by the creditor, which, in that case, is equivalent to payment.

COMPERTORIUM, in the civil law, signifies a judicial inquest made by delegates to search out and relate the truth of a case.

COMPITALIA, or COMPITALITIA, in Roman antiquity, feasts instituted by Servius Tullius in honour of the Lares. These feasts were observed on the 12th of January and 6th of March. Tarquinius Superbus, consulting the oracle upon the subject of the sacrifices to be offered on that occasion, was answered that he should offer heads to the Lares: for which reason, the Romans presented the heads of young children in sacrifice to those deities. But Junius Brutus ordered poppy-heads to be offered in their stead. Macrobius relates, that they satisfied the Lares, by offering the images of men and women made in straw; and that for each slave in their family, they threw in so many bales of wool.

COMPLEMENT, in astronomy, the distance of a star from the zenith: or the arch comprehended between the place of the star above the horizon and the zenith.

COMPLEMENT, in geometry, is what remains of a quadrant of a circle, or of 90°, after any certain arch has been taken away from it. Thus, if the arch taken away be 40°, its complement is 50: because 50+40 =90. The sine of the complement of an arch is called the co-sine, and that of the tangent the co-tangent, &c.

COMPLEMENTS in a parallelogram, are the two smaller parallelograms made by drawing two right lines through the diagonal, and parallel to the sides of the parallelogram.

In every parallelogram, these complements are equal. See MECHANICS.

COMPLEX terms, or ideas, in logic, are such as are compounded of several simple ones. Complex ideas are often considered as single and distinct beings, though they may be made up of several simple ideas, as a body, a spirit, a horse, a flower; but when several of these ideas of a different kind are joined together, which are usually considered as distinct single beings, they are called a compound idea, whether these united ideas be simple or complex. Complex ideas, however compounded and recompounded, though their number is infinite, and their variety endless, may be all reduced under these three heads, modes, substances, and relations.

COMPLEX proposition, is either that which has at least one of its terms complex; or such as contains several members, as casual propositions; or it is several ideas offering themselves to our thoughts at once, by which we are led to affirm the same thing of different objects, or different things of the same object. Thus, God is infinitely wise, and infinitely powerful. In like manner, in the proposition, Neither kings nor people are exempt from death.

COMPLEXUS, in anatomy, a broad and pretty long muscle, lying along the back-part and side of the neck. See ANATOMY.

COMPOSITE NUMBERS, are such as can be measured exactly by a number exceeding unity; as 6 by 2 or 3, or 10 by 5, &c. so that 4 is the lowest composite number. Composite numbers between themselves, are those which have some common measure besides unity; as 12 and 15, as being both measured by 3.

COMPOSITE ORDER. See ARCHITECTURE.

COMPOSITION, in grammar, the joining of two words together; or prefixing a particle to another word, to augment, diminish, or change its signification.

COMPOSITION, in logic, a method of reasoning, by which we proceed from some general self-evident truth, to other particular and singular ones.

COMPOSITION, in music, the art of disposing musical sounds into airs, songs, &c. either in one or more parts, to be sung by a voice, or played on instruments.

Under composition are comprehended the rules, 1. Of melody, or the art of making a single part; that is, contriving and disposing the simple sounds, so as that their succession and progression may be agreeable to the ear. 2. Of harmony, or the art of disposing and concerting several single parts together, so as that they make one agreeable whole. It may be proper to observe here, that melody being chiefly the business of the imagination, the rules of its composition serve only to prescribe certain limits to it, beyond which the imagination, in searching out the variety and beauty of airs, ought not to go; but harmony being the work of the judgment, its rules are more certain and extensive, and more difficult in practice.

COMPOSITION, in painting, consists of two parts, invention and disposition; the first of which is the choice of the objects which are to enter into the composition of the subject the painter intends to execute, and is

either simply historical or allegorical. See PAINTING.

COMPOSITION, in commerce, a contract between an insolvent debtor and his creditors, by which the latter accept of a part of the debt in compensation for the whole, and give a general acquittance accordingly.

COMPOSITION, in printing, commonly termed composing, the arranging of several types, or letters, in the composing-stick, in order to form a line; and of several lines ranged in order in the galley, to make a page; and of several pages to make a form. Generally the composing-stick is made of iron, sometimes of wood; more or less in length or depth, according to the page to be composed, or the fancy of the compositor. It has two sliding-pieces, fastened by means of a nut and screw, which are slipped forwards or backwards, according to the space which the lines, notes, &c. are to take up, or the compositor thinks proper. The composing-stick ordinarily contains seven or eight lines of a middle-sized letter: these lines, when set, are taken out by means of a thin slip of brass called a rule, and disposed in the galley: then others are composed, until a page is formed, which being done, it is tied up and set by: the rest of the pages that make up a sheet, being prepared in the same manner, are carried to the imposing or correcting-stone, and being there ranged in order, they are disposed in an iron frame, fitted with wooden furniture: then the quoins being stuck in, the chace, or frame, is put in the press, in order to their being printed. See PRINTING.

COMPOSITION of motion, is an assemblage of several directions of motion, resulting from several powers acting in different, though not opposite, directions. See MECHANICS.

COMPOSITION of proportion, is the comparing the sum of the antecedent and consequent, with the consequent in two equal ratios; as suppose, 4 : 8 : : 3 : 6, they say, by composition of proportion, 12 : 8 : : 9 : 6. The same holds of the sum of the antecedent and consequent, compared with the antecedent: thus we likewise say 12 : 4 : : 9 : 6. There is a great difference between composition of proportion by addition and by multiplication. See PROPORTION.

COMPOST, in husbandry and gardening, several sorts of soils, or earthy matters, mixed together, in order to make a manure, for assisting the natural earth in the work of vegetation, by way of amendment or improvement.

COMPOSTO, in music, means compounded or doubled, as a fifteenth is an octave doubled, or an octave is compounded of a fifth and a fourth.

COMPOUND FLOWER, one consisting of several distinct lesser flowers, or corollulæ, each furnished with a style, stamina, &c. The corollulæ are of two kinds, viz. tubulated and ligulated: the tubulated are always furnished with a campanulated limb, divided into four or five segments; whereas the ligulated corollulæ have only a flat, linear limb, terminated by a single point, or by a broader extremity, divided into three or five segments. The plants with compound flowers are extremely numerous, forming a class by themselves, called by Linnæus syngenesia.

COMPOUNDS, PRIMARY, in chemistry. If the science of chemistry had made sufficient progress, this division would comprehend all the primary compounds which the simple combinable substances are capable of forming. These might all be classed under six heads. Three of these would consist of compounds which oxygen forms with the other simple substances; for all these compounds are either combustible oxyds, products, or supporters. The fourth class would consist of the compounds which the simple combustibles form with one another and with the metals; the fifth class, of the combinations of the metals with one another; and the sixth would consist of the combinations of the simple incombustibles with the combustibles and the metals. But in the present imperfect state of the science, the advantages attending this arrangement would not compensate for the violence of the changes which it would introduce. It would oblige us to classify substances together which have always been considered as distinct, and to separate many bodies which have hitherto been always grouped together. Besides, we should be forced to omit a number of substances which are still undecompounded, and which are not the less important because they cannot with propriety be introduced among the simple substances. For these reasons the primary compounds may be arranged under the five following heads:

1. Alkalies. 2. Earths. 3 Oxyds. 4. Acids. 5. Compound combustibles.

COMPOUNDS, SECONDARY. Many of the primary compounds are susceptible of forming combinations with each other. Thus acids combine with alkalies, with earths, and with metallic oxyds, and form compounds called salts; the earths combine with the fixed alkalies, and form glass; oils combine with alkalies, and form soaps. To these is given the name of secondary compounds, which, as far as we are at present acquainted with them, may be arranged under the five following claases. 1. Combinations of earths with each other, and with metallic oxyds. 2. Combinations of earths with alkalies. 3. Combinations of acids with alkalies, earths, and metallic oxyds. 4. Combinations of sulphureted hydrogen with alkalies, earths, and metallic oxyds. 5. Combinations of oils with alkalies, earths, and metallic oxyds.

COMPREHENSION, or SYNECDOCHE, a trope or figure in rhetoric, which puts the name of the whole for a part, or of a part for the whole; a general for a particular of the same kind, or a particular for a general. By this trope a round and certain number is often set down for an uncertain one.

COMPRESS, in surgery, a bolster of soft linen cloth, folded in several doubles, frequently applied to cover a plaster, in order not only to preserve the part from the external air, but also the better to retain the dressings, or medicines. See SURGERY.

COMPTONIA, a genus of the monoecia triandria class and order. The male cal. is an ament, two-leaved; cor. none; anthers two-parted. The female is also an ament, cal. six-leaved; cor. none; styles two; nect. ovate. There is one species, a shrub of North America, named after bishop Compton, eminent for his taste in botany.

COMPULSOR, an officer under the Roman emperors, dispatched from court into the provinces, to compel the payment of taxes, &c. not paid within the time prescribed. These were charged with so many exactions, that Honorius cashiered them.

COMPUTATION, in law, is used with respect to the true account or construction of time: so understood, as that neither party to an agreement, &c. may do wrong to the other; and that the determination of time be not left at large, or taken otherwise than according to the judgment and intention of law.

If a lease is ingrossed, bearing date January 1, 1806, to have and to hold for three year from henceforth, and the lease is not executed till the 2d of January; in this case the words 'from henceforth' shall be accounted from the delivery of the deed, and not by any computation from the date. And if the lease be delivered at four o'clock in the afternoon on the said second day, it shall end the first day of January, in the third year; the law in such computations, rejecting all fractions or divisions of the day.

COMPUTO, in law, a writ to compel a bailiff, receiver, or accountant, &c. to deliver up his accounts. The same lies for executors of executors, and against the guardian in socage for waste made in the minority of the heir.

CONCENTRATION, in general, signifies the bringing things nearer a centre. Hence the particles of salt in sea-water are said to be concentrated, that is, brought nearer each other, by evaporating the watery part: thus, also, wine is said to be concentrated, when its watery parts are separated in the form of ice by frost.

CONCENTRIC, in mathematics, something that has the same common centre with another: it stands in opposition to excentric.

The method of Nonius for graduating instruments consists in describing with the same quadrant 45 concentric arches, dividing the outermost into 90 equal parts, the next into 80, &c.

CONCERT. A musical performance in which any number of practical musicians, either vocal or instrumental, or both, unite in the exercise of their respective talents. The concerts of the antient Greeks were executed only in the unison or octave.

CONCERTO. (Ital.) A composition expressly written for the display of some particular instrument, with accompaniments for the band.

CONCERTANTE. (Ital.) A concerto for two or more instruments, with accompaniments for a band.

CONCERTINO. (Ital.) The principal instrument in a concerto or concertante; as oboe concertino, the principal hautboy.

CONCERTATO intimates the piece of music is composed in such a manner, as that all the parts may have their recitativos, be it for two, three, four, or more voices or instruments.

CONCESSION, in rhetoric, a figure, whereby something is freely allowed, that yet might bear dispute, to obtain something that one would have granted to him, and which he thinks cannot fairly be denied; as in the following concession of Dido, in Virgil:

The nuptials he disclaims, I urge no more;
Let him pursue the promis'd Latian shore.
A short delay is all I ask him now;
A pause of grief, an interval from woe.

CONCHA, in anatomy, the larger cavity of the external ear, situated before the meatus auditorius, or passage into the internal ear. See ANATOMY.

CONCHOID, in geometry, the name of a curve, given it by its inventor, Nicomedes, and thus generated.

Draw the right line Q Q (Plate Miscel. fig. 16.), and A C perpendicular to it in the point E; and from the point C draw right lines C M, cutting the right line Q Q in Q; and make Q M = Q N, A E = E F, viz. equal to an invariable line: then the curve in which are the points M, is called the first conchoid; and the other, in which are the points N, the second; the right line Q Q being the directrix, and the point C the pole: and from hence it will be very easy to make an instrument to describe the conchoid. The line Q Q is an asymptote to both the curves, which have points of contrary flexion. If $QM = AE = a$, $EC = b$, $MR = EP = x$, $ER = PM = y$; then will $a^2 b^2 - 2 a^2 b x + a^2 x^2 = b^2 x^2 - 2 b x^3 + x^4 + x^2 y^2$, and express the nature of the second conchoid; and $x^4 + 2 b x^3 + y^2 x^2 + b^2 x^2 = a^2 b^2 + 2 a^2 b a + a^2 x^2$, the nature of the first; and so both these curves are of the third kind.

This curve was used by Archimedes and other antients, in the construction of solid problems; and sir Isaac Newton says that he himself prefers it before other curves, or even the conic sections, in the construction of cubic and biquadratic equations, on account of its simplicity and easy description. See sir Isaac Newton's Universal Arithmetic.

CONCLAMATION, in Roman antiquity, a custom of calling the dead party by his name for eight days successively; on the ninth, concluding him past all hopes of recovery, they carried him forth and buried him.

CONCLAVE, the place in which the cardinals of the Romish church meet, and are shut up, in order to the election of a pope. The conclave is a range of small cells, ten feet square, made of wainscot: these are numbered, and drawn for by lot. They stand in a line along the galleries and hall of the Vatican, with a small space between each. Every cell has the arms of the cardinal over it. The conclave is not fixed to any one determinate place, for the constitutions of the church allow the cardinals to make choice of such a place for the conclave as they think most convenient; yet it is generally held in the Vatican. The conclave is very strictly guarded by troops: neither the cardinals, nor any person shut up in the conclave, are spoken to, but at the hours allowed of, and then in Italian or Latin; even the provisions for the conclave are examined, that no letters be conveyed by that means from the ministers of foreign powers, or other persons who may have an interest in the election of the pontiff.

After this assembly has continued three days, they are only allowed one dish for one meal; and after five days, only bread and water: but this rule is not very religiously observed.

CONCOCTION. See PHYSIOLOGY.

CONCORD, in grammar, that part of construction called syntax, in which the words of a sentence agree; that is, in which nouns are put in the same gender, number, and case; and verbs in the same number and person with nouns and pronouns.

CONCORD, in common law, the agreement between parties, who intend to levy a fine of lands to one another, how and in what manner they shall pass.

CONCORD, in music, an union of two or more sounds, which by their harmony produce an agreeable effect upon the ear. Unisonance being the relation of equality between the pitch of two or more sounds, all unisons are considered by most theorists as concords in the first degree. But an interval being a difference of pitch, or a relation of inequality between two sounds, will form a concord or discord, according to the circumstances of that particular relation. Of concords there are two kinds, the one called perfect, the other imperfect; perfect concords consist of the fifth and eighth, imperfect concords of the third and sixth. The imperfect concords have also another distinction; that of the greater and lesser third and sixth. The concords are again divided into consonant and dissonant. The consonant concords are the perfect concord and its derivatives; every other is a dissonant concord. We apply the word concord also to the state of an instrument in respect of its tuning, as also to the agreement of two or more voices: as when we say "That instrument is not in concord," or "not in tune;" "Those voices do not concord," or "do not harmonise and agree."

CONCORDANT VERSES, are such as have several words in common, but which by the addition of other words convey an opposite or at least a very different meaning; as,

Et { canis / lupus } in sylva { venatur / nutritur }
& omnia { servat. / vastat. }

CONCORDAT, in the canon law, a covenant or agreement in some beneficiary matter, as relating to a resignation, permutation, or other ecclesiastical cause. This word is used absolutely among the French for an agreement between pope Leo I. and Francis I. of France, for regulating the manner of nominating to benefices.

CONCRETE, in logic, is used in contradistinction to abstract; for example, when we consider any quality, as whiteness, inhering in any subject, as suppose in snow; if we say the snow is white, then we speak only of whiteness in the concrete: but if we consider whiteness by itself, as a quality that may be in paper, in ivory, and in other things, as well as in snow, we are then said to consider, or to take, it in the abstract.

CONCRETIONS, MORBID. Hard substances occasionally make their appearance in different parts of the animal body, both in the solids and in the cavities destined to contain the fluids. In the first case, they are usually denominated concretions or ossifications; in the second, calculi. The knowledge of these bodies is of importance both to the physiologist and physician. Their formation is an irregularity in the animal economy, and is likely therefore to throw light upon its functions; for we succeed best in detecting the secrets of nature when she deviates from that regularity which she usually follows. They often produce the most excruciating diseases; and the sufferings of the patient can only be effectually relieved by removing their cause. The different animal concretions at present known may be divided into five classes:

1. Ossifications,
2. Intestinal concretions,
3. Biliary calculi,
4. Urinary calculi, } See CALCULI.
5. Gouty concretions.

I. OSSIFICATIONS. All the concretions which make their appearance in the solids of the animal body may be comprehended under this title with propriety; because they have all a close resemblance to bone, being composed of similar constituents. The following are the most remarkable of these concretions.

1. Pineal concretions. It is well known to anatomists that small concretions like sand are often lodged in that part of the brain called the pineal gland. It was suspected from analogy that they consisted chiefly of phosphat of lime; but Dr. Wollaston was the first who examined them chemically, and proved the truth of this opinion. He dissolved some of the sand in nitric acid, and evaporated the solution; small crystalline needles made their appearance, indicating the presence of phosphat of lime.

2. Salivary concretions. Small concretions occasionally make their appearance in the salivary glands, especially the parotid and sublingual. From the experiments of Wollaston and Fourcroy, we learn that the basis of these concretions is phosphat of lime united to a membranous substance, which retains the shape of the concretion after the solution of the phosphat. This at least was the case in a small salivary calculus which we examined. The same chemists ascertained that the tartar of the teeth is phosphat of lime.

3. Pancreatic concretions. The hard substances sometimes found in the pancreas are said to be of the same nature with those of the salivary glands. The assertion, we presume, is merely from analogy.

4. Pulmonary concretions. Many people subject to cough, or threatened with consumption, occasionally cough up small rounded white concretions. It is very common to find the lungs of such persons filled with similar bodies. We examined some of these bodies coughed up by a consumptive patient, and found them composed of phosphat of lime united to a thick membranous substance, which retained the form of the concretion. The same result had been obtained long before by Fourcroy.

5. Hepatic concretions. The liver also is sometimes full of similar bodies. The shape of the hepatic concretions, as far as our observations go, is more irregular, and we have seen them of greater size, than the pulmonary concretions. By analysis, their composition is the same as that of the last species.

6. Concretions in the prostate. From the experiments of Dr. Wollaston, we learn that the concretions which sometimes form in the prostate gland have likewise phosphat of lime for their basis.

7. The extremities of the muscles and the larger bloodvessels sometimes harden, and assume the appearance of bone. It is believed that this change is a real ossification,

or that these bodies are converted into real bone. We do not know whether any such ossifications have been analysed.

II. Concretions, intestinal. Concretions of very considerable size are sometimes found lodged in the stomach and intestines; seldom indeed in the human body, but more frequently in some of the inferior animals. Some of these bodies have acquired great celebrity under the name of bezoars; but their medical virtue, at least in this country, has long ago sunk to its just level. We are in possession of a chemical analysis of only a very small number of such concretions; even their figure and external characters have been but imperfectly described.

1. Of the horse. Two concretions, taken from the intestines of the horse, have been analysed; the first by Fourcroy, the second by Bertholdi; and both of them were composed of the same constituents. The first was of a grey colour, round, and weighed five pounds. It was radiated or crystallized in its structure. In the centre were several cavities filled with vegetable matter. It was insoluble in cold, but slightly soluble in boiling water. It was composed almost entirely of phosphat of magnesia and ammonia. The second was brownish-grey, round, and above four inches in diameter. Its specific gravity was 1,670. It was composed of eight concentric strata, all crystallized. In the centre there was found a small plate of iron. Its constituents were

18. 0	magnesia
26. 0	phosphoric acid
3. 2	ammonia
46. 0	water
4. 0	animal matter
97. 2	

2. Bezoars. The substances called bezoars, are supposed to be concretions formed in the stomach or intestines of different graminivorous animals. They are brought to Europe from India and America, and vary exceedingly both in their appearance and properties. To attempt a description would be useless, till we know more precisely the animals in which they are formed, and how many different animals yield them. Dr. Pearson analysed one specimen, and found it entirely composed of vegetable matter. See Calculi, and Bezoar.

III. Concretions, gouty. It is well known that concretions occasionally make their appearance in joints long subject to gout. These concretions, from their colour and softness, have received the name of chalkstones. They are usually small, though they have been observed of the size of an egg. It had long been the opinion of physicians that these concretions were similar to the urinary calculi. Of course, after the discovery of uric acid by Scheele, it was usual to consider the gouty chalkstones as collections of that acid. They were subjected to a chemical analysis by Dr. Wollaston, in 1797, who found them composed of uric acid and soda.

Gouty concretions are soft and friable. Cold water has little effect upon them; but boiling water dissolves a small portion. If an acid is added to this solution, small crystals of uric acid are deposited on the sides of the vessel.

These concretions are completely soluble in potash, when the action of the alkaline solution is assisted by heat.

When treated with diluted sulphuric or with muriatic acid, the soda is separated; but the uric acid remains, and may be separated by filtration. The liquid, when evaporated, yields crystals of sulphat or muriat of soda, according to the acid employed. The residuum possesses all the characters of uric acid. When distilled it yields ammonia, prussic acid, and the acid sublimate of Scheele. When dissolved in a little nitric acid, it tinges the skin of a rose colour, and when evaporated, leaves a rose-coloured deliquescent residuum. It is soluble in potash, and may be precipitated by any acid and by ammonia; first in the state of a jelly, and then breaking down into a white powder.

When uric acid, soda, and a little warm water, are triturated together, a mass is formed, which, after the surplus of soda is washed off, possesses the chemical properties of gouty concretions.

COND, Con, or Conn, in the sea-language, to guide or direct the ship to her right course, by giving directions to the man at the helm how to steer.

CONDENSER, a pneumatic engine or syringe, whereby an uncommon quantity of air may be crowded into a given space; so that sometimes ten atmospheres, or ten times as much air as there is at the same time in the same space without the engine, may be thrown in by means of it, and its egress prevented by valves properly disposed.

It consists of a brass cylinder, wherein is a moveable piston; which being drawn out, the air rushes into the cylinder, through a hole provided on purpose; and when the piston is again forced into the cylinder, the air is driven into the receiver through an orifice, furnished with a valve to hinder its getting out. See Pneumatics.

CONDERS, a term used in the herring fishery, for people who stand on cliffs or eminences near the sea-coast, to direct the fishermen which way the shoal of herrings passes; their course being more conspicuous to those who stand on high cliffs ashore, than to those on board the vessels.

CONDITION, in the civil law, a clause of obligation stipulated as an article of a treaty or contract; or in a donation of testament, legacy, &c.: in which last case a donee does not lose his donative, if it is charged with any dishonest or impossible conditions. The conditions under which a donation can be made, are distinguished into three kinds: 1. The casual, which depends merely on chance; 2. The potestative, which is absolutely in our power; and, 3. The mixed condition, which is compounded of the other two.

Condition, in common law, a restraint annexed to a thing, so that by the non-performance the party to it shall sustain loss, and by the performance receive advantage; or it is a restriction of men's acts, qualifying or suspending the same, and making them uncertain whether they shall take effect or not. Also it is defined to be, what is referred to a contingency, which may or may not take place.

CONDITIONAL syllogism, in logic, a syllogism where the major is a conditional proposition. Thus,

If there is a God, he ought to be worshipped:
But there is a God;
Therefore he ought to be worshipped.

The Arminian divines maintain, that all the decrees of God relating to the salvation and damnation of man, are truly conditional; and the calvinists that they are absolute. The science of conditionals, that is, of conditional truths, is the knowledge which God has of things considered not according to their essence, their nature, or their real existence, but under a certain supposition which imports a condition never to be accomplished.

CONDORMIENTES, in church-history, religious sectaries, who hold their name from sleeping all together, men and women, young and old. They arose in the thirteenth century near Cologne, where they are said to have worshipped an image of Lucifer, and to have received answers and oracles from him.

CONDUCTOR, in surgery, an instrument which serves to conduct the knife in the operation of cutting for the stone, and in laying up sinuses and fistulas. See Surgery.

Conductor, in electricity. All bodies are divided into conductors and non-conductors. The latter are called electrics. See Electricity.

Conductors, in military affairs, are assistants given to the commissary of the stores to receive or deliver out stores to the army, to attend at the magazines by turns when in garrison, and to look after the ammunition-waggons in the field. They bring their accounts every night to the commissary, and are immediately under his command.

CONDYLOMA, in medicine, a tubercle or callous eminence which arises in the folds of the anus, or rather a swelling or hardening of the wrinkles of that part. See Surgery.

CONE, in geometry, a solid figure, having a circle for its base, and its top terminated in a point or vertex. See Conic Sections.

CONE and Key, accounts and key. A woman at the age of 14 or 15, might take the charge of her house and receive cone and key; so that a woman was held to be of competent years, when she was able to keep the accounts and key of her house.

CONFECTION signifies a liquid or soft electuary, of which there are various sorts directed in dispensatories. See Pharmacy.

CONFECTOR, in Roman antiquity, a sort of gladiator hired to fight in the amphitheatre against beasts, thence also denominated bestiarius.

CONFEDERACY, in law, is when two or more confederate, to do any damage or injury to another, or to commit any unlawful act. And though a writ of confederacy do not lie if the party be not indicted and in a lawful manner acquitted, yet false confederacy between divers persons shall be punished, though nothing be put in execution.

CONFERVA, a genus belonging to the cryptogamia class of plants; and in the natural method ranking under the 57th order, algæ. The tubercles are of different sizes, on capillary, very long fibres. There are 21 species, most of which grow on stones in slow streams, on the sides of cisterns, or in ponds.

CONFESSION of offence, in law, is when a prisoner is appealed or indicted of treason or felony, and brought to the bar to be arraigned, and his indictment being read to him, the court demands what he can say thereto: then either he confesses the offence, and the indictment to be true, or pleads Not Guilty.

Confession is two-fold, either express or implied. An express confession is, when a person directly confesses the crime with which he is charged, which is the highest conviction that can be. 2 Haw. 333. But it is usual for the court, especially if it be out of clergy, to advise the party to plead, and put himself upon his trial, and not immediately to record his confession, but to admit him to plead. 2 H. H. 225. An implied confession is, where a defendant in a case not capital, does not directly own himself guilty, but in a manner admits it, by yielding to the king's mercy, and desiring to submit to a small fine; which submission the court may accept if they think fit, without putting him to a direct confession. 2 Haw. 233.

Confession in a civil action. Sometimes there is a confession in a civil action, but not usually of the whole complaint; for then the defendant would probably end the matter sooner, or not plead at all, but suffer judgment to go by default; but sometimes, after tender and refusal of debt, if the creditor harass his debtor with an action, it then becomes necessary for the defendant to confess the debt and plead the tender; for a tender by the debtor and refusal by the creditor, will in all cases discharge the costs. 4 Black. 303. So in order to strengthen the creditor's security, it is usual for the debtor to execute a warrant of attorney to confess judgment in an action to be brought by such creditor; which judgment when confessed, is complete and binding. 3 Black. 397.

CONFESSION, among divines, the verbal acknowledgment which a Christian makes of his sins.

The Romish church requires confession, not only as a duty, but has advanced it to the dignity of a sacrament: this confession is made to the priest, and is private and auricular; and the priest is not to reveal it under pain of the highest punishment.

CONFESSION *of faith*, a list of the several articles of belief in any church, as the Augsburg confession is that of the Lutheran church.

CONFESSIONAL, or CONFESSIONARY, a place in churches, under the great altar, where the bodies of deceased saints, martyrs, and confessors, were deposited. This word is also used by the Romanists for a desk in the church where the confessor takes the confessions of the penitents.

CONFIRMATION, in law, is a conveyance of an estate or right in esse, whereby a voidable estate is made sure and unavoidable, or whereby a particular estate is increased. Thus a bishop grants his chancellorship by patent, for the term of the patentee's life; this is no void grant, but voidable by the bishop's death, except it be strengthened by the confirmation of the dean and chapter. 2 Black. 325.

CONFISCATE, in law: if a man be indicted that he feloniously stole the goods of another man, when in truth they are the proper goods of him indicted, and which being brought into court against him he disclaims them, by this disclaimer he shall lose the goods, although afterwards he be acquitted of the felony, and the king shall have them as confiscated. Staundf. pl. cor. l. c. 24.

CONFORMATION, in medicine, that make and construction of the human body, which is peculiar to every individual. Hence those diseases called morbi malæ conformationis, or organical diseases, are those which depend upon the bad conformation of the parts. These, if external, may admit of chirurgical cure; and proper exercise, regimen, and medicine, may sometimes contribute much to the relief even of those which are internal, or at least may render them supportable.

CONGE' *d'elire*, in ecclesiastical polity, the king's permission royal to a dean and chapter in the time of a vacancy, to choose a bishop; or to an abbey, or priory, of his own foundation, to choose their abbot or prior. The king of England, as sovereign patron of all archbishoprics, bishoprics, and other ecclesiastical benefices, had of antient time free appointment to all ecclesiastical dignities, whenever they chanced to be void; investing them first per baculum & annulum, and afterwards by his letters patent; and in course of time he made the election over to others, under certain forms and limitations; as that they should, at every vacation, before they choose, demand the king's congé d'elire, and after the election, crave his royal assent, &c.

CONGE', in architecture, a mould in form of a quarter-round, or a cavetto, which serves to separate two members from one another; such as that which joins the shaft of the column to the cincture, called also apophyge.

CONGES are also rings or ferrels formerly used in the extremities of wooden pillars, to keep them from splitting, afterwards imitated in stone-work.

CONGELATION, freezing, or such a change produced by cold in a fluid body, that it quits its former state and becomes congealed. See COLD, and FREEZING.

CONGIARY, CONGIARIUM, in Roman antiquity, a kind of donative of wine or oil, bestowed on that people by their emperors, and so called from the congius, wherewith it was measured out to them. Sometimes, indeed, the congiary was made in money or corn; and the medals struck on such occasions, are known by the same name.

CONGIUS, a liquid measure of the antient Romans, containing the eighth part of the amphora, or the fourth of the urna, or six sextarii. The congius in English measure contains 207,0676 solid inches; that is, seven pints, 4,942 solid inches.

CONGLOBATE GLAND, in anatomy, a little smooth body, wrapt up in a fine skin, by which it is separated from all other parts, only admitting an artery and a nerve to pass in, and giving way to a vein and excretory canal to come out, of which sort are the glands of the brain.

CONGLOMERATE GLAND, that which is composed of several little conglobate glands, all tied up together in one common tunicle or membrane. Sometimes all their excretory ducts unite, and make one common pipe, through which the liquor of them all runs, as the pancreas and parotides do. Sometimes the ducts uniting, form several pipes, which only communicate with one another by cross canals; and such are the mammæ: others again have several pipes without any communication with one another, of which sort are the glandulæ lachrymales and prostatæ: and a fourth sort, is when each little gland has its own excretory duct, through which it transmits its liquor to a common bason; as the kidneys.

CONGLUTINATION, the gluing or fastening any two bodies together by the intromission of a third, whose parts are unctuous and tenacious in the nature of glue.

CONGREGATION, an assembly of several ecclesiastics united, so as to constitute one body; as an assembly of cardinals, in the constitution of the pope's court, met for the dispatch of some particular business. These assemblies, being sixteen in number, are distributed into several chambers, after the manner of our offices and courts: the first whereof is the pope's congregation, whose business it is to prepare the most difficult beneficiary matters to be afterwards debated in the consistory: the second is the congregation of the holy office, or the inquisition: the third is the congregation de propaganda fide: the fourth is the congregation for explaining the council of Trent: the fifth is the congregation of the index, deputed to examine into pernicious and heretical books: the sixth is the congregation of immunities, established to obviate the difficulties that arise in the judgments of such suits as are carried on against churchmen: the seventh is the congregation of bishops and regulars: the eighth is the congregation for the examination of bishops, &c.

CONGREGATIONALISTS, in church-history, a sect of protestants who reject all church-government, except that of a single congregation. In other matters, they agree with the presbyterians.

CONGRESS, in political affairs, an assembly of commissioners, envoys, deputies, &c. from several courts, meeting to concert matters for their common good.

CONIC SECTIONS are curve lines formed by the intersections of a cone and a plane. Before we speak of these sections, we shall briefly describe the cone itself and some of its properties.

A cone may be conceived to be generated in the following manner: Take an immoveable point A (plate Conic Sections, fig. 1.) elevated above the plane of a circle BCDE; and suppose a straight line XZ drawn through the point and extended both ways from it to an indefinite length, to be carried quite round the circle, all the while touching its circumference, and continuing still fixed to the immoveable point; the line by this motion will describe two conic surfaces, which are vertical or opposite, having their common vertex at the immoveable point.

The solid contained within this conic surface, between the immoveable point A and the circumference of the circle BCDE, is a cone: the immoveable point A is the vertex; the circle BCDE is the base; and a straight line AF drawn from the vertex to the centre of the base, is the axis of the cone: all straight lines drawn from the vertex to the circumference of the base, as AB, AC, AD, AE, &c. are sides of the cone. If the axis of a

cone be perpendicular to its base, it is called a right cone, as in fig. 2.; if the axis be inclined to the base, it is called a scalene or oblique cone, such as that in fig. 3.; and a right cone is always understood, when the contrary is not expressed.

If this leg or axis be greater than half the base, the solid produced is an acute-angled cone; if less, it is an obtuse-angled cone; and if equal, a right-angled cone. Thus the cone BAC (fig. 4.) is less acute than the cone BDC, because the angle BDF is less than the angle BAF.

Properties of the cone. 1. Cones and pyramids having the same bases and altitudes, are equal to each other. It is shewn that every triangular prism may be divided into three equal pyramids; and therefore that a triangular pyramid is one-third of a prism standing on the same base, and having the same altitude. Hence, since every multangular body may be resolved into triangular ones, every pyramid is the third part of a prism, standing upon the same base, and having the same altitude; and as a cone may be esteemed an infinite-angular pyramid; and a cylinder an infinite-angular prism, a cone is a third part of a cylinder which has the same base and altitude. Hence we have a method of measuring the solidity and surface of a cone and pyramid. Thus, find the solidity of a prism or cylinder, having the same base with the cone or pyramid; which found, divide by 3, the quotient will be the solidity of the cone or pyramid: or the solidity of any cone is equal to the area of the base multiplied into one third part of its altitude. As for the surfaces, that of a right cone, not taking in the base, is equal to a triangle whose base is the periphery, and altitude the side of the cone; therefore the surface of a right cone is had by multiplying the periphery of the base into half of the side, and adding the product to that of the base.

2. The altitudes of similar cones are as the radii of the bases; and the axes likewise are as the radii of the bases, and form the same angle with them.

3. Cones are to one another in a ratio compounded of their bases and altitudes.

4. Similar cones are in a triplicate ratio of their homologous sides, and likewise of their altitudes.

5. Of all cones standing upon the same base, and having the same altitude, the superficies of that which is most oblique is the greatest, and so the superficies of the right cone is the least; but the proportion of the superficies of an oblique cone to that of a right one, or which is the same thing, the comparison thereof to a circle, or the conic sections, has not yet been determined.

If a cone be cut by a plane through the vertex, the section will be a triangle ABC, Plate fig. 6.

If a cone be cut by a plane parallel to its base, the section will be a circle. If it be cut by a plane DEF, fig. 6. in such a direction that the side AC of a triangle passing through the vertex, and having its base BC perpendicular to EF, may be parallel to DP, the section is a parabola; if it be cut by a plane DR, fig. 7, meeting AC, the section is an ellipse; and if it be cut by a plane DMO, fig. 8, which would meet AC extended beyond A, it is an hyperbola.

If any line HG, fig. 6, be drawn in a parabola perpendicular to DP, the square of HG will be to the square of EP as DG to DP; for let LHK be a section parallel to the base, and therefore a circle, the rectangle LGK will be equal to the square of HG, and the rectangle BPC equal to the square of EP; therefore these squares will be to each other as their rectangles, that is, as BP to LG, that is, DP to DG.

There are three modes of investigating the properties of these curves. 1. By taking the demonstrations from the sections of a cone, which, from the many intersections of planes with planes, and planes with solids, is apt to perplex the learner, and is now seldom adopted. 2. By taking some general property of the figures on a plane, from which all the rest may be determined geometrically; or by taking the general property of each curve singly, and from thence deducing geometrically all the other properties of that curve. 3. By taking the equation to all the curves, from whence their respective properties may be discovered algebraically; or by taking the equation to each single curve, from whence its properties may be discovered algebraically.

By whichever of these three methods the properties of conic sections are investigated, the general property is discovered, which makes the bases of the other methods. If they are considered as curves on a plane surface, they are shewn to have the same properties with those formed by the intersections of a plane with a cone: and again, the equation is produced, which makes the basis of the algebraical process. For a beginner, the geometrical method seems clearly to have the preference; and that which deduces from a common property the relations of each curve to the other, as well as the respective properties of each curve, seems to be better than that which considers each curve separately, and, after an examination of its properties, enters into a comparison of each curve with the others. Boscovich in a very elegant manner has deduced the properties of the three curves, from a property common to all; and his method has been made still easier for beginners lately by Mr. Newton, of Jesus-college, Cambridge; who, laying aside the musical proportion on which Boscovich founds his demonstrations, has, within a short compass, introduced every thing requisite for the study of the Principia and the higher mathematics. The basis of this method is the relation of two lines to each other, drawn the one from a given point, the other perpendicular to a line given in position.

(1) If any point S be assumed without the line DX (fig. 9, 10.), and, whilst the line SP revolves about S as a centre, a point P moves in it in such a manner that its distance from the point S shall always be to PE (its distance from the line DX) in a given ratio, the curve described by the point P is called a conic section, a parabola, an ellipse, or an hyperbola, according as SP is equal to, less, or greater than, PE. (2) The indefinite right line DX is called the directrix. (3) The point S is called the focus. (4) The ratio of SP to PE is called the determining ratio. (5) If a line SD be drawn through the focus perpendicular to the directrix, which is produced indefinitely, it is called the axis of the conic section. (6) The point A, where the curve meets the axis, is called the vertex. (7) A right line LST, drawn through the focus parallel to the directrix, and terminated by the curve in the points L, T, is called the principal parameter, or the latus rectum.

Cor. 1. SP being greater than PE in the hyperbola, two curves will be described, one on each side of the directrix; which are called opposite hyperbolas.

Cor. 2. When the revolving line SP comes into the position SAD; SP, PE, will be equal to SA, AD; therefore, SA is to AD in the determining ratio.

Cor. 3. When the line SP comes into the position SL or ST, the distance of P from the directrix will be equal to SD, and SL or ST will be to SD in the determining ratio; and therefore the latus rectum LT is bisected in S.

Cor. 4. The latus rectum in the parabola is equal to twice the distance of the focus from the directrix, or to four times its distance from the vertex: for SL is equal to SD, and SA is equal to AD; therefore LT is equal to twice SD, or to four times SA.

(8) The tangents DLQ, DT*q* (figs. 11, 12.), which are drawn through the extremities of the latus rectum, are called focal tangents. (9) The right line AM, in the ellipse and hyperbola, is called the transverse axis, or the axis major. (10) If the transverse axis be bisected in C, the point C is called the centre of the ellipse or hyperbola. (11) If a line BC*b*, which is bisected in C, be drawn perpendicular to the transverse axis, and CB, C*b*, be each of them a mean proportional between SA, SM, the segments of the axis intercepted between the focus and the vertices BC*b*, is called the conjugate axis, or the axis minor. (12) A right line PN*p*, drawn through any point N in the axis parallel to the tangent KAG, or perpendicular to the axis, and terminated by the curve in the points P and *p*, is called an ordinate to the axis. (13) And the segment of this axis AN, intercepted between the ordinate and the vertex, in all the sections, as also the other segment NM in the ellipse and hyperbola, is called an abscissa. (14) Any line passing through the centre of an ellipse or hyperbola, which is terminated both ways by the curve in the former, and by the opposite curves in the latter, is called a diameter. (15) A line drawn through any point in the parabola parallel to the axis, is called a diameter to the parabola. (16) Any point where a diameter meets the curve is called a vertex to that diameter. (17) If from the centre C, at the distance CA (fig. 13.), half the transverse axis, a circle be described, cutting the directrix of the hyperbola in the points H, *h*, and lines be drawn from the centre through the points of intersection, these lines are called the asymptotes. (18) If AM be the transverse axis, and B*b* the conjugate axis, of any two opposite hyperbolas; and two other hyperbolas be described, of which the transverse axis is B*b*, and the conjugate axis AM; these hyperbolas are said to be conjugate to the former. (19) When the two axes are equal, the hyperbolas are said to be equilateral.. (20) If a right line be drawn through any point in the diameter of a conic section parallel to the tangent at its vertex, which is terminated both ways by the curve, it is called an ordi-

nate to that diameter. (21) The segments of any diameter of a conic section, which is intercepted between an ordinate and the vertex, is called an abscissa. (22) A diameter which is parallel to the tangent at the vertex of any diameter of the ellipse or hyperbola, is called a conjugate diameter. (23) A line which is a third proportional to any diameter of the ellipse or hyperbola and its conjugates, is called a parameter to that diameter. (24) If a line be drawn through the focus of a parabola, parallel to the ordinates of any diameter, which is terminated both ways by the curve, it is called a parameter to that diameter.

From these fundamental properties all the others are derived, and the curves may be described mechanically. This description depends for the *parabola*, on the property that a line from any point in the curve to the focus is equal to the line drawn from the same point perpendicularly on the directrix; for the *ellipse*, on the property that the sum of the lines drawn from the foci to any point is equal to the major axis; for the *hyperbola*, that the difference of the lines drawn from the foci to any point in the curve is equal to the major axis. Hence to draw the parabola.

Description of conic sections on a plane.

1. Parabola. Let AB (fig. 14.) be any right line, and C any point without it, and DKF a ruler, which let be placed in the same plane in which the right line and point are, in such a manner that one side of it, as DK, be applied to the right line AB, and the other side KF coincide with the point C; and at F, the extremity of the side KF, let be fixed one end of the thread FNC, whose length is equal to KF, and the other extremity of it at the point C; and let part of the thread, as FN, be brought close to the side KF by a small pin N; then let the square DKF be removed from B towards A, so that all the while its side DK be applied close to the line BA; and in the mean time the thread being extended, will always be applied to the side KF, being stopt from going from it by means of the small pin; and by the motion of the small pin N there will be described a certain curve, which is called a semi-parabola. And if the square be brought to its first given position, and in the same manner be moved along the line AB, from B towards H, the other semi-parabola will be described.

2. Ellipse. If any two points, as A and B (fig. 15.), be taken in any plane, and in them are fixed the extremities of a thread, whose length is greater than the distance between the points, and the thread extended by means of a small pin C; and if the pin be moved round from any point until it return to the place from whence it began to move, the thread being extended during the whole time of the revolution, the figure which the small pin by this revolution describes is called an ellipse.

3. Hyperbola. If to the point A (fig. 16.) in any plane, one end of the ruler AB be placed in such a manner, that about that point, as a centre, it may freely move; and if to the other end B of the ruler AB be fixed the extremity of the thread BDC, whose length is smaller than the ruler AB, and the other end of the thread being fixed in the point C, coinciding with the side of the ruler AB which is in the same plane with the given point A; let part of the thread, as BD, be brought close to the side of the ruler AB, by means of a small pin D; then let the ruler be moved about the point A, from C towards T, the thread all the while being extended, and the remaining part coinciding with the side of the ruler being stopt from going from it by means of the small pin; and by the motion of the small pin D, a certain figure is described, which is called the semi-hyperbola.

The ellipse returns into itself. The parabola and hyperbola may be extended without limit.

Every line perpendicular to the directrix of a parabola meets it in one point, and falls afterwards within it; and every line drawn from the focus meets it in one point, and falls afterwards without it. And every line that passes through a parabola, not perpendicular to the directrix, will meet it again, but only once.

Every line passing through the centre of an ellipse is bisected by it; the transverse axis is the greatest of all these lines, the lesser axis the least, and those nearer the transverse axis greater than those more remote.

In the hyperbola, every line passing thro' the centre is bisected by the opposite hyperbola, and the transverse axis is the least of all these lines; also the second axis is the least of all the second diameters. Every line drawn from the centre within the angle contained by the asymptotes, meets at once, and falls afterwards within it; and every line drawn through the centre without the angle, never meets it; and a line which cuts one of the asymptotes, and cuts the other extended beyond the centre, will meet both the opposite hyperbolas in one point.

If a line GM (fig. 14.) be drawn from a point in a parabola perpendicular to the axis, it will be an ordinate to the axis, and its square will be equal to the rectangle under the abscissa MI and latus rectum; for because GMC is a right angle, GM^2 is equal to the difference of GC^2 and CM^2; but GC is equal to GE, which is equal to MB; therefore GM^2 is equal to $BM^2 - CM^2$; which, because CI and IB are equal, is (8 Euc. 2.) equal to four times the rectangle MI and IB, or equal to the rectangle under MI and the latus rectum.

Hence it follows, that if different ordinates be drawn to the axis, their squares, being each equal to the rectangle under the abscissa and latus rectum, will be to each other in the proportion of the abscissas; which is the same property as takes place in the parabola cut from the cone, and proves those curves to be the same.

This property is extended also to the ordinates of other diameters, whose squares are equal to the rectangle under the abscissas and parameters of their respective diameters.

In the ellipse, the square of the ordinate is to the rectangle under the segments of the diameter, as the square of the diameter parallel to the ordinate is to the square of the diameter to which it is drawn, or as the first diameter to its latus rectum; that is, LK^2 (fig. 15.) is to $EK \times KF$ as EF^2 to GH^2.

In the hyperbola, (fig. 16,) the square of the ordinate is to the rectangle contained under the segments of the diameters betwixt its vertices, as the square of the diameter parallel to the ordinate, to the square of the diameter to which it is drawn, or as the first diameter to its latus rectum; that is, SX^2 is to $EX \times XK$ as MN^2 to KE^2.

Or if an ordinate be drawn to a second diameter, its square will be to the sum of the squares of the second diameter, and of the line intercepted betwixt the ordinate and centre, in the same proportion; that is, RS^2 (fig. 16.) is to ZG^2 added to GM^2 as KE^2 to MN^2.

These are the most important properties of the conic sections; and by means of these, it is demonstrated, that the figures are the same described on a plane as cut with a cone; which we have demonstrated in the case of the parabola.

From the genesis of the sections it may be observed how one section degenerates into another. For an ellipsis being that plane of any section of the cone which is between the circle and parabola, it will be easy to conceive that there may be a great variety of ellipses produced from the same cone; and when the section comes to be exactly parallel to one side of the cone, then the ellipsis degenerates into a parabola. Now a parabola being that section whose plane is always exactly parallel to the side of the cone, cannot vary as the ellipsis may; for as soon as ever it begins to move out of that position of being parallel to the side of the cone, it degenerates either into an ellipsis or hyperbola: that is, if the section inclines towards the plane of the cone's base, it becomes an ellipsis; but if it incline towards the cone's vertex, it then becomes an hyperbola, which is the plane of any section that falls between the parabola and the triangle; and therefore there may be as many varieties of hyperbola produced from one and the same cone as there may be ellipses.

In short, a circle may change into an ellipsis, the ellipsis into a parabola, the parabola into an hyperbola, and the hyperbola into a plain isosceles triangle. And the centre of the circle, which is its focus, divides itself into two focuses, as soon as ever the circle begins to degenerate into an ellipsis; but when the ellipsis changes into a parabola, one end of it flies open, one of its foci vanishes, and the remaining focus goes along with the parabola when it degenerates into an hyperbola. And when the hyperbola degenerates into a plain isosceles triangle, this focus becomes the vertical point of the triangle, namely, the vertex of the cone. So that the centre of the cone's base may be truly said to pass gradually through all the sections until it arrives at the vertex of the cone, still carrying its latus rectum along with it. For the diameter of a circle being that right line which passes through its centre or focus, and by which all other right lines drawn within the circle are regulated and valued, may be called the circle's latus rectum; and though it lose the name of diameter when the circle degenerates into an ellipsis, yet it retains the name of latus rectum with its first properties in all the sections, gradually shortening as the focus carries it along from one section to another, until at last both it and the focus become coincident, and terminate in the vertex of the cone.

Equations of the conic sections are derived from the above properties. The equation of

any curve is an algebraic expression, which denotes the relation betwixt the ordinate and abscissa; the abscissa being equal to x, and the ordinate equal to y.

If p be the parameter of a parabola, then $y^2 = px$; which is an equation for all parabolas.

If a be the diameter of an ellipse, p its parameter; then $y^2 = \frac{p}{a}\overline{-ax + xx}$; an equation for all ellipses.

If a be a transverse diameter of a hyperbola, p its parameter; then $y^2 = \frac{p}{a}\overline{\times ax + xx}$.

If a be a second diameter of a hyperbola, then $y^2 = \frac{p}{a}\overline{\times aa + xx}$; which are equations for all hyperbolas.

As all these equations are expressed by the second powers of x and y, all conic sections are curves of the second order; and conversely, the locus of every quadratic equation is a conic section, and is a parabola, ellipse, or hyperbola, according as the form of the equation corresponds with the above ones, or with some other deduced from lines drawn in a different manner with respect to the section.

General properties of conic sections.—A tangent to a parabola bisects the angle contained by the lines drawn to the focus and directrix; in an ellipse and hyperbola, it bisects the angle contained by the lines drawn to the foci.

In all the sections, lines parallel to the tangent are ordinates to the diameter passing through the point of contact; and in the ellipse and hyperbola, the diameters parallel to the tangent, and those passing through the points of contact, are mutually conjugate to each other. If an ordinate be drawn from a point to a diameter, and a tangent from the same point which meets the diameter produced; in the parabola, the part of the diameter betwixt the ordinate and tangent will be bisected in the vertex; and in the ellipse and hyperbola, the semidiameter will be a mean proportion betwixt the segments of the diameter, betwixt the centre and ordinate, and betwixt the centre and tangent.

The parallelograms formed by tangents drawn through the vertices of any conjugate diameters, in the same ellipse or hyperbola, will be equal to each other.

Properties peculiar to the hyperbola.—As the hyperbola has some curious properties arising from its asymptotes which appear at first view almost incredible, we shall briefly demonstrate them.

(1) The hyperbola and its asymptotes never meet: if not, let them meet in S (fig. 16.); then by the property of the curve the rectangle KX × XE is to SX^2 as GE^2 to GM^2 or EP^2; that is, as GX^2 to SX^2; wherefore KX × XE will be equal to the square of GX; but the rectangle KX × XE, together with the square of GE, is also equal to the square of GX; which is absurd.

(2) If a line be drawn through an hyperbola parallel to its second axis, the rectangle, by the segments of that line, betwixt the point in the hyperbola and the asymptotes, will be equal to the square of the second axis.

For if SZ (fig. 16.) be drawn perpendicular to the second axis, by the property of the curve, the square of MG, that is, the square of PE, is to the square of GE, as the squares ZG and the square of MG together, to the square of SZ or GX; and the squares of RX and GX are in the same proportion, because the triangles RXG, PEG, are equiangular; therefore the squares ZG and MG are equal to the square of RX; from which, taking the equal squares of SX and ZG, there remains the rectangle RSV, equal to the square of MG.

(3) Hence, if right lines be drawn parallel to the second axis, cutting an hyperbola and its asymptotes, the rectangles contained betwixt the hyperbola and points where the lines cut the asymptotes will be equal to each other; for they are severally equal to the square of the second axis.

(4) If from any points, d and S, in an hyperbola, there be drawn lines parallel to the asymptotes $d\,a$ SQ and S $b\,d\,c$, the rectangle under $d\,a$ and $d\,c$ will be equal to the rectangle under QS and S b; also the parallelograms $d\,a\,G\,c$, and SQG b, which are equiangular, and consequently proportional to the rectangles, are equal.

For draw YW RV parallel to the second axis, the rectangle Y d × d W is equal to the rectangle RS × SW; wherefore WD is to SV as RS is to d Y. But because the triangles RQS, a YD, and GSV, $c\,d$ W, are equiangular, W d is to SV as $c\,d$ to S b, and RS is to DY as SQ to $d\,a$; wherefore, $d\,c$ is to S b as SQ to $d\,a$; and the rectangle $d\,c$, $d\,a$, is equal to the rectangle QS, S b.

(5) The asymptotes always approach nearer the hyperbola.

For, because the rectangle under SQ and S b or QG, is equal to the rectangle under $d\,a$ and $d\,c$, or AC and QG is greater than a G; therefore, $d\,a$ is greater than QS.

(6) The asymptotes come nearer the hyperbola than any assignable distance.

Let X be any small line. Take any point, as d, in the hyperbola, and draw $d\,a$, $d\,c$, parallel to the asymptotes: and as X is to $d\,a$, so let a G be to GQ. Draw QS parallel to $a\,d$, meeting the hyperbola in S; then QS will be equal to X. For the rectangle SQ × QG will be equal to the rectangle $d\,a$ × a G; and consequently SQ is to $d\,a$ as A G to GQ.

If any point be taken in the asymptote below Q, it can easily be shown that its distance is less than the line X.

Uses of conic sections.—Any body, projected from the surface of the earth, describes a parabola, to which the direction wherein it is projected is a tangent: and the distance of the directrix is equal to the height from which a body must fall to acquire the velocity with which it is projected: hence the properties of the parabola are the foundation of gunnery.

All bodies acted on by a central force which decreases as the square of the distances increases, and impressed with any projectile motion making any angle with the direction of the central force, must describe parabolas, ellipses, and hyperbolas, according to the proportion between the central and projectile force. This is proved by direct demonstration.

The great principle of gravitation acts in this manner: and all the heavenly bodies describe conic sections, having the sun in one of the foci; the orbits of the planets are ellipses, whose transverse and lesser diameters are nearly equal. It is uncertain whether some of the comets describe ellipses with very unequal axes, and so return after a great number of years; or whether they describe parabolas and hyperbolas, in which case they will never return.

They are of great use also in many other parts of the mathematics; in dialing, for delineating the signs in the projection of the sphere, many of whose circles are projected into these curves; in optics, to reflect or refract rays accurately to a focus; in logarithms, and in the higher parts of algebra, one or other of them is continually applied; and no one can make any great progress in the mathematics, without understanding thoroughly the chief properties of conic sections.

The principal writers on conic sections in modern days are, Hamilton, Robertson, Vince, Newton, &c.

CONJUGATE *diameter*, or axis of an ellipsis, the shortest of the two diameters, or that bisecting the transverse axis.

CONJUGATE *hyperbolas*. See CONIC SECTIONS.

CONJUGATION, in grammar, a regular distribution of the several inflections of verbs in their different voices, moods, tenses, numbers, and persons, so as to distinguish them from one another.

The Latins have four conjugations, distinguished by the terminations of the infinitive āre, ēre, ĕre, and īre; the vowels before *re* of the infinitive in the first, second, and fourth conjugations, being long vowels, and that before *re* in the infinitive of the third being a short one. See VOWEL.

The English have scarcely any natural inflexions, deriving all their variations from additional particles, pronouns, &c. whence there is scarcely any such thing as strict conjugation in that language.

CONIUM, *hemlock*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The partial involucra are halved, and mostly triphyllous; the fruit subglobose and quinque-striated, the striæ crenated on each side. There are five species; the most remarkable are:

1. Conium Africanum, with prickly seeds, a native of the Cape of Good Hope, and rarely growing above nine inches high: the lower leaves are divided like those of the small wild rue, and are of a greyish colour; those upon the stalk are narrower, but of the same colour: these are terminated by umbels of white flowers, each of the larger umbels being composed of three small ones; the involucrum has three narrow leaves situated under the umbel.

2. Conium maculatum, or the greater hemlock, grows naturally on the sides of banks and roads in many parts of Britain. It is a biennial plant, which perishes after it has ripened its seeds. It has a long taper root like a parsnip, but smaller. The stalk is smooth, spotted with purple; and rises from four to upwards of six feet high, branching out towards the top, with decompounded leaves. The stalks are terminated by umbels of white flowers. This species is sometimes applied externally in the form of decoction, infusion, or poultice, as a discutient. These are apt to excoriate, and their vapour is to some particularly disagreeable and hurtful. The stalks are insignificant, and the roots very virulent. With regard to its virtue, when taken internally, it has been gene-

rally accounted poisonous; which it doubtless is, in a high degree, when used in any considerable quantity. But Dr. Stoerk has lately found, that in certain small doses it may be taken with great safety; and that, without disordering the constitution, it sometimes proves a powerful resolvent in obstinate disorders. In scirrhus, the internal and external use of hemlock has been found useful, but mercury has been generally used at the same time. In open cancer, it often abates the pains, and is free from the constipating effects of opium. It is likewise used in scrophulous tumours and ulcers in general. It is also recommended by some in chincough and other diseases. Its common and perhaps best form is that of the powdered leaves, in the dose at first of two or three grains a day, which in some cases has been gradually increased to upwards of two ounces without producing giddiness. An extract from the seeds is said to produce giddiness sooner than that from the leaves. Hence, while both the London and Edinburgh colleges have given a place to the *succus spissatus cicutæ*, into the pharmacopœia of the latter an *extractum seminum cicutæ* is also introduced.

3. Conium tenuifolium, with striated seeds, differs from the last in having taller stalks, which are not so much spotted. The leaves are much narrower, and of a paler green; and this difference is constant. It is a biennial plant, and grows naturally in Germany.

CONJUNCTION, in astronomy, the meeting of two stars or planets in the same degree of the zodiac.

CONJUNCTION, in grammar, an indeclinable word or particle, which serves to join words and sentences together, and thereby shews their relation or dependance one upon another.

CONJURATION. To use conjuration, witchcraft, &c. was made felony by the 1st Jac. I. c. 12.; but that superstitious statute having produced many pernicious effects, it was wisely repealed by the 9th Geo. II. c. 5., wherein it is enacted, that no prosecution, suit, or proceeding, shall be commenced or carried on against any person for witchcraft, sorcery, enchantment, or conjuration, or for charging another with any such offence, in any court whatsoever. But, by the same statute, if any person shall pretend to exercise or use any kind of witchcraft, sorcery, enchantment, or conjuration, or undertake to tell fortunes, or pretend from his skill or knowledge in any occult or crafty science to discover where or in what manner any goods or chattels supposed to have been stolen or lost may be found; every person so offending, being convicted on indictment or information, shall suffer imprisonment for a year without bail or mainprize; and once in each quarter of the year, in some market-town of the proper county, upon the market-day there, stand openly on the pillory for one hour; and shall also (if the court by which such judgment shall be given shall think fit) be obliged to give sureties for his good behaviour, in such sum and for such time as the court shall judge proper, according to the circumstances of the offence; and in such case shall be further imprisoned till such sureties shall be given. 4 Black. 60.

CONNARUS, Ceylon sumach, a genus of the decandria order in the monadelphia class of plants, and in the natural method ranking with those of which the order is doubtful. The stigma is simple; the capsule bivalved, unilocular, and monospermous. There are four species; the most remarkable is:

Connarus monocarpus, a native of India. It rises with a ligneous stalk eight or ten feet high, which is hard, rigid, and covered with a black bark; and divides upward into two or three branches with trifoliate leaves, having long footstalks placed alternate. It is propagated by cuttings, and is treated like other tender exotics.

CONNIVENT *valves*, in anatomy, those wrinkles, cellules, and vascules, which are found in the inside of the two great intestines, the ileum and jejunum.

CONOID, in geometry, a solid body, generated by the revolution of a conic section about its axis. See CONIC SECTIONS.

CONOID, *elliptical*, is a solid formed by the revolution of an ellipsis about one of its diameters, and more generally called a spheroid.

CONOID, *parabolical*, is generated by the revolution of a parabola about its axis.

CONOID, *hyperbolical*, is generated by the revolution of an hyperbola about its axis.

CONOIDES, in anatomy, a gland found in the third ventricle of the brain, called pinealis from its resemblance to a pine-apple. Descartes fixed the seat of the rational soul in this gland.

CONOPS, in zoology, a genus of insects belonging to the order diptera; the characters of which are: the rostrum is porrected and jointed like a knee; the antennæ terminate by a flat and solid articulation, resembling the bowl of a spoon, with a lateral bristle, which, when closely examined, appears to be very hairy. Of this genus there are thirteen species.

1. The calcitrans is to be found every where, especially in autumn, when it harasses the horses, and draws blood from them with its sting.

2. The macrocephala might at first sight be mistaken for a species of wasp. It is smooth; the forepart of the head is lemon-colour, as are the poisers; the feet are dun-coloured; the thorax is variegated with black and reddish dun: the same takes place with respect to the segments of the abdomen, some of which are edged with lemon-colour, chiefly the second and part of the third towards the sides: the wings are brown, watered, and clouded. This beautiful conops is found in meadows. The eleven other species are not deserving particular notice.

CONSANGUINITY, or kindred, is the connection or relation of persons descended from the same stock or common ancestor; and is either lineal or collateral. Lineal consanguinity is that which subsists between persons, of whom one is descended in a direct line from the other; as grandfather, father, and son. Collateral consanguinity is that which subsists between persons descended from the same common ancestor, but not from one another; as brothers, uncles, and nephews. 2 Black. 204.

Consanguinity terminates in the sixth and seventh degree, except in the succession of the crown, in which case it is continued to infinity. Marriage is prohibited by the church to the fourth degree of consanguinity inclusive; but by the law of nature, consanguinity is no obstacle to marriage, except in the direct line.

The civilians call *fratres consanguinei*, those born of the same father, in opposition to *fratres uterini*, who are only born of the same mother. It is the common opinion that the former was not allowed to complain of an inofficious testament, that is, of being disinherited without cause, except from the turpitude of the person appointed heir in their place.

CONSCRIPT, *conscriptus*, in Roman antiquity, an appellation given to the senators of Rome, who were called conscript fathers on account of their names being entered all in one register.

CONSECRATION, among medalists, is the ceremony of the apotheosis of an emperor. The consecration on medals is represented thus: on one side is the emperor's head, crowned with laurel, and sometimes veiled, and the inscription gives him the title DIVVS; on the reverse is a temple or altar, or an eagle taking flight toward heaven; and sometimes the emperor is seen in the air, borne up by the eagle; the inscription always CONSECRATIO.

CONSEQUENT *of a ratio*, in mathematics, the latter of the two terms of a ratio, or that to which the antecedent is compared; thus in $m:n$, or m to n, n is the consequent, and m the antecedent. See RATIO, and PROPORTION.

CONSEQUENTIAL *losses* or *damages*, in law. It is a fundamental principle of law and reason, that he who does the first wrong, shall answer for all the consequential damages. 12 Mod. 639. But this admits of limitation. Though a man do a lawful thing, yet, if any damage thereby befal another, he shall answer if he could have avoided it.

CONSERVATOR, an officer ordained for the security and preservation of the privileges of some cities and communities, having a commission to judge of and determine the differences among them.

In most catholic universities there are two conservators; one of whom decides the differences between the regents, students, &c. and the other takes cognizance of spiritual matters between ecclesiastics: the former is called conservator of royal privileges, or those granted by kings; the latter is called the conservator of apostolical privileges, or those granted by the pope.

CONSERVATOR *of the peace*, in our antient customs, a person who had a special charge to keep the king's peace. The chamberlain of Chester is still a conservator in that county; and petty constables are, by the common law, conservators, &c. of the king's peace.

CONSERVATOR *of the truce and safe-conducts*, an officer formerly appointed by the king's letters patent, whose business it was to make enquiry of all offences committed against the king's truce and safe-conducts upon the main seas out of the liberties of the cinque-ports.

CONSERVATORIOS are musical schools established for the instruction of children in music. There are four of these at Venice, designed for the education of girls, and three at Naples for the instruction of boys.

CONSIDERATION, is the material cause

CONIC SECTIONS.

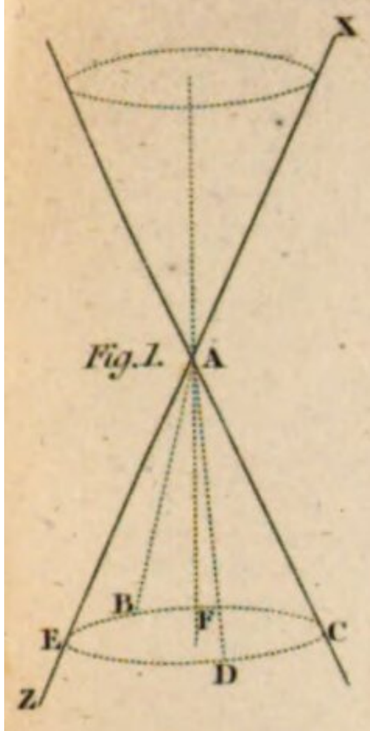


Fig. 1.

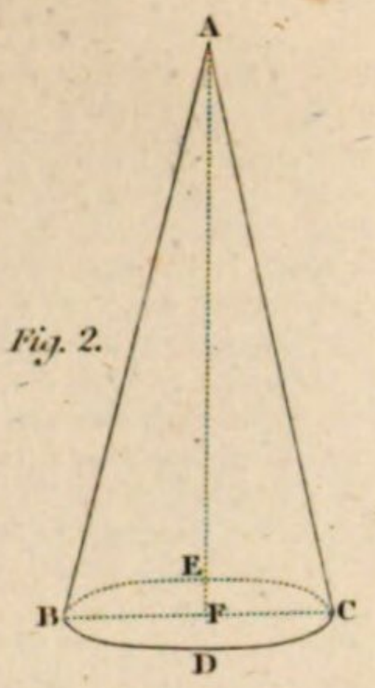
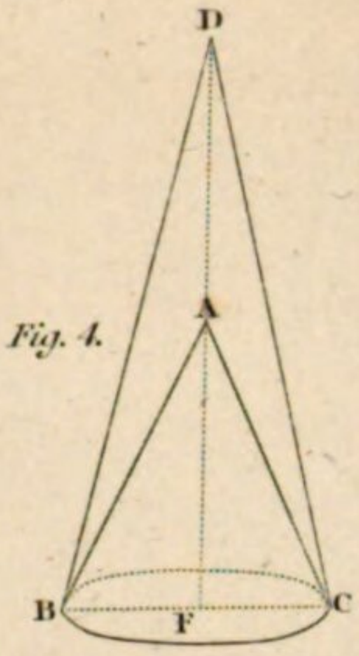


Fig. 2.



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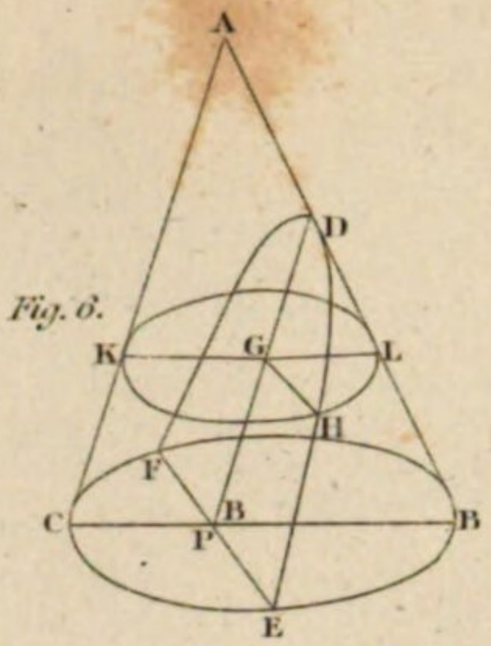


Fig. 6.

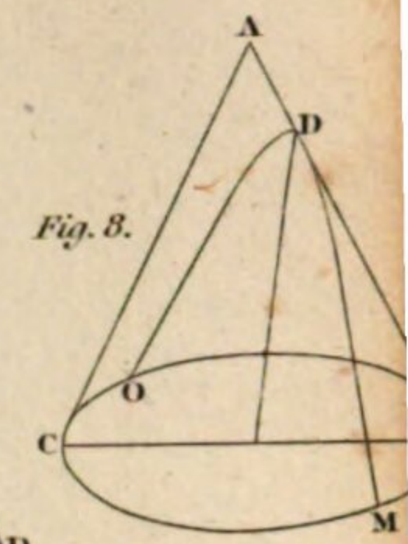
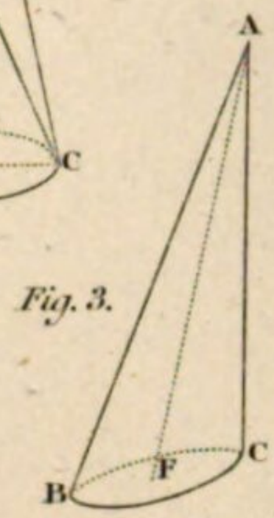


Fig. 8.



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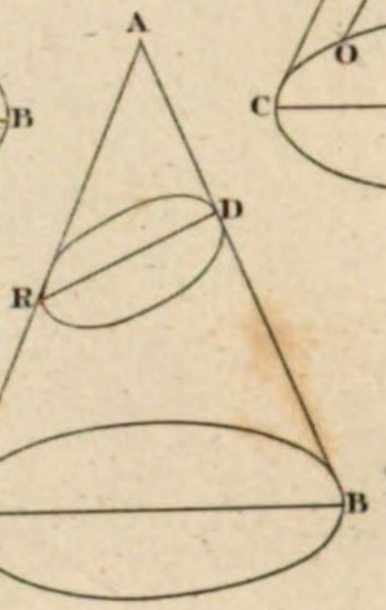


Fig. 7.

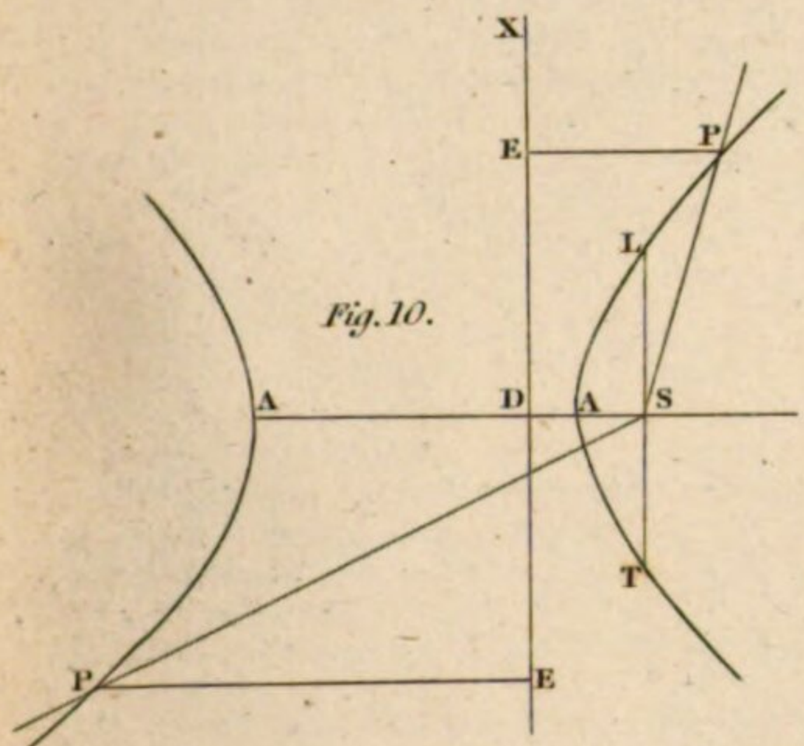
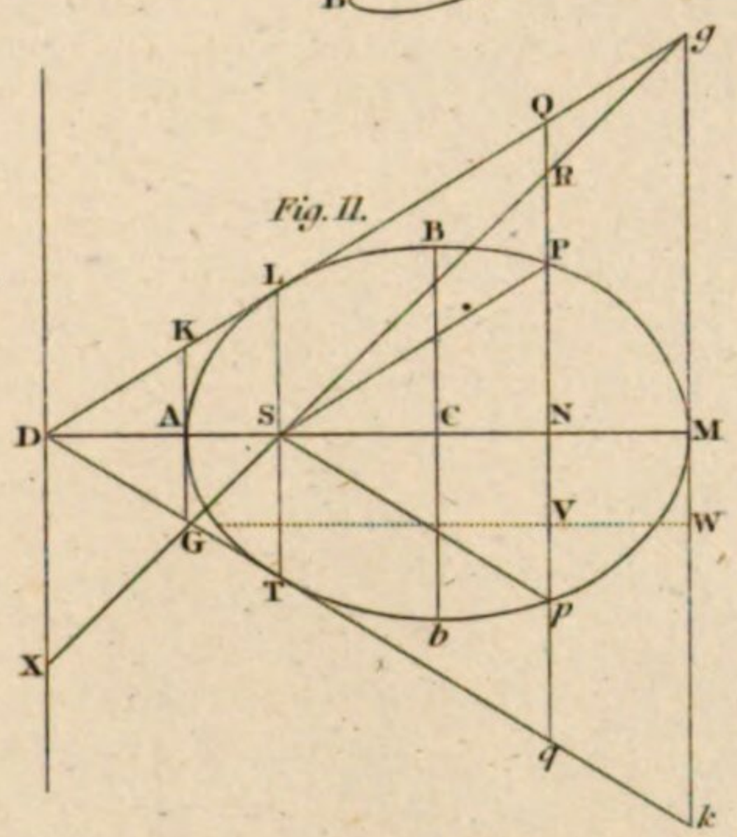


Fig. 10.



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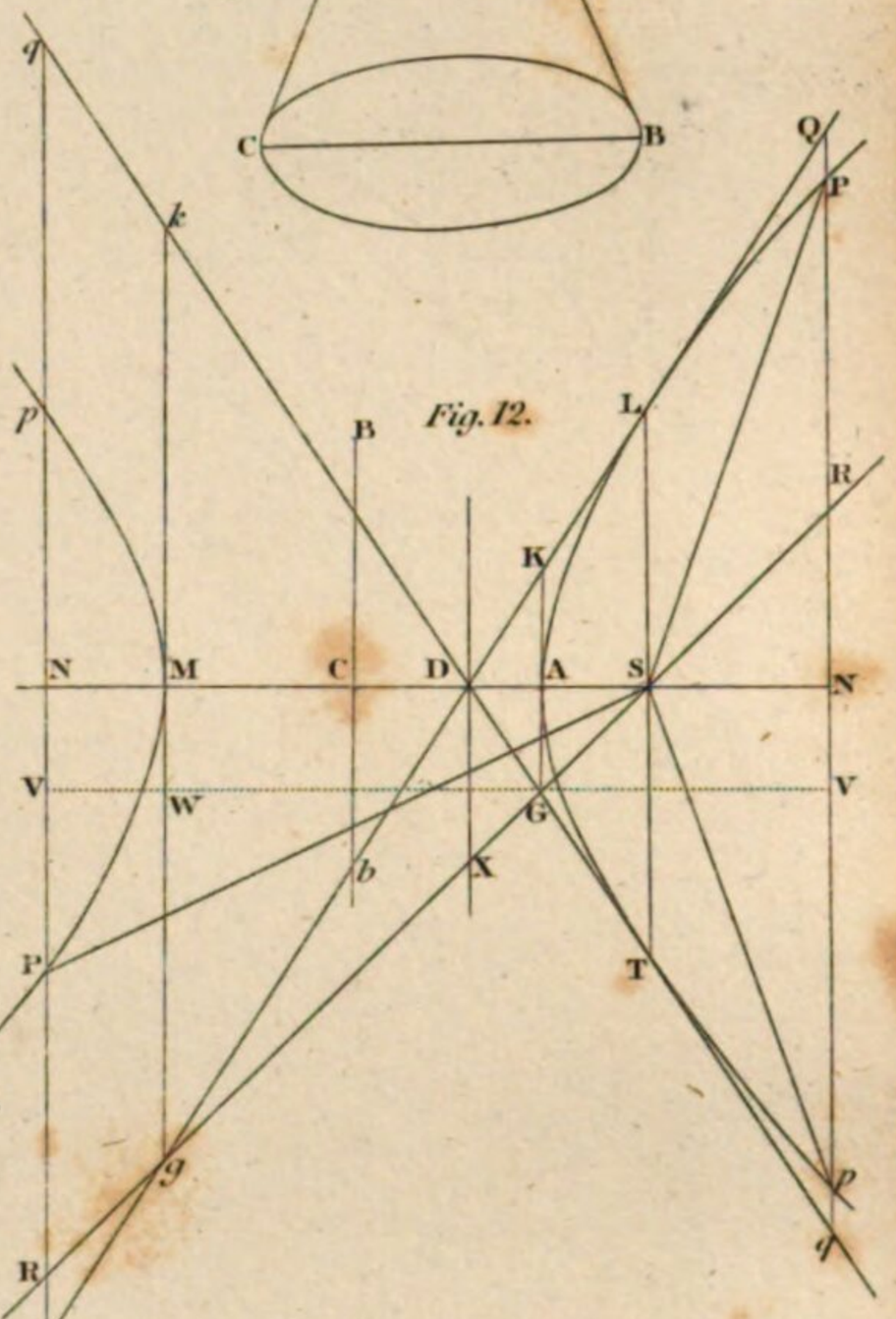


Fig. 12.

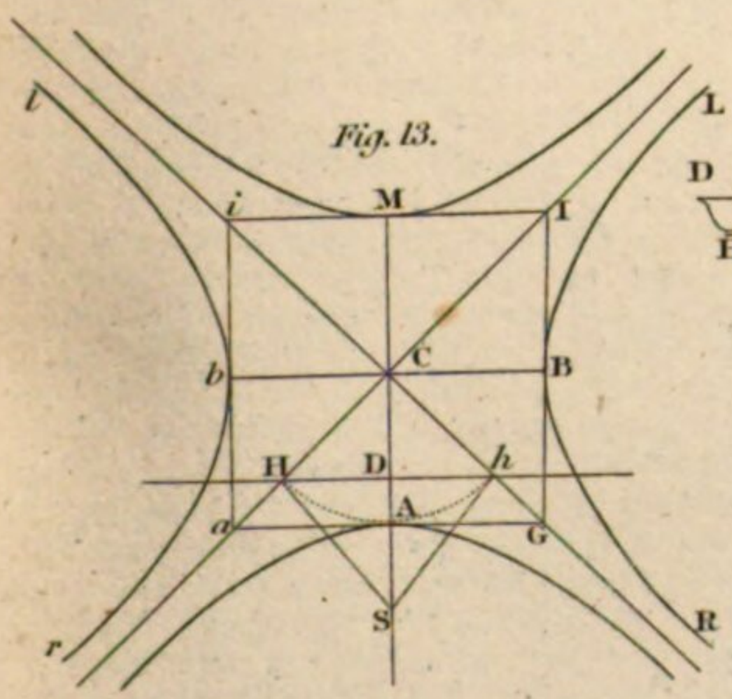
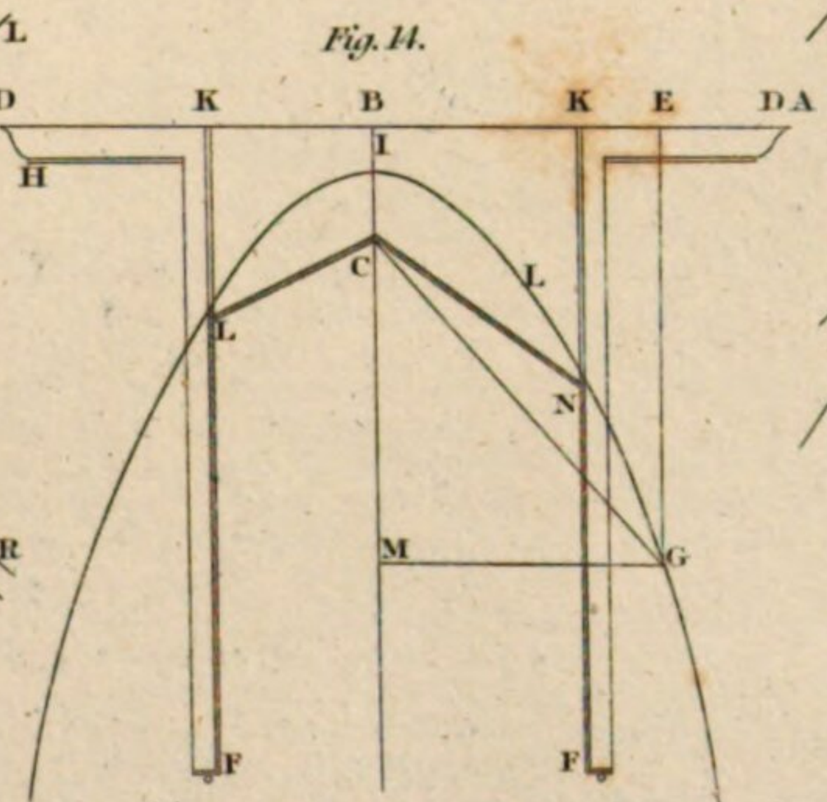


Fig. 13.



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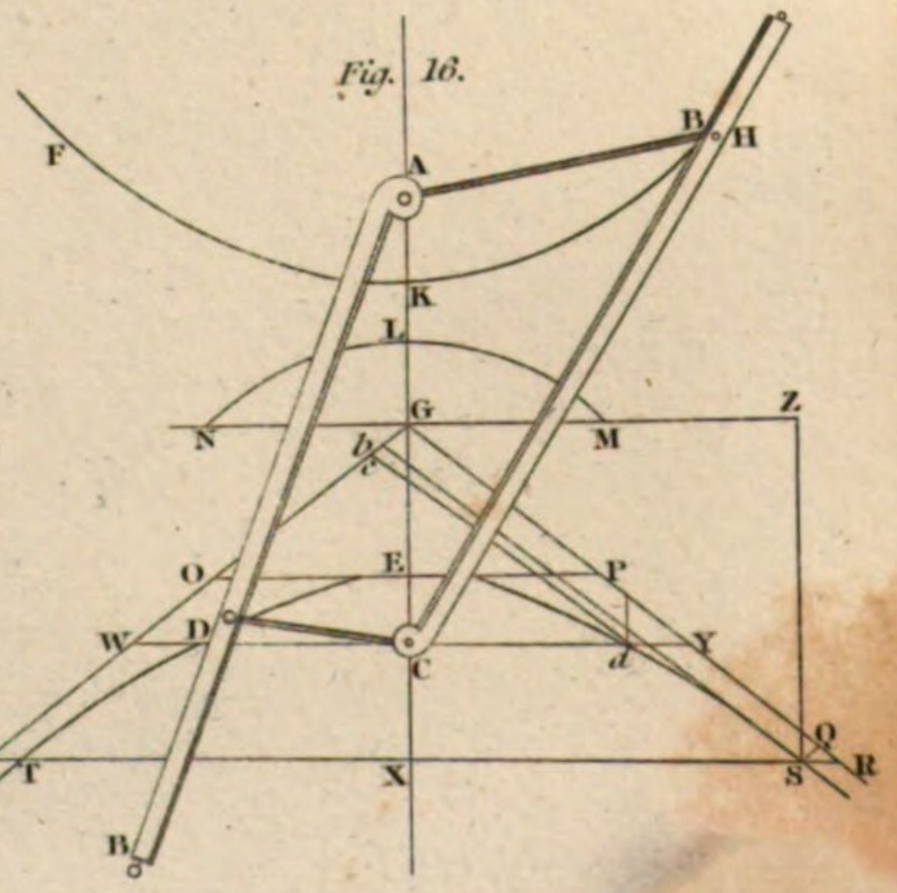


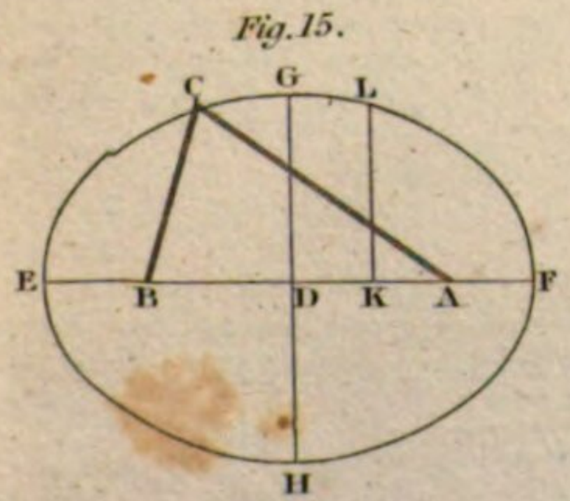


Fig. 15.

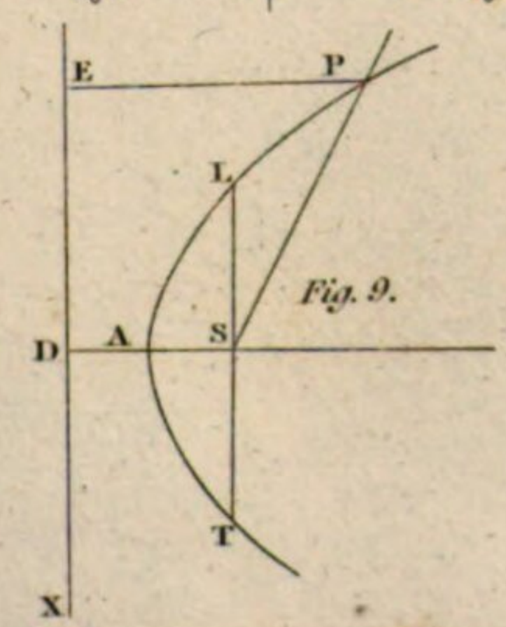


Fig. 9.

London, Published May 1 1808, by R. Phillips, Bridge Street, Blackfriars.

of a contract, without which it would not be effectual or binding. Consideration in contracts, is something given in exchange, something that is mutual and reciprocal; as money given for goods sold, or work performed for wages: and a consideration of some sort or other is so absolutely necessary to the forming of a contract, that a *nudum pactum*, or agreement to do or pay any thing on one side without any compensation on the other, is totally void in law; and a man cannot be compelled to perform it. 2 Black. 445. A consideration is necessary to create a debt, otherwise it is a *nudum pactum*. Jenk. 290. in Pl. 27.

CONSIGNMENT, the sending, or delivering over, goods, money, or other property, to another person. It may be either consigned unconditionally, or for some particular purpose. Consigned goods are supposed in general to be the property of him *by* whom they are consigned, but to be at the disposal of him *to* whom they are consigned.

CONSILIUM, in law, is used to signify a speedy day appointed to argue a demurrer; which the court grants after the demurrer joined, on reading the records of the cause.

CONSISTENTES, in church history, an appellation given to such penitents as were permitted to assist at prayers, but not to partake of the sacrament.

CONSISTORY, at Rome, is an ecclesiastical assembly held in the presence of the pope, for the reception of princes or their ambassadors, for the canonization of saints, for the promotion of cardinals, and other important affairs.

When a public consistory is to be held, the pope's throne is erected in the great hall of the apostolic palace: the pope is seated on cloth of gold, under a canopy of the same, and the foot of the throne is covered with red cloth. The cardinal bishops and priests sit on the right, below the throne, and the deacons on the left, but so as to have their faces towards the pope. The archbishops, bishops, prothonotaries, and other prelates, sit on the steps of the throne: on the lowest step the subdeacons, auditors, clerks of the chamber, and acolyths with woollen cowls; and the ecclesiastical officers of the pope's court on the ground. The nephews of the reigning pope, and other Roman princes, are ranged on each side of the throne; and the entrance of the passage leading to the throne is occupied by the pope's guard. Besides the public consistory, there is also a private one, held in a retired chamber, called the chamber of papegay, into which none are admitted but cardinals: here the pope appears in a white silk cassock, and a red velvet cap laced with silver; and here are first proposed and passed all bulls for bishoprics, abbeys, &c. which are thence called consistorial benefices.

In England, the archbishop and bishop of every diocese has a consistory court, held before his chancellor or commissary in his cathedral church, or other convenient place in his diocese, for ecclesiastical causes. From the bishop's court the appeal is to the archbishop; from the archbishop's court to the delegates.

CONSOLE, in architecture, an ornament cut upon the key of an arch, which has a projecture, and, on occasion, serves to support little cornices, figures, busts, and vases.

CONSOLIDATION, in the civil law, signifies the uniting the possession or profit of land with the property, and vice versa. Thus, if a man has by legacy usufructum fundi, and afterwards buys the property or fee simple of the heir, this is called a consolidation.

CONSOLIDATION, in our law, is the uniting two benefices into one by assent of the ordinary, patron, and incumbent.

CONSONANCE, in music, if we are to deduce the definition of the word from its etymology, is the effect of two or more sounds heard at the same time; but its general signification is confined to concording intervals. When the interval of a consonance is invariable, it is called perfect; and when it may be either major or minor, it is termed imperfect.

CONSONANT, a letter that cannot be sounded without some single or double vowel before or after it. Consonants are first divided into single and double; the double are *x* and *z*, the rest are all single: and these are again divided into mutes and liquids; eleven mutes, *b, c, d, f, v, g, j, k, p, q, t;* and four liquids, *l, m, n, r.* But the most natural division of consonants is that of the Hebrew grammarians, who have been imitated by the grammarians of other oriental languages. These divide the consonants into five classes, with regard to the five principal organs of the voice; which all contribute, it is true, but one more notably than the rest, to certain modifications, which make five general kinds of consonants. Each class comprehends several consonants, which result from the different degrees of the same modification, or from the different motions of the same organs: these organs are the throat, palate, tongue, teeth, lips; whence the five classes of consonants are denominated guttural, palatal, lingual, dental, and labial.

CONSPIRACY, in law, the unlawful confederation of any persons by oath or other covenant, that each of them shall aid and bear the other falsely and maliciously to indict or cause to be indicted, or falsely to move or maintain pleas. From which it seems clearly to follow, that not only those who actually cause an innocent man to be indicted, and also to be tried upon the indictment (whereupon he is lawfully acquitted), are properly conspirators; but that those also are guilty of this offence who basely conspire to indict a man falsely and maliciously, whether they do any act in prosecution of such confederacy or not. 1 Haw. 189. For this offence the conspirators (for there must be at least two to form a conspiracy) may be indicted at the suit of the king, and may be sentenced to fine, imprisonment, and pillory. 4 Black. 136.

CONSTABLE. Lord high constable, an antient officer of the crown both of England and France, whose authority was so very extensive, that the office has been laid aside in both kingdoms, except upon particular occasions, such as the king's coronation. The constable of France had his person privileged, and during the king's minority was named next to the princes of the blood. The army obeyed him next the king. He managed all that belonged to war, either for punishment of delinquents, distribution of booty, surrender of places, &c. The jurisdiction and functions of this office were afterwards in the mareschals of France. The function of the constable of England consisted in the care of the common peace of the land, in deeds of arms, and matter of war. By a law of Richard II. the constable of England had the determination of things concerning wars and blazonry of arms, which could not be discussed by the common law. The first constable was created by the Conqueror: the office continued hereditary till the 13th of Henry VIII; when it was laid aside, as being so powerful as to become troublesome to the king.

CONSTABLE: by the laws of Alfred, the freemen were to distribute themselves into decennaries and hundreds; and every ten freeholders chose an annual officer, whom they called constable, borsholder, tithingman, or headborough, as the head of the decennary or ten. These in every hundred where there was a feudal lord, were sworn in and admitted by the lord or his steward, in his leet; but where there was no feudal lord, the sheriff, in his turn, had the swearing of them in. So if there was no feudal lord of the hundred, an annual officer was chosen, who was to preside over the whole hundred, and was called the high constable.

Who may or may not be chosen constables. The antient officers of any of the colleges in the two universities are exempted from this office. Doug. 531. Any person of the age of 63 years or upwards, is not compellable to serve the office of constable within the city of Westminster. No person born out of the kingdom of England, or the dominions thereof, (except he be born of English parents, see ALIENS), is eligible to serve this office, even though he be naturalized. 5 Burn. 2790. Counsellors, attorneys, and all other officers whose attendance is required in the courts of Westminster-hall, aldermen of London, the president and fellows of the fellowship of physic in London; surgeons and apothecaries in London and within seven miles thereof, being free of the company of apothecaries; and teachers or preachers in holy orders in a congregation legally tolerated, shall be exempted from the office of a constable. The prosecutor of a felon to conviction, or the person to whom he shall assign the certificate thereof, shall be discharged from the office of constable.

But generally speaking, every housekeeper, inhabitant of the parish, and of full age, is liable to fill the office of constable. He ought however to be of the abler sort of parishioners, as being more likely to perform his duty with probity and discretion. 8 Co. 42.

Mode of choosing constables. It seems regularly, that the petty constable ought to be chosen in the leet, and the high constable in the torn, which is the general leet of the whole hundred; and if there be no leet, then, that the petty constable ought to be chosen also in the torn. 1 Burn. 400.

The high constables of hundreds are generally chosen either at the sessions, or by the greater number of the justices of the division; and they may be sworn at sessions, or by warrant from the sessions, which course has often been allowed and commended by the justices of assize. Dalt. c. 28. The office of petty constable being very necessary for the preservation of the peace, the justices of the

peace have ever since the institution of their office taken upon them as conservators of the peace, not only to swear the petty constables who have been chosen at a torn or leet, but also to nominate and swear those who have not been chosen at any such court, on neglect of the sheriffs or lords to hold their courts, or to take care that such officers are appointed in them. And this power of the justices, having been confirmed by the uninterrupted usage of many ages, shall not now be disputed. 2 Haw. 65.

The office, duty, power, &c. of constables. The original and proper authority of a high constable, as such, seems to be the very same within his hundred as that of the petty constable within his vill. The other branches of his office, such as the surveying of bridges, levying county rates; the issuing precepts concerning the appointment of the overseers of the poor, surveyors of highways, assessors and collectors of the land-tax and window-duties, &c.; are in him, not of necessity, but as matter of convenience. 4 Inst. 265. Every high or petty constable is by common law a conservator of the peace. 2 Haw. 33. The general duty of constables is to preserve the king's peace in their several districts, for which purpose they are armed, as well by the common law as by the legislature, with the very large and serious powers of arresting and imprisoning their fellow-subjects, forcibly entering their dwellings, and other extensive authorities, which it is highly their duty to exercise with becoming moderation and humanity. The high constable is as much the officer of the justices of the peace, as the constable of the vill. Fort. 128.

The constable is the proper officer to the justice of the peace, and bound to execute his warrants. Hence it has been resolved, that where the statute authorizes a justice of the peace to convict a man of a crime, and to levy the penalty by warrant of distress, without saying to whom such warrant shall be directed, or by whom it shall be executed, the constable is the proper officer to serve such warrant, and indictable for disobeying it. 2 Haw. 262.

But as the office of constable is by no means judicial, but wholly ministerial, he may execute such warrants, &c. directed to him, by deputy, if on account of indisposition, absence, or other special cause, he cannot conveniently do it in person. 2 Bur. 1259.

The high constables shall, at the general or quarter sessions, if required, account for the general county rate by them received, on pain of being committed to gaol till they shall account; and shall pay over the money in their hands, according to the order of the said court, on like pain of imprisonment. And all their accounts and vouchers shall, after having been passed at such sessions, be deposited with the clerk of the peace, to be kept among the records, and be inspected by any justice without fee. 12 Geo. II. c. 29. s. 8.

Constables should be very careful to keep in their custody whatever things they take upon felons. The same caution is to be observed in respect of such stolen goods as they take in the execution of such warrants. The law strictly requires this, that they may be produced in evidence upon the trial of the prisoner; for the identity of such things is to be proved upon the constable's oath, as well as the time when taken, and place where: if therefore he suffer such goods to go even out of his sight, he weakens his evidence, if he does not destroy it: and should the goods be by accident, or otherwise, lost, he is not only answerable to the court for acting wrong, which may defeat the prosecution, but also to the prosecutor for the value of the goods; nor will it be a sufficient plea to the court that he left them in the hands of a justice, even by his command; for as they were taken by him, the law requires them at his hands. And as the goods taken on persons charged with felony, or by search-warrants, are, as the law terms it, in abeyance; after the jury have returned their verdict, if the prisoner be convicted, the constable is to deliver such goods to the prosecutor. On the contrary, if the prisoner be acquitted, the goods revert to him, the cause of seizure being discharged; but if any difficulty should arise, the safest way is to pray the direction of the court. The duty of the constable indeed absolutely obliges him to produce such goods at the trial; but after this is over, he should be careful how he brings them out of court, lest he should suffer by actions at law from both parties.

An officer who has negligently suffered a prisoner to escape, may take him wherever he finds him, without mentioning any fresh pursuit.

A person found guilty upon an indictment or presentment of a negligent escape of a criminal actually in his custody, is punishable by fine and imprisonment, according to the quality of the offence. 2 Haw. 134.

But a voluntary escape is no felony, if the act done were not felony at the time of the escape made: as in case of a mortal wound given, and the party not dying till after the escape; so that the offence was but a trespass at the time of the escape; but the officer may be fined to the value of his goods. Dault. c. 129.

An action brought against a constable, headborough, or tithingman, for any matter done by virtue of their office, shall be laid in the county where the fact was committed, and not elsewhere. 21 Jac. c. 12. s. 5.

The constable executing a justice's warrant for levying a penalty, or other sum of money directed by an act of parliament, by distress, may deduct his own reasonable charges of taking, keeping, and selling, the goods distrained, returning the overplus on demand. 27 Geo. II.

The sheriff or steward of the leet having power to place a constable in his office, has consequently a power of removing him. 2 Haw. 63. And it has been the practice of the justices of the peace, for good cause, to displace such constables as have been chosen and sworn by them. 2 Haw. 65.

If a constable shall continue more than a year in his office, the sessions may discharge him, and put another in his place, till the lord shall hold a leet; and should the court or judge refuse to discharge a constable, the king's-bench may compel them by mandamus. 2 Haw. 65.

In the manner that constables are chosen they may be removed, and by the like authority; therefore, if there should be cause to remove an high constable, it has not been thought fit that any one or two justices should do it upon their discretion, but that it should be done by the greater part of the justices of that division, or at the sessions. Dalt. c. 28.

Of London constables. The constables must be freemen of the city, and nominated by the inhabitants of the ward on St. Thomas's day, confirmed or disallowed at the next wardmote, and afterwards sworn into office at the next court of aldermen on the Monday ensuing Twelfth-day. They swear to keep the king's peace to the utmost of their power; to arrest affrayers, rioters, and such as make contests to the breach of the peace, and carry them to the house of correction, or compter of one of the sheriffs; and in case of resistance, to make outcry to them, and pursue them from street to street, and from ward to ward, till they are arrested; to search for common nuisances in their respective wards, being required by scavengers, &c. and upon request to assist the beadle and raker in collecting their salaries and quarterage; to present to the lord mayor and ministers of the city defaults relating to the ordinances of the city. They are to certify to the mayor's court, once a month, the names and surnames of all freemen deceased; and also of the children of such freemen, being orphans. They are to certify the name, surname, place of dwelling, profession, and trade, of every person who shall just come into the ward, and keep a roll thereof, for which purpose they are to enquire once a month into what persons are come into the said ward; and if such persons are found to be ejected from any other ward for any misdemeanour, and refuse sureties for their good behaviour, they are to give them and their landlords warning to depart; and on refusal, they may be imprisoned, and the landlords fined a year's rent. Rep. 129. 138.

Constables are to keep watch and ward from the 10th of September to the 10th of March, from nine in the evening till seven the next morning, and from the 10th of March to the 10th of September, from ten in the evening till five next morning. They shall use their best endeavours for preventing fires, robberies, and disorders, and arrest malefactors, and go twice or oftener about their wards in every night; and the watchmen are to apprehend all suspected persons, &c. and to deliver them to the constable of the night, who shall carry them before a justice of the peace. Constables misbehaving themselves to forfeit 20*s.*; and the lord mayor, or two justices for the city, may hear and determine offences, and levy penalties by distress and sale of goods, &c. They must place the king's arms, and the arms of the city, over their doors, and if they reside in alleys, at the ends of such alleys towards the streets, to signify that a constable lives there.

There are also constables of particular places, as constable of the Tower, of Dover-castle, of Windsor-castle, of the castle of Caernarvon, and many other of the castles of Wales, whose office is the same with that of the castellani, or governors of castles.

CONSTAT, in law, a certificate that the clerk of the pipe and auditors of the exchequer grant at the request of any person who intends to plead or move in that court, for the discharge of any thing. A constat is superior to an ordinary certificate, because it contains nothing but what is evident on record.

CONSTELLATION, in astronomy, a system of several stars that are seen in the heavens near to one another. Astronomers

not only mark out the stars, but, that they may better bring them into order, they distinguish them by their situation and position in respect to each other; and therefore they distribute them into asterisms, or constellations, allowing several stars to make up one constellation; and for the better distinguishing and observing them, they reduce the constellations to the forms of animals, as men, bulls, bears, &c. or to the images of some things known, as of a crown, a harp, a balance, &c. or give them the names of those whose memories, in consideration of some notable exploit, they had a mind to transmit to future ages. The division of the stars by images and figures is of great antiquity, and seems to be as old as astronomy itself; for in the most antient book of Job, Orion, Arcturus, and the Pleiades, are mentioned: and we meet with the names of many of the constellations in the writings of the first poets, Homer and Hesiod. See ASTRONOMY.

The antients, in their division of the firmament, took in only so much as came under their notice, distributing it into forty-eight. Modern astronomers divide the whole starry firmament into three regions: 1. The zodiac, or that portion of the heavens in which the planets would appear to move, to an eye placed in the sun. The breadth of this space depends on the inclination of the orbits in which the planets move, to one another; and includes twelve constellations, commonly called the signs of the zodiac, viz. aries, taurius, gemini, cancer, leo, virgo, libra, scorpio, sagittarius, capricornus, aquarius, and pisces. 2. All that region of the heavens that lies on the north side of the zodiac, which contains 21 constellations, viz. the ursa minor and major, draco, cepheus, bootes, corona septentrionalis, hercules, lyra, cygnus, cassiopeia, perseus, andromeda, triangulum, auriga, pegasus, equuleus, delphinus, sagitta, aquila, serpentarius, and serpens; to which were added afterwards two others, viz. that of antinous, which was made of the stars not included in any image, near the eagle; and Berenice's hair, consisting of stars which are near the lion's tail. 3. That region on the southern side of the zodiac, which contains 15 constellations, known to the antients, viz. cetus, the eridanus, lepus, orion, canis major, canis minor, argo, hydra, crater, corvus, centaurus, lupus, ara, corona meridionalis, and piscis australis: to these are lately added twelve more constellations, which are not to be seen by us who inhabit the northern regions, because of the convexity of the earth, but in the southern parts they are very conspicuous; these are the phœnix, grus, pavo, indus, avis paradisi, triangulum australe, musca, chameleon, piscis volans, toucan, hydrus, xiphias. The galaxy, or milky-way, is also to be reckoned among the constellations. See each constellation, and the number of stars it contains, under its proper head; and also the article ASTRONOMY.

CONSTITUTION, an ordinance, decision, regulation, or law, made by authority of any superior, ecclesiastical or civil. The constitutions of the Rōman emperors make a part of the civil law, and the constitutions of the church make a part of the canon law.

CONSTITUTION, by way of eminence, is an appellation given to that bull of pope Clement XI. which begins with the word unigenitus.

CONSTITUTION, *apostolical*, a collection of regulations attributed to the apostles, and supposed to have been collected by St. Clement, whose name likewise they bear. It is the general opinion, however, that they are spurious, and that St. Clement had no concern in them. They appeared first in the 4th age, but have been much changed and corrupted since that time. They are divided into eight books, consisting of a great number of rules and precepts, relating to the duties of Christians, and particularly the ceremonies and discipline of the church. Mr. Whiston, in opposition to the general opinion, asserts them to be a part of the sacred writings dictated by the apostles in their meetings, and written down from their own mouths by St. Clement; and intended as a supplement to the New Testament, or rather as a system of christian faith and polity. The reason why the constitutions are suspected by the orthodox, and perhaps the reason also why their genuineness is defended by Mr. Whiston, is, that they seem to favour Arianism.

CONSTITUTION, in a physical sense, is that particular disposition of the human body, which results from the properties and mutual actions of the solids and fluids, and which renders them capable of exercising the functions proper and conformable to nature.

CONSTRUCTION, in geometry, is the drawing such lines, such a figure, &c. as are previously necessary for the making any demonstration appear more plain and undeniable.

CONSTRUCTION *of equations*, in algebra, is the finding the roots or unknown quantities of an equation, by geometrical construction of right lines or curves; or the reducing given equations into geometrical figures. And this is effected by lines or curves, according to the order or rank of the equation.

The roots of any equation may be determined, that is, the equation may be constructed, by the intersections of a straight line with another line or curve of the same dimensions as the equation to be constructed; for the roots of the equation are the ordinates of the curve at the points of intersection with the right line, and it is well known that a curve may be cut by a right line in as many points as its dimensions amount to. Thus, then, a simple equation will be constructed by the intersection of one right line with another; a quadratic equation, or an affected equation of the 2d rank, by the intersection of a right line with a circle, or any of the conic sections; which are all lines of the 2d order, and which may be cut by the right line in two points, thereby giving the two roots of the quadratic equation. A cubic equation may be constructed by the intersection of the right line with a line of the 3d order, and so on.

But if, instead of the right line, some other line of a higher order be used, then the second line, whose intersections with the former are to determine the roots of the equation, may be taken as many dimensions lower as the former is taken higher. And in general an equation of any height will be constructed by the intersections of two lines whose dimensions, multiplied together, produce the dimension of the given equation. Thus, the intersections of a circle with the conic sections, or of these with each other, will construct the biquadratic equations, or those of the fourth power, because $2 \times 2 = 4$; and the intersections of the circle or conic sections with a line of the third order, will construct the equations of the fifth and sixth powers, and so on. For example:

To construct a simple equation. This is done by resolving the given simple equation into a proportion, or finding a third or fourth proportional, &c. Thus, 1. If the equation be $ax = bc$; then $a : b :: c : x = \frac{bc}{a}$, the fourth proportional to a, b, c.

2. If $ax = b^2$; then $a : b :: b : x = \frac{b^2}{a}$, a third proportional to a and b.

3. If $ax = b^2 - c^2$; then, since $b^2 - c^2 = \overline{b+c} \times \overline{b-c}$, it will be $a : b+c :: b-c : x = \frac{b+c \times b-c}{a}$, a fourth proportional to a, $b+c$, and $b-c$.

4. If $ax = b^2 + c^2$; then construct the right-angled triangle ABC, (See Plate Miscel. fig. 17.) whose base is b, and perpendicular is c, so shall the square of the hypothenuse be $b^2 + c^2$, which call b^2; then the equation is $ax = b^2$, and $x = \frac{b^2}{a}$, a third proportional to a and b.

To construct a quadratic equation. 1. If it be a simple quadratic, it may be reduced to this form $x^2 = ab$; and hence $a : x :: x : b$, or $x = \sqrt{ab}$ a mean proportional between a and b. Therefore upon a straight line (fig. 18) take AB $= a$, and BC $= b$; then upon the diameter AC describe a semicircle, and raise the perpendicular BD to meet it in D; so shall BD be $= x$ the mean proportional sought between AB and BC, or between a and b.

2. If the quadratic be affected, let it first be $x^2 + 2ax = b^2$; then form the right-angled triangle whose base AB (fig. 19) is a, and perpendicular BC is b; and with the centre A and radius AC, describe the semicircle DCE; so shall DB and BE be the two roots of the given quadratic equation $x^2 + 2ax = b^2$.

3. If the quadratic be $x^2 - 2ax = b^2$, then the construction will be the very same as of the preceding one $x^2 + 2ax = b^2$.

4. But if the form be $2ax - x^2 = b^2$; form a right-angled triangle whose hypothenuse FG is a, (fig 20,) and perpendicular GH is b; then with the radius FG and centre F describe a semicircle IGK; so shall IH and HK be the two roots of the given equation $2ax - x^2 = b^2$, or $x^2 - 2ax = -b^2$. See Maclaurin's Algebra, part iii, cap. 2, and Simpson's Algebra, p. 267.

To construct cubic and biquadratic equations.—These are constructed by the intersections of two conic sections; for the equation will rise to four dimensions, by which are determined the ordinates from the four points in which these conic sections may cut one another; and the conic sections may be assumed in such a manner, as to make this equation coincide with any proposed biquadratic, so that the ordinates from these four intersections will be equal to the roots of the proposed biquadratic. When one of the intersections of the conic section falls upon the axis, then one of the ordinates vanishes; and the equation by which these ordinates are determined, will then be of three dimensions only, or a cubic; to which any proposed cubic equation may be accommodated. So that the three remaining ordinates will be the roots of that proposed cubic. The conic sections for this purpose should be such as are most easily described; the circle may be one, and the parabola is usually assumed for the other.

CONSUBSTANTIATION, a tenet of the lutheran church with regard to the manner of the change made in the bread and wine

in the eucharist. The divines of that profession maintain, that after consecration, the body and blood of our Saviour are substantially present, together with the substance of the bread and wine; which is called consubstantiation or impanation.

CONSUL, is an officer established by virtue of a commission from the king and other princes, in all foreign countries of any considerable trade, to facilitate and dispatch business, and protect the merchants of the nation. The consuls are to maintain a correspondence with the ministers of England residing in the courts whereon their consulate depends. They are to support the commerce and the interest of the nation; to dispose of the sums given and the presents made to the lords and principals of places, to obtain their protection, and prevent the insults of the natives on the merchants of the nation. By the treaty of Utrecht between Great Britain and Spain, the consul residing in the king of Spain's dominions shall take inventories of the estates of the English dying intestate in Spain; and these estates shall be intrusted to two or three merchants, for the security and benefit of the heirs and creditors.

The statute of 9 Geo. II. enacts, that it shall be lawful for persons appointed by the consuls at the ports of Cadiz and St. Mary's in Spain, with the majority of the British factors and merchants there, to receive from all English and Irish ships trading there, any sums of money not exceeding one rial plate per ducat on the freight of goods and merchandize there imported, and on all tonnage goods not exceeding two rial plates per ton, and all their bills of lading shall specify to pay the same under denomination of contribution. And all British and Irish commanders trading to the said ports, and delivering there, shall, within ten days after their arrival, deliver a manifesto upon oath, specifying the particulars of the cargo, and to whom consigned; which oath is to be administered by the consul, or whom he shall appoint, and the clearances outwards detained by him till payment of the money is made; and any departing without his clearances, the consul on such master's return to any port in the king's dominions, may have an action at law against him for the said money. All moneys raised to be applied to the relief of shipwrecked mariners, or other distressed persons his majesty's subjects, and other charitable uses, are appointed by the consul.

CONSULTATION, in law, a writ by which a cause being removed from the spiritual court to the king's court, is returned thither again; and the reason is, that if the judges of the king's court, by comparing the libel with the suggestion of the party, find the suggestion false or not proved, and on that account the cause to be wrongfully called from the ecclesiastical court, then upon this consultation or deliberation they decree it to be returned. This writ is in the nature of a procedendo; yet properly a consultation ought not to be granted, only in cases where a person cannot recover at the common law. In causes of which the ecclesiastical and spiritual courts have jurisdiction, and they are not mixed with any temporal thing; if suggestion is made for a prohibition, a consultation shall be awarded. See PROHIBITION.

CONSUMPTION, in medicine, a word of very extensive signification, implies all disorders that bring any decay or waste upon the constitution. See MEDICINE.

CONTACT, is when one line, plane, or body, is made to touch another, and the parts that do thus touch are called the points or places of contact. The contact of two spherical bodies, and of a tangent with the circumference of a circle, is only in one point.

CONTAGION. See MEDICINE.

CONTENT, in geometry, the area or quantity of matter or space included in certain bounds. The content of a tun of round timber is 43 solid feet. A load of hewn timber contains 50 cubic feet; in a foot of timber are contained 1728 cubic or square inches: and as often as 1728 inches are contained in a piece of timber, be it round or square, so many feet of timber are contained in the piece. See GAUGING.

CONTIGUOUS ANGLES, in geometry, are such as have one leg common to each angle; and are sometimes called adjoining angles, in contradistinction to those produced by continuing their legs through the point of contact, which are called opposite or vertical angles.

CONTINGENT, something casual or uncertain. Hence future contingent, in logic, denotes a conditional event which may or may not happen, according as circumstances fall out. The ancient Socinians maintained that God cannot foresee future contingents, because depending on the free motions of the will of man.

CONTINGENT is also a term of relation for the quota that falls to any person upon a division. Thus each prince in Germany, in time of war, is to furnish so many men, so much money and munition, for his contingent.

CONTINGENT USE, in law, is an use limited in a conveyance of lands which may or may not happen to vest, according to the contingency mentioned in the limitation of the use. And a contingent remainder is where no present interest passes; but the estate is limited to take effect, either to a dubious and uncertain person, or upon a dubious and uncertain event; so that the particular estate may chance to be determined, and the remainder never take effect.

CONTINUANCE, in law, is the continuing of a cause in court by an entry made for that purpose upon the records there.

CONTINUANCE *of a writ or action*, is its continuing in force from one term to another, where the sheriff has not returned a former writ issued out in the same action. With respect to continuances, the court of king's bench is not to enter them on the roll till after issue or demurrer, and then they enter the continuance of all on the back before judgment.

CONTINUANDO, a term used in a special declaration of trespass, where the plaintiff would recover damages for several trespasses in one and the same action. To avoid multiplicity of suits, a person may in one action of trespass recover damages for many trespasses committed, by laying the same to be done with a continuando.

CONTINUED PROPORTION, in arithmetic, is that where the consequent of the first ratio is the same with the antecedent of the second; as 4:8::8:16, in contradistinction to discrete proportion. See DISCRETE.

CONTINUO, in music, signifies the thorough bass, as basso continuo is the continual or thorough bass; which is sometimes marked in music books by the letters B. C.

CONTOBARDITES, in church-history, a sect of heretics in the sixth century, who allowed of no bishops.

CONTOUR, the outline of a figure. It is sometimes used with great latitude, to express the general cast or lineaments of the visage. See PAINTING.

CONTOURNE', in heraldry, is used when a beast is represented standing or running with its face to the sinister side of the escutcheon; they being always supposed to look to the right, if not otherwise expressed.

CONTOURNIATED, a term among antiquaries applied to medals, the edges of which appear as if turned in a lathe. This sort of work seems to have had its origin in Greece, and to have been designed to perpetuate the memories of great men, particularly those who had borne away the prize at the solemn games. Such are those remaining of Homer, Solon, Euclid, Pythagoras, Socrates, and several athletæ.

CONTRA FORMAM COLLATIONIS, a writ that lies where a man had given lands to the warden and master of an hospital, to support certain poor men: if they alienated the land, then the donor or his heirs should bring this writ to recover them.

CONTRA FORMAM STATUTI, the usual conclusion of every indictment for an offence created by statute.

CONTRA FORMAM FEOFFAMENTI, is a writ which lies for the heir of a person enfeoffed of lands or tenements, who is distrained by the lord for more services than are contained in the charter of feoffment.

CONTRABAND, in commerce, a prohibited commodity or merchandise bought or sold, imported or exported, in prejudice to the laws and ordinances of a state, or the public prohibitions of the sovereign. Contraband goods are not only liable to confiscation themselves, but also subject all other merchandise found with them in the same box, bale, or parcel, together with the horses, waggons, &c. which conduct them. There are contrabands likewise, which, besides the forfeiture of the goods, are attended with several penalties and disabilities.

The principal goods prohibited to be imported into Great Britain, are * alamodes and lustrings, except in the port of London, and by licence; * ammunition, without licence from the king; * arms, without licence from the king; * bits for bridles; * popish books; brandy or rum, in casks less than 60 gallons, or in ships less than 15 tons burden; * buttons of all sorts; printed, painted, stained, or dyed callicoes; cards for wool, and playing cards; * chocolate ready made, or cocoa paste; cinnamon without licence, except from India; * woollen cloths; * dice; leather gloves; East India, Persia, and China wrought silks, Bengals, stuffs mixed with silk, or herba, except into the port of London, and under special regulations; * fringes of silk or thread; gold or silver thread, lace, fringe, or other works made thereof; * malt from beyond sea * salt in ships under twenty tons, or not in bulk; * silk embroidered, twined silk; * wrought silk mixed with gold, silver, or other

materials; * tea, except by the India company; tobacco manufactured; * utensils of war, without licence from the king; * cut whale-bone.

Goods prohibited to be exported, are boxes, cases, or dial-plates, for clocks and watches, without the movement and makers' names; bullion, without proper certificates, &c.; frames for stockings: metal not of British ore, except copper-bars; wool; scouring and fuller's clay; sheep and sheepskins with the wool; tallow; utensils used in the silk and woollen manufactory; white ashes, &c.

N. B. Such goods in the preceding list as have an asterisk prefixed before them, besides the forfeiture in common with the rest, are attended with several penalties.

CONTRAMANDATIO PLACITI, countermanding what was formerly ordered, and giving the defendant further time to answer.

CONTRACT, a covenant or agreement between two or more persons, with a lawful consideration or cause. Contracts are twofold, either express or implied. Express contracts are, where the terms of the agreement are openly uttered, as to pay a stated price for certain goods. Implied, are such as reason and justice dictate, and which therefore the law presumes that every man undertakes to perform: thus if a man takes up wares from a tradesman, without any agreement of price, the law concludes that he contracted to pay their real value. 2 Black 443.

These are good contracts in law, because there is one thing in consideration for another; but if a person promises to give or pay 20*s.* which afterwards, on being demanded, he refuses to pay, no action lies to recover it; because such a promise will not amount to a contract, it being no more than a bare promise, termed in law nudum pactum. Yet if any thing was given in consideration of such a promise, was it but to the value of a penny, it is deemed a good contract, and consequently will be binding. In contracts the time is to be regarded, in and from which they are made; and there is a difference where a day of payment is limited thereon, and where not: for when it is limited, the contract is good immediately, and an action lies on it without payment; but in the other case it is otherwise.

CONTRACT, *usurious*, is an agreement to pay more interest for money than the laws allow. See USURY.

It is a devastavit in executors, to pay a debt upon an usu ious contract.

CONTRA-HARMONICAL *proportion*, in arithmetic, is that relation of three terms, wherein the difference of the first and second is to the difference of the second and third as the third is to the first: thus, 3, 5, and 6, are numbers contra-harmonically proportional, for 2 : 1 : : 6 : 3.

CONTRAST, the artificial opposition in works of painting and sculpture, of groups, attitudes, or colours; so as by their variety and striking difference, to enhance the value of each other. See PAINTING.

CONTRATE-WHEEL, in watch-work, that next to the crown, the teeth and hoop of which lie contrary to those of the other wheels, whence it takes its name. See CLOCK-WORK.

CONTRAVALLATION, in the military art, implies a line formed in the same manner as the line of circumvallation, to defend the besiegers against the enterprises of the garrison; so that the army forming a siege lies between the lines of circumvallation and contravallation. The trench of this line is towards the town, at the foot of the parapet, and is never made but when the garrison is numerous enough to harass and interrupt the besiegers by sallies. This line is constructed in the rear of the camp, and by the same rule as the line of circumvallation, with this difference; that as it is only intended to resist a body of troops much inferior to a force which might attack the circumvallation, so its parapet is not made so thick, nor the ditch so wide and deep; six feet is sufficient for the first, with the ditch eight feet broad and five feet deep.

CONTRAYERAA, in the materia medica, the name by which the root of the dorstenia plant is known in the shops. See MATERIA MEDICA.

CONTRE, in heraldry, an appellation given to several bearings, on account of their cutting the shield contrary and opposite ways. Thus we meet with contre-bend, contre-chevron, contre-pale, &c. when there are two ordinaries of the same nature opposite to each other, so as colour may be opposed to metal, and metal to colour.

CONTRIBUTIONE *facienda*, in law, a writ that lies where tenants in common are bound to do the same thing, and one or more of them refuse to contribute their part; as where they jointly hold a mill pro indiviso, and equally share the profits of it, if the mill fall to decay, and one or more of the persons refuse to contribute to its reparation, the rest shall have this writ to compel them.

CONTROL, COMPTROL, or CONTROLE, is properly a double register kept of acts, issues, &c. of the officers or commissioners in the revenue, army, &c. in order to perceive the true state thereof, and to certify the truth, and the due keeping of the acts subject to the enregisterment.

CONTROLLER, an officer appointed to control or oversee the accounts of other officers, and, on occasion, to certify whether or not things have been controlled or examined. In England we have several officers of this name; controller of the king's house, controller of the navy, controller of the customs, controller of the mint, &c.

CONTROLLER *of the hanaper*, an officer that attends the lord chancellor daily, in term and in seal-time, to take all things sealed in leather bags, from the clerks of the hanaper; and to mark the number and effect thereof, and enter them in a book, with all the duties belonging to the king and other officers for the same, and so charge the clerk of the hanaper with them.

CONTROLLER *of the pipe*, an officer of the exchequer, that makes out a summons twice every year, to levy the farms and debts of the pipe.

CONTROLLERS *of the pells*, two officers of the exchequer, who are the chamberlain's clerks, and keep a control of the pell of receipt, and goings out.

CONTUMACY, in law, a refusal to appear in court when legally summoned, or the disobedience to the rules and orders of a court having power to punish such offence. In a criminal sense, the contumacious is condemned, not because the crime is proved on him, but because he is absent. In England contumacy is to be prosecuted to outlawry.

CONTUSION, in medicine and surgery, any hurt of the body that is inflicted by a blunt instrument; and since, in this case, an indefinite number of small vessels and fibres are injured and broken, a contusion may properly be said to be a congeries of an indefinite number of small wounds. See SURGERY.

CONVALLARIA, or *lily of the valley*, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under sarmentaceæ, or 11th order. The corolla is sexfid; the berry spotted and trilocular. The species are 11, two of which are natives of Britain, viz. the maialis, or May lily; and the multiflora, or Solomon's seal. They are plants of considerable beauty, and may be easily propagated by their creeping roots.

CONVENTICLE, a diminutive of convent; denoting properly a cabal, or secret assembly, of a part of the monks of a convent, to make a brigue or party in the election of an abbot. From the ill use of these assemblies the word is come into disrepute; and now stands for any mischievous, seditious, or irregular assembly. The term conventicle is said, by some, to have been first applied in England to the schools of Wickliffe; and has been since used to signify the religious assemblies of all in this country who do not conform to the established doctrines and worship of the church of England.

By 22 Car. II. cap. 1, it is enacted, that if any persons of the age of 16 years, subjects of this kingdom, shall be present at any conventicle, where there are five or more assembled, they shall be fined five shillings for the first offence, and ten shillings for the second; and persons preaching incur a penalty of twenty pounds. Also suffering a meeting to be held in a house, &c. is liable to twenty pounds penalty. Justices of the peace have power to enter such houses, and seize persons assembled, &c. and if they neglect their duty they shall forfeit one hundred pounds. And if any constable, &c. know of such meetings, and do not inform a justice of peace, or chief magistrate, &c. he shall forfeit five pounds. But the 1st W. and M. cap. 18, ordains, that protestant dissenters shall be exempt from penalties: though if they meet in a house with the doors locked, barred, or bolted, such dissenters shall have no benefit from the act. Officers of the government, &c. present at any conventicle, at which there shall be ten persons, if the royal family be not prayed for in express words, shall forfeit forty pounds, and be disabled. Stat. 10 Anne, cap. 2.

CONVENTUAL, in general, denotes something belonging to a convent or monastery: thus monks who actually reside in a convent are called conventuals, in contradistinction to those who are only guests, or in possession of benefices depending on the house.

CONVERGING or *convergent lines*, in geometry, are such as continually approach nearer one another, or whose distance becomes still less and less. These are opposed to divergent lines, the distance of which becomes continually greater: those lines which converge one way diverge the other.

CONVERGING HYPERBOLA, is one whose

concave legs bend in towards one another, and run both the same way.

CONVERGING RAYS, in optics, those rays that, issuing from divers points of an object, incline towards another, till at last they meet and cross, and then become diverging rays. See OPTICS.

CONVERSE, in mathematics. One proposition is called the converse of another, when, after a conclusion is drawn from something supposed in the converse proposition, that conclusion is supposed; and then, that which in the other was supposed, is now drawn as a conclusion from it: thus, when two sides of a triangle are equal, the angles under these sides are equal; and, on the converse, if these angles are equal, the two sides are equal.

CONVERSION, in war, a military motion whereby the front of a battalion is turned where the flank was, in case the battalion is attacked in the flank.

CONVERSION *of equations*, in algebra, is when the quantity sought, or any part or degree of it, being in fractions, the whole is reduced to one common denomination, and then omitting the denominators, the equation is continued in the numerators only. Thus suppose $a - b = \frac{aa + cc}{d} + b + b$; multiply all by d, and it will stand thus, $da - db = aa + cc + db + db$.

CONVERSION *of propositions*, in logic, the changing of the subject into the place of the predicate, and the predicate into the place of the subject; and yet always retaining the same quality of both propositions: as, Every right-lined triangle has the sum of its angles equal to two right ones: Every right-lined figure that has the sum of its angles equal to two right ones, is a triangle.

CONVEX, an appellation given to the exterior surface of gibbous or globular bodies; in opposition to the hollow inner surface of such bodies, which is called concave: thus we say, a convex lens, mirror, superficies, &c. See OPTICS.

CONVEYANCE, in law, a deed which passes land from one to another. The most common conveyances now in use are, deeds of gift, bargain and sale, lease and release, fines and recoveries, settlements to uses, &c. A conveyance cannot be fraudulent in part, and good as to the rest; for if it is fraudulent and void in part, it is void in all, and it cannot be divided. Fraudulent conveyances to deceive creditors, defraud purchasers, &c. are void, by stat. 50 Ed. III. c. 6. 13 Eliz. c. 5—27. Eliz. c. 4.

CONVICTION is either where a man is outlawed, or appears and confesses, or else is found guilty by the inquest. Cromp. Inst. 9.

Summary proceedings are directed by several acts of parliament for the conviction of offenders, and the inflicting certain penalties imposed by those acts. In these there is no intervention of a jury, but the party accused is acquitted or condemned by the suffrage of such person only as the statute has appointed for his judge.

The law implies that there must be a conviction before judgment, though not so mentioned in a statute; and where any statute makes a second offence felony, or subject to a heavier penalty than the first, it is always implied that such second offence ought to be committed after a conviction of the first. 1 How. 13—107. Judgment amounts to a conviction, though it does not follow that every one who is convict is adjudged. 1 Horn. 14. A conviction ought to be in the present tense, and not in the time past. Ld. Raym. 1376. Str. 608. A conviction ought to be on an information or claim precedent. Ld. Raym. 510.

When an act of parliament orders the conviction of offenders before justices of the peace, &c. it must be intended after summons to bring them in, that they may have an opportunity of making their defence; and if it be otherwise the conviction shall be quashed.

CONVICT-RECUSANT, one who has been legally presented, indicted, and convict, for refusing to come to church to hear the common prayer, according to the several statutes of 1 Eliz. 2. 23 Eliz. 1, and 3 Jac. I.

CONVIVIUM, *banquet*, in our old customs, a kind of tenure whereby the tenant was obliged to provide an entertainment for his lord once, or oftener, every year. It corresponded with the procuration of the clergy.

CONVOCATION, is the assembly of all the clergy to consult of ecclesiastical matters in time of parliament. There are two houses of convocation: the one called the higher convocation-house, where all the archbishops and bishops sit severally by themselves; the other the lower convocation-house, where all the rest of the clergy sit; that is, all the deans and archdeacons, one proctor for every chapter, and two proctors for all the clergy of each diocese: in all 166 persons.

The archbishop of Canterbury is the president of the convocation, and prorogues and dissolves it by mandate from the king. The convocation is not only to be assembled by the king's writ, but the canons made by them are to have the royal assent. They are to have the examining and censuring of heretical and schismatical books and persons, &c. but appeal lies to the king in chancery, or to his delegates. 4 Inst. 322. 2 Rol. Abr. 225. The clergy called to the convocation, and their servants, &c. have the same privileges as members of parliament. Stat. 8 H. VI. c. 1.

CONVOLVULUS, *bind-weed*, a genus of the pentandria class, and monogynia order, and in the natural method ranking under the 29th order, campanaceæ. The corolla is campanulated and plaited; there are two stigmata; the capsule is bilocular, and the cells are dispermous.

Of this genus there are 110 species, the most remarkable of which are the following:

1. The sepium, or large white bind-weed, is often a troublesome weed in gardens, when its roots are interwoven with those of trees and shrubs, or under hedges, as every small piece of root is apt to grow. It flourishes under moist hedges, and has white or purplish blossoms.

2. The scammonia, or Syrian bind-weed, grows naturally in Syria. The roots are thick, run deep into the ground, and are covered with a dark bark. The branches extend on every side to the distance of 10 or 12 feet: they are slender, and trail on the ground; and are furnished with narrow, arrow-pointed leaves. The flowers are of a pale yellow; and come out from the side of the branches, two sitting upon each long footstalk: these are succeeded by roundish seed-vessels, having three cells filled with seeds. From this species the scammony of the shops is produced.

3. The purpureus, or convolvulus major, an annual plant growing naturally in Asia and America, has been long cultivated in the British gardens. If these plants are properly supported, they will rise 10 or 12 feet high in warm summers. There are three or four lasting varieties: the most common has a purple flower; the others have a white, a red, or a whitish-blue flower, which last has white seeds. They flower in June, July, and August, and their seeds ripen in autumn.

4. The nil, or blue bind-weed, rises with a twining stalk 8 or 10 feet high; with heart-shaped leaves, divided into three lobes, which end in sharp points. These are woolly, and stand upon long footstalks. The flowers also come out on long footstalks, each sustaining two flowers of a very deep blue colour, whence their name of nil or indigo. This is one of the most beautiful plants of the genus: it flowers all the latter part of the summer, and in good seasons the seeds ripen very well in the open air.

5. The batatas, or Spanish potatoe, has esculent roots, which are annually imported from Spain and Portugal, where they are greatly cultivated for the table; but they are too tender to thrive in the open air in Britain. Their roots are like the common potatoe, but require much more room: for they send out many trailing stalks, which extend six or eight feet every way, and at their joints send out roots which in warm countries grow to be very large bulbs; so that from a single root planted 40 or 50 large potatoes are produced.

6. The canariensis, with soft woolly leaves, is a native of the Canaries, but has long been preserved in the British gardens. It has strong fibrous roots, whence arise several twining woody stalks, which, where they have support, will grow more than 20 feet high; garnished with oblong heart-shaped leaves, which are soft and hairy. The flowers are produced from the wings of the leaves, several standing upon one footstalk. They are for the most part of a pale blue; but there is a variety with white flowers. They appear in June, July, and August, and sometimes ripen seeds here.

7. The tricolor, or convolvulus minor, is a native of Portugal, but has long been cultivated in the gardens of this country. It is an annual plant, which has several thick herbaceous stalks growing about two feet long; which do not twine like the other sorts, but decline towards the ground, upon which many of the lower branches lie prostrate: they have spear-shaped leaves, which sit close to the branches; the footstalks of the flowers come out just above the leaves of the same joint, and at the same side of the stalks. They are about two inches long, each sustaining one large open bell-shaped flower, which in some is of a fine blue colour with a white bottom; in others it is pure white, and some are beautifully variegated with both colours. The white flowers are succeeded by light seeds, and the blue by dark-coloured seeds: which difference is pretty constant.

8. The soldanella, or sea bind-weed, styled

also brassica marina, grows naturally on the sea-beach in many parts of England, but cannot be long preserved in gardens. It has many small white stringy roots, which spread wide, and send out several weak trailing branches. These twine about the neighbouring plants like those of the common bind-weed, with kidney-shaped leaves like those of the lesser celandine. The flowers are produced on the side of the branches at each joint. They are of a reddish-purple colour, and appear in July. They are succeeded by round capsules, having three cells, each containing one black seed.

9 The turpethum is a native of the island of Ceylon. This has fleshy thick roots which spread far in the ground; and abound with a milky juice that flows out when the roots are broken or wounded, and soon hardens into a resinous substance when exposed to the sun and air. From the root shoot forth many twining branches, which twist about each other, or the neighbouring plants, like the common bind-weed. They have heart-shaped leaves that are soft to the touch, like those of the marshmallow. The flowers are produced at the joints on the side of the stalks, several standing together on the same footstalk: they are white, and shaped like those of the common great bind-weed; and are succeeded by round capsules, having three cells containing two seeds each.

10. The jalappa, or jalap, used in medicine, is a native of Aleppo in Spanish America, situated between La Vera Cruz and Mexico. It has a large root of an oval form, full of a milky juice; from which come out many herbaceous twining stalks, rising eight or ten feet high, with variable leaves; some of them being heart-shaped, others angular, and some oblong and pointed. They are smooth, and stand upon long footstalks: the flowers are shaped like those of the common greater bind-weed, each footstalk supporting only one flower. See Pl. N. H. fig. 142.

The second sort is propagated by seeds, which must be sown on a border of light earth. The plants must have some tall stakes placed near them for their branches to twine about, otherwise they will spread on the ground, and make a bad appearance. The third sort is annual, and must be propagated by seeds sown on a hotbed in spring; and towards the end of May they should be planted out in warm borders, and treated in the same manner with the former. The fourth species is sometimes propagated in this country. The roots must be planted on a hotbed in the spring: and if the plants are covered in bad weather with glasses, they will produce flowers, and some small bulbs from the joints of the stalks; but if they are exposed to the open air they seldom grow to any size. The fifth is propagated by laying down the young shoots in the spring, which generally put out roots in three or four months: they may then be taken from the old plants, and each placed in a separate pot, which is to be set in the shade till they have taken new root; after which they may be placed with other hardy greenhouse plants till autumn, when they should be removed into the greenhouse, and afterwards treated in the same manner as myrtles and other greenhouse plants. The turbith and jalap are too tender to live in this country, unless they are constantly kept in a stove. The other species require no particular directions for their cultivation.

The root of the first sort proves a very acrid purgative to the human race, but is eaten by hogs in large quantities without any detriment. The inspissated juice of the second species is used in medicine as a strong purgative; as are also the roots of the jalappa and turpethum. The soldanella has likewise been used with the same intention. Half an ounce of the juice, or a drachm of the powder, is an acrid purge. The leaves applied externally are said to diminish dropsical swellings of the feet. See MATERIA MEDICA.

CONVOY, in marine affairs, one or more ships of war, employed to accompany and protect merchant ships, and prevent their being insulted by pirates, or the enemies of the state in time of war.

CONVOY, in military affairs, a detachment of troops employed to guard any supply of men, money, ammunition, provisions, stores, &c. conveyed in time of war, by land or sea, to a town or army. A body of men that marches to secure any thing from falling into the enemy's hand, is also called a convoy. An officer having the command of a convoy must take all possible precautions for its security; and endeavour, before its march, to procure some good intelligence concerning the enemy's out-parties. And as the commanding officer of the place from which the convoy is to march, and those of such other places as he is to pass by, are the most proper persons to apply to for assistance; he must therefore take such measures as will enable him to keep up a constant intercourse with them. The conducting a convoy is one of the most important and most difficult of all military operations.

CONVULSION, *spasmus*. See MEDICINE.

CONYZA, *fleabane*, a genus of the polygamia superflua order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The pappus is simple, the calyx imbricated and roundish, the corollulæ of the radius trifid. There are 41 species, none of which merit any particular description.

COOMB or *comb of corn*, a dry measure containing four bushels, or half a quarter.

COOPER, one who manufactures casks, tubs of all sizes, pails, and some other similar articles used in domestic concerns. These are made generally of oak timber; a great part of which comes from America, cut up into narrow pieces or staves; they are sometimes bent, and sometimes straight, according to the purposes for which they are wanted. The staves are kept together by means of hoops, made from hazel or ash, or of iron. To make them hold water, or other liquids, split flags are inserted, which swell by moisture, and effectually prevent the vessels from leaking.

Coopers, by 23 H. VIII. c. 4, shall make their vessels of seasonable wood; and make them with their own marks, on forfeiture of *3s. 4d.*: and the contents of vessels are appointed to be observed under a like penalty.

COPAIBA, or *balsam of copaiba*, a liquid resinous juice, flowing from incisions made in the trunk of the copaifera balsamum. Pure balsam of copaiba dissolves entirely in rectified spirit, especially if the menstruum is previously alkalized. Distilled with water it yields a large quantity of a limpid essential oil; and in a strong heat, without addition, a blue oil. See next article.

COPAIFERA, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under those of which the order is doubtful. There is no calyx; there are four petals; the legumen ovate; one seed with an arillus, or coat, resembling a berry. We know of but one species, the officinalis, which yields the copaiba balsam mentioned in the preceding article. This tree grows near a village called Ayapel, in the province of Antiochi, in the Spanish West Indies, about ten days journey from Carthagena. There are great numbers of these trees in the woods about this village, which grow to the height of 30 or 60 feet. Some of these trees do not yield any of the balsam; those which do are distinguished by a ridge which runs along their trunks. These trees are wounded in the centre; and calabash shells, or some other vessels, are applied to the wounded part to receive the balsam, which will all flow out in a short time. One of these trees will yield five or six gallons of balsam: but though they will thrive well after being tapped, yet they never afford any more.

COPAL, a substance of great importance as a varnish, obtained from the rhus copalinum, a tree in North America. It is a beautiful transparent resinous-like substance. When heated it melts like other resins; but it differs from them in not being soluble in alcohol, nor in oil of turpentine without peculiar management. Neither does it dissolve in the fixed oils like other resins. The specific gravity of copal varies from 1.045 to 1.139. Mr. Hatchett found it soluble in alkalies and nitric acid with the usual phenomena; so that in this respect it agrees with the other resins. The solution of copal in alkalies he found indeed opalescent, but it is nevertheless permanent. It deserves attention, that he found resin when dissolved in nitric acid, and then thrown down by an alkali, to acquire a smell resembling that of copal.

When copal is dissolved in any volatile liquid, and spread thin upon wood, metal, paper, &c. so that the volatile menstruum may evaporate, the copal remains perfectly transparent, and forms one of the most beautiful and perfect varnishes that can well be conceived. The varnish thus formed is called copal varnish, from the chief ingredient in it. This varnish was first discovered in France, and was long known by the name of vernis martin. The method of preparing it is concealed; but different modes of dissolving copal in volatile menstrua have been from time to time made public. The following are the most remarkable of these:

When copal is kept melted till a sour-smelling aromatic odour has ceased to proceed from it, and then mixed with an equal quantity of linseed oil which has been deprived of all colour by exposure to the sun, it unites with the oil, and forms a varnish, which must be dried in the sun.

When copal is treated with oil of turpentine in close vessels, the vapour, being prevented from escaping, exerts a greater pressure, and the heat rises above the boiling point. This additional heat is said to enable

the oil to dissolve the copal. The solution, mixed with a little poppy oil, forms a varnish which is distinguished from the vernis martin merely in having a very slight tinge of brown.

The method of dissolving copal in oil of turpentine, published by Mr. Sheldrake, seems to depend upon the same principle with the last solution. On two ounces of copal, broken into small pieces, is poured a mixture of four ounces of ammonia, with a pint of oil of turpentine. The whole is kept boiling very gently, so that the bubbles may be counted as they rise. If the heat is allowed to diminish, or if it is raised too high, the process stops, and cannot be again resumed. The matrass in which the mixture is boiled, is stopped with a cork, secured in its place by a brass wire, and perforated by a pin. When the copal is nearly dissolved, the process is stopped, and the whole allowed to cool before uncorking the matrass. This varnish has a deep colour; but when spread thin and allowed to dry, it becomes colourless. Its defect is the difficulty with which it dries. This defect Mr. Sheldrake remedies by throwing the solution into its own weight of nut oil, rendered drying by white-lead, and agitating till the turpentine is separated.

To dissolve copal in alcohol Mr. Sheldrake dissolves half an ounce of camphor in a pint of that liquid, and pours the solution on four ounces of copal. The matrass is placed in a sand-bath, and the process is conducted exactly as that last described. The solution thus formed contains a great deal of copal, and forms a varnish which is perfectly colourless; but considerable heat is necessary to drive off the camphor. See VARNISH.

COPARCENARY. An estate held in coparcenary, is where lands of inheritance descend from the ancestor to two or more persons. It arises either by common law, or particular custom. By common law, as where a person seised in fee-simple, or fee-tail, dies, and his next heirs are two or more females, his daughters, sisters, aunts, cousins, or their representatives; in this case they shall all inherit: and these coheirs are then called coparceners; or, for brevity sake, parceners. Parceners by particular custom are, where lands descend, as in gavelkind, to all the males in equal degree, as sons, brothers, uncles, or other kindred; and in either of these cases, all the parceners put together make but one heir, and have but one estate among them. 2 Black. 137.

COPE, among ecclesiastical writers, an ornament usually worn by chantors and subchantors, when they officiated in the church solemnity. It is also worn by Romish bishops, and other ordinaries; and reaches from the shoulders to the feet.

COPE, among miners, a duty of 6*d.* for every load of ore.

COPERNICAN SYSTEM, that system of the world in which the sun is supposed at rest in the centre, and the planets, with the earth, to move in ellipses round him. See ASTRONOMY.

COPHTIC, or Coptic language, is that spoken by the Cophts; being the antient language of the Egyptians, intermixed with the Greek, and the characters of it being those of the Greek. The antient Coptic is now a dead language, to be met with no where but in books; and those only translations of the scriptures, and of ecclesiastical offices, or others that have a relation thereto; the language now used over all the country being the Arabic.

COPTIC MONKS, religious, among the Christians of Egypt, who have the highest veneration for a monastic life, considering it as the philosophy of the law of Jesus Christ, and the monks as terrestrial angels or celestial men. They are obliged to part with their possessions, to renounce marriage for ever, to live in deserts, to be clothed in wool, and to eat no meat.

COPIA LIBELLI DELIBERANDA, a writ that lies where a person cannot get the copy of a libel from a judge of the spiritual court.

COPING or *copping of a wall*, in architecture, the top or covert of a wall, made sloping to carry off the wet.

COPPER, a metal next to iron in specific gravity, but lighter than gold, silver, or lead.

If we except gold and silver, copper seems to have been more early known than any other metal. In the first ages of the world, before the method of working iron was discovered, copper was the principal ingredient in all domestic utensils and instruments of war. Even during the Trojan war, as we learn from Homer, the combatants had no other armour but what was made of bronze, which is a mixture of copper and tin. The word cuprum, or copper, is derived from the island of Cyprus; where it was first discovered, or at least wrought to any extent, by the Greeks.

This metal is of a fine red colour, and has a great deal of brilliancy. Its taste is styptic and nauseous; and the hands, when rubbed for some time on it, acquire a peculiar and disagreeable odour. Its specific gravity, when melted, is 8.667; but after being hammered it is 8.9. Its malleability is great: it may be hammered out into leaves so thin as to be blown about by the slightest breeze. Its ductility is also considerable. Its tenacity is such, that a copper wire 0.078 inch in diameter is capable of supporting 302.26 pounds avoirdupois without breaking. When heated to the temperature of 27° Wedgewood, or, according to the calculation of Mortimer, to 1450 degrees Fahrenheit, it melts, and if the heat is increased it evaporates in visible fumes. When allowed to cool slowly it assumes a crystalline form. The abbé Mongez, to whom we owe many valuable experiments on the crystallization of metals, obtained it in quadrangular pyramids, often inserted into one another.

Copper is not altered by water: it is incapable of decomposing it even at a red heat, unless air has free access to it at the same time; in that case the surface of the metal becomes oxydated. Every one must have remarked, that when water is kept in a copper vessel, a green crust of verdegris, as it is called, is formed on that part of the vessel which is in contact with the surface of the water. When copper is exposed to the air its surface is gradually tarnished; it becomes brown, and is at last covered with a dark-green crust. This crust consists of oxyd of copper combined with carbonic acid gas. At the common temperature of the air, this oxydation of copper goes on but slowly; but when a plate of metal is heated red-hot, it is covered in a few minutes with a crust of oxyd, which separates spontaneously in small scales when the plate is allowed to cool. The copper plate contracts considerably in cooling, but the crust of oxyd contracts but very little; it is therefore broken to pieces, and thrown off, when the plate contracts under it. Any quantity of this oxyd may be obtained by heating a plate of copper, and plunging it alternately into cold water. The scales fall down to the bottom of the water.

In a violent heat, or when copper is exposed to a stream of oxygen and hydrogen gas, the metal takes fire and burns with great brilliancy, emitting a lively green light of such intensity, that the eye can scarcely bear the glare. The product is an oxyd of copper.

There are two oxyds of copper at present known; and it does not appear that the metal is capable of being exhibited in combination with more than two doses of oxygen. The protoxide is of a fine orange-colour; but the peroxide is black, though in combination it assumes various shades of blue, green, and brown.

1. The protoxide of copper was first observed by Proust; but we are indebted to M. Chenevix, who found it native in Cornwall, for the investigation of its properties. It may be prepared by mixing together 57.5 parts of black oxyd of copper, and 50 parts of copper reduced to a fine powder by precipitating it from muriatic acid by an iron plate. This mixture is to be triturated in a mortar, and put with muriatic acid into a well-stopped phial. Heat is disengaged, and almost all the copper is dissolved. When potash is dropt into this solution, the orange oxyd of copper is precipitated. But the easiest process is to dissolve any quantity of copper in muriatic acid by means of heat. The green liquid thus obtained is to be put into a phial, together with some pieces of rolled copper, and the whole is to be corked up closely. The green colour gradually disappears; the liquid becomes dark brown and opaque; and a number of dirty-white crystals, like grains of sand, are gradually deposited. When this liquid, or the crystals, are thrown into a solution of potash, the orange-coloured oxyd precipitates in abundance. This oxyd is composed of 88.5 parts of copper and 11.5 oxygen. It attracts oxygen with such avidity, that it can scarcely be dried without becoming bluish-green, at least on the surface: but when once dry it retains its colour pretty well.

2. The peroxide of copper is easily procured pure from the scales which are formed upon the surface of red-hot copper. These scales have a violet-red colour, owing to the presence of a little metallic copper upon their under surface; but when kept for some time red-hot in an open vessel, they become black, and are then pure peroxide of copper. The same oxyd may be obtained by dissolving copper in sulphuric or nitric acid, precipitating by means of potash, and then heating the precipitate sufficiently to drive off any water which it may retain. The peroxide of copper is composed of 80 parts of copper and 20 of oxygen. When mixed with somewhat less than its own weight of copper in powder, and heated to redness, the whole

is converted into protoxide. The oxides of copper are easily reduced to the metallic state when heated with charcoal, oils, or other fatty bodies; and even with some of the metals, especially zinc.

3. When copper is dissolved in nitric acid, and a sufficient quantity of potash is added to the solution, a blue powder falls to the bottom, which was formerly considered as a peculiar oxyd of copper, and accordingly called blue oxyd of copper. But Mr. Proust has shown that it is nothing else than the black oxyd combined with water; and has therefore called it hydrat of copper. When distilled, 100 parts of it yield 25 parts of water, and there remain behind 75 parts of black oxyd. When this blue powder is exposed moist to the atmosphere, it gradually becomes green. This was formerly supposed to be owing to the absorption of oxygen; accordingly the green powder was called green oxyd of copper. But Mr. Proust has shewn that this change is not owing to the absorption of oxygen, but to the combination of the black oxyd of copper with carbonic acid.

Copper has never been combined with carbon nor hydrogen; but it combines readily with sulphur and phosphorus, and forms with them compounds called sulphuret and phosphuret of copper.

When equal parts of sulphur and copper are stratified alternately in a crucible, they melt, and combine at a red heat. Sulphuret of copper thus obtained is a brittle mass, of a black or very deep blue grey colour, much more fusible than copper; and composed, according to the experiments of Mr. Proust, of 78 parts of copper, and 22 of sulphur. The same compound may be formed by mixing copper filings and sulphur together, and making them into a paste with water, or even by merely mixing them together without any water, and allowing them to remain a sufficient time exposed to the air. Eight parts by weight of copper filings, mixed with three parts of flowers of sulphur, are put into a glass receiver, and placed upon burning coals: the mixture first melts, then a kind of explosion takes place; it becomes red-hot, and, when taken from the fire, continues to glow for some time like a live coal. If we now examine it, we find it converted into sulphuret of copper. This experiment has excited great attention, and has been very often repeated; because it is the only instance known of apparent combustion without the presence of oxygen. Mr. Proust has shewn that the sulphuret of copper is capable of combining with an additional dose of sulphur, and of forming a new compound which may be called supersulphuret of copper. It is brittle, has a yellow colour, and a metallic lustre; and is found native abundantly, being well known to mineralogists by the name of copper pyrites.

M. Pelletier formed phosphuret of copper by melting together 16 parts of copper, 16 parts of phosphoric glass, and one part of charcoal. Margraf was the first person who formed this phosphuret. His method was to distil phosphorus and oxyd of copper together. It is formed most easily by projecting phosphorus into red-hot copper. It is of a white colour; and, according to Pelletier, is composed of 20 parts of phosphorus and 80 of copper. This phosphuret is harder than iron: it is not ductile, and yet cannot easily be pulverized. Its specific gravity is 7.1220. It crystallizes in four-sided prisms. It is much more fusible than copper. When exposed to the air it loses its lustre, becomes black, falls to pieces, the copper is oxydated, and the phosphorus converted into phosphoric acid. When heated sufficiently the phosphorus burns, and leaves the copper under the form of black scoriæ.

Copper is not capable of combining with azote. Muriatic acid gas readily converts it into an oxyd, with which it enters into combination.

Copper is capable of combining with most of the metals; and some of its alloys are of very great utility.

The alloy of gold and copper is easily formed by melting the two metals together. This alloy is much used, because copper has the property of increasing the hardness of gold without injuring its colour. Muschenbroeck has ascertained that the hardness of this alloy is a maximum when it is composed of seven parts of gold and one of copper. The gold coin both in Britain and France is an alloy, containing eleven parts of gold and one of copper. Its specific gravity is considerably above the mean; consequently the density of the metals is increased by alloying them together. It ought to be 17.153, but it actually is 17.486; so that the density is increased one-forty-eighth part. This alloy being more fusible than gold, is employed as a solder to join pieces of that metal together.

Platinum may be alloyed with copper by fusion, but a strong heat is necessary. The alloy is ductile, hard, takes a fine polish, and is not liable to tarnish. This alloy has been employed with advantage for composing the mirrors of reflecting telescopes.

Silver is easily alloyed with copper by fusion. This alloy is harder and more sonorous than silver, and yet the density of the metals is diminished. Thus when 137 parts of silver and 7 of copper are alloyed together, the specific gravity ought to be 10.3016, but it actually is 10.1752; consequently the bulk of the two metals is increased by alloying them together about $\frac{1}{81}$ part. When the proportion of copper is small the colour of the silver is not altered. The silver coin of this country is composed of 1 part of copper and 15 of silver; that of France of 7 parts of copper and 137 of silver, or 1 part copper and 19.57 silver. The French silver coin therefore is purer than the British.

The amalgam of copper cannot be formed by simply mixing that metal with mercury, nor even by the application of heat; because the heat necessary to melt copper sublimes mercury. It may be obtained by triturating mercury with common salt and verdigris, or by keeping plates of copper in a solution of mercury and nitric acid. The amalgam is at first soft, and will take any impression; but it soon becomes hard when exposed to the air.

The affinities of copper and its oxyds are exhibited by Bergman in the following order:

Copper.	Oxyd of Copper.
Gold,	Oxalic acid,
Silver,	Tartaric,
Arsenic,	Muriatic,
Iron,	Sulphuric acid,
Manganese,	Saclactic,
Zinc,	Nitric,
Antimony,	Arsenic,
Platinum,	Phosphoric,
Tin,	Succinic,
Lead,	Fluoric,
Nickel,	Citric,
Bismuth,	Lactic,
Cobalt,	Acetic,
Mercury,	Boracic,
Sulphur,	Prussic,
Phosphorus.	Carbonic.

Copper is not unfrequently found native and malleable, sometimes in small and slender fibres, and sometimes in little globular and irregular masses. However, it is most frequently found in the state of ore, sometimes blended with the strata of stones, where it discovers itself in blue or green efflorescences. The green and blue ochres also are a sort of ores of copper, and the pyritæ and marcasites frequently contain large quantities of this metal. There is also a rich kind of copper ore of a reddish-grey colour; and another of a dusky-purple or blackish colour. But besides all these there are two other appearances of copper ore, known by the names of lapis lazuli, and the turcois or turquoise.

In Germany and Sweden there are very good mines of copper ore; and we have some in England, particularly in Cornwall, not inferior to the finest Swedish.

In order to discover whether the pyrites contains any copper, let it be roasted in an open fire, and a solution made by pouring upon it a quantity of warm water: into this solution let iron plates, perfectly clean and free from grease, be immersed; and if the pyrites contains any copper it will stick to these iron plates, in form of a fine yellow powder.

As to the method of obtaining copper from the ore, this last being previously washed and powdered, is smelted by means of a black flux; and the metal is found at the bottom of the vessel when cold, in the form of a solid and malleable mass; which may be farther refined by repeating the operation. See MINERALOGY.

COPPERAS, a name given to the martial or sulphate of green vitriol. See IRON.

COPULA, in logic, the verb that connects any two terms in an affirmative or negative: as, "Riches make a man happy;" where *make* is the copula: "No weakness is any virtue;" where *is* is the copula.

COPULATIVE PROPOSITIONS, in logic, those where the subject and predicate are so linked together by copulative conjunctions, that they may be all severally affirmed or denied one of another. Example, "Riches and honours are apt to elate the mind, and increase the number of our desires."

COPY, in a legal sense, is the transcript of an original writing; as the copy of a patent, of a charter, deed, &c. but a clause out of either cannot be given in evidence to prove the original, as it must be absolutely a true office-copy of the whole.

COPYHOLD, a tenure for which the tenant has nothing to shew but the copy of the rolls made by the steward, as he enrols

and makes remembrances of all other things done in the lord's court; thus a tenant by copy of court-roll is he who is admitted a tenant of any lands or tenements within a manor, that, time out of mind, by use and custom of the manor, have been demisable, and demised to such as will take the same in fee, or fee-tail, for life, years, or at will, according to the custom of the manor, by copy of court-roll of the said manor.

The customs of manors differ as much as the humours and tempers of the respective antient lords; so a copyholder by custom may be tenant in fee-simple, in fee-tail, for life, by the courtesy, in dower, for years, at sufferance, or on condition; subject, however, to be deprived of these estates upon the concurrence of those circumstances which the will of the lords, promulged by immemorial custom, has declared to be a forfeiture, or absolute determination of those interests; as in some manors the want of issue, in others the want of issue male, in others the cutting down of timber, in others the non-payment of rent or fine. Yet none of these interests amount to freehold; for the freehold of the whole manor abides always with the lord only, who has granted out the use of occupation, but not the corporal seisin, or true possession, of certain parts or parcels thereof, to these his customary tenants at will. 2 Black. 148.

Where, by special custom, a descent of copyholds may be contrary to the common law, such custom shall be interpreted strictly; but otherwise the lands must descend according to the rules of the common law. Durnf. and East, 466.

Copyholds are not transferable by matter of record, even in the king's courts; but only in the court baron of the lord, by surrender and admittance. 2 Black. 366.

If one would exchange a copyhold to another, both must surrender to each other's use, and the lord admit accordingly. Co. Copyhold, s. 36. 39.

If a man will devise his copyhold estate, he cannot do it by his will, but he must surrender to the use of his will, and in it declare his intent. Id. But when the legal estate is in trustees, a man cannot, in that case, surrender the copyhold lands to the use of his will; but they will pass by his will only. 2 Atk. 33. 1 Vez. 489.

So a mortgager may dispose of the equity of redemption by will, without surrender; for he has at that time no estate in the land whereof to make a surrender.

A devise of a copyhold to the heir is void; for where two titles meet the worthier is to be preferred. Str. 489.

A copyhold may be intailed by special custom, and the intail cut off by recovery or surrender in the lord's court. But a recovery in the lord's court, without custom to warrant it, will not be a bar to the intail, but a surrender in that case will bar it. 2 Ver. 603. But where there are two customs to bar estates tail, one by recovery, and the other by surrender, either of them may be pursued. Str. 1197.

Recovery in the lord's court differs in nothing that is material from recoveries of freehold land in the king's court; but the method of surrender is easier and cheaper. 2 Black. 365.

A copyhold is not barred by fine, and five years non-claim. Noy.

Surrender is yielding up the estate by the tenant into the hands of the lord, for such purposes as in the surrender are expressed.

A steward of a manor may take a surrender out of the manor, but cannot admit out of the manor. 4 Co. 26. A feme-covert is to be secretly examined by the steward on her surrendering her estate. 1 Inst. 59.

Until admittance of the surrendree, the surrenderor continues tenant, and shall receive the profits, and discharge all services due to the lord; but he cannot revoke his surrender, except in the case of a surrender to the use of his will, which is always revocable. And if the lord will not admit the surrendree, he may be compelled to it by a bill in chancery or mandamus. 2 Black. 368. And this method of conveyance, by surrender and admittance, is so essential to the nature of a copyhold estate, that it cannot possibly be transferred by any other assurance. No feoffment, fine, or recovery, in the king's courts, has any operation upon it. Ibid. Upon admittance the tenant pays a fine to the lord, according to the custom of the manor, and takes the oath of fealty. Id. If a copyholder does not pay the services due to the lord, or refuses to attend at the lord's court, or to be of homage, or to pay his fine for admittance, or to do suit at the lord's mill, or the like, it is in law a forfeiture. Rol. Abr. 509.

If there be a tenant for life, remainder in fee, and tenant for life commit a forfeiture by which his estate for life is forfeited, the lord enters for the forfeiture; yet this shall not bind him in the remainder, but only the tenant for life. Ibid.

If a copyholder commit a felony or treason he forfeits his copyhold to the lord, without any particular custom; only the king shall first have thereof the year, day, and waste. Gibb. Ter. 226.

If a copyhold escheat, the lord may grant it out again with what improved fine he will. Hil. 5.

COPY-RIGHT. See LITERARY PROPERTY.

COR, the *heart*. See ANATOMY.

COR CAROLI, in astronomy, an extra-constellated star in the northern hemisphere, situated between the coma Berenices and ursa major; so called by Dr. Halley in honour of king Charles.

COR HYDRÆ, a fixed star of the first magnitude, in the constellation of hydra.

COR LEONIS, or *regulus*, in astronomy, a fixed star of the first magnitude, in the constellation leo.

CORACIAS, the roller, in ornithology; a genus of birds of the order of picæ, the characters of which are: the bill is straight, bending towards the tip, with the edges cultrated: the nostrils are narrow and naked; the legs for the most part short: the toes placed three before and one behind, and divided to their origin. Sixteen species have been enumerated, though some of them are suspected to be only varieties. This genus is not confined to one spot of the globe, as one or other of the different species may be met with in all the four quarters of it. The following are the most remarkable:

1. The garrula, or garrulous roller, is about the size of a jay; the bill black, and at the base beset with bristles, which do not cover the nostrils: the head, neck, breast, and belly, are of a light-blueish green; back and scapulars, reddish brown; coverts on the ridge of the wing, rich blue, beneath them pale green; upper part and tips of the quills dusky; the lower parts of a fine deep blue; tail forked of a light blue; the legs are short and of a dirty yellow. Mr. Pennant observes that these birds are frequent in several parts of Europe, in most parts of which it is a bird of passage. Mention is made of them in Sweden and Denmark, on the one hand, and as far as Africa on the other: not that they are found in all the parts between, nor in the same plenty. Willughby tells us, that in Germany, Sicily, and Malta, they are so common as to be sold in the markets, and in poulterers' shops. Adanson says, that "it comes to reside for some months of the summer in some parts of Europe, and goes back to spend the remainder of the year in Senegal," having shot one on board the ship, on its passage, in April. Frisch observes, that it makes its nests in woods, where there is birch; that it does not come to its colour till the second year; flies in troops in autumn; often seen in tilled grounds, with rooks and other birds, searching for worms, small seeds, and roots. Its flesh tastes like that of a turtle. It is said also sometimes to make its nest in holes in the ground, in one of which nests two eggs were found.

2. The cyanea, or blue-striped roller is in length eight inches; the bill three quarters of an inch long, bent at the tip, and of a black colour: the irides are red; the general colour of the plumage deep blue-black, dashed with streaks of greenish blue; the tail and legs are black; it inhabits New Caledonia.

3. The Sinensis, or Chinese roller is of the size of a jay: the bill and irides are red; the head, hind part of the neck, back, rump, and upper tail-coverts, are green; the under parts of the body, from the chin to the vent, are yellowish white, tinged with green; but the thighs are grey; the wing-coverts are olive-brown; quills the same, with a mixture of chesnut in some; the legs and claws are of a pale red, and longer than in other rollers. It inhabits China, and is called at Canton Santa-hoang. It is not very common.

CORAL *fishery*. Red coral is found in the Mediteranean, on the shores of Provence, from Cape de la Couronne to that of St. Tropez; about the isles of Majorca and Minorca; on the south of Sicily; on the coasts of Africa; and, lastly, in the Ethiopic ocean, about cape Negro. The divers say, that the little branches are found only in the caverns whose situation is parallel to the earth's surface and open to the south. The manner of fishing being nearly the same wherever coral is found, it will suffice to instance the method used at the bastion of France, under the direction of the company established at Marseilles for that fishery. Seven or eight men go in a boat commanded by the patron or proprietor, and when the net is thrown by the caster, the rest work the vessel, and help to draw the net in. The net is composed of two rafters of wood tied cross-wise, with leads fixed to them: to these they fasten a quantity of hemp twisted loosely round, and intermingled with some large netting. This instrument is let down where they think there is coral, and pulled up again when the coral is strongly entangled

in the hemp and netting. For this purpose, six boats are sometimes required; and if in hauling in, the rope happens to break, the fishermen run the hazard of being lost. Before the fishers go to sea, they agree for the price of the coral; which is sometimes more, sometimes less, a pound; and they engage, on pain of corporal punishment, that neither they nor their crew shall embezzle any, but deliver the whole to the proprietors. When the fishery is ended, which amounts one year with another to twenty-five quintals for each boat, it is divided into thirteen parts, of which the proprietor has four, the caster two, and the other six men one each: the thirteenth belongs to the company for payment of the boat furnished them. Red or white coral in fragments, for physic, pays on importation $7\frac{1}{2}d.$ the pound, and draws back on exportation $6\frac{4}{5}d.$ Whole coral unpolished, the pound, pays 3*s.* $10\frac{1}{2}d.$ and draws back 1*s.* $4\frac{4}{5}d.$ Whole coral polished, the pound, pays 5*s.* $1\frac{1}{2}d.$ and draws back 4*s.* $7\frac{4}{5}d.$

CORALLINA, or *coral*, in zoology, a genus belonging to the order of vermes zoophyta. The trunk is radicated, jointed, and calcareous. The species are distinguished by the form of their branches, and are found in the ocean adhering to stones, bones, shells, &c. The corals were formerly believed to be vegetable substances hardened by the air; but are now known to be composed of a congeries of animals, which are even endued with the faculty of moving spontaneously. The islands in the South-sea are mostly coral rocks covered over with earth. The little creatures, which have scarcely sensation enough to distinguish them from plants, build up a rocky structure from the bottom of that sea, too deep to be measured by human art, till it reaches the surface. Some of the coralline islands appear to be of a much older date than others; particularly the Friendly Islands: and it is probable that, as these submarine works are continually going on, new islands may by that means frequently be produced. M. de Peyssonel of Marseilles, in consequence of a series of experiments and observations from about the year 1720 to 1750, seems to have been the first who threw a proper light upon the nature and productions of coral and similar marine substances. Those bodies which the count de Marsigli imagined to be flowers, this ingenious naturalist discovered to be insects inhabiting the coral; for upon taking branches of it out of the water, the flowers, which proceeded from a number of white points answering to the holes that pierced the bark, and the radiation of which resembled the flower of the olive-tree, entered into the bark, and disappeared: but upon being again restored to the water, they were some hours after perceptible. These flowers spread on white paper lost their transparency, and became red as they dried. The holes in the bark correspond to small cavities upon the substance of the coral; and when the bark is removed there may be seen an infinite quantity of little tubes connecting the bark with the inner substance, besides a great number of small glands adhering to them; and from these tubes and glands the milky juice of coral issues forth: the holes in the bark are the openings through which the insects that form these substances for their habitation come forth: and those cavities which are partly in the bark, and partly in the substance, are the cells which they inhabit. The organs of the animal are contained in the tubes, and the glandules are the extremities of its feet; and the milky liquor is the blood and juice of the animal, which are more or less abundant in proportion to its health and vigour. When the insects are dead, they corrupt, and communicate to the water the smell of putrid fish. The juice or liquor runs along the furrows perceived upon the proper substance or body of coral, and stopping by little and little becomes fixed, and hard, and is changed into stone; and being stopped in the bark, causes the coral to increase proportionably and in every direction. In forming coral, and other marine productions of this class, the animal labours like those of the testaceous kind, each according to his species; and their productions vary according to their several forms, magnitudes, and colours.

The coral insect, or polype, expands itself in water, and contracts itself in air, or when it is touched with the hand in water, or acid liquors are poured upon it: and he actually saw these insects move their claws or legs, and expand themselves, when the sea-water containing coral was placed near the fire, and keep them in their expanded state when separated from the coral in boiling water. Broken branches of coral have been observed to fasten themselves to other branches, and have continued to grow; and this is the case when they are connected with detached pieces of rock and other substances, from which no nourishment could be derived. The coral insects in their cells, not having been injured, continue their operations; and as they draw no nourishment from the stone of the coral, they are able to increase in a detached and separate state. Coral was found to be equally red in the sea as out of it; and it was more shining when just taken out of the water than even when it is polished; and the bark by being dried becomes somewhat pale. It grows in different directions, sometimes perpendicularly downwards, sometimes horizontally, and sometimes upwards; and in the caverns of the sea, open to every exposure.

M. Donati of Turin has also adopted the same hypothesis, viz. that coral is a mass of animals of the polype kind; and instead of representing the coral beds and cells which contain them as the work of polypes, he thinks it more just to say, that coral and other coralline bodies have the same relation to the polypes united to them, that there is between the shell of a snail and the snail itself, or the bones of an animal and the animal itself.

There are properly but three kinds of coral; red, white, and black: the black is the rarest and most esteemed; but the red was formerly in great repute as a medicine. When coral is newly taken up out of the sea, the small protuberances on its surface are soft, and yield, on being pressed, a milky juice which effervesces with acids. The cortical part with which the coral is all over covered is not near so compact as the internal, and may be easily taken off whilst fresh; and from this part it is usually freed before it comes to the market. The greatest coral trade is in Genoa and Leghorn. See Plate Nat. Hist. fig. 143.

CORALLINES, in natural history, were formerly reckoned a genus of plants, and Mr. Tournefort enumerates 36 species of them; but in the Linnæan system they belong to the class zoophytes, and are defined by modern naturalists to be submarine plant-like bodies, that consist of many slender finely divided and jointed branches, resembling some species of moss; or animals growing in the form of plants, having their stems fixed to other bodies: these stems are composed of capillary tubes, whose extremities pass through a calcareous crust, and open into pores on the surface. The branches are often jointed, and always subdivided into smaller branches which are either loose and unconnected, or joined as if they were glued together. They are distinguished from plants by their texture and hardness: they also yield in distillation a considerable quantity of volatile salt; and their smell, in burning, resembles that of burnt horns and other animal substances. Many of the corallines seem to consist of a single tube, containing a single parent animal. Every branch emitted contains an offspring of this parent dependant upon it, and yet capable of producing its like in the emission of a new branch. Others consist of many such tubes united, rising together, and encircling the deserted tubes of their progenitors, whose exuviæ become the substratum of a rising generation. Mr. Ellis distributes corallines into the vesiculated, tubular, celliferous, and articulated kinds.

Vesiculated corallines are distinguished by their horny hollow ramifications: most of them are furnished with little denticles on their branches, like leaves on mosses; and at certain seasons of the year they are furnished with small bodies like bladders, proceeding from their stems and branches, and differing in form according to the different species. Their colour, when dry, is of a yellowish or pale brown, and their nature is elastic. They are found adhering to rocks, shells, and fucuses, by small root-like tubes: they recover their form in water, after having been dried; and when put into vinegar, they cause no effervescence. See Plate fig. 1, where *a* represents the sea-tamarisk in its natural size, and A the denticles considerably magnified. Fig. 2. *b*, B, are the sea-cypress: fig. 3. *c d*, C D, the small climbing coralline with well-shaped cups.

Tubular corallines are composed of a number of simple tubes, growing up nearly together; or of such branched ones as have neither denticles nor vesicles. These are horny and elastic like the former, and recover their original form in water. Some of them appear wrinkled like the windpipe, and others like the intestines of small animals. See E, fig. 4.

Celliferous corallines are those which appear, when magnified, to be fine thin cells, the habitations of small animals connected together, and disposed in a variety of elegant forms like branches. These effervesce with acids. See fig. 5. F, *f*, with a part (G H) magnified.

Articulated corallines consist of short pieces of a stony or cretaceous brittle matter, whose surface is covered with pores or cells which are joined by a tough, membranous, flexible substance, composed of many small tubes of the like nature compacted together. The stony part is soluble in vinegar, and the other part remains entire. Fig. 6 is the coralline

of the shops. It is fixed to rocks and shells by stony joints, which, as they rise, are united to others by extremely fine and slender tubes: these may be discovered by a good eye, or a common magnifier. As the stems extend themselves, they become pennated by side-branches which come out opposite to each other, and are joined in the same manner; the joints of this species are like the upper part of an inverted cone, but a little compressed: the whole surface is covered over with very minute circular-shaped cells like pores. If a branch of this coralline is put into vinegar, these cells are dissolved with the whole cretaceous substance; instead of which there appear rows of minute ramifications, which seem to have communicated with each of these cells. Upon some specimens of this coralline, we may observe small figures like seed-vessels, with which the branches frequently terminate: they are also found on the sides, as may be seen at A, where they are margined. When a branch is rendered soft by being steeped in vinegar, there may be squeeezd out from the little knobs at the ends and sides, small twisted figures. We frequently find this coralline of different colours, as red, green, ash, and white; but all of it, by being exposed to the sun and air on the shore, becomes white. Besides the above, Mr. Ellis enumerates other genera of marine productions; as the keratophyta eschara fig. 7, sponges, and alyconium; all which are the nests or matrices of sea-animals. This class of marine bodies is formed lihe fungi of various figures, and with different sorts of covering; some having a gritty, and some a callous skin, with a spongy substance in the inside: other species are of a fleshy substance.

C and C 1 are views of one of the warts magnified: C 2 is the appearance of the polype, when the cretaceous matter was dissolved: C 3 represents the particles that compose the incrustation, magnified; D fig. 8, is a sea-willow, or keratophyton dichotomum.

CORANICH, among the Scotch and Irish, the custom of singing at funerals, antiently prevalent in those countries, and still practised in several parts. Of this custom Mr. Pennant gives an account, having assisted at one in the south of Ireland, where it was performed in the fullness of horror. "The cries (says he) are called by the Irish ugohne and hullulu; two words very expressive of the sound uttered on these occasions; and being the Celtic stock, etymologists would swear to be the origin of the ολολυγμὸς of the Greeks, and ululatus of the Latins. Virgil is very fond of using the last whenever any of his females are distressed; as are others of the Roman poets, and generally on occasions similar to this. It was my fortune to arrive at a certain town in Kerry at the time that a person of some distinction departed this life; my curiosity led me to the house, where the funeral seemed conducted in the purest classical form. The conclamatio was set up by the friends in the same manner as Virgil describes that consequential of Dido's death. Immediately after this followed another ceremony, fully described by Camden in his account of the manners of the antient Irish; the earnest expostulations and reproaches given to the deceased for quitting this world, where she enjoyed so many blessings, so good a husband, and such fine children. But when the time approached for carrying out the corpse, the cry was redoubled. 'Tremulis ululatibus æthera complent' a numerous band of females waiting in the outer court to attend the hearse, and to pay in chorus the last tribute of their voices. The habits of this sorrowing train, and the neglect of their persons, were admirably suited to the occasion; their robes were black and flowing, resembling the antient pallia; their feet naked, and their hair long and dishevelled. The corpse was carried slowly along the verge of a most beautiful lake, the ululatus was continued, and the whole procession ended among the venerable ruins of an old abbey."

The same custom prevailed among the Hebrews, and is beautifully described in bishop Lowth's justly celebrated Lectures on the Sacred Poetry of the Hebrews.

CORBAN, in Jewish antiquity, were those offerings which had life, in opposition to the minchab, or those which had not. It is derived from the word karab, which signifies "to approach;" because the victims were brought to the door of the tabernacle. The corbans were always looked upon as the most sacred offerings. The Jews are reproached with defeating, by means of the corban, the precept of the fifth commandment, which enjoins the respect due to parents: for when a child had no mind to relieve the wants of his father or mother, he would say to them, "It is a gift (corban) by whatsoever thou mightest be profited by me;" i. e. "I have devoted that to God which you ask of me, and it is no longer mine to give."

CORBAN is also a ceremony which the Mahometans perform at the foot of mount Ararat in Arabia, near Mecca. It consists in killing a great number of sheep, and distributing them among the poor.

CORBEILS, in fortification, little baskets about a foot and a half high, eight inches wide at the bottom, and twelve at the top; which being filled with earth, are frequently set one against another upon the parapet or elsewhere, leaving certain port-holes, whence to fire upon the enemy under covert, without being seen by them.

CORBEL, in architecture, the representation of a basket, sometimes seen on the heads of caryatides. The word is also used, in building, for a short piece of timber placed in a wall, with its end sticking out six or eight inches, as occasion serves, in manner of a shouldering-piece.

CORCELET, in natural history, that part of the fly-class which is analogous in its situation to the breast in other animals. Many have called it the breast in these also, but improperly; because the breast of other animals is the seat of the lungs and trachea, but these organs are in the fly-class distributed through the whole body. The wings are affixed to this part in the fly-class; and there are some distinctions of great consequence in regard to the arrangement and distribution of these animals into genera. Some flies have a double corcelet, or one divided into two parts; and this is the case of the fly produced from the formica leo, which therefore does not carry its only distinction in the figure of its antennæ. One pair of the legs of this fly are attached to the first or anterior corcelet, which is also capable of moving on the other.

The corcelets of some flies are also much more elevated than those of others; and in some this elevation is carried so far, that the head is forced by it to be bent downward, and the creature is nearly made hump-backed by it. The gnat kind, and the tipulæ, furnish instances of this elevated and hump-backed form. A series of flies of two wings are known by a very particular armament which they carry on the corcelet, usually called their breast. This consists of two long slender sharp-pointed prickles, which are immoveable in their insertions, and seem meant as offensive or defensive weapons; but in what manner they are used is not easily to be determined. All these flies are produced from long water-worms with open and funnel-fashioned tails, or furnished with their aperture for respiration at the hinder extremity.

CORCHORUS, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking under the 37th order, columniferæ. The corolla is pentapetalous, the calyx pentaphyllous and deciduous, and the capsule many-valved and many-celled. There are 16 species; of which the most remarkable is the olitorius, an annual, and a native of Asia, Africa, and America. It rises with a round, striated, upright, branched stalk, to near two feet, with leaves differing in shape; some being oval, some cut off straight at their base, and others almost heart-shaped. The flowers come out at the sides of the branches opposite to the leaves. They stand singly on very short peduncles; are composed of five small yellow petals, and a great number of stamina surrounding an oblong germen, which becomes a long, rough, sharp-pointed capsule, opening in four parts, each filled with greenish angular seeds. This plant is sold by the Jews about Aleppo, and is therefore called Jew's mallow. The leaves are a favourite salad among that people; and they boil and eat them with their meat.

CORCULUM. See BOTANY, and PLANTS.

CORD OF WOOD, a certain quantity of wood for burning, so called because formerly measured with a cord. The dimensions of a statute cord of wood are eight feet long, four feet high, and four feet broad.

CORDAGE, a term used, in general, for all sorts of cord, whether small, middling, or great, made use of in the rigging of ships. Cordage cable-laid, as the seamen term it, is made with nine strands, *i. e.* the first three strands are laid slack, and then three of them being closed together, make a cable. See CABLE.

The same for tacks, but they are laid tapering.

Cordage hawser-laid, is made only with three strands. Cordage-stays are cable-laid, but made with four strands, as cables are with three; with the addition of a heart, which goes through the centre of them.

White cordage is that which has not yet been tarred. Cordage tarred in spinning is that which is made of rope-yarn ready tarred.

Cordage tarred in the stove is that which has passed through hot tar, in coming out of the stove. Every quintal of cordage may take about twenty pounds of tar. Cordage

CORALLINES.

1

a

2

b

Vesiculated

A

B

C

D

Tubular

1

E

3

c

d

6

Articulated

Celliferous 5

F

G

H

7

f

Keratophyta

8

D

C 3

C

C 1

C 2

Brown sculp

remade is that which is made of ropes used before. Cordage, when very old, is used for oakum to caulk the seams of ships.

When a rope is said to be six inches it is understood of its circumference. A rope of sixty threads is one composed of so many rope-yarns.

CORDED, in heraldry. A cross-corded some authors take for a cross-wound or wrenched about with cords.

CORDELIER, in church history, a Franciscan, or religious of the order of St. Francis. The cordeliers are enjoined to live in common: those who are admitted into the order, are first to sell all they have and give it to the poor. The priests are to fast from the feast of All Saints till the Nativity.

CORDIA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 41st order, asperifoliæ. The corolla is funnel-shaped; the style dichotomous or divided into two threads, and each of these divided into other two. There are five species, of which the principal are the myxa and sebestena.

1. The myxa, or Assyrian plum, grows wild in Assyria or Egypt, and also on the coast of Malabar. It rises to the height of a middling plum-tree; and its branches are furnished with oval woolly leaves, standing without order. The flowers are produced in bunches; are white, and consist of one tubular petal, and a like calyx, nearly of an equal length, and both are cut into five parts to their brims. In their centre are five very small stamina, and one slender style crowned with an obtuse stigma. The germen is roundish, and swells to a plum of the same form, and about the size of a damson, of a dark brown colour, a sweet taste, and very glutinous. In some parts of Turkey they cultivate this tree in great abundance, not only for the sake of the fruit to eat, but to make birdlime of, which is a great article of trade in a town called Seid.

2. The sebestena, or rough-leaved cordia, grows naturally in both the Indies, and sends forth several shrubby stalks eight or ten feet high. The young leaves are serrated, but the full-grown ones are not. They are of an oblong oval form, rough, of a deep green, and stand alternately on footstalks. The flowers terminate the branches in large clusters of the shape and colour of the marvel of Peru, and wear a most beautiful appearance. Each has five stamina and one bifid style. The plums are much of the shape of those of the myxa, and are eaten in the same manner. The fruit of this tree is less valuable than the wood, a small piece of which thrown upon a clear fire will perfume a room with a most agreeable odour.

CORDIAL, in medicine, whatever raises the spirits, and gives them a sudden strength and cheerfulness. See MEDICINE.

CORDON, in fortification, a row of stones, made round on the outside, and set between the wall of the fortress which lies aslope, and the parapet which stands perpendicular, after such a manner, that this difference may not be offensive to the eye; whence the cordons serve only as an ornament, ranging round about the place, being only used in fortifications of stone-work: for in those made with earth the void space is filled up with pointed stakes.

CORDWAINERS, the term whereby the statutes denominate shoemakers. The word is formed from the French cordonnier, which Menage derives from cordouan, a kind of leather brought from Cordova, of which they formerly made the upper leathers of their shoes. Others derive it from cords, because antiently shoes were made of cords; as they still are in some parts of Spain, under the name of alpargates. But the former etymology is better warranted: for, in effect, the French workmen who prepare the cordovas are still called cordouanniers. In Paris, before the revolution, they had two pious societies under the title of frères cordonniers. The produce of their shoes went into a common stock, to furnish necessaries for their support; and the rest was distributed among the poor.

COREOPSIS, tickseeded sunflower: a genus of the polygamia frustranea order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is paleaceous; the pappus two-horned; the calyx erect and polyphyllous, surrounded with patent radiated leaflets at the base. There are 20 species, most of them herbaceous perennials. They rise from 3 to 8 feet; terminated by clusters of compound radiated flowers of a yellow colour. They have all perennial fibrous roots, and annual stalks, which rise in the spring, flower from July to October, and decay to the root in November. The flowers are all shaped like sunflowers, but smaller, and are very ornamental. They are easily propagated by slipping or dividing the roots in autumn.

CORIANDRUM, *coriander*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The corolla is radiated; the petals inflexed-emarginated; the involucrum universal and monophyllous; the partial involucra halved; the fruit spherical. There are only two species, both of them herbaceous annuals, the leaves of which are useful for the kitchen, and the seeds for medicine. Both species have divided small leaves, somewhat resembling parsley: but there is only one species generally cultivated, namely, the sativum. This has a small fibrous white root, crowned by many-parted leaves, having broadish segments; and in the centre an upright, round, branchy stalk, two feet high, having all the branches terminated by umbels of flowers, which are succeeded by globular fruit. It is propagated by seed, which, when a good crop is wanted, ought to be sown in March, either in drills a foot asunder, or by broadcast, and then raked in. When the plants are an inch or two high, they should be hoed to six or eight inches distance. The seeds, when fresh, have a strong disagreeable smell, which improves by drying, and becomes sufficiently grateful: they are recommended as carminative and stomachic.

CORIARA, the *tanner's* or *myrtle-leaved sumach*, a genus of the decandria order, in the dioecia class of plants, and in the natural method ranking under the 54th order, miscellaneæ. The male calyx is pentaphyllous; the corolla pentapetalous, very like the calyx, and united with it; the antheræ bipartite. The female calyx is pentaphyllous; the corolla like that of the male; the styles five, seeds five, covered with a like number of succulent petals, forming altogether the resemblance of a berry. There are three species, the myrtifolia, rusufolia, and the sarmentosa. The first two are natives of the south of France, but the last is most commonly cultivated in this country. It is a pretty ornamental plant, with a shrubby pithy brown stem, closely branching from the bottom; and forms a bushy head three or four feet over, with oblong, pointed, bright-green leaves, having small spikes of whitish flowers at the ends of the branches. It is easily propagated by suckers from the root, in which it abounds plentifully, and may be taken off with fibres every autumn or winter. It is much used in France for tanning leather, whence its name tanner's sumach.

CORINTHIAN ORDER. See ARCHITECTURE.

CORIS, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is monopetalous and irregular; the calyx prickly; the capsule quinquevalved, superior. There is only one species, viz. the monspeliensis, or blue maritime coris. There are two varieties of this plant, one with a red, and the other with a white flower; but these are only accidental, and arise from the same seeds. They grow wild about Montpelier, and in most places in the south of France: they seldom grow above six inches high, and spread near the surface of the ground like heath; and in June, when they are full of flowers, make a very pretty appearance. They may be propagated by sowing their seeds in a bed of fresh earth, and afterwards removing the young plants, some in pots, and others into a warm border. They generally bear out winter colds well enough, but severe frosts will sometimes destroy them; for which reason it is proper to keep some of them in pots, which should be put under a hotbed frame in winter.

CORISPERMUM, *tickseed*, a genus of the digynia order, in the monandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. There is no calyx; two petals, and one oval naked seed. There are two species; but neither of them are remarkable for their beauty, or any other quality.

CORK. See QUERCUS.

CORK-FOSSIL, a name given to a kind of stone. It is a species of amianthus, consisting of flexible fibres loosely interwoven, and somewhat resembling vegetable cork. It is the lightest of all stones; by fire it is fusible, and forms a black glass.

CORK-JACKET, a kind of waistcoat, composed of four pieces of cork, two for the breasts, and two for the back; each pretty near, in length and breadth, to the quarters of a waistcoat without flaps; the whole is covered with coarse canvas, with two holes to put the arms through. There is a space left between the two back-pieces, and the same betwixt each back and breast-piece, that they may sit the easier to the body. Thus the waistcoat is only open before, and may be fastened on the wearer with strings; or, if it should be thought more secure, with buckles and leather straps. This waistcoat is the invention of Mr. Dubourg: but it has been improved by Dr. Wilkinson, of Woodford, who rendered it much more

accommodating to the motions of the body in swimming, by cutting the cork into small pieces, and quilting them between two waistcoats of canvas. Even the most timorous, with one of these jackets may safely venture into a rough sea.

A cork spencer has lately been invented to save from drowning, in cases of shipwreck; which consists of a belt, containing refuse pieces of cork, or old bottle-corks, enclosed in any kind of covering, and fastened round the body with tapes. The excellence of this consists in its cheapness, the whole being made for five shillings. See DROWNING.

COR-MASS, the name of a grand procession, said to have been established at Dunkirk during the dominion of Charles V. and renewed on St. John's day, the 24th of June. After the celebration of high mass, the procession, consisting of the several tradesmen of the town, began. Each person had a burning taper of wax in his hand; and after each company came a pageant, followed by the patron saint, usually of solid silver, richly wrought and adorned. The companies were followed by music; and after the musicians, the friars in the habits of their order, the secular priests, and then the abbot magnificently adorned, and preceded by the host. Machines likewise of various fantastical forms and devices, and as variously accoutred, formed a part of the show on this occasion; which has been described as one of the most superb and magnificent in the world.

CORN, in country affairs, the grain or seeds of plants separated from the spica or ear, and used for making bread. See HUSBANDRY.

CORN-LAWS. It is against the common law of England to buy or sell corn in the sheaf, before it is thrashed and measured: the reason whereof seems to be, because by such sale, the market is in effect forestalled. 3 Inst. 197.

Every person who shall sell or buy corn without measuring, or otherwise than by the Winchester measure, sealed and stricken by the brim, shall on conviction before one justice on the oath of one witness fofeit 40*s*. besides the whole of the corn so sold or bought, or the value thereof, half to the poor, and half to the informer.

On complaint to a justice, that corn has been bought, sold, or delivered, contrary to the act, the proof shall lie upon the defendant, to make it appear by oath of one witness, that he sold or bought the same lawfully: and if he shall fail therein, he shall forfeit as before mentioned, to be levied by distress and sale. 22 and 23 C. II. c. 8 and 12; and K. v. Arnold, T. 33, G. III.

And if any mayor, or other head officer, shall knowingly permit the same, he shall on conviction at the county sessions, forfeit 50*l*. half to the prosecutor and half to the poor, by distress and sale. For want of distress, to be imprisoned by warrant of the justices, till payment be made. 22 C. III. c. 8. s. 3.

The last acts now in force to regulate the returns of the prices of grain, are statutes 31 G. III. c. 30, 33 G. III. c. 65. By the former the statutes 1 Jac. II. c. 19: 1 W. and M. c. 12: 1 G. II. c. 12: 10 G. III. c. 39: 13 G. III. c. 43: 21 G. III. c. 50: and 29 G. III. c. 58, are all repealed; as also every provision in any other act regulating the importation of wheat, &c. except such as relate to the making of malt for exportation, and the exportation thereof. So much of the 15 Car. II. as prohibits the buying of corn to sell again, and the laying it up in granaries, is also repealed.

By the statutes of 31 G. III. c. 30, and 33 G. III. c. 65, bounties are granted on exportation at certain prices, and the exportation prohibited when at higher prices; the quantity of corn to be exported to foreign countries is settled; and the maritime counties of England are divided into districts. The exportation of corn is to be regulated in London, Kent, Essex, and Sussex, by the prices at the corn-exchange; the proprietors of which are to appoint an inspector of corn-returns, to whom weekly returns are to be made by the factors; and he is to make weekly accounts, and transmit the average price to the receiver of the returns, to be transmitted to the officers of the customs, and inserted in the London Gazette. The exportation in other districts and in Scotland, to be regulated by the prices at different appointed places, for which mayors, justices, &c. are to elect inspectors. Declarations are to be truly made by factors, of corn sold by them. Orders of council may regulate importation, &c. such orders to be laid before parliament. 32 Geo. III. c. 50. and 33 Geo. III. c. 3.

CORN, in medicine and surgery, a hard tumour like a flat wart, growing in several parts of the feet, especially upon the joints of the toes. This disorder is not unjustly attributed to the wearing of too strait or narrow-toed shoes, which never fail to produce these tubercles, especially if the person is obliged to stand or walk much, and in the summer time.

CORNEA TUNICA, in anatomy, the second coat of the eye; so called from its substance, which resembles the horn of a lanthorn. See ANATOMY.

CORNER-STONES, among builders, the two stones which stand one in each jaumb of a chimney. The breadth of each stone ought to be equal to that of the jaumb, and its face to be hollowed in the sweep of a circle; their height ought to reach from the hearth to the mantle-tree: they are commonly made of Ryegate or fire-stone.

CORNET, in the military art of the antients, an instrument much in the nature of a trumpet: when only it sounded, the ensigns were to march alone without the soldiers: whereas when the trumpet only sounded, the soldiers were to move without the ensigns. The cornets and buccinæ sounded the charge and retreat, and the cornets and trumpets sounded during the course of the battle.

CORNET is also a commissioned officer in a troop of horse or dragoons.

CORNICULARIUS, in Roman antiquity, an officer of the army, appointed to assist the military tribune in quality of lieutenant.

CORNUCOPIÆ, a genus of the digynia order, in the triandria class of plants, and in the natural method ranking under the 4th order, gramina. The involucrum is monophyllous, funnel-shaped, crenated, and multiflorous; the calyx bivalved; the corolla one-valved. There are two species.

CORNUS, *cornel-tree, cornelian cherry, or dogwood*; a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 47th order, stellatæ. The involucrum is most frequently monyphyllous; the petals above the receptacle of the fruit, four; the fruit itself a bilocular kernel. Of this genus there are 12 species; the most remarkable are the following: 1. The mas or cornelian cherry-tree, has an upright tree-stem, rising 20 feet high, branching and forming a large head, with oblong leaves, and small umbels of yellowish-green flowers at the sides and ends of the branches; appearing early in the spring, and succeeded by small, red, cherry-like, eatable, acid fruit. 2. The sanguinea, bloody-twig, or common dogwood, has an upright tree-stem, branching 10 or 12 feet high, having blood-red shoots, with oblong pointed nervous leaves two inches long; and all the branches terminated by umbellate white flowers, succeeded by black berries: of this there is a kind with variegated leaves. 3. The Florida or Virginian dog-wood, has a tree-stem branching 12 or 15 feet high, and fine red shoots, with large heart-shaped leaves; and the branches terminated by umbellate white flowers, having a large involucrum succeeded by dark-red berries. Of this species there are several varieties, chiefly distinguished by the colour of their berries, which are red, white, or blue. All the species may be propagated by seeds, which ought to be sown in autumn, otherwise they will lie a year in the ground. They may also be propagated by suckers, of which they produce great plenty, or by laying down the young branches.

CORNUTIA, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is quinquedentated; the stamina longer than the corolla; the style very long; the berry monospermous. There are two species: the pyramidata has blue pyramidal flowers and hoary leaves. It grows plentifully in several of the islands of the West Indies, also at Campeachy, and at La Vera Cruz. It rises to the height of 10 or 12 feet, with rude branches, the leaves being placed opposite. The flowers are produced in spikes at the end of the branches, and are of a fine blue. They usually appear in autumn, and will sometimes remain in beauty for two months or more. It is propagated either by seeds or cuttings, and makes a fine appearance in the stove, but is too tender to bear the open air in this country.

COROLLA, among botanists, the most conspicuous part of a flower, surrounding the organs of generation. See BOTANY.

COROLLARY, is an useful consequence drawn from something already advanced or demonstrated: thus, it being demonstrated that a triangle which has two equal sides, has also two angles equal, this corollary will follow; that a triangle which has three sides equal, has also its three angles equal.

CORONA, among botanists, expresses any thing growing on the head of a seed. See BOTANY.

CORONA *borealis*, the northern crown or garland, in astronomy, a constellation of the northern hemisphere, whose stars in Ptolemy's catalogue are 8, in Tycho's as many, and in Mr. Flamsteed's 31.

CORONAL, coronalis, in anatomy, the first suture of the scull. See ANATOMY.

CORONARY *vessels*, vasa coronaria, in anatomy, certain vessels which furnish the substance of the heart with blood.

CORONATORE *eligendo*, in law, a writ that lies directed to the sheriff, out of the court of chancery, on the death or discharge of any coroner, commanding him to call the freeholders of the county for the election of a new coroner, and to certify to the said court both the election and the name of the party chosen, and to administer his oath to him,&c.

CORONER, a very antient officer at the common law: he is called coroner, because he acts principally in the pleas of the crown; and coroners were of old time the conservators of the peace. This officer ought to be a sufficient person, that is, the most wise and discreet knight that best would and might attend upon such an office. St. Westm. c. 10. By the 14 Ed. III. st. 1, c. 8, no coroner shall be chosen unless he shall have land in fee sufficient in the same county wherein he may answer to all manner of people. The lord chief justice of the king's-bench is the sovereign coroner of the whole realm.

How elected. In antient times, none under the degree of knight were chosen. 2 Inst. 32. 176. But as the chief intent was to prevent the choosing of persons of mean ability, it seems the design of it is sufficiently answered by choosing men of substance and credit; and as the constant usage for several ages past has been accordingly, it seems to be no objection at this day that the person chosen is not a knight. 2 Haw. 42. 43.

By the 28 Ed. III. c. 6. it is enacted, that all coroners of the counties shall be chosen in full county-courts, by the commoners of the said counties, of the most meet and lawful people that shall be found in the same, to execute the said office. But though they are chosen by the county, it must be pursuant to the king's writ, issuing out of and returnable into chancery; and none but freeholders have a voice at such election, for they only are suitors to the county-court. 2 Inst. 99., 2 Haw. 43. 44. When chosen they shall be sworn by the sheriff for the due execution of their office. 2 Hale. H. 55.

His duty in taking inquisitions. When any person comes to an untimely death, the township shall give notice thereof to the coroner; otherwise if the body be interred before he come, the township shall be amerced. Hale's Pl. 170. And if the township shall suffer the body to lie till putrefaction without sending for him, they shall be amerced. 2 Haw. 48.

When the coroner has received notice, he shall issue a precept to the constables of the four, five, or six next townships, to return a competent number of good and lawful men of their townships, to appear before him in such a place, to make an inquisition touching that matter. 4 Ed. I. st. 2. Or he may send a precept to the constable of the hundred. Wood, b. 4. c. 1. And there must be twelve jurors at the least. 2 Inst. 148. If the constable make no return, or if the jurors returned shall not appear, their defaults are to be retured to the coroner, and they shall be amerced before the judges of the assize. 2 H. H. 55.

The jury, after being sworn, is to be charged by the coroner to inquire, upon the view of the body, how the party came by his death. 2 H. H. 60.

Every coroner upon an inquisition before him found, whereby any person shall be indicted for murder or manslaughter, or as an accessary before the offence committed, shall put in writing the effect of the evidence given to the jury before him being material; and shall bind over the witnesses to the next general gaol-delivery to give evidence; and shall certify the evidence, the recognizance, and the inquisition or indictment before him taken and found, at or before the trial, on pain of being fined by the court. 1 & 2 P. & M. c. 13. s. 5.

But the coroner cannot enquire of accessaries after the fact. He ought to enquire into the death of all persons dying in prison, that it may be known whether they died by violence or any unreasonable hardships.

His general power and duty. Besides his judicial place, the coroner has an authority ministerial, as a sheriff; namely, when there is a just exception taken to the sheriff, judicial process shall be awarded to the coroner for the execution of the king's writ. And in some special cases the king's original writ shall be immediately directed to him. 4 Inst. 271. He is bound to be present in the county-court to pronounce judgment of outlawry upon the exigent, after quinto exactus, at the fifth court, if the defendant do not appear. Wood, b. 4. c. 1.

It is his duty to enquire of treasure that is found, who were the finders, and likewise who is suspected thereof. He may also receive the appeal of an approver for an offence in the same, or in a different county; and if the appellee be in the same county, he may award process against him to the sheriff till it come to the exigent; but if the appellee be in a foreign county, the coroner cannot award process against him, but must leave it to the justices of a gaol-delivery, before whom the appeal is afterwards recorded. 2 Haw. 52.

Punishment for misdemeanour. Justices of assize and peace have power to enquire of and punish the defaults and extortions of coroners. 1 Hen. VIII. c. 7. and 25 Geo. II. c. 29. s. 6.

His fees. The coroner shall have for his fee, upon every inquisition taken upon the view of the body slain, 13*s.* 4*d.* of the goods and chattels of him that is the slayer and murderer, if he have any goods; and if he have no goods, of such amerciament as any township should happen to be amerced for the escape of the murderer. 3 Hen. VII. But as the said fee of 13*s.* 4*d.* is not an adequate reward for the general execution of the said office, therefore for every inquisition taken upon view of a body dying in gaol, the coroner shall have 20*s.*, and also 9*d.* for every mile he shall be compelled to travel from his usual place of abode to take such inquisition, to be paid by order of the justices in sessions, out of the county rates. 25 Geo. II. c. 29. s. 1.

CORONILLA, jointed podded colutea, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is bilabiated, with two segments above coalited; the vexillum scarcely any longer than the alæ; the legumen much contracted between the seeds. To this genus Linnæus also joins the emerus, or scorpion sena, though Mr. Miller makes it a distinct species. There are 14 species, all plants of considerable beauty, with very bright yellow flowers. All of them, however, are rather too tender for this climate, except the emerus. This species rises with a shrubby stem, branching numerously six or eight feet high, with winged leaves of three pair of lobes, terminated by an odd one; and at the sides of the branches numerous long flower-stalks, each supporting two or three large yellow flowers, succeeded by longish pods; it is easily propagated by seeds, and likewise by layers or cuttings. The leaves of this plant are esteemed laxative, and used as a substitute for common sena in some parts of Europe. A dye is procured by fermentation from the leaves, like that of indigo.

CORPORA *cavernosa*, in anatomy. See ANATOMY.

CORPORAL, an inferior officer under a serjeant, in a company of foot, who has charge over one of the divisions, places and relieves sentinels, and keeps good order in the corps-de-garde: he also receives the word from the inferior rounds which pass by his corps-de-garde. This officer carries a fusee, and is commonly an old soldier. There are generally three corporals in each company.

CORPORAL *of a ship of war*, an officer under the master at arms, employed to teach the officers the exercise of small arms, or of musketry; and to attend at the gang-way on entering ports, and observe that no spirituous liquors are brought into the ship, unless by express leave from the officers. He is also to extinguish the fire and candles at eight o'clock in winter and nine in summer, when the evening-gun is fired; and to walk frequently down in the lower decks in his watch, to see that there are no lights but such as are under the charge of proper sentinels.

CORPORATION, a body politic, or incorporate, so called because the persons or members are joined into one body, and are qualified to take and grant, &c. Corporations are either spiritual or temporal; spiritual as bishops, deans, arch-deacons, parsons, vicars, &c. temporal as mayor, commonalty, bailiffs, burgesses, &c. And some corporations are of a mixed nature, composed of spiritual and temporal persons, such as heads of colleges and hospitals, &c. All corporations are said to be ecclesiastical or lay; ecclesiastical are either regular, as abbeys, priories, chapters, &c. or secular, as bishoprics, deanries, archdeaconries, &c. lay, as those of cities, towns, companies, or communities of commerce. Corporations may be established three different ways, viz. by prescription, letters patent, or act of parliament; but are most commonly established by patent or charter. London is a corporation by prescription: but though corporations may be by prescription, yet it shall be intended, that it did originally derive its authority by a grant from the king.

A corporation may be dissolved; for it is created upon a trust; and if it is broken, it is forfeited. No person shall bear office in any corporation but such as have received the sacrament, taken oaths, &c. A corporation cannot sue or appear in person, but by an attorney. Ordinances made by corporations

to be observed on pain of imprisonment, forfeiture of goods, &c. are contrary to Magna Charta. Actions arising in any corporation may be tried in the corporation courts; but if they try actions not within their jurisdiction, and encroach upon the common law, they are liable to be punished for it. The corporation of the city of London is to answer for all particular misdemeanors committed in any of the courts of justice within the city, and for all other general misdemeanors committed in the city.

CORPS DE GARDE, a post in an army, sometimes under cover, sometimes in the open air, to receive a number of soldiers, who are relieved from time to time, and are to watch in their turns for the security of some more considerable post.

Corps-de-garde is frequently used for the men who watch in this post.

CORPS, in architecture, a term to signify any part that projects or advances beyond the naked of a wall, serving as a ground for some decoration.

CORPSE. If any person steal the shroud or other apparel from a dead body, it will be a felony. 3 Inst. 110. 12 Rep. 113. But stealing the corpse itself only, is not felony; but it is punishable as a misdemeanour, by indictment at common law. 2 Black. 236.

CORPULENCY, in medicine, the state of a person too much loaded with flesh or fat.

An excessive degree of corpulency or fatness becomes a disease, when the whole body, as well as the belly, is grown into such a bulk, that the actions, especially with respect to motion and respiration, are greatly impaired, if not entirely impeded. Boerhaave observes, that corpulency does not consist in the solids of the body being increased, but in their being distended to a greater pitch by the abundance of humours collected in them. Corpulency is supposed to arise from a copious, oily, soft blood, and is promoted by any thing that tempers and softens the blood; such are want of exercise and motion, an indolent life, too much sleep, nourishing foods, &c.

There is not a better remedy to reduce a corpulent habit, than acetum sciliticum drunk upon an empty stomach. Semen fraxini, or bird's-tongue as it is called, ʒj, drunk in a morning in a glass of wine, is very much commended as an effectual diuretic, and on that account abates corpulency. Borellus recommends the chewing of tobacco; but it is not safe for all persons to use it, lest it should throw them into a consumption. Dr. Fleming recommends from one to four grains of Castile soap to be taken at bedtime. Those that are naturally gross and fat, oftener die suddenly than other people. The most extraordinary instance of corpulency perhaps ever known, was that of Edw. Bright of Malden, in Essex, who, dying in Nov. 1750, at the age of 29 years, weighed 616 pounds; his waistcoat, with great ease, was buttoned round seven men of ordinary size.

CORPUS, in anatomy, a term applied to several parts of the animal structure, as corpus callosum, corpus cavernosum, &c.

CORPUS CALLOSUM, a medullary part of the brain, which covers the whole lateral ventricles.

CORPUS CAVERNOSUM, a cavernous substance, surrounding the vagina.

CORPUS CUM CAUSA, in law, a writ issuing out of the chancery to remove both the body and record, touching the cause of any man lying for execution upon a judgment for debt, into the king's-bench, there to lie till he has satisfied the judgment.

CORPUSCLE, in physics, a minute particle, or physical atom, being such as a natural body is made up of. By this word are not meant the elementary particles, but such, whether of a simple or compound nature, whose parts will not be dissipated by ordinary degrees of heat. Sir Isaac Newton, in the second book of his Optics, shews a way of guessing, with great accuracy, at the size of the component corpuscles of bodies.

CORRECTION, in printing, the pointing out or discovering the faults in a printed sheet, in order to be amended by the compositor before it be printed off.

The corrections are placed on the margin of every page, against the line in which the faults are found; and there are different characters used to express different corrections: thus ꝺ is put for dele, to intimate that something, as a point, letter, word, &c. dashed in that line is to be taken out. If any thing is to be inserted, the place is to be marked thus ʌ and the thing to be inserted added in the margin. When there are two or more corrections in the same line, then they are all separated in the margin by little bars, thus |. If a space is omitted, its place is marked with a caret, and in the margin thus ‡‡. When a letter is inverted, it is expressed in the margin thus ©. When any thing is to be transposed it is directed thus, Extraordinary scarce ever fail of attainments exciting envy, for Extraordinary attainments scarce ever fail of exciting envy, and in the margin is added *tr.* If Italic characters are to be changed for Roman, or vice versa, a line is drawn thus — under the letters, and Rom. or Ital. is written in the margin. If a space, or an m or n quadrat, stick up, and print black, it is marked in the margin with a dash, thus |. If a word, sentence, or paragraph is entirely omitted, the place is marked with a caret, and in the margin is put the word *out*. If the letters of a word stand too far asunder, a line is drawn under them, and in the margin is put a crooked line or hook, thus ⌣. There are many other marks used in correcting, as √ for superior, *cap.* for capital, *l. c.* for lower-case, &c.

CORRECTOR *of the staple*, a clerk belonging to the staple, whose business is to write down and record the bargains that merchants make there.

CORRECTOR, in medicine and pharmacy, an ingredient in a composition which guards against or abates the force of another. See PHARMACY.

CORRELATIVE, something opposed to another in a certain relation. Thus, father and son are correlatives. Light and darkness, motion and rest, are correlative and opposite terms.

CORROSION, in a general sense, the action of gnawing away, by degrees, the continuity of the parts of bodies. Acids corrode most natural bodies.

CORROSIVES, in surgery are medicines which corrode whatever part of the body they are applied to: such are burnt alum, white precipitate of mercury, white vitriol, red precipitate of mercury, butter of antimony, and lapis infernalis.

CORRUGATOR. See ANATOMY.

CORRUPTICOLÆ, in church-history, a sect of heretics, so called from their maintaining that the body of Christ was corruptible, that the fathers had owned it, and that to deny it was to deny the truth of our Saviour's passion.

CORRUPTION, the destruction, extinction, or at least cessation for a time, of the proper mode of existence of any natural body.

CORRUPTION *of blood*, in law, an infection accruing to a man's state attainted of felony and treason, and to his issue; for as he loses all to the prince, &c. his issue cannot be heirs to him, nor to any other ancestor by him; and if he was noble, his heirs are rendered ignoble.

CORSELET, a little cuirass; or, according to others, an armour or coat made to cover the whole body; antiently worn by the pike-men, usually placed in the front and flanks of the battle, for the better resisting the enemy's assaults, and guarding the soldiers placed behind them.

CORTUSA, bear's-ear sanicle; a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 21st order, preciæ. The corolla is wheel-shaped, with its throat like an elevated ring; the capsule unilocular, oval, and quinquevalved at the top. There are two species; both of them very low, flowery, herbaceous perennials, crowned by umbels of monopetalous wheel-shaped flowers, of a fine red colour. They are natives of mountainous rocky parts abroad, so must have a dry lean soil; or they may be kept in pots of dry sandy earth placed in the shade, and in the summer must be duly watered; and their propagation here is by slipping the roots in October.

CORUNDUM, a mineral, of which there are two species, the perfect and imperfect. Perfect corundumor sapphire is found in the East Indies, especially in Pegu and the island of Ceylon; and it is most commonly crystallized. The crystals are of no great size; their primitive form, as has been demonstrated by Bournon, is a rhomboid whose angles are 86° and 94°, and which therefore is nearly rectangular. Sometimes it occurs in this form, though but seldom. Bournon has described no less than eight modifications of it.

The texture of the sapphire is foliated; but in the more perfect specimens the plates are separated with difficulty. Fracture conchoidal. It causes only a single refraction. Specific gravity from 3.207 to 4.161. Colour most frequently blue; sometimes red, purple, yellow, and green; and sometimes colourless: imperfect corundum is usually crystallized; sometimes found in amorphous masses. The figures of the crystals are the same as those of the last species; opaque, except when in very thin pieces; specific gravity from 3.710 to 4.180; colour grey, often with various shades of blue and green.

Mr. Chenevix obtained the following constituents from different specimens of corundum subjected to chemical analysis.

Imperfect corundum.

	From the Carnatic.	From Malabar.	From China.	From Ava.
Silica	5.0	7.0	5.25	6.5
Alumina	91.0	86.5	86.50	87.0
Iron	1.5	4.0	6.50	4.5
Loss	2.5	2.5	1.75	2.0
	100.0	100.0	100.00	100.0

Perfect corundum.

	Blue, or sapphire.	Red, or oriental ruby.
Silica	5.25	7.0
Alumina	92.00	90.0
Iron	1.00	1.2
Loss	1.75	1.8
	100.00	100.0

Mr. Klaproth's analysis of sapphire differs a little from the above, but his analysis of imperfect corundum agrees with it. He found the sapphire composed of

98.5 alumina
1.0 oxyd of iron
0.5 lime

100.0

CORUS, *Omer*, *Homer*, or *Chomer*, in the Jewish antiquities, a measure containing 10 baths, or 75 gallons and 5 pints, as a measure for things liquid, and 32 pecks and 1 pint, as a measure for things dry.

CORUSCATION, a glittering or gleam of light issuing from any thing. It is chiefly used for the electrical fluid when rendered visible, as in a flash of lightning, &c. There are methods of producing artificial coruscations, or sparkling fiery meteors, which will be visible not only in the dark but in the day-time.

CORVUS, the raven or crow kind, in ornithology; a genus of birds of the order of picæ, the distinguishing characteristics of which are these: the beak is convex and cultrated; the nostrils are covered with bristly feathers; the tongue is forked and cartilaginous; and the feet are of the walking kind. The species are 19, the most remarkable of which are (see Plate Nat. Hist. fig. 144.):

1. The corax, or raven of English authors, weighs three pounds, and is about two feet two inches in length; the colour is black, finely glossed with a rich blue, the belly excepted, which is of a dusky colour. They are very docile birds, and may be trained up to fowling like hawks, or to fetch and carry like spaniels; they may be taught to speak like parrots; and, what is most extraordinary of all, they may be taught to imitate the human voice in singing. They have a great propensity to pilfer, often hiding things of value, to the great loss of the owner, without use to themselves. They frequent the neighbourhood of great towns, where they are useful in devouring the carcases and filth which would otherwise prove a nuisance. They, however, also destroy many living animals; such as rabbits, young ducks, and chickens, and not unfrequently lambs which have been dropped in a weak state. In clear weather they fly in pairs to a great height, making a deep loud noise, different from the common croaking. Their scent is remarkably good, and they are very long-lived. The raven builds her nest early in the spring, laying five or six eggs, of a pale blueish-green colour, spotted with brown.

2. The corone, or carrion-crow, in the form of its body agrees with the raven; also in its food, which is carrion and other filth. It will also eat grain and insects; and like the raven will pick out the eyes of animals: whence it was formerly distinguished from the rook, which feeds entirely on grain and insects, by the name of the gor, or gor-crow. Virgil says that its croaking forebodes rain; "Tum cornix plena pluviam vocat improba voce." It was also thought a bird of bad omen, especially if it happened to be seen on the left hand: "Sæpe sinistra cava prædixit ab ilice cornix." England breeds more of this kind of birds than any other country in Europe. But though the crow abounds in Britain, it is so rare in Sweden, that Linnæus speaks of it only as a bird that he once knew killed there. It lays the same number of eggs as the raven, and of the same colour. Immediately after deserting their young they go in pairs. Both these birds are often found white or pied, an accident that befals black birds more frequently than any others. Mr. Pennant says, he has observed one entirely of a pale-brown colour, not only in its plumage, but even in its bill and feet. The crow weighs about 20 ounces. Its length is 18 inches; its breadth two feet two inches.

3 The frugilegus, or rook, is the corvus of Virgil; no other species of this kind being gregarious. It differs not greatly in its form from the carrion-crow: the most remarkable difference is in the nostrils and root of the bill; which parts in the crow are well clothed with feathers, but in the rook are bare, or covered only with some bristly hairs. This arises from its thrusting the bill into the earth continually, after the various worms and erucæ of insects, on which it feeds; for it does not live on carrion, like the last species or the raven. Besides insects, it also feeds on all sorts of grain, to some inconvenience perhaps to the husbandman, but no doubt he is doubly repaid by the good done to him in extirpating the maggot of the chafer-beetle, which in some seasons destroys whole crops of corn by feeding on the roots. The rook is a gregarious bird, sometimes being seen in immense flocks, so as almost to darken the air. These flights they regularly perform morning and evening, except in breeding-time, when the daily attendance of both male and female is required for the use of incubation, or feeding the young; for it is observed that they do both by turns. As these birds are apt to form themselves into societies, such places as they frequent during the breeding-time are called rookeries; and they generally choose a large clump of the tallest trees for this purpose, but make so great a litter, and such a perpetual chatter, that nothing but habit and a length of time can reconcile one to the noise. The eggs are like those of crows, but less, and the spots larger. They begin to build in March, and after the breeding-season forsake their nest-trees, going to roost elsewhere, but have been observed to return to them in August. In October they repair their nests. In Britain they remain the whole year; yet we are told that both in France and Silesia they are birds of passage.

4. The cornix, or Royston crow, in its habits resembles the rook, feeding on insects, and flying together in great flocks; but is easily distinguished by its plumage; its back, breast, and belly, being ash-colour, inclining to light blue, and consequently much handsomer; it is also rather larger than the rook, weighing 22 ounces. In England it is a bird of passage, visiting that kingdom in the beginning of winter, and leaving it with the woodcocks. In the maritime parts they feed on crabs and shell-fish. They are very common in Scotland; in many parts of the Highlands, and in all the Hebrides, Orkneys, and Shetlands, it is the only species of genuine crow, the carrion and rook being unknown there. It breeds and continues in those parts the whole year round. In the Highlands they breed indifferently in all kinds of trees; lay six eggs; have a shriller note than the common crows; are much more mischievous; pick out the eyes of lambs, and even of horses when entangled in bogs. They are, therefore, in many places proscribed, and rewards given for killing them. For want of other food these birds will eat cranberries or other mountain berries.

5. The dauricus, or white-breasted crow, is in length about 12 inches; the bill is black; the head and throat are black, glossed with blue; the neck and breast white; the rest of the body, wings, and tail, blue-black; the legs of a lead-colour; the claws black. Pallas describes the same species, which he says came early in the spring in great flights from China, and the southern Monguls country, into the parts about the lake Baikal, but most frequent about the towns and villages on the river Lena, in which part the jackdaws and Royston crows are very seldom seen. They live chiefly on insects.

6. The monedula, or jackdaw, weighs nine ounces; the length 13 inches, the breadth 28. The head is large in proportion to its body; which Mr. Willughby says, argues him to be ingenious and crafty. It is a docile and loquacious bird. Jackdaws breed in steeples, old castles, and in high rocks, laying five or six eggs. Sometimes they have been known to breed in hollow trees near a rookery, and join those birds in their foraging parties. In some parts of Hampshire they make their nests in rabbit-holes. They also build in the interstices between the upright and transum stones of Stonehenge; a proof of the prodigious height of that stupendous antiquity, for their nests are placed beyond the reach of the shepherd-boys, who are always idling about this spot. They are gregarious birds, and feed on insects, grain, and seeds. These birds are frequently brought up tame; they have a practice of hiding that part of their food which they cannot eat; and often, along with it, they secrete small valuables, sometimes occasioning injurious suspicions of theft in servants or others not guilty.

7. The glandarius, or jay, is one of the most beautiful of British birds. The weight is between six and seven ounces; the length 13 inches. The forehead is white streaked with black; the head is covered with very long feathers, which it can erect at pleasure into the form of a crest; the whole neck, back, breast, and belly, are of a faint purple dashed with grey; the covert-feathers of the wings are of the same colour. The first quill-feather is black; the exterior webs of the nine next are ash-coloured; the interior webs dusky; the six next are black, but the

lower sides of their exterior webs are white tinged with blue; the two next wholly black; the last of a fine bay-colour, tipt with black. Jays build chiefly in woods, making their nests of sticks, fibres of roots, and tender twigs; and lay five or six eggs, of the size of a pigeon's, cinereous olive marked with pale brown. The young keep with the old ones till the next pairing-time in spring, when they choose each his mate to produce their future progeny. In general they feed on acorns, nuts, seeds, and fruits of all kinds, but will sometimes destroy young chickens and eggs, and will also take away birds that have been caught in a trap, or entangled with birdlime. They are often kept in cages, and will talk pretty well.

8. The caryocatactes, or nutcracker, is somewhat less than the jackdaw: the bill is strong, straight, and black; the colour of the whole head and neck, breast and body, of a rusty brown; the crown of the head and rump are plain; the other parts marked with triangular white spots; the wings are black; the coverts spotted in the same manner as the body; the tail is rounded at the end, black tipt with white; the vent-feathers are white; the legs dusky. We find these birds scattered in many parts of Europe, but no where so plenty as in Germany. They visit England very seldom; and are also found in North America, but not near the sea-coasts.

9. The pica, or magpie, is in length above 18 inches, and weighs eight or nine ounces. In manners it approaches the crow, feeding almost on every thing in turn, both animal and vegetable; and like that will kill young ducks and chickens, and suck the eggs. It builds its nest with art, making a thorny cover at top, leaving a hole in the side for admittance; lays six or seven pale-greenish eggs, thickly spotted with black. It is a crafty bird in every state, and, if brought up young, becomes exceedingly familiar; and will talk a great many sentences, as well as imitate every noise within hearing, like a parrot, but not so plain.

10. The graculus, or red-legged crow, is but thinly scattered over the northern world: no mention is made of it by any of the Faunists; nor do we find it in other parts of Europe, except Britain and the Alps. It is produced in the island of Candia in Asia; and it visits Egypt towards the end of the inundation of the Nile. Except in Egypt, it affects mountainous and rocky places; builds its nest in high cliffs or ruined towers; and lays four or five eggs, white spotted with a dirty yellow. It feeds on insects, and also on new-sown corn. They commonly fly high, make a shriller noise than the jackdaw, and may be taught to speak. It is a very tender bird, and unable to bear very severe weather; is of an elegant, slender make; active, restless, and thieving; much taken with glitter, and so meddling as not to be trusted where things of consequence lie. It is very apt to catch up bits of lighted sticks, so that there are instances of houses being set on fire by its means; on which account Camden calls it incendiaria avis. It is found in Cornwall, Flintshire, Caernarvonshire, and Anglesea, in the rocky cliffs along the shores. It is also found in Scotland as far as Strathnavern, and in some of the Hebrides. Its colour is wholly black, beautifully glossed over with blue and purple: the legs and bill are of a bright orange-colour inclining to red; the tongue is almost as long as the bill, and a little cloven; the claws are large, hooked, and black.

11. The cristatus, or blue jay, is much smaller than the common jay. The bill is black, and above an inch long: the head is crested and blue: a streak on each side of the head and throat are of a blueish white, and there is a spot of the same over the eye: the hind part of the neck and back is blue: the wings and tail the same; all the feathers of the last, except the two middle ones, tipped with white; the feathers of both it and the wings elegantly barred with black, and the greater coverts and second quills tipped with white: the breast is of a blossom-colour: the belly and under tail-coverts white: the legs are dusky brown: the tail is nearly as long as the rest of the bird. The colours of the female are less bright than those of the male. The species is said to be peculiar to North America, but not seen farther north than the town of Albany.

12. The canadensis is in length nine inches, and weighs two ounces. The bill is blackish, and not quite an inch long: the irides are black: the forehead and throat are of a dirty yellow-white; the hind-head and sides of a blackish brown: the upper parts of the body are brown: beneath, pale ash. These birds inhabit Canada; and are frequent near Hudson's-bay, where they are called whiskijohn and whiskijack. They breed early in the spring; build in pine-trees; and have two, rarely three, young at a time. The eggs are blue. They are not gregarious. Their food is black moss, worms, and flesh. They are very bold pilfering birds, stealing from the traveller even salt meat; and devouring often the bait from the traps set for the martins, as soon as the persons who set them turn their backs. They lay up stores for winter; at which time they are seldom seen unless near habitations.

CORVUS, the raven, in astronomy, a constellation of the southern hemisphere, wherein, according to Ptolemy and Tycho's catalogue, are seven stars; whereas the Britannic catalogue reckons no less than ten.

CORVUS, in Roman antiquity, a military engine, or rather gallery, moveable at pleasure by means of pulleys, chiefly used in boarding the enemy's ships, to cover the men.

CORYBANTES, in antiquity, priests of the goddess Cybele, who, inspired with a sacred fury, danced up and down, tossing their heads, and beating on cymbals or brazen drums. They inhabited mount Ida, in the island of Crete, where they nourished the infant Jupiter, keeping a continual rattling with their cymbals, that his father Saturn, who had resolved to devour all his male offspring, might not hear the child's cries.

CORYBANTICA, in Grecian antiquity, a festival kept in honour of the corybantes.

CORYCOMACHIA, among the antients, was a sort of exercise in which they pushed forwards a ball, suspended from the ceiling, and at its return either caught it with their hands, or suffered it to meet their body. Oribasius informs us it was recommended for extenuating too gross bodies.

CORYLUS, the hazel, a genus of the polyandria order, in the monœcia class of plants; and in the natural method ranking under the 50th order, amentaceæ. The male calyx is monophyllous, scale-like, trifid, and uniflorous; there is no corolla; the stamina eight in number: the female calyx diphyllous and lacerated; no corolla; two styles; and an egg-shaped nut. There are three species: 1st. The corylus avellana (from Avellino, in Italy, where they were first cultivated), or hazel, of which the filbert is a variety. 2d. Corylus rostrata, or American cuckold-nut. 3d. Corylus columo, Constantinopolitan hazel. They are all of the large shrub kind, hardy and deciduous; and have several varieties valuable for their nuts, as also for their variety in large wildernesses and shrubbery works. They will prosper in almost any soil or situation, and turn to good account when growing in coppices to cut as underwood, and as poles for various uses; as hoops, spars, hurdles, handles to husbandry implements, walking-sticks, fishing-rods, &c. for which purposes they may be cut every fifth, seventh, or eighth year, according to the purposes for which they are designed. The best method of propagating them is by layers, though they may also be raised from the nuts.

The kernels of the fruit have a mild, farinaceous, oily taste, agreeable to most palates. Squirrels and mice are fond of them, as well as some birds, such as jays, nutcrackers, &c. A kind of chocolate has been prepared from them, and there are instances of their having been formed into bread. The oil expressed from them is little inferior to the oil of almonds; and is used by painters, and by chemists, for receiving and retaining odours.

Evelyn tells us, that no plant is more proper for thickening of copses than the hazel, for which he directs the following expeditious method: Take a pole of hazel (ash or poplar may also be used) of 20 or 30 feet in length, the heads a little lopped, giving it a chop near the ground to make it succumb; this fastened to the earth with a hook or two, and covered with some fresh mould at a competent depth (as gardeners lay their carnations), will produce a great number of suckers, and thicken and furnish a copse speedily.

CORYMBIUM, a genus of the monogamia order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The calyx is diphyllous, uniflorous, and prismatical; the corolla monopetalous and regular; there is one woolly seed below each floret. There are four species.

CORYMBUS. See BOTANY, *Glossary*.

CORYNOCARPUS, a genus of the monogynia order, in the pentandria class of plants. The calyx is a pentaphyllous perianthium; the corolla consists of five roundish, erect, and hollow petals; the stamina five subulated filaments arising from the base of the petals; the antheræ are erect and oblong; the pericarpium a monospermous, turbinated, clavated nut. There is one species, a native of New Zealand.

CORYPHA, mountain palm, or umbrella-tree, a genus of the order of palmæ, belonging to the monœcia class of plants. The corolla is tripetalous; the stamina six, with one pistil; the fruit a monospermous plum. There are two species. The umbracula is a native of the West Indies, where it is called codda pana. It rises to a considerable height, and produces at the top many large, palmated,

plaited leaves, the lobes of which are very long, and are placed regularly round the end of a long spiny footstalk, in a manner representing a large umbrella. The flowers are produced on a branched spadix, from a compound spatha or sheath; they are hermaphrodite, and each consists of one petal, divided into three oval parts, and contains six awl-shaped stamina, surrounding a short slender style, crowned with a simple stigma. The germen is nearly round, and becomes a large globular fruit of one cell, including a large round stone. These plums having a pleasant flavour are held in esteem by the Indians.

CORYPHÆNA, in ichthyology, a genus belonging to the order of thoracici. The head is declined and truncated; the branchiostege membrane has six rays; and the back-fin runs the whole length of the back. There are twelve species, most of them natives of foreign seas. The most remarkable are the blue and parrot fishes, described by Mr. Catesby. The head of the first is of an odd structure, resembling that of the spermaceti whale: the mouth is small, each mandible armed with a single row of even teeth, so closely joined that they seem entire bones; the iris of the eye is red. On the back is a long pliant fin, somewhat indented on the edge; behind the gills are two fins, one under the abdomen and another behind the anus. The tail is forked; and the whole fish entirely blue. They are taken on the coasts of the Bahama islands, and in most of the seas between the tropics. The parrot-fish has a large mouth, paved as it were with blunt teeth, closely connected after the manner of the lupus marinus. The body is covered with large green scales; the eyes are red and yellow; the upper part of the head brown, the lower part and the gills blue, bordered with a dusky red; a streak of red extends from the throat behind the gills, at the upper end of which is a bright-yellow spot. The fins are five in number: one extending almost the length of the back, of a bay or cinnamon colour; there are two behind the gills, blended with black, green, and purplish colours, with the upper edge verged with blue; under the abdomen is another red fin verged with blue; under the anus extends another long narrow green fin, with a list of red through the middle of it. At the basis of the tail on each side is a large yellow spot. The tail is large, forked, and green, with a curved red line running through the middle parallel to the curve, and ending in two points. This fish is more esteemed for beauty than the delicacy of its taste. They are taken on the coasts of Hispaniola, Cuba, and the Bahama islands. See Plate Nat. Hist. figs. 145, 146.

COS, the *whetstone*, in natural history, a genus of vitrescent stones, consisting of fragments of an indeterminate figure, subopake and granulated. Of this genus there are several species, some consisting of rougher and others of smoother, or even of altogether impalpable, particles; and used not only for whetstones, but also for mill-stones and other similar purposes.

COS TURCICA, *turkey-stone*, a species of stones of the garnet kind, belonging to the siliceous class. It is of a dull white, and often of an unequal colour; some parts appearing more compact than others. Its specific gravity is 2598: it strikes fire with steel, and effervesces with acids. Mr. Kirwan found that 100 parts of it contain 25 of mild calcareous earth (carbonate of lime), and no iron. Cronstedt is of opinion that there are probably two sorts of stones known by this name, as that described by Wallerius neither gives fire with steel nor effervesces with acids. It is used as a whetstone; and those of the finest grain are the best hones for the most delicate cutting tools, and even for razors, lancets, &c.

CO-SECANT, in geometry, the secant of an arch which is the complement of another to 90°. See TRIGONOMETRY.

COSHERING, a seignoral prerogative, whereby the lord and his followers lay and feasted themselves at his tenant's house.

COSINAGE, a writ that lies where the tresayle or great-grandfather is seized in his demesne, as of fee at the day of his death, of certain lands or tenements, and dies, and then a stranger enters, and abates; for then shall his heir have this writ of cosinage.

CO-SINE, in trigonometry, the sine of an arch, which is the complement of another to 90°. See TRIGONOMETRY.

COSMOGRAPHY, a description of the several parts of the visible world; or the art of delineating the several bodies according to their magnitudes, motions, relations, &c. It consists of two parts, astronomy and geography.

COSTIVENESS, *obstructio alvi*, in medicine, a preternatural detention of the fæces, with an unusual dryness and hardness of them, and thence a suppression of their evacuation. See MEDICINE.

COSTS, in law. By the statute of Gloucester, 6 Ed. I. c. 1. it is provided that the demandant may recover against the tenant, the costs of his writ, together with his damage; and that this act shall hold place in all cases, when the party is to recover damages. 1 New. Abr. 511. Costs of the writ extend to all legal costs of suit, but not expences of travel, loss of time, &c. 2 Inst. 288. When double damages are given by act of parliament, the costs shall be doubled also; for damages include costs. Str. 1048. Persons suing *in forma pauperis*, shall not pay costs. 3 Black. 400.

If it is an action, wherein there can be no such certifying, as debt, assumpsit, trover, trespass for taking goods, trespass for spoiling goods, trespass for beating a servant whereby he lost his service, it is out of the statute, and the plaintiff may have full costs. Salk. 208. Where costs are allowed, it is not necessary for the jury to give them, but they may leave it to the court to do it, who are the best able to judge of what costs are fitting to be given. It is the course of the court of king's-bench, to refer the taxation of costs to the proper officer of the court, and not to make any special rules for such matters, except it be in extraordinary cases. 1 Lit. Abr. 338.

The matter of costs in equity, is not held a point of right, but merely discretionary, according to the circumstances of the case, as they appear more or less favourable to the party vanquished. 3 Black. 451. If costs be refused to be paid, an attachment lies. 1 Nels. Abr. 550. The king and any person suing to his use, shall neither pay nor receive costs. Stat. 24 H. VIII. c. 8.

The 18 Geo. III. c. 19. authorizes any justice, who shall have heard and determined the matter of a complaint made before him, to award such costs to be paid by either party and in such manner as to him shall seem meet, to the party injured: and if the person so ordered by the justice, shall not forthwith pay, or give satisfaction to the justice, the same shall be levied by distress: and if goods and chattels of such person cannot be found, the justice shall commit him to the house of correction for the place where such person shall reside; to be kept to hard labour for any time not exceeding one month, nor less than ten days; or till such sum, with the expences attending the commitment, be first paid.

Provided, that upon the conviction of any person upon a penal statute, where the penalty shall be at or exceed the sum of 5*l.* the said costs shall be deducted by the justice, at his discretion, out of the penalty, so that such deduction shall not exceed one-fifth part of the penalty; and the remainder of the penalty shall be divided among the persons who would have been entitled to the whole thereof, if this act had not been made. Costs double or treble are allowed to defendants sued for acting under almost every statute relating to officers of justice, customs or other duties, highways, paving, &c. For more matter concerning costs, see Bac. Abr. & 6 Vin. Abr. tit. Costs.

COSTUME, a term among painters: thus, a painter must observe the costume; that is, he must make every person and thing sustain its proper character; and not only observe the story, but the circumstances, the scene of action, the country or place, and make the habits, arms, manners, proportions, and the like, to correspond.

COSTUS, in botany, a genus of the monandria-monogynia class of plants, the flower of which consists of three lanceolated, concave, equal petals, placed pretty erect; the fruit is a roundish, coronated, trivalvular capsule, with three cells, containing several triangular seeds. There are three species. The root of this plant, or the costus Arabicus in pharmacy, is an attenuant, a diuretic, and a sudorific: it is given in obstructions of the menses, and in chronic cases, in which there are infractions of the viscera; its dose is from ten grains to half a dram, but we seldom hear of its being given singly. It is used in the Venice treacle, mithridate, and caryocostine electuary. Costus must be chosen recent, dense, odorous, bitterish, and not carious. It pays on importation a duty of $3\frac{87\frac{1}{2}}{100}d.$ per pound, and there is a drawback on exportation of $3\frac{40}{100}d.$

CO-TANGENT, the tangent of an arch, which is the complement of another to 90°. See TRIGONOMETRY.

COTESIAN *theorem*, in geometry, an appellation used for an elegant property of the circle discovered by Mr. Cotes. The theorem is this:

If the factors of the binomial $a^c + x^c$ be required, the index c being an integer number. With the centre O, (Plate Miscel. fig. 21,) and radius AO $= a$, describe a circle, and divide its circumference into as many equal parts as there are units in $2c$, at the points A, B, C, D, &c.; then in the radius, produced if necessary, take OP $= x$; and from the point P, to all the points of division in the circumference, draw the lines PA, PB, PC, &c.; so shall these lines taken alternately be the factors sought: viz.

PB × PD × PF &c = $a^c + x^c$,

and PA × PC × PE &c = $a^c \sim x^c$, viz. $a^c - x^c$, or $x^c - a^c$, according as the point P is within or without the circle.

For instance, if $c = 5$, divide the circumference into 10 equal parts, and the point P being within the circle, then will

$OA^5 + OP^5 = BP \times DP \times FP \times HP \times KP$,

and $OA^5 - OP^5 = AP \times CP \times EP \times GP \times IP$.

In like manner, if $c = 6$, having divided the circumference into twelve equal parts, then will

$OA^6 + OP^6 = BP \times DP \times FP \times HP \times KP \times MP$,

$OA^6 - OP^6 = AP \times CP \times EP \times GP \times IP \times LP$.

The demonstration of this theorem may be seen in Dr. Pemberton's Epist. de Cotesii Inventis. See also Dr. Smith's Theoremata Logometrica et Trigonometrica, added to Cotes's Harm. Mens. pa. 114; De Moivre Miscel. Analyt. pa. 17; and Waring's Letter to Dr. Powell, pa. 39.

By means of this theorem, the author was enabled to make a farther progress in the inverse method of fluxions, than had been done before. But in the application of his discovery there still remained a limitation, which was removed by M. Demoivre.

COTICE, or *Cotise*, in heraldry, is the fourth part of the bend; and with us seldom if ever borne but in couples, with a bend between them.

COTINUS. See RHUS.

COTTAGE, in law, a little house for habitation, without lands belonging to it, stat. 4 Edw. I. But by a later statute, 31 Eliz. c. 7, no man may build a cottage unless he lays four acres of land to it, except in cities or market-towns, or within a mile of the sea, or for the habitation of miners, sailors, foresters, shepherds, &c.; excepting also cottages erected by justices of the peace for poor impotent persons. The above four acres of land must be freehold, and land of inheritance; copyhold, or lease for years, are not sufficient tenure by the statute.

COTTON, a soft downy substance found on the gossypium, or cotton-tree. See GOSSYPIUM. Cotton is separated from the seeds of the plant by a mill, and then spun and prepared for all sorts of fine work, as stockings, waistcoats, quilts, &c. With it they likewise make callico and muslin; and sometimes it is mixed with wool, sometimes with silk, and even with gold itself. The finest sort comes from Bengal and the coast of Coromandel. Cotton makes a very considerable article in commerce, and is distinguished into cotton-wool and cotton-thread. The first is brought mostly from the West India islands, and Smyrna: the most esteemed is white, long, and soft. Those who buy it in bales should see that it has not been wet, moisture being very prejudicial to it.

Of cotton-thread, that of Damas, called cotton-d'ounce, and that of Jerusalem, called bazas, have been the most esteemed; as also that of the West Indian islands. But with the help of the machines now in general use in Britain, we are able to spin it of almost any degree of fineness. Cotton of Siam is a kind of silky cotton in the Antilles, so called because the grain was brought from Siam. It is of an extraordinary fineness, even surpassing silk in softness. They make hose of it there, preferable to silk for their lustre and beauty. They sell at from 10 to 12 and 15 crowns a pair, but there are very few made unless for curiosity.

The manner of packing cotton as practised in the Antilles is thus: The bags are made of coarse cloth, of which they take three ells and a half each; the breadth is one ell and three inches. When the bag has been well soaked in water, they hang it up, extending the mouth of it to cross pieces of timber nailed to posts, fixed in the ground seven or eight feet high. He who packs it goes into the bag, which is six feet nine inches deep, or thereabout, and presses down the cotton, which another throws in, with hands and feet; observing to tread it equally every where, and putting in but little at a time. The best time of packing is in rainy moist weather, provided the cotton is under cover. The bag should contain from 300 to 320 pounds. The tare abated in the Antilles is three in the hundred.

COTTON-*spinning*, the art or process of reducing cotton-wool into yarn or thread.

The most simple method for this purpose, and the only one in use for a long time in this country, was by the hand, upon the well-known domestic machine called a one-thread wheel. But as the demand for cotton goods began to increase, other inventions were thought of for expediting this part of the manufacture. About 60 years ago, one Paul and others of London contrived an engine for a more easy and expeditious method of spinning cotton, and for which they obtained a patent; but the undertaking did not prove successful. Some years after, various machines were constructed by different persons for facilitating the spinning of cotton, but without producing any very material or lasting advantage. At length, about the year 1767, Mr. James Hargrave, a weaver in the neighbourhood of Blackburn in Lancashire, constructed a machine by which a great number of threads (from 20 to 80) might be spun at once, and for which he obtained his majesty's letters-patent. This machine is called a jenny, and is the best contrivance for spinning woof or shoot that has hitherto appeared. It is now commonly constructed for 84 threads; and with it one person can spin 100 English hanks in the day, each hank containing 840 yards.

Carding of COTTON, as a preparation for spinning, used formerly to be performed by the hand, with a single pair of cards, upon the knee: but this being a tedious method, ill suited to the rapid operations of the new spinning-machines, other methods were contrived for affording a quicker and more adequate supply. The first improvement for this purpose was likewise made by Mr. Hargrave; and consisted in applying two or three cards to the same board, and fixing them to a stool or stock; whence they obtained the name of stock-cards. With these, one woman could perform two or three times as much work as she could do before in the common way. A still more expeditious method of carding, however, by what are commonly called cylinder-cards, was soon afterwards invented, and is that which is now most commonly practised: but as several persons lay claim to this invention, it is not easy to determine to whom in particular the merit of it is due.

The next and most capital improvements which this branch of manufacture received were from Mr. Arkwright, a native of Lancashire, afterwards sir Richard Arkwright of Cromford in Derbyshire. He first brought forward his new method of spinning cotton in 1768, for which he obtained a patent in 1769: he afterwards, in 1775, obtained a patent for engines which he had constructed to prepare the materials for spinning; though one of these patents, being challenged at law, was set aside some years before it expired. The result of Mr. Arkwright's different inventions and improvements, is a combination of machinery, by which cotton is carded, roved, and spun, with the utmost exactness and equality; and such a degree of perfection attained in spinning warp, as is not to be equalled in any other part of the world. To these improvements this country is entirely indebted for the great extent of its cotton-manufactures; large buildings having been erected for that branch both in England and Scotland, many of which contain several thousands of spindles, each driven by one or more large water-wheels; and some of such extent as to spin at the rate of one thousand yards of twist or warp-yarn in a minute.

Other machines have been invented at different times, and a variety of improvements made by different mechanics and manufacturers; one of which in particular we must not omit to mention. It is called a mule, being a kind of mixture of machinery between the warp-machine of Mr. Arkwright and the woof-machine or hand-jenny of Mr. Hargrave; and was also invented in Lancashire. This machine promises to be of great use in spinning cotton-yarn for muslins to a degree of fineness never before known in this country, being nearly equal in quality to those usually brought from India.

COTTUS, or *Bull-head*, in ichthyology, a genus belonging to the order of thoracici. The head is broader than the body, and the gill-membrane has six rays. There are six species, of which the most remarkable are: 1. The gobio, or river-bullhead, very common in all our clear brooks: it lies almost always at the bottom, either on the gravel or under a stone: it deposits its spawn in a hole which it forms among the gravel, and quits it with great reluctance. It feeds on water-insects. This fish seldom exceeds the length of three inches and a half: the head is large, broad, flat, and thin at its circumference, being well adapted for insinuating itself under stones; on the middle part of the covers of the gills is a small crooked spine turning inwards. The eyes are very small, the irides yellow; the body grows slender towards the tail, and is very smooth. The colour of this fish is as disagreeable as its form, being dusky mixed with a dirty yellow; the belly is whitish. The taste, however, is excellent. 2. The cataphractus (See Plate N. H. fig. 147) is very common on most of the British coasts. It seldom exceeds five inches and a half in length, and even seldom arrives at that size. The head is large, bony, and very rugged: the end of the nose is armed with four short upright spines; on the throat are a number of short white beards; the body is octagonal, and covered with a number of strong bony crusts divided into several compartments, the ends of which project into a sharp point, and form several echinated lines along the back and sides from the head to the tail. 3. The scorpius, or father-lasher, is not uncommon on the rocky coasts of this island; it lurks under stones, and will take a bait. It seldom exceeds 8 or 9 inches in length. The head is large, and has a most formidable appearance, being armed with vast spines, which it can oppose to any enemy that attacks it, by swelling out its cheeks and gill-

132

Coccinella septempunctata
Lady bird

133

Coffea Arabica
Coffee Tree

134

Coluber ahætula

135

Coluber argus

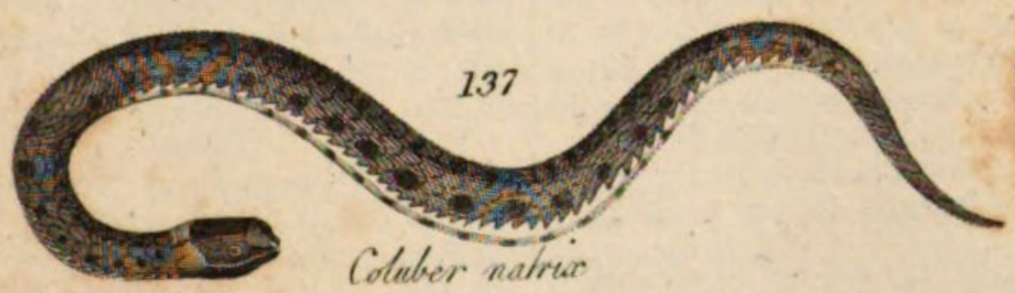
136

Coluber berus

139

Columba
Brown Indian Dove

137



Coluber natrix

138

Coluber naja

140

Conus musicus

141

Conus papilio

142

Convolvolus Jalapa
Jalap Tree

143

Corallina rubens
Red corallines

144

Corvus calvus
Bald crow

145

Coryphæna rupestris

covers to a large size. The nose and space contiguous to the eyes are furnished with short sharp spines; the covers of the gills are terminated by exceeding long ones, which are both strong and very sharp-pointed. The mouth is large, the jaws covered with very small teeth; the roof of the mouth is furnished with a triangular spot of very minute teeth. This species is very frequent in the Newfoundland seas, where it is called scolping: it is also as common on the coast of Greenland, in deep water near the shore. It is a principal food of the natives, and the soup made of it is said to be agreeable as well as wholesome.

COTULA, *may-weed;* a genus of the polygamia superflua order, in the syngenesia class of plants. The receptacle is almost naked; the pappus marginated; the florets of the disc quadrifid, of the radius frequently none. There are 15 species, most of them herbaceous annuals, rising six or eight inches high, and adorned with yellow flowers. None of them are natives of this country, and most of them require artificial heat.

COTULA, or *Cotyla*, in antiquity, a liquid measure among the Greeks, equal to the hemina of the Romans, containing half a sextary, or four acetabula: hence it appears that it contained ten ounces of wine, and nine of oil. It is observed that the cotula was used as a dry measure as well as a liquid one, from the authority of Thucydides, who in one place mentions two cotulæ of wine, and in another two cotulæ of bread.

COTYLEDON, *navel-wort;* a genus of the pentagynia order in the decandria class of plants; and in the natural method ranking under the 13th order, succulentæ. The calyx is quinquefid; the corolla monopetalous: there are five nectariferous scales at the base of the germen, and five capsules. There are nineteen species, most of them succulent perennials for the green-house; though some require to be kept in a stove. They rise from half a foot to a yard and a half high, and are adorned with yellow flowers growing in umbels. They are easily propagated, either by seed or cuttings of their branches.

COUCH, in painting, a term used for each lay or impression of colour, either in oil or water, with which the painter covers his canvas, wall, wainscot, or other matter to be painted. The word is also used for a lay or impression on any thing, to make it more firm and consistent, or to screen it from the weather. Thus, paintings are covered with a couch of varnish; a canvas to be painted must have two couches of size, before the colours are laid on; two or three couches of white lead are laid on wood, before the gold is applied. The leather-gilders lay a couch of water and whites of eggs on the leather, before they apply the gold or silver leaf. The gold wire-drawers also use the word couch for the gold or silver leaf, wherewith they cover the mass to be gilded or silvered. The gilders use the term couch, for the quantity of gold and silver leaves applied on the metals in gilding and silvering. It is often vulgarly pronounced coat.

COUCHANT, in heraldry, is understood of a lion, or other beast, when lying down, but with his head raised; which distinguishes the posture of couchant from dormant, wherein he is supposed quite stretched out and asleep.

COUCHE', in heraldry, denotes any thing lying along: thus, chevron couché is a chevron lying sideways, with the two ends on one side of the shield, which should properly rest on the base.

COUCHING *of a cataract*, in surgery, one of the two chief methods of curing a cataract, by couching with the needle. See SURGERY.

COVENANT, the agreement or consent of two or more by deed in writing, sealed and delivered; whereby either, or one of the parties, promises to the other, that something is done already, or shall be done afterwards: he that makes the covenant, is called the covenantor, and he to whom it is made the covenantee. Shep. Touch. 160.

A covenant is generally either in fact, or in law. In fact, is that which is expressly agreed between the parties, and inserted in the deed. In law, is that covenant which the law intends and implies, though it be not expressed in words; as if a lessor demise and grant to his lessee, an house or lands for a certain term, the law will intend a covenant on the lessor's part, that the lessee shall, during the term, quietly enjoy the same against all incumbrances. 1 Inst. 384.

COVENANT TO STAND SEISED TO USES, is when a man that has a wife, children, brother, sister, or kindred, by covenant in writing under hand and seal agrees, that for their, or any of their provision or preferment, he or his heirs, will stand seised of land to their use, either in fee-simple, fee-tail, or for life.

CO-VERSED SINE, in geometry, the remaining part of the diameter of a circle, after the versed sine is taken from it. See TRIGONOMETRY.

COVERT WAY, or *Corridor*, in fortification, a space of ground, level with the field, on the edge of the ditch, three or four fathoms broad, ranging quite round the half-moons, and other works toward the country. It has a parapet raised on a level, together with its banquets and glacis. The greatest effort in sieges, is to make a lodgment on the covert-way, because the besieged usually palisade it along the middle, and undermine it on all sides.

COVERTURE, in law, is applied to the condition of a married woman, who by the laws of this realm is sub potestate viri, and therefore disabled to make bargain with any, to the prejudice of herself or her husband, without his assent and privity, or at least without his allowance and confirmation.

COUGH, *tussis*, in medicine, a convulsive motion of the diaphragm, muscles of the larynx, thorax, and abdomen, violently shaking, and expelling the air that was drawn into the lungs by inspiration. See MEDICINE.

COVIN, is a deceitful assent or agreement between two or more, to the prejudice of another. As if a tenant for term of life, or tenant in tail, will secretly conspire with another, that the other will recover against the tenant for life, the lands which he holds, &c. in prejudice of him in the reversion.

COULTER, in husbandry, an iron instrument, fixed in the beam of a plough, and serving to cut the edge of each furrow.

COUNCIL, *Common*, in the city of London, is a court wherein are made all bye-laws which bind the citizens. It consists, like the parliament, of two houses: an upper, composed of the lord-mayor and aldermen; and a lower, of a number of common-councilmen chosen by the several wards, as representatives of the body of the citizens.

COUNCIL, *Privy*, the executive part of the civil government of Great Britain. It is composed of eminent persons, the number of whom is at the sovereign's pleasure, who are bound by oath to advise the king to the best of their judgment, with all the fidelity and secrecy that becomes their station. The king may declare to, or conceal from, his privy-council whatever he thinks fit; and has a select council out of their number commonly called the cabinet-council, (generally the principal officers of state) with whom his majesty determines such matters as are most important, and require the utmost secrecy. All proclamations from the king and the privy-council ought to be grounded on law, otherwise they are not binding to the subject. Privy-counsellors, though but gentlemen, have precedence of all the knights and younger sons of barons and viscounts, and are styled right honourable.

COUNCIL *of war*, an assembly of the principal officers of an army or fleet, occasionally called by the general or admiral to concert measures for their conduct with regard to sieges, retreats, engagements, &c.

COUNCIL, in church-history, an assembly of prelates and doctors, met for the regulating matters relating to the doctrine, or discipline, of the church.

COUNCIL, *œcumenical* or *general*, is an assembly which represents the whole body of the universal church. The Romanists reckon eighteen of them; Bullinger, in his treatise de Conciliis, six; Dr. Prideaux, seven; and bishop Beveridge has increased the number to eight, which, he says, are all the general councils which have ever been held since the time of the first christian emperor. They are as follows: 1. The council of Nice, held in the reign of Constantine the Great, on account of the heresy of Arius. 2. The council of Constantinople, called under the reign and by the command of Theodosius the Great, for much the same end that the former council was summoned. 3. The council of Ephesus, convened by Theodosius the Younger, at the suit of Nestorius. 4. The council of Chalcedon, held in the reign of Martianus, which approved of the Eutychian heresy. 5. The second council of Constantinople, assembled by the emperor Justinian, condemned the three chapters taken out of the books of Theodorus of Mopsuestia, having first decided that it was lawful to anathematize the dead. Some authors tell us, that they likewise condemned the several errors of Origen about the Trinity, the plurality of worlds, and the pre-existence of souls. 6. The third council of Constantinople, held by the command of Constantine Pogonatus the emperor, in which they received the definitions of the first five general councils, and particularly that against Origen and Theodorus of Mopsuestia. 7. The second Nicene council. 8. The fourth council of Constantinople, assembled when Lewis II. was emperor of the West. The regulations which they made are contained in twenty-seven canons.

COUNSEL, *for prisoners*. The judges never scruple to allow a prisoner counsel, to instruct him what questions to ask, or even to ask questions for him with respect to matters of fact; for as to matters of law, arising on the

trial, they are entitled to the assistance of a counsel. 4 Black. 335.

COUNSELLOR, or COUNSEL, one retained by a client, to plead his cause in a court of judicature. A counsellor in law retained, has a privilege to enforce any thing which he is informed of by his client, and to give it in evidence, it being pertinent to the matter in question, and not to examine whether it is true or false; but it is at the peril of him who informs him; for a counsellor is at his peril to give in evidence, that which his client informs him, being pertinent to the matter in question, otherwise action upon the case lies against him by his client. Cro. Jac. 90.

The fees to counsellors are not in the nature of wages or pay, or that which we call salary or hire; which are duties certain, and grow due by contract for labour or service; but what is given them, is honorium, not merces; being a gift, which gives honour as well to the taker as the giver: nor is it certain or contracted; for no price or rate can be set upon counsel, which is invaluable and inestimable, so as it is more or less according to the circumstances, namely, the ability of the client, the worthiness of the counsellor, the weightiness of the cause, and the custom of the country. It is a gift of such a nature, that the able client may not neglect to give it, without ingratitude, for it is but a gratuity or token of thankfulness: yet the worthy counsellor may not demand it without doing wrong to his reputation. Præf. to Dav. Rep. 22, 23.

COUNT, *comes*, a nobleman who possesses a domain erected into a county. The dignity is a medium between that of a duke and a baron. See EARL. Counts were originally lords of the court, or of the emperor's retinue, and had their name comites a comitando. Eusebius tells us, that Constantine divided them into three classes: of the two first the senate was composed: those of the third had no place in the senate, but enjoyed several other privileges of senators. There are counts that served on land, others at sea; some in a civil, and some in a legal capacity. The quality of count is now no more than a title which a king grants upon erecting a territory into a county, with a reserve of jurisdiction and sovereignty to himself. A count has a right to bear on his arms a coronet adorned with three precious stones, and surmounted with three large pearls, whereof those in the middle and extremities of the coronet advance above the rest.

COUNT, in law, signifies the original declaration of complaint in a real action, as a declaration is in a personal one.

COUNT-WHEEL, in the striking part of a clock, a wheel which moves round once in twelve or twenty-four hours.

COUNTER-APPROACHES, in fortification, lines and trenches made by the besieged in order to attack the works of the besiegers, or to hinder their approaches.

COUNTER-APPROACH, *line of*, a trench which the besieged make from their covered way to the right and left of the attacks, in order to scour the enemies' works. This line must be perfectly enfiladed from the covered way and the half-moon, that it may be of no service to the enemy, in case he gets possession of it.

COUNTER-BATTERY, is a battery raised to play upon another to dismount the guns.

COUNTER-BOND, a bond of indemnification given to one who has given his bond as a security for another's payment of a debt, or the faithful discharge of his office or trust.

COUNTER-CHARGED, in heraldry, is when any field or charge is divided or parted by any line or lines of partition, consisting all interchangeably of the same tinctures.

COUNTER-DEED, a secret writing either before a notary or under a private seal, which destroys, invalidates, or alters, a public one.

COUNTERFEITS, in our law, are persons that obtain any money or goods by counterfeit letters or false tokens; who, being convicted before justices of assize or of the peace, &c. are to suffer such punishment as shall be thought fit to be inflicted under death, as imprisonment, pillory, &c.

COUNTER-FACED, or CONTRE-FACE', in heraldry, is the same that we call barry per pale counterchanged; but then the number of panes into which the field is divided, is always specified.

COUNTER-FOIL, or COUNTER-STOCK, in the exchequer, that part of a tally which is kept by an officer of the court.

COUNTER-FORTS, spurs or buttresses serving as props to a wall subject to bulge or be thrown down.

COUNTER-FUGUE, a fugue in which the subjects move in contrary directions.

COUNTER-GAGE, in carpentry, a method used in measuring the joints. For example, they transfer the breadth of a mortis to the place in the timber where the tenon is to be, in order to make them fit each other.

COUNTER-GUARD, in fortification, is a work raised before the point of a bastion, consisting of two long faces parallel to the faces of the bastion, making a saliant angle: they are sometimes of other shapes, or otherwise situated.

COUNTERMAND, in the English law, is where a thing before executed is by some act or ceremony afterwards made void by the party that did it.

COUNTERMARCH, in military affairs, a change of the face or wings of a battalion, by which means those that were in the front come to be in the rear. It also signifies returning or marching back again.

COUNTER-MARK, a mark put upon goods that have been marked before. It is also used for the several marks put upon goods belonging to several persons, to shew that they must not be opened but in the presence of them all or their agents. In goldsmith's work, the counter-mark is the mark punched upon the work at the hall, to shew that the metal is standard.

Counter-mark of a medal is a mark added to it a long time after its being struck. It is sometimes an emperor's head, sometimes a cornucopia, &c. Counter-marks are distinguished from the monograms in this, that being struck after the medal, they are indented; whereas the monograms being struck at the same time with the medals, have a little relievo.

COUNTER-MINE, in war, a well and gallery driven and sunk till it meets the enemy's mine, to prevent its effect.

COUNTER-PALED, *contre-pallé*, in heraldry, is when the escutcheon is divided into 12 pales parted per fesse, the two colours being counterchanged; so that the upper are of one colour, and the lower of another.

COUNTER-PART, in music, denotes one part to be applied to another. Thus the bass is said to be a counterpart to the treble. In law, it is the duplicate or copy of any indenture or deed.

COUNTER-PASSANT, is when two lions are in a coat of arms, and the one seems to go quite the contrary way from the other.

COUNTER-PLEA, in law, a cross or contrary plea; particularly such as the demandant alleges against a tenant in courtesy or dower, who prays the king's aid, &c. for his defence.

COUNTERPOINT, in music, the act of combining and modulating consonant sounds. This branch of musical practice derives its name from the points formerly employed in composition instead of notes, and may be understood point against point, or note against note. This was the primitive state of counterpoint, which has since been called plain or simple counterpoint, in contradistinction to the modern figured or florid counterpoint, in which, for the purpose of beautifying the melody and enriching the general effect, many notes in succession are frequently set in one part against a single note in another.

COUNTER-QUARTERED, in heraldry, denotes the escutcheon, after being quartered, to have each quarter again divided into two.

COUNTER-SALIENT, is when two beasts are borne in a coat leaping from each other directly the contrary way.

COUNTERSCARP, in fortification, is properly the exterior talus or slope of the ditch; but it is often taken for the covered way and the glacis. In this sense we say, the enemy have lodged themselves on the counterscarp.

COUNTERSCARP, *angle of the*, is that made by the two sides of the counterscarp, meeting before the middle of the curtin.

COUNTERSIGNING, the signing the writing of a superior in quality of secretary. Thus charters are signed by the king, and countersigned by a secretary of state or lord chancellor.

COUNTER-SWALLOWTAIL, in fortification, an outwork in form of a single tenaille, wider at the gorge than the head.

COUNTER-TENOR, high tenor, a term applied to the highest natural male voice.

COUNTER-TRIPPING, is when two beasts are borne in a coat in a walking posture, the head of the one being next the tail of the other.

COUNTERS *in a ship*, are two. 1. The hollow arching from the gallery to the lower part of the straight piece of the stern, is called the upper counter. 2. The lower counter is between the transom and the lower part of the gallery.

COUNTY, in geography, originally signified the territory of a count or earl, but now it is used in the same sense with shire, and contains a circuit or portion of the realm, into which the whole land is divided, for the better government of it, and the more easy administration of justice; so that there is no part of this nation which is not within some county; and every county is governed by an annual officer, whom we call a sheriff. Fortescue, c. 24. See SHERIFF.

COUNTIES *palatine*, are those of Chester, Durham, and Lancaster. Of these

three, the county of Durham is now the only one remaining in the hands of a subject; for the earldom of Chester was united to the crown by king Henry III. and has ever since given title to the king's eldest son. And the county-palatine or duchy of Lancaster, in the reign of king Henry IV., was by act of parliament vested in the king, and his heirs, kings of England, for ever. 1 Black. 118.

There is a court of chancery in the counties-palatine of Lancaster and Durham, over which there are chancellors; that of Lancaster called the chancellor of the duchy: and there is a court of exchequer at Chester, of a mixed nature, for law and equity, of which the chamberlain of Chester is judge. There are also a chief justice of Chester, and other justices in the other counties-palatine, to determine civil actions and pleas of the crown. In all of these the king's ordinary writs are of no force; and the judges of assize, who sit within these franchises, sit by virtue of a special commission from the owners thereof, and under the seal thereof, and not by the usual commission under the great seal of England. 3 Black. 79.

COUNTY-CORPORATE, a title given to several cities on which the English monarchs have thought proper to bestow extraordinary privileges, annexing to them a particular territory of land or jurisdiction; as the county of Middlesex annexed to the city of London, the county of the city of York, the county of the city of Bristol, &c.

COUNTY-COURT. This was formerly a court of great dignity and splendour; the bishop and the earl, with the principal gentlemen of the shire, sitting therein to administer justice, both in lay and ecclesiastical causes. But its dignity was much impaired when the bishop was prohibited, and the earl neglected, to attend it: and in modern times, as the proceedings are removable hence into the king's superior courts, by writ of pone or recordare, this has occasioned the business of the county-court in a great measure to decline.

By the 2d and 3d Edw. VI. c. 25, no county-court shall be longer deferred than one month from court to court; so that the county-court shall be kept every month, and not otherwise; and only 28 days shall be reckoned to the month. 2 Inst. 74. And it may be kept at any place within the county, unless restrained by statute. Wood, c. 4. c. 1.

The suitors, that is, the freeholders, are the judges of this court; except that in re-disseisin, by the statute of Merton, the sheriff is judge.

The jury in this court ought to be freeholders; but the quantum of their estate is not material.

This court shall hold pleas between party and party, where the debt or damage is under 40*s*. 4 Inst. 266. But in replevin the sum may exceed 40*s*. Id.

It has not cognizance of trespass *vi et armis*, because a fine is thereby due to the king, which it cannot impose. Id. But by virtue of a writ of justices, the court may hold plea of trespass *vi et armis*, and of any sum, or of all actions personal above 40*s*. Id.

Causes may be removed from this court by a writ of recordare, issuing out of the chancery, directed to the sheriff, commanding him to send the plaint that is before him in his county-court (without writ of justicies) into the court of king's bench or common pleas, to the end that the cause may be there determined; whereupon the sheriff is to summon the other party to be in that court (into which the plaint is to be sent) at a day certain; and he is to make certificate of all this under his own seal, and the seal of four suitors of the same court. Read, County-court.

Causes may also be removed by pone, which differs in nothing from a recordare, except that it removes such suits as are before the sheriff by writ of justicies, and a recordare is to remove the suit that is by plaint only, without a writ. Id. And though the plea be discontinued in the county, yet the plaintiff or defendant may remove the plaint into the common pleas or king's bench, and it shall be good, and he shall declare upon the same. Id.

COUNTY-RATE. By the 12th Geo. II. c. 29. the justices at their general or quarter sessions, or the greater part of them (and by 13 Geo. II. c. 18. justices of liberties and franchises not subject to county-commissioners), shall have power to make one general county-rate, to answer all former distinct rates, which shall be assessed on every parish, &c. and collected and paid by the high constables of hundreds to treasurers appointed by the justices, which money shall be deemed the public stock, &c.: but appeal lies by the churchwardens and overseers against the rate of any particular parish. 22 Geo. III. c. 17. This rate is,—

For the repairing of bridges and highways thereto adjoining, and salaries for the surveyors of bridges; for building and repairing county-gaols; for repairing shire-halls; for the salary of the master of the house of correction, and relieving the weak and sick in his custody; for the relief of the prisoners in the king's bench and marshalsea prisons, and of poor hospitals in the county, and of those who shall sustain losses by fire, water, the sea, or other casualties, and other charitable purposes for the relief of the poor, as the justices in sessions shall think fit; for the relief of the prisoners in the county-gaol; for the preservation of the health of the prisoners; for the salary of the chaplain of the county-gaol; for setting prisoners to work; for salary of persons making returns of the prices of corn; for charges attending the removal of any of the said general county-rates by certiorari; for money for purchasing lands at the ends of county-bridges; for charges of rebuilding or repairing houses of correction, and for fitting up and furnishing the same, and employing the persons sent thither; for charges of apprehending, conveying, and maintaining, rogues and vagabonds; for charges of soldiers' carriages over and above the officers' pay for the same, by the several yearly acts against mutiny and desertion, and by the militia act; for the coroner's fee of 9*d*. a mile for travelling to take an inquisition, and 20*s*. for taking it; for charges of carrying persons to the gaol or house of correction; for the gaoler's fees for persons acquitted of felony or discharged by proclamation; for charges of prosecuting and convicting felons; for charges of prosecuting and convicting persons plundering shipwrecked goods; for charges of maintaining the militia-men's families by the several militia acts; for charges of bringing insolvent debtors to the assizes, in order to their discharge, if themselves are not able to pay; for the charges of transporting felons, or conveying them to the places of labour and confinement; for charges of carrying parish apprentices, bound to the sea service, to the port to which the master belongeth.

By the 12th Geo. II. c. 29, the churchwardens and overseers shall, in 30 days after demand made, out of the money collected for relief of the poor, pay the sums so assessed on each parish or place: and if they shall neglect or refuse so to pay, the high-constable shall levy the same by distress and sale of their goods, by warrant of two or more justices residing in or near such parish or place. Where there is no poor-rate, the justices, in their general or quarter sessions, shall by their order direct the sum assessed on such parish, township, or place, to be rated and levied by the petty constable or other peace-officer, as money for the relief of the poor is by law to be rated or levied. The high-constables, at or before the next session respectively after they have received the money, shall pay the same to the treasurer; and the money so paid shall be deemed the public stock: and the said high-constables shall deliver in a true account on oath (if required) of the money by them received, before the said justices at their general or quarter sessions. The treasurer shall pay so much of the money in his hands to such persons, as the justices in session shall from time to time appoint, for any uses and purposes to which the public stock of any county, city, division, or liberty, is or shall be applicable; and shall deliver in a true account on oath (if required) of his receipts and disbursements to the justices at every general or quarter session, and also the proper vouchers for the same, to be kept amongst the records of the sessions: and the discharge of the said justices, by their order at their general or quarter session, shall be a sufficient discharge to the treasurer: and no new rate shall be made until it appears by the treasurer's accounts or otherwise, that three-fourths of the money collected has been expended for the purposes aforesaid. If the churchwardens and overseers of any parish or place shall think such parish or place is overrated, they may appeal to the next general or quarter session.

COUP-DE-MAIN, in military affairs, implies a desperate resolution in all small expeditions of surprise, &c. The favourable side of the proposed action must ever be viewed; for if what may happen, arrive, or fall out, is chiefly thought upon, it will at the very best, not only greatly discourage, but in general it will produce a total failure. The very name of an expedition implies risk, hazard, precarious warfare, and a critical but desperate operation or coup-de-main.

COUP-*d'œil*, in a military sense, signifies that fortunate aptitude of eye in a general or other officer, by which he is enabled at one glance on the map to see the weak parts of an enemy's country, or to discern the strong ones of his own. By possessing a ready coup-d'œil, a general may surmount the greatest difficulties, particularly in offensive operations. On a small scale this faculty is of the greatest utility. Actions have been

recovered by a sudden conception of different openings upon the enemy, which could only be ascertained by a quick and ready eye, during the rapid movements of opposing armies.

COUPED, *coupé*, in heraldry, is used to express the head or any limb of an animal cut off from the trunk smooth; distinguishing it from that which is called erased, that is, forcibly torn off, and therefore is ragged and uneven.

COUPED is also used to signify such crosses, bars, bends, chevrons, &c. as do not touch the sides of the escutcheon, but are, as it were, cut off from them.

COUPLE-CLOSS, in heraldry, the fourth part of a chevron, never borne but in pairs, except there is a chevron between them.

COUPURE, in fortification, are passages sometimes cut through the glacis, of about 12 or 15 feet broad, in the re-entering angle of the covert-way, to facilitate the sallies of the besieged. They are sometimes made through the lower curtin, to let boats into a little haven built on the rentrant angle of the counterscarp of the outworks.

COURAP, the modern name for a distemper very common in Java and other parts of the East Indies. It is a sort of herpes or itch on the arm-pits, groins, breast, and face: the itching is almost perpetual; and the scratching is followed by great pain and a discharge of matter, which makes the linen stick so to the skin as not easily to be separated without tearing off the crust. Courap is a general name for any sort of itch; but this distemper is thus called by way of eminence. It is so contagious that few escape it. For the cure, gentle and repeated purging is used, and externally the ointment of nitrated quicksilver.

COURSE, in navigation, the point of the compass or horizon which a ship steers on, or the angle which the rhumb-line on which it sails makes with the meridian; being sometimes reckoned in degrees, and sometimes in points of the compass.

When a ship sails either due north or south, she sails on a meridian, makes no departure, and her distance and difference of latitude are the same.

When she sails due east or west, her course makes right-angles with the meridian, and she sails either upon the equator or a parallel to it; in which case she makes no difference of latitude, but her distance and departure are the same.

But when the ship sails between the cardinal points, on a course making always the same oblique angle with the meridians, her path is then the loxodromic curve, being a spiral cutting all the meridians in the same angle, and terminating in the pole.

COURSE, in architecture, a continued range of stones, level or of the same height throughout the whole length of the building.

COURSES, in a ship, the mainsail and foresail: when the ship sails under them only, without lacing on any bonnets, she is then said to go under a pair of courses. To sail under a main course and bonnets, is to sail under a mainsail and bonnet.

COURT. A court is defined to be a place appropriated to the judicial administration of justice. The law has appointed a considerable number of courts, some with a more limited, others with a more extensive, jurisdiction; some of these are appropriated to enquire only, others to hear and determine; some to determine in the first instance, others upon appeal and by way of review.

The most general division of our courts is into such as are of record, or not; those of record are again divided into such as are supreme, superior, or inferior.

The supreme court of this kingdom is the high court of parliament, consisting of the king, lords, and commons, who are vested with a kind of omnipotence in making new laws, and repealing and reviving old ones; and on the right balance of these depends the very being of our constitution.

Superior courts of record are again those that are more or less principal: the more principal ones are the lords' house in parliament, the chancery, king's bench, common pleas, and exchequer: the less principal ones are such as are held by commission of gaol-delivery, oyer and terminer, assize, nisi prius, &c. by custom or charter, as the courts of the palatine of Lancaster, Chester, Durham; or by virtue of acts of parliament, as the court of sewers, justices of the peace, &c.

The inferior courts of record, as ordinarily so called, are corporation courts, courts-leet, and sheriff's torn, &c.

Courts not of record, are the courts-baron, county-courts, hundred-courts, &c. Also the admiralty and ecclesiastical courts, which are not courts of record, but derive their authority from the crown, and are subject to the controul of the king's temporal courts where they exceed their jurisdiction. All these are bounded and circumscribed by certain laws and stated rules, to which in all their proceedings and judicial determinations they must square themselves. Hale's An. 35.

And here it may be proper to observe, that where a statute prohibits a thing, and appoints that the offence shall be heard and determined in any of the king's courts of record, it can be proceeded against only in one of the courts of Westminster-hall. Dyer, 236.

Every court of record is the king's court, though the profits may be another's; if the judges of such courts err, a writ of error lies; the truth of its records shall be tried by the records themselves, and there shall be no averment against the truth of the matter recorded. Co. Lit. 17. All such courts are created by act of parliament, letters patent, or prescription; and every court, by having power given it to fine and imprison, is thereby made a court of record, the proceedings of which can only be removed by writ of error or certiorari. Co. Lit. 260.

A court that is not a court of record, cannot impose any fine on an offender, nor award a capias against him, nor hold plea of debt or trespass, if the debt or damages amount to 40*s.*; nor of trespass done *vi et armis*, though the damages are laid to be under 40*s.*

COURT-BARON, is a court which every lord of the manor (antiently called the barons) has within his own precincts. This court is an inseparable ingredient of every manor; and if the number of the suitors should so fail as not to leave sufficient to make a jury or homage, that is, two tenants at the least, the manor itself is lost. 2 Black. 90.

The court-baron is of two natures: the one is a customary court, appertaining to the copyholders or other customary tenants, and of this the lord or his steward is the judge; the other is a court of common law, and is before the freeholders who owe suit and service to the manor, the steward being rather register than judge.

The copyholders' or customary court, is for grants and admittances upon surrenders and descents, on presentment of the homage or jury. The homage may enquire of the death of tenants after the last court, and who is the next heir; of fraudulent alienation of lands, to defeat the lord of his profits; of rent or service withdrawn; of escheats and forfeitures; of cutting down trees without licence or consent; of suit not performed at the lord's mill; of waste by tenant for life; of surcharge of common; of trespass in corn, grass, meadow, woods, hedges; of pond-breach; of removing mere-stones and land-marks; of by-laws not observed, and the like. The method of punishment is by amercement.

COURT *of chancery*. See CHANCELLOR, and CHANCERY.

COURT *of chivalry*, otherwise called the marshal court, the judges of which were the lord constable of England and the earl marshal of England; but since the extinguishment of the hereditary office of constable in the reign of Henry VIII. this court has been holden before the earl marshal only; and if it exceed its jurisdiction, it may be prohibited by the common law courts. 2 Haw. 602. It seems at this day to have a jurisdiction as to disputes concerning precedency and points of honour and satisfaction therein; and may proceed against persons for falsely assuming the name and arms of honourable persons. 2 Haw. 11. This court is to be governed by its own usages, as far as they go, and in other cases by the civil law; but since it is no court of common law, no condemnation in it causes any forfeiture of lands or corruption of blood; neither can an error in it be remedied by a writ of error, but only by appeal to the king; yet the judges of the common law take notice of its jurisdiction, and give credit to a certificate of its judges.

COURT *christian*, so called because, as in secular courts, the king's laws sway and decide causes, so in ecclesiastical courts, the laws of Christ should rule and direct; for which cause the judges in these courts are divines, as archbishops, bishops, archdeacons, &c.

COURT *of common pleas*. See COMMON PLEAS.

COURT *of delegates*, is the highest court for civil affairs that concern the church. See DELEGATES.

COURTS, *ecclesiastical*, are those courts which are held by the king's authority, as supreme governor of the church, for matters which chiefly concern religion. As to suits in spiritual or ecclesiastical courts, they are for the reformation of manners; as, for punishing of heresy, defamation, laying violent hands on a clerk, and the like; and some of their suits are to recover something demanded, as tithes, a legacy, contract of marriage, &c.; and in cases of this nature, the court may give costs, but not damages. The proceedings in the ecclesiastical courts are ac-

cording to the civil and canon law: they are not courts of record.

COURT *of exchequer*. See EXCHEQUER.

COURT *of hustings*, the highest court of record holden at Guildhall, for the city of London, before the lord mayor and aldermen, the sheriffs, and recorder. 4 Inst. 247. This court determines all pleas, real and mixed; and here all lands, tenements, and hereditaments, rents, and services, within the city of London and suburbs of the same, are pleadable in two hustings; one called hustings of the plea of lands, and the other hustings of the common pleas. In the hustings of plea of lands are brought writs of right patent, directed to the sheriffs of London. In the hustings of common pleas are pleaded writs ex gravi querela, writs of gravelet, of dower, waste, &c. If an erroneous judgment be given in the hustings, the party grieved may sue a commission out of chancery, directed to certain persons, to examine the record, and thereupon do right.

COURT *of king's bench*. See KING'S BENCH.

COURT *of the legate*, was a court obtained by cardinal Wolsey of pope Leo X. 9 Hen. VIII. wherein he had power to prove wills, and dispense with offences against the spiritual laws, &c. This court was, however, of short continuance.

COURT *of marshalsea*. See MARSHALSEA.

COURT *martial*, is a court for punishing the offences of officers and soldiers in time of war. See 22, 29, and 32 Geo. II. c. 3, 6, 25, and 34.

COURT *of nisi prius*. See NISI PRIUS.

COURT *of peculiars*, a spiritual court, held in such parishes as are exempt from the jurisdiction of the bishops, and are peculiarly belonging to the archbishop of Canterbury, in whose province there are 57 such peculiars.

COURT *of piepowder*, a court held in fairs to do justice to buyers and sellers, and for redress of disorders committed in them; so called because they are most usual in summer, when the suitors to the court have dusty feet; and from the expedition in hearing causes proper thereunto, before the dust goes off the feet of the plaintiff and defendant. The court of piepowder may hold plea of a sum above 40*s*. The steward before whom the court is held is the judge, and the trial is by merchants and traders in the fair; and the judgment against the defendant shall be, quod amercietur. If the steward proceeds contrary to the statute 17 Edw. IV. he shall forfeit 5*l*.

COURT *of requests*, was a court of equity, of the same nature with the court of chancery, but inferior to it. This court having assumed great power to itself, so that it became burthensome, Mich. anno 40 and 41 Eliz. in the court of common pleas, it was upon solemn argument adjudged, that the court of requests was no court of judicature, &c.; and by the statute 16 and 17 Char. I. c. 10, it was taken away. 4 Inst. 97.

By 41 Geo. III. c. 14, for extending the powers of the court of requests within the city of London, all debts amounting to less than 5*l*. due from any person within the jurisdiction of the city, are to be exclusively sued for and recovered. Two aldermen, and not less than twenty inhabitants, householders of the several wards and districts, are appointed commissioners, and sit in rotation. The process is by summons; and the commissioners have power to award payment by such instalments as are consistent with the circumstances and ability of the debtor. In this court an attorney's privilege is of no avail.

COURT *of the lord steward of the king's household*. The lord steward, or, in his absence, the treasurer and comptroller of the king's house, and steward of the marshalsea, may inquire of, hear and determine, in this court, all treasons, murders, manslaughters, bloodsheds, and other malicious strikings, whereby blood shall be shed, in any of the palaces and houses of the king, or in any other house wherein his royal person shall abide.

COURTS *of universities*. These courts are called the chancellor's courts, and are kept by the vice-chancellors of Oxford and Cambridge. Their jurisdiction extends to all causes ecclesiastical and civil (except for maihem, felony, and relating to freehold) where a scholar, servant, or minister of the universities, is one of the parties to the suit. They proceed in a summary way, according to the practice of the civil law; and the judges in their sentences follow the justice and equity of the civil law, or the laws, statutes, and customs of the universities, or the laws of the land, at their discretion. If any erroneous judgment be given in these courts, appeal lies to the congregation; thence to the convocation; and thence to the king in chancery by his delegates.

COURTS *of Wales*. By 34 and 35 Hen. VIII. c. 26, it is enacted, that there shall be a court of great session kept twice in every year in each of the twelve counties of Wales; and the justices of those courts may hold pleas of the crown in as large a manner as the king's bench, &c.; and also pleas of assize, and all other pleas and actions real and personal, in as large a manner as the common pleas, &c.

Writs of error shall lie from judgments in this great session, it being a court of record to the court of king's bench at Westminster. But the ordinary original writs of process from the king's courts at Westminster do not run into the principality of Wales, though process of execution does, as do also prerogative writs.

COURTESY, or CURTESY *of England*, a certain tenure whereby a man marrying an heiress seized of lands of fee simple or fee tail general, or seized as heir of the tail special, and having a child by her that comes alive into the world, though both it and his wife die forthwith, yet if she was in possession, he shall keep the land during his life, and is called *tenant per legem Angliæ*, or tenant by the courtesy of England; because this privilege is not allowed in any country except Scotland, where it is called *curialitas Scotiæ*.

COUSU, in heraldry, signifies a piece of another colour or metal placed on the ordinary, as if it were sewed on, as the word imports.

COVERT, in heraldry, denotes something like a piece of hanging, or a pavilion, falling over the top of a chief or other ordinary, so as not to hide but only to be a covering to it.

COWARD, in heraldry, a term given to a lion borne in an escutcheon with his tail doubled or turned in between his legs.

COWL, or COUL, a habit worn by the Bernardins and Benedictines, of which there are two kinds: one white, very large, worn in ceremonies; the other black, worn on ordinary occasions in the streets, &c.

CRAB, in zoology. See CANCER.

CRAB'S-CLAWS. See MATERIA MEDICA.

CRAB'S-EYES. See MATERIA MEDICA.

CRAB, or GIN, an engine used for mounting large guns on their carriages, &c. It is composed of three long and stout legs, meeting together at their tops; these legs are round poles of about 12 or 13 feet long, whose diameters at the lower end are about four inches, five just below the roller besides the cheeks that are added to them in that place, and about three inches and a half above.

Two of these poles can be fixed at a certain distance from each other, by means of two iron bars placed horizontally, one being about four feet long, the other about seven; and a roller is made to run upon pivots turning on, or in, these two poles: this roller is commonly seven inches and three-fourths in diameter, and six feet long. A portion of twenty inches is left square at each end, and holes made in each to receive the handspikes by which the men turn the roller: but the middle part is made cylindrical, to wind the cable upon. The transverse iron bars are fixed with one end to one of the poles by means of a bolt, and with the other end to the other pole with a bolt and key; so as to be readily taken out, in order that when the gin is to be removed from place to place the poles may lie close together upon the carriage. There are two iron bands and two iron bolts to fasten each cheek (for the pivots) to the poles, and iron plates round the poles where the iron bars are fixed. The poles are hooped at each end; and the upper ends have straps through which an iron bolt passes: this bolt keeps the upper ends together, as well as serves to support the iron to which the windlass is hooked. The windlass contains two brass pulleys, about which the cable goes, which is fixed to the dolphins of the gun or mortar with another windlass, containing two brass pulleys likewise. When this machine is used, the whole is laid flat on the ground, the lower end of the single pole extending the contrary way, in order to fasten the upper windlass when the cable has been turned round both: after this the upper end is raised gradually till the feet of the three poles (each of which has an iron prong) stand nearly at equal distances; in such a manner as the legs of a theodolite, or plain table, when set up for use in the practice of surveying.

CRADLE, in surgery, a case in which a broken leg is laid after being set.

CRADLE, among shipwrights, a timber frame made along the outside of a ship, for the convenience of launching her with ease and safety. See Plate Miscel. fig. 22.

CRAFT, in the sea-language, signifies all manner of nets, lines, hooks, &c, used in fishing. Hence all such little vessels as ketches, boys, and smacks, &c, used in the fishing trade, are called small craft.

CRAMBE, SEA-CABBAGE, SEA-BEACH KALE, or SEA-COLEWORT, a genus of the siliquosa order, in the tetradynamia class of plants; and in the natural method ranking under the 39th order, siliquosæ. The four longer filaments are forked at top, with an

anthera only on one point of each; the fruit is a dry, globose, and deciduous berry. There are six species, three of them herbaceous esculents with perennial roots, producing annually large leaves resembling those of cabbage spreading on the ground, with strong flower-stalks and yellowish flowers. Only one of the species is a native of Britain. It grows wild on the shores of many of the maritime counties of England, but is cultivated in many gardens as a choice esculent; and the young robust shoots of its leaves and flower-stalks, as they issue forth from the earth after the manner of asparagus-shoots, are then in the greatest perfection for use. At this period, if covered when they rise with a garden-pot, they appear white as if blanched, and when boiled eat exceedingly sweet and tender. Its principal season for use is in April and May. This plant may also be employed in the pleasure-ground as a flowering perennial, for the stalks divide into fine branchy heads of flowers. It is propagated by seeds sown in any common light earth in autumn or spring, where the plants are to remain, which, when two years old, will produce shoots fit for use, will multiply exceedingly by the roots, and continue for many years. The crambe fruticosa is a greenhouse plant.

CRAMP, in medicine, a convulsive contraction of a muscular part of the body. It affects all parts indifferently; but the hams calves, feet, and toes, oftener than the arms and hands.

CRAMP-IRON, or CRAMPS, a piece of iron bent at each end, which serves to fasten together pieces of wood, stones, or other things.

CRAMPONE'E, in heraldry, an epithet given to a cross which has at each end a cramp or square piece coming from it; that from the arm in chief towards the sinister angle, that from the arm on that side downwards, that from the arm in base towards the dexter side, and that from the dexter arm upwards.

CRANE. See GRUS.

CRANE, a machine used in building, on wharfs, and in warehouses, for raising and lowering huge stones, ponderous weights, packages, &c.

Cranes, until of late years, were commonly constructed as follows: The principal member is a strong upright beam or arbor, firmly fixed in the ground, and sustained by eight arms, coming from the extremities of four pieces of wood laid across, through the middle of which passes the foot of the beam. About the middle of the arbor the arms meet, and are mortised into it: its top ends in an iron pivot, on which is borne a transverse piece, advancing out to a good distance, something after the manner of a crane's neck, whence the machine has its name. This projecting piece is now more commonly called the jib or gibbet. The middle and extremities of this are again sustained by arms from the middle of the arbor: and over it comes a rope or cable, to one end of which the weight is fixed; the other is wound about the spindle of a wheel, which when turned (commonly by means of men walking upon the inside of the rim of the wheel) draws the rope, and that heaves up the weight; which may afterwards be applied to any side or quarter by the mobility of the transverse piece on the pivot. These cranes have usually been made of two kinds: in the first, called the rat-tailed crane, the whole machine with the load turns upon a strong axis: in the second kind the gibbet alone moves on its axis. But in either kind, if the machinery is put into motion by men walking within the wheel, as has been till lately the almost universal practice in this country, the labourers employed are exposed to extreme danger, and have frequently met with the most shocking and fatal accidents. It is not then to be wondered at, that skilful mechanists should at length have devised cranes that are not only more safe, but more powerful in their operation, than the common walking crane.

The late Mr. Ferguson invented a crane which has three trundles, with different numbers of staves, that may be applied to the cogs of a horizontal wheel with an upright axle; round which is coiled the rope that draws up the weight. This wheel has 96 cogs; the largest trundle 24 staves, the next 12, and the smallest 6; so that the largest revolves 4 times for one revolution of the wheel, the next 8, and the smallest 16. A winch is occasionally fixed on the axis of either of these trundles for turning it; and is applied to the one or the other according as the weight to be raised is smaller or larger. While this is drawing up, the ratch-teeth of a wheel slip round below a catch that falls into them, prevents the crane from turning backwards, and detains the weight in any part of its ascent, if the man who works at the winch should accidentally quit his hold, or wish to rest himself before the weight is completely raised. Making a due allowance for friction, a man may raise by such a crane, from three times to twelve times as much in weight as would balance his effort at the winch, viz. from 90 to 360 lbs. taking the average labour.

But several cranes which are preferable to the common walking-crane, while they are free from the dangers attending that machine, lose at the same time one of its advantages; that is, they do not avail themselves of that addition to the moving power which the weight of the men who are employed may furnish. Yet this advantage has been long since ensured by the mechanists on the continent, who cause the labourers to walk upon an inclined plane, turning upon an axis. The same principle has been lately brought into notice, probably without ever knowing it had been adopted before, by Mr. James White, of Chevening, in Kent: his crane is exhibited in fig. 1. as it was described in the Transactions of the Society for the Encouragement of the Arts. See Pl. Cranes.

A (fig. 1.) is a circular inclined plane, moving on a pivot underneath, and carrying round with it the axis E. A person walking on this plane, and pressing against the lever B, throws off the gripe D, by means of an iron rod C; and thus admits the plane and its axis to move freely, and raise the weight G by the coiling of the rope F round the axis E.

To shew more clearly the construction and action of the lever and gripe, a plan of the circular inclined plane, with the lever and gripe, is added, (see fig. 2.) where B represents the lever, D the spring or gripe. In this plan, where the lever B is in the situation in which it now appears, the spring or gripe D presses against the periphery of the plane, as shewn by the double line, and the machine cannot move; but when the lever B is pressed out to the dotted line H, the gripe is also thrown off to the dotted line I, and the whole machine left at liberty to move. One end of a rope or cord, of a proper length, is fixed near the end of the lever B, and the other end made fast to one of the uprights, serving to prevent the lever moving too far when pressed by the man.

The supposed properties of this crane, for which the premium of 40 guineas was adjudged by the society to the inventor, are as follows:

1. It is simple, consisting merely of a wheel and axle. 2. It has comparatively little friction, as is obvious from the bare inspection of the figure. 3. It is durable, as is evident from the two properties abovementioned. 4. It is safe; for it cannot move but during the pleasure of a man, and while he is actually pressing on the gripe-lever. 5. This crane admits of an almost infinite variety of different powers, and this variation is obtained without the least alteration of any part of the machine. If, in unloading a vessel, there should be found goods of any weight, from a few hundreds to a ton and upwards, the man that does the work will be able so to adapt his strength to each as to raise it in a space of time proportionate to its weight; he walking always with the same velocity as nature and his greatest ease may teach him.

It is a great disadvantage in some cranes, that they take as long time to raise the smallest as the largest weight, unless the man who works them turns or walks with such velocity as must soon tire him. In other cranes, perhaps, two or three different powers may be procured; to obtain which, some pinion must be shifted, or fresh handle applied or resorted to. In this crane, on the contrary, if the labourer finds his load so heavy as to permit him to ascend the wheel without its turning, let him only move a step or two towards the circumference, and he will be fully equal to the task. Again, if the load is so light as scarcely to resist the action of his feet, and thus to oblige him to run through so much space as to tire him beyond necessity, let him move laterally towards the centre, and he will soon feel the place where his strength will suffer the least fatigue by raising the load in question. One man's weight applied to the extremity of the wheel would raise upwards of a ton; and it need not be added, that a single-sheaved block would double that power. Suffice it to say, that the size may be varied in any required ratio; and that this wheel will give as great advantage at any point of its plane as a common walking-wheel of equal diameter, as the inclination can be varied at pleasure, as far as expediency may require. It may be necessary to observe, that what in the figure is the frame, and seems to form a part of the crane, must be considered as a part of the house in which it is placed; since it would be mostly unnecessary should such cranes be erected in houses already built. With respect to the horizontal part, by walking on which the man who attends the jib occasionally assists in raising the load, it is not an essential part of this invention, where

the crane is not immediately contiguous to the jib; although, where it is, it would certainly be very convenient and economical.

Notwithstanding, however, the advantages which have been enumerated, Mr. White's crane is subject to this objection, that it derives less use than might be wished from the weight of the man or men: for a great part of that weight (half of it, if the inclination be 30 degrees) lies directly upon the plane, and has no tendency to produce motion. Besides, when this crane is of small dimensions, the effective power of the men is very unequal, and the barrel too small for winding a thick rope: when large, the weight of the materials added to that of the men put it out of shape, and give it the appearance of a large unwieldy moving floor.

Fig. 3 represents a crane in common use, in situations where no building is wanted over it. A B is a strong upright shaft, working through a collar in the timber-floor of the wharf, and on a pivot in the bottom of a well, some feet below it. D E are the timbers forming the jib to support the pulley I over which the chain passes. G H I is a cast iron cross bolted to the framing at two of its extremities: another cross fixed in the same manner to the other side, makes a frame for the wheels K, L, M, N. K is a pinion with 15 teeth: the ends of its spindle O pass through the cross, and are squared for winch handles by which it turned. This works into the wheel L of 22 teeth, its spindle P, and has also square ends for the winches. It has a pinion N of 7 teeth upon it, which works the wheel M of 100 teeth, fixed to the roll on which the chain winds, whose spindle is *q*. This crane has the advantage of traversing a whole circle, which for many purposes is very useful. It has several different powers by men working at winches put on the different spindles separately or combined. When the man works by the spindle P, the pinion K is thrown out of gear by sliding its spindle along, and when he works by the spindle Q, the wheels K and L are thrown out. This is prevented from happening accidentally by a collar on each spindle acting against a double clep R, fig. 4. moving on a centre at S, and is made to act by the weight T: when this weight is lifted up, both spindles are at liberty to be slid along. In figure 5, is shewn the method, in common use, of slinging a large block of stone, by which the necessity of passing the chain under it is avoided.

Fig. 6 is a simple and effective crane at a wharf on the banks of the Thames, between Greenwich and Woolwich. A B C are three upright posts connected at the top by a triangular frame, across the middle of which is a beam D, between this and a block on the ground the jib plays: on each side of the upright shaft E, two bars F G are bolted, spreading out as they recede from it to receive the wheel H; I I are braces to support the bars. At that part where the braces are bolted to the upright, an horizontal frame K is fixed for carrying the roll and winch: the rope which winds round this goes over the pulley L, and round the large wheel H. The rope which lifts the goods winds on each end of the axle of this wheel; and the middle of it passes through a pulley-block O, to which the goods are hooked.

Fig. 7 is a crane used at several of the wharfs belonging to the Grand-junction canal company at Paddington; the frame of it is the same as fig. 6. A is the main shaft. B B are the horizontal bars of greater length than usual, bolted to the shaft A, near the middles, and having two struts (E E and F F) at each end, which makes this kind of jib very strong. The wheel G is placed at the short end of the jib; and the rope which winds round its axis, passes over pulleys H at the other end.

CRANE-LINES, in a ship, are lines going from the upper end of the spritsail-topmast to the middle of the fore-stays. They serve to keep the spritsail-topmast upright and steady in its place, and to strengthen it.

CRANICHIS, a genus of the class and order gynandria decandria. The essential character is, nectary galeated. There are five species.

CRANIOLARIA, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The calyx of the flower is double, the under one tetraphyllous, the upper one a monophyllous spatha; the tube of the corolla very long; the capsule almost the same with that of the martynia. There is one species, a native of New Spain, not possessed of any remarkable property.

CRANK, a contrivance in machines, in manner of an elbow, only of a square form, projecting from a spindle, and serving by its rotation to raise and fall the pistons of engines.

CRANK likewise denotes the iron support for a lantern, and also the iron made fast to a stock of a bell for ringing it. In the sea-language, a ship is said to be crank-sided when she can bear but small sail, for fear of oversetting; and when a ship cannot be brought on the ground without danger, she is said to be crank by the ground.

CRANZIA, a genus of the pentandria monogynia class and order. The calyx is five-parted, petals five; nect. none; berry or berried caps. There is one species, a native of the East Indies.

CRAPE, a light transparent stuff, in manner of gauze: made of raw silk gummed and twisted on the mill, woven without crossing, and much used in mourning. Crapes are either craped (*i.e.* crisped), or smooth; the first double, expressing a closer mourning; the latter single, used for that less deep. The white is reserved for young people. The silk destined for the first is more twisted than that for the second; it being the greater or less degree of twisting, especially of the warp, which produces the crisping given it when taken out of the loom, steeped in clear water, and rubbed with a piece of wax for the purpose. Crapes are all dyed raw. The invention of this stuff came originally from Bologna; but, till of late years, Lyons is said to have had the chief manufacture of it.

CRASPEDIA, a genus of the class and order syngenesia polygamia segregata. The calyx is imbricate. Florets in depressed bundles, down feathered, recept. chaffy. There is one species, a native of New Zealand.

CRASSULA, lesser orpine, or live-ever; a genus of the pentagynia order, in the pentandria class of plants; and in the natural method ranking under the 13th order, succulentæ. The calyx is pentaphyllous; the petals five, with five nectariferous scales at the base of the germen, and five capsules. There are 64 species, all of them natives of warm climates. Several of them are cultivated in this country, but require the assistance of artificial heat for their preservation. They rise from one foot to six or eight in height, and are ornamented with oblong, thick, succulent leaves, and funnel-shaped pentapetalous flowers of a scarlet, white, or greenish colour. They are propagated by offsets or cuttings; and must be potted in light sandy compost, retained in a sunny part of the greenhouse all winter, and very sparingly watered. In summer they may be placed in the full air in a sheltered place, and in dry weather watered twice a week.

CRATÆGUS, wild service-tree, hawthorn, &c. a genus of the digynia order, in the icosandria class of plants; and in the natural method ranking under the 36th order, pomaceæ. The calyx is quinquefid; the petals five; the berry inferior, dispermous. There are 23 species, all of the tree and shrub kind, hardy, and deciduous. Those most valuable for economical and ornamental purposes in gardening are the following;

1. The oxycantha, hawthorn, or white thorn, grows naturally all over Europe. In the state in which we are used to observe it, it is nothing better than a tall, uncouth, irregular shrub; but trained up as a standard, it swells to a large timber size, with a tall stem and a full spreading head. The standard-hawthorn, whether we view its flowers in the spring, its foliage in the summer, or its fruit in the autumn or winter, is one of the most ornamental plants, standing singly, that can be scattered over a park or lawn.

The common hawthorn sports in the following varieties: the large scarlet hawthorn; the yellow hawthorn; the white hawthorn; the maple-leaved hawthorn; the double-blossomed hawthorn; the Glastonbury thorn. The last of these differs in no respect from the common hawthorn, only that it sometimes flowers in the winter. It is said to have originally been the staff of Joseph of Arimathea, who, attended by eleven companions, came over into Britain, and founded, in honour of the Blessed Virgin, the first Christian church in this isle. As a proof of his mission, he is said to have stuck his staff into the ground, which immediately shot forth and bloomed. This tree is falsely said to have blossomed on Christmas day ever since, and is universally distinguished by the name of the Glastonbury thorn.

2. The azarolus, or parsley-leaved thorn, is a native of Italy and the south of France. It will grow to be fifteen or sixteen feet high. The leaves are large, nearly trifid, serrated, and obtuse. The flowers are large, come out in May, and in the different varieties are succeeded by fruit of different size, shape, and relish. The principal varieties of this species are: the azarole with strong thorns; the azarole with no thorns; the jagged-leaved azarole; the oriental medlar.

3. The aria, called the white-beam tree, is a native of most of the cold countries of Europe. It will grow to be more than twenty feet high. This tree is engaging at

all times of the year, and catches the attention even in the winter; for then we see it stand, though naked of leaves, with a straight stem, with smooth branches spotted with white, at the end of which are the buds, swelled for the next year's shoot, giving the tree a bold and fine appearance. In the spring the leaves come out, of course, and look delightfully, having their upper surface green and the lower white. Their figure is oval; they are unequally serrated, about three inches long, and half as wide. Several strong nerves run from the mid-rib to the border, and they are placed alternately on the branches, which appear as if powdered with the finest meal. The flowers are produced at the end of the branches in May: they are white; grow in large bunches, having mealy footstalks; and are succeeded by red berries, which will be ripe in autumn.

4. The terminalis, wild service, or maple-leaved service, is a large growing tree, native of England, Germany, Switzerland, and Burgundy. It will arrive at near fifty feet, and is worth propagating for the sake of the timber, which is very white and hard. This tree grows naturally in several woods in England; and it is the fruit of this species that is tied in bunches and exposed for sale in the autumn: it is gathered in the woods, and by some persons is much liked. The leaves in some degree resemble those of the maple-tree in shape; their upper surface is a fine green, their under hoary; and they grow alternately on the branches. The flowers come out in May, exhibiting themselves in large clusters at the end of the branches. They are white, and are succeeded by the fruit, which, when ripe, is of a brown colour, and about the size of a large haw.

5. The coccinea, or great American hawthorn, is a native of Virginia and Canada. It will grow to be near twenty feet high. The stem is robust, and covered with a light-coloured bark. The branches are produced without order, are of a dark-brown colour, and possessed of a few long sharp thorns. The leaves are spear-shaped, oval, smooth, and serrated; of a thickish consistence, and often remain on the tree the greatest part of the winter. Each separate flower is large; but as few of them grow together, the umbels they form are rather small. They come out in May, and are succeeded by a large dark-red coloured fruit, which ripens late in the autumn. The varieties of this species are: the pear-leaved thorn; the plum-leaved thorn with very long strong spines and large fruit; the plum-leaved thorn with short spines and small fruit.

6. The crus galli, or cockspur-thorn, is a native of Virginia and Canada, and grows to about twenty feet high. It rises with an upright stem, irregularly sending forth branches, which are smooth, and of a brownish colour, spotted thinly with small white spots. It is armed with thorns that resemble the spurs of cocks, which gained it the appellation of cockspur-thorn. In winter the leaf-buds appear large, turgid, and have a bold and pleasant look among others of different appearances. In summer this tree is very delightful. The leaves are oval, angular, serrated, smooth, and bend backwards. They are about four inches long, and three and a half broad; have five or six pair of strong nerves running from the mid-rib to the border; and dye to a brownish-red colour in the autumn. The flowers are produced in very large umbels, making a noble show in May; and are succeeded by large fruit of a bright red colour, which have a good effect in the winter. The principal varieties of this species are: the cockspur hawthorn with many thorns; the cockspur hawthorn with no thorns; the cockspur hawthorn with eatable fruit.

7. The tomentosa, woolly-leaved hawthorn, grows to about seven or eight feet high. The branches are slender, and closely set with sharp thorns. The leaves are cuneiform, oval, serrated, and hairy underneath. The flowers are small, and of a white colour: they are produced from the sides of the branches about the end of May; and are succeeded by yellow fruit, which ripens late in autumn. There is a variety of this called the Carolina hawthorn, which has longer and whiter leaves, large flowers and fruit, and no thorns.

8. The viridis, or green-leaved Virginia hawthorn, has the stem and branches together destitute of thorns. The leaves are lanceolate, oval, nearly trilobate, serrated, smooth, and green on both sides. The flowers are white, moderately large, come out the end of May, and are succeeded by a roundish fruit, which will be ripe late in the autumn.

The respective species are all propagated by sowing the seeds; and the varieties are continued by budding them upon stocks of the white thorn. This latter method is generally practised for all the sorts; though, when good seeds can be procured, the largest and most beautiful plants are raised that way.

CRATER, in astronomy, a constellation of the southern hemisphere, consisting of seven stars according to Ptolemy's catalogue, of eight in Tycho's, and eleven in the Britannic catalogue.

CRATEVA, the garlic pear; a genus of the monogynia order, in the dodecandria class of plants; and in the natural method ranking under the 25th order, putamineæ. The corolla is tetrapetalous; the calyx quadrifid; the berry inferior, dispermous. There are five species, natives of both Indies. They are of the tree kind; and are chiefly distinguished by their fruit. The tapia, or garlic pear, has a smooth round fruit about the size of an orange, with a hard brown shell or cover, which incloses a mealy pulp, filled with kidney-shaped seeds. It has a strong smell of garlic, and communicates the same to such animals as feed upon it. The tender buds from the young branches being bruised and applied to the naked skin, will blister as effectually as cantharides. It rises to the height of about thirty feet. The marmelos grows to the size of a very large tree, with trifoliate leaves. The flowers have the smell of roses, and are succeeded by an oblong fruit of the size of an apple, covered with a very hard bony shell, and containing a soft fleshy pulp, having the taste of quinces. From the flowers of this plant is obtained by distillation a water highly odoriferous and cordial; and the pulpy part of the fruit is prepared into various kinds of marmalades. Both species may be propagated in this country by seeds.

CRAX, in ornithology, the curassou, a genus of birds belonging to the order of gallinæ. The base of the beak of each mandible is covered with wax; and the feathers of the head are curled. There are five species, viz. 1. the alecator, or Indian hen of Sloane, is about the size of a small turkey. It is black, with a white belly. A yellow wax covers about half of each mandible; the tongue is entire; the temples are bare and black; the tail is roundish, and consists of 14 prime feathers; the legs are strong, and of a dusky-brown colour. They are frequent at Guiana; and are called powese by the natives from their cry, which is somewhat similar; are pretty numerous in the woods, and make no small part of the food of the planters, who are supplied with them by the Indian hunters; and their flesh is reckoned delicate, much like that of a turkey. They are easily brought up tame, and are frequently found in the Dutch settlements of Berbice, Essequibo, and Demerara. They are called at Brasil by the name of curasso. 2. The rubra, or Peruvian hen, is red, with a blueish head. These birds are natives of Mexico and Peru. They feed on fruits, and perch at night on trees: the flesh is white, and esteemed very good food. They are frequently kept tame in our menageries in England, and readily mix with other poultry, feeding on bread and grain; but this climate is not warm enough for their nature, they not being able to bear the dampness of the grass of our meadows, which renders them subject to have their toes rot off. They will often live in this state some time; and in one instance which Mr. Latham saw, the whole of one foot was gone, and but part of one toe left on the other, before the creature died. 3. The mitu, or Brazilian pheasant, is black, with a dusky belly, and red wax: it is a native of Guinea and Brazil. 4. The globicera, has a yellow protuberance between the nostrils, and is of a blueish-black colour: it is likewise a native of Brazil. 5. The pauxi, or Mexican pheasant of Brisson, is of a blueish colour, with blue wax, and the tip of the tail and belly white: is a native of Mexico. See Pl. Nat. Hist. figs. 148, 149.

CRAY-FISH, or CRAW-FISH. See CANCER.

CRAYON, a name for all coloured stones, earths, or other minerals, used in designing or painting in pastel. Crayons may be made of any colour, and adapted for the faces of men, women, landscapes, clouds, sun-beams, buildings, and shadows, in the following manner. Take plaister of Paris, or alabaster calcined, and of the colour of which you intend to make your crayons, a sufficient quantity: grind them first asunder, and then together, and with a little water make them into a paste: then roll them with your hand upon the grinding-stone into long pieces, and let them dry moderately in the air; when they are to be used, scrape them to a point like a common pencil.

CRAYON-PAINTING. Whether the painter works with oil-colours, water-colours, or crayons, the grand object of his pursuit is still the same: a just imitation of nature. But each species has its peculiar rules and methods. Painting with crayons requires, in many respects, a treatment different from painting in oil-colours; because all colours used dry are in their nature of a much warmer complexion than when wet with oils, &c. For this reason, in order to produce a picture,

CRANES.

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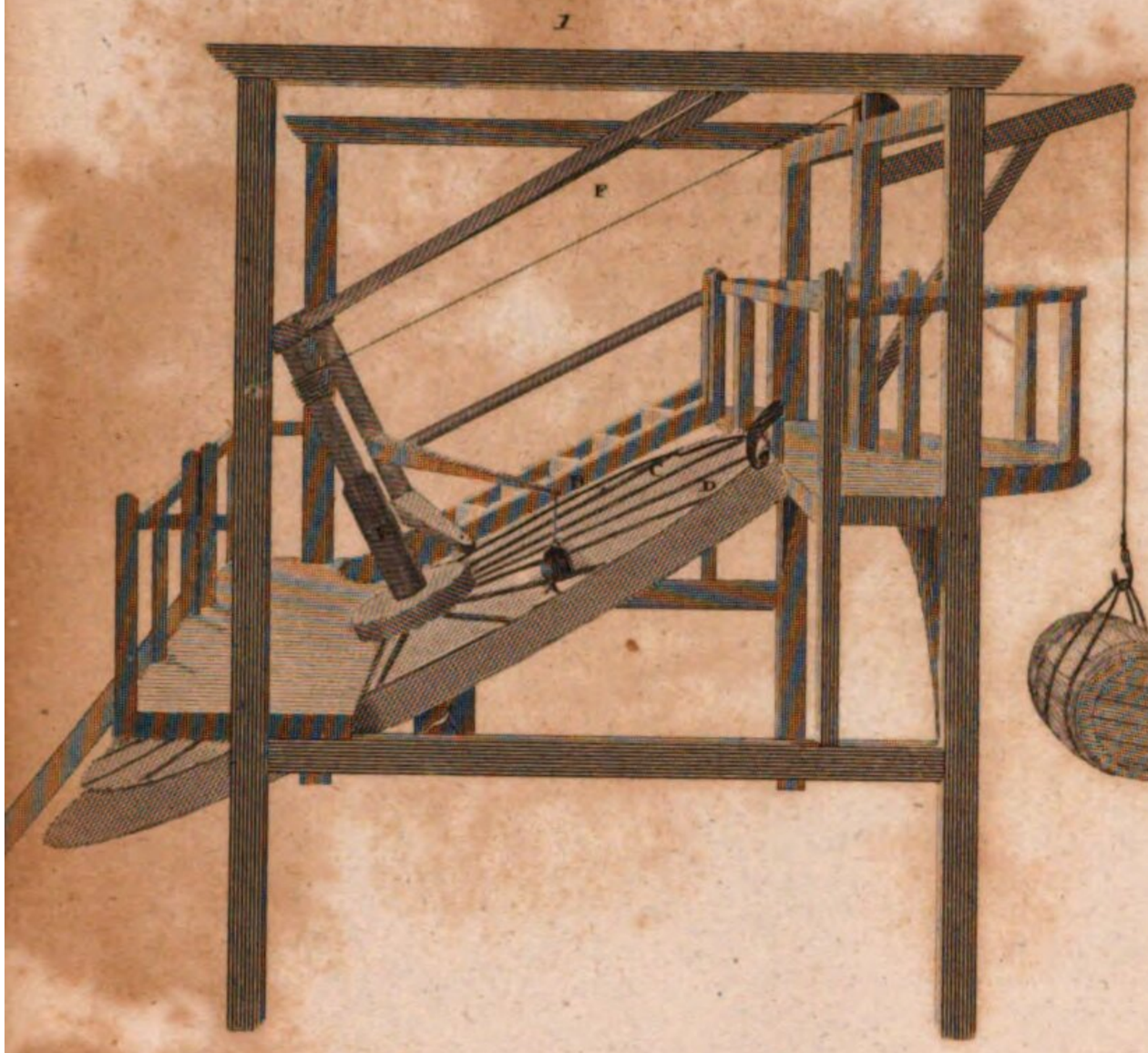

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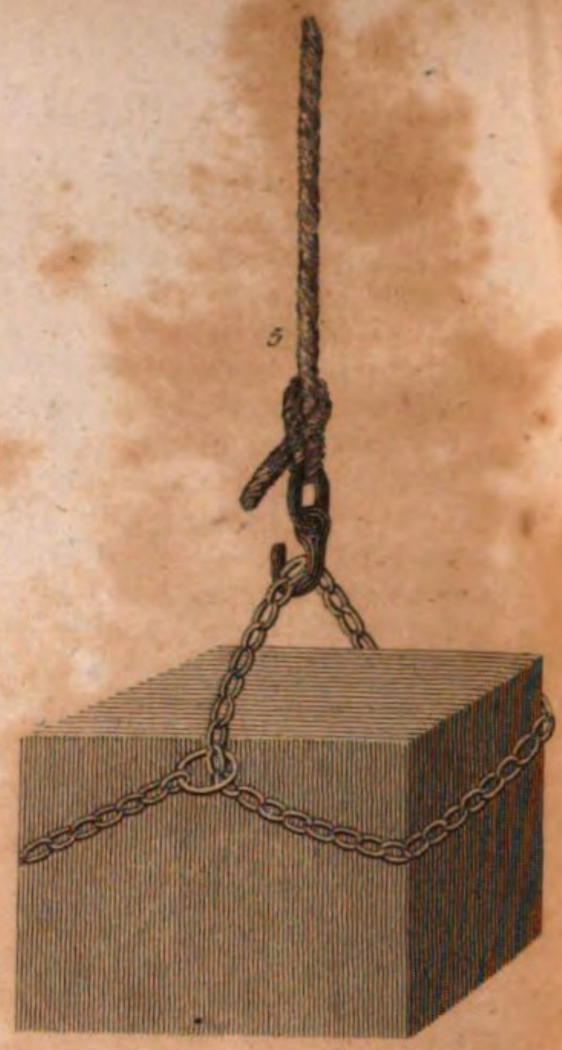

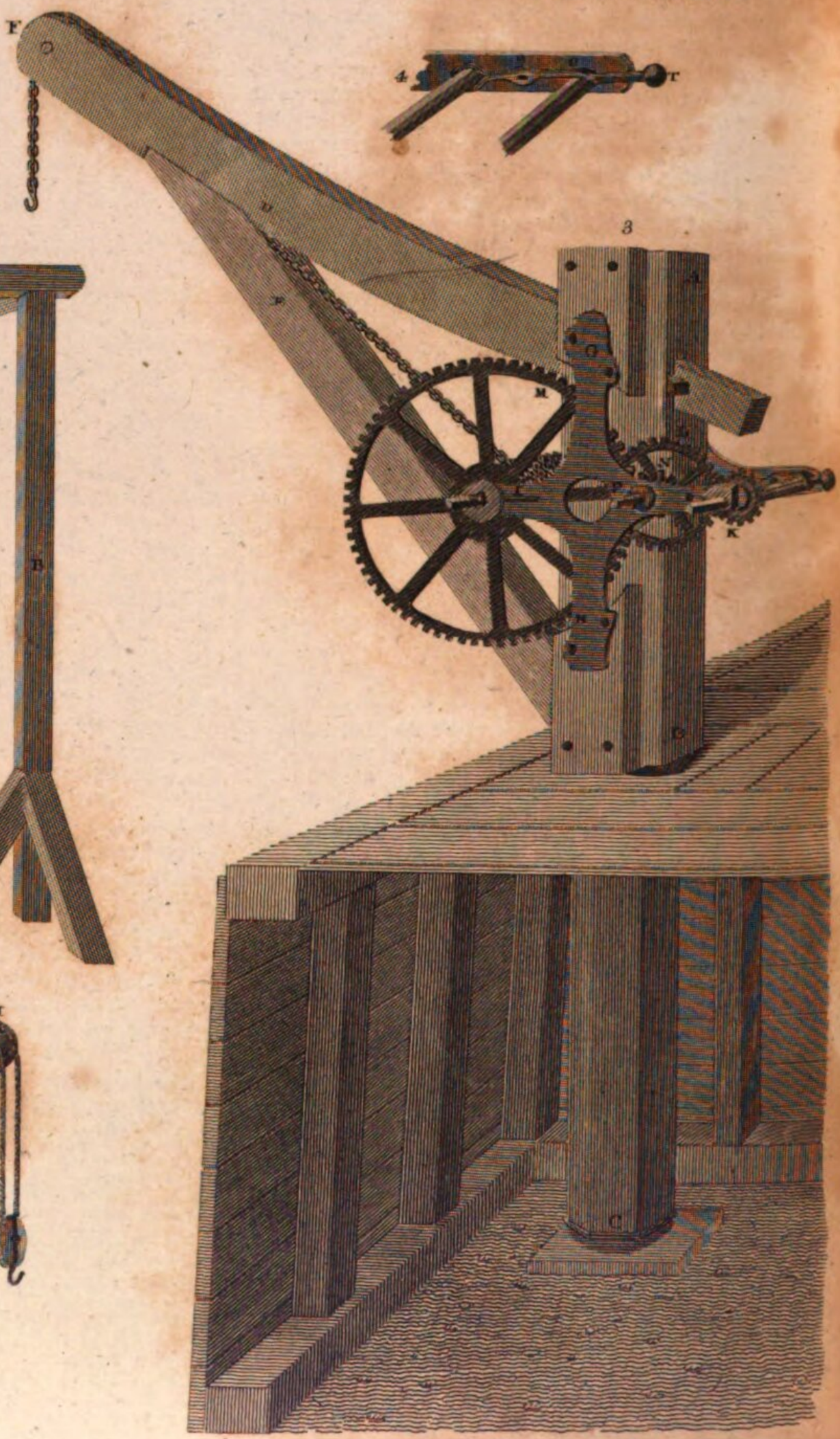

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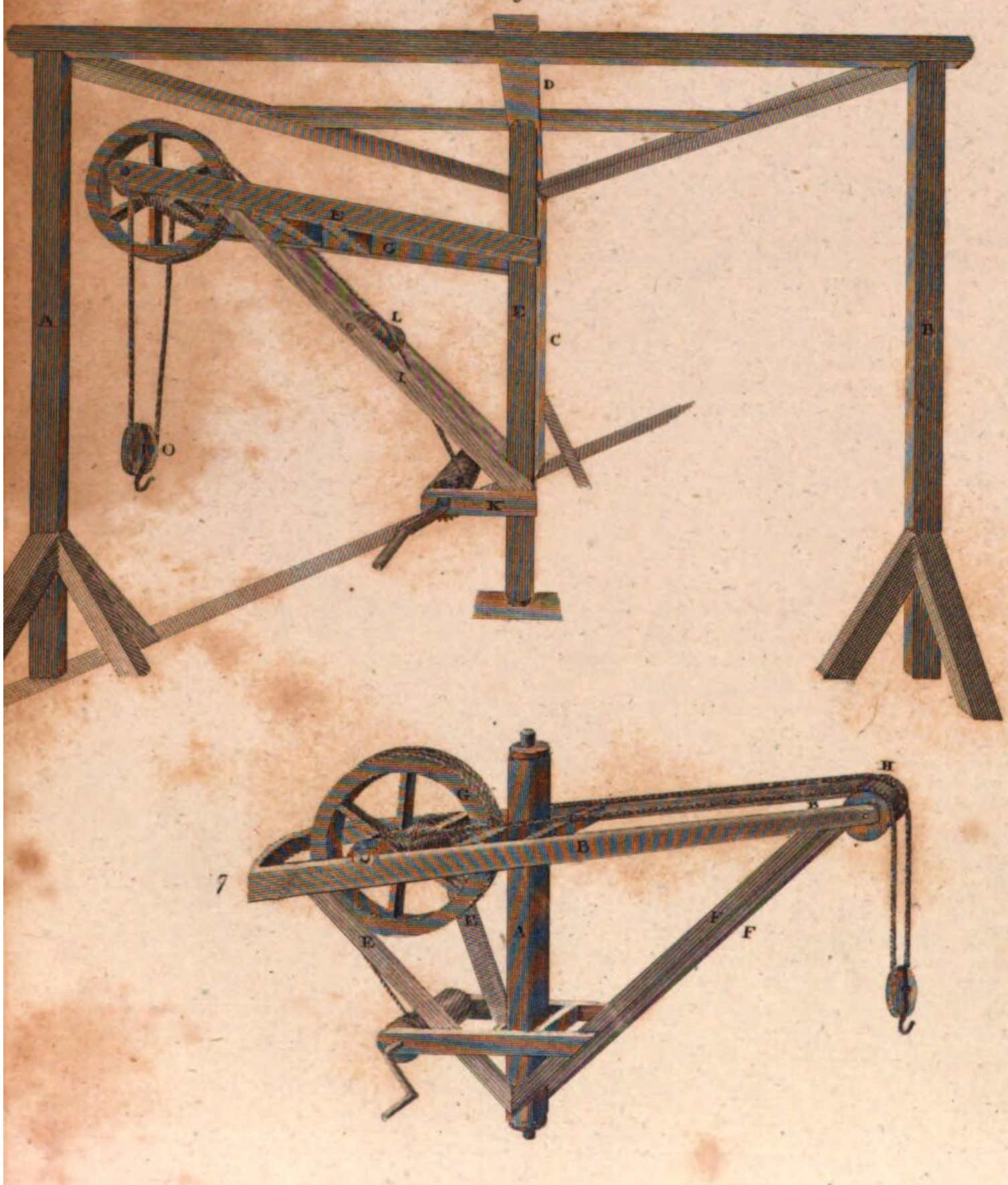

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a much greater portion of what painters term cooling tints must be applied in crayon-painting, than it would be judicious to use in oils. Without any danger of a mistake, it is to be supposed, the not being acquainted with this observation is one great cause why so many oil-painters have no better success when they attempt crayon-painting. On the contrary, crayon-painters being so much used to those tints which are of a cold nature when used wet, are apt to introduce them too much when they paint with oils, which is seldom productive of a good effect.

We shall now endeavour to give the student some directions towards the attainment of excellence in this art.

Of the application of the crayons, with some previous dispositions.—The student must provide himself with some strong blue paper, the thicker the better, if the grain is not too coarse or knotty, though it is almost impossible to get any entirely free from knots. The knots should be levelled with a penknife or razor, otherwise they will prove exceedingly troublesome. After this is done the paper must be pasted very smooth on a linen cloth, previously strained on a deal frame, the size according to the artist's pleasure: on this the picture is to be executed; but it is most eligible not to paste the paper on till the whole subject is first dead-coloured. The method of doing this is very easy, by laying the paper with the dead-colour on its face, upon a smooth board or table, when, by means of a brush, the back side of the paper must be covered with paste; the frame with the strained cloth must then be laid on the pasted side of the paper; after which turn the painted side uppermost, and lay a piece of clean paper upon it, to prevent smearing it: this being done, it may be stroked gently over with the hand; by which means all the air between the cloth and the paper will be forced out.

When the paste is perfectly dry, the student may proceed with the painting. The advantages arising from pasting the paper on the frame according to this method, after the picture is begun, are very great, as the crayons will adhere much better than any other way; which will enable the student to finish the picture with a firmer body of colour, and greater lustre.

When the painters want to make a very correct copy of a picture, they generally make use of tiffany or black gauze, strained tight on a frame; which they lay flat on the subject to be imitated, and with a piece of sketching chalk trace all the outlines on the tiffany. They then lay the canvas to be painted on flat upon the floor, placing the tiffany with the chalked lines upon it, and with an handkerchief brush the whole over: this presents the exact outlines of the picture on the canvas. The crayon-painter may also make use of this method when the subject of his imitation is in oils; but in copying a crayon-picture he must have recourse to the following method, on account of the glass:

The picture being placed upon the easel, let the outlines be drawn on the glass with a small camel's-hair pencil dipped in lake, ground thin with oils, which must be done with great exactness. After this is accomplished, take a sheet of paper of the same size and place it on the glass, stroking over all the lines with the hand, by which means the colour will adhere to the paper, which must be pierced with pin-holes pretty close to each other. The paper intended to be used for the painting must next be laid upon a table, and the pierced paper placed upon it; then with some fine pounded charcoal, tied up in a piece of lawn, rub over the pierced lines, which will give an exact outline; but great care must be taken not to brush this off till the whole is drawn over with sketching chalk; which is a composition made of whiting and tobacco-pipe clay, rolled like the crayons, and pointed at each end.

When a student paints immediately from the life, it will be most prudent to make a correct drawing of the outlines on another paper, the size of the picture he is going to paint, which he may trace by the preceding method, because erroneous strokes of the sketching chalk (which are not to be avoided without great expertness) will prevent the crayons from adhering to the paper, owing to a certain greasy quality in the composition.

The student will find the sitting posture, with the box of crayons on his lap, the most convenient method for him to paint. The part of the picture he is immediately painting should be rather below his face; for if it is placed too high the arm will be fatigued. Let the windows of the room where he paints be darkened, at least to the height of six feet from the ground; and the subject to be painted should be situated in such a manner that the light may fall with every advantage on the face, avoiding too much shadow, which seldom has a good effect in portrait-painting, especially if the face he paints from has any degree of delicacy.

Before he begins to paint let him be attentive to his subject, and appropriate the action or attitude proper to the age of the subject: if a child, let it be childish; if a young lady, express more vivacity than in the majestic beauty of a middle-aged woman, who also should not be expressed with the same gravity as a person far advanced in years. Let the embellishments of the picture, and introduction of birds, animals, &c. be regulated by the rules of propriety and consistency.

The features of the face being correctly drawn with chalks, let the student take a crayon of pure carmine, and carefully draw the nostril and edge of the nose next the shadow; then, with the faintest carmine tint, lay in the highest light upon the nose and forehead, which must be executed broad. He is then to proceed gradually with the second tint, and the succeeding ones, till he arrives at the shadows, which must be covered brilliant, enriched with much lake, carmine, and deep green. This method will at first offensively strike the eye, from its crude appearance; but in the finishing it will be a good foundation to produce a pleasing effect, colours being much more easily sullied when too bright, than, when the first colouring is dull, to raise the picture into a brilliant state. The several pearly tints discernible in fine complexions must be imitated with blue verditer and white, which answers to the ultramarine tints used in oils. But if the parts of the face where these tints appear are in shadow, the crayons composed of black and white must be substituted in their places.

Though all the face when first coloured should be laid in as brilliant as possible, yet each part should be kept in its proper tone; by which means the rotundity of the face will be preserved.

Let the student be careful when he begins the eyes, to draw them with a crayon inclined to the carmine tint, of whatever colour the irises are of; he must lay them in brilliant, and at first not loaded with colour, but executed lightly: no notice is to be taken of the pupil yet. The student must let the light of the eye incline very much to the blue cast, cautiously avoiding a staring white appearance (which when once introduced is seldom overcome), preserving a broad shadow thrown on its upper part by the eyelash. A black and very heavy tint is also to be avoided in the eyebrows; it is therefore best to execute them like a broad glowing shadow at first, on which, in the finishing, the hairs of the brow are to be painted; by which method of proceeding the former tints will shew themselves through, and produce the most pleasing effect.

The student should begin the lips with pure carmine and lake, and in the shadow use some carmine and black; the strong vermilion tints should be laid on afterwards. He must beware of executing them with stiff harsh lines, gently intermixing each with the neighbouring colours, making the shadow beneath broad, and enriched with brilliant crayons. He must form the corner of the mouth with carmine, brown ochre, and greens, variously intermixed. If the hair is dark, he should preserve much of the lake and deep carmine tints therein; this may easily be overpowered by the warmer hair teints, which, as observed in painting the eyebrows, will produce a richer effect when the picture is finished; on the contrary, if this method is unknown or neglected, a poverty of colouring will be discernible.

When the head is brought to some degree of forwardness, let the back-ground be laid in, which must be treated in a different manner, covering it as thin as possible, and rubbing it into the paper with a leather stump. Near the face the paper should be almost free from colour, for this will do great service to the head, and by its thinness give both a soft and solid appearance. In the back-ground also no crayon that has whiting in its composition should be used, but chiefly such as are the most brilliant and the least adulterated. The ground being painted thin next the hair, will give the student an opportunity of painting the edges of the hair over in a light and free manner when he gives the finishing touches.

The student having proceeded thus far, the face, hair, and back-ground, being entirely covered, he must carefully view the whole at some distance, remarking in what respect it is out of keeping, that is, what parts are too light and what too dark; being particularly attentive to the white or chalky appearances, which must be subdued with lake and carmine. The above method being properly put into execution, will produce the appearance of a painting principally composed of three colours, viz. carmine, black, and white, which is the best preparation a painter can make for the producing a fine crayon picture.

The next step is to complete the back-ground and the hair, as the dust, in painting these, will fall on the face, and would much

injure it if that was completed first. From thence proceed to the forehead, finishing downward till the whole picture is completed.

In painting over the forehead the last time, begin the highest light with the most faint vermilion tint, in the same place where the faint carmine was first laid, keeping it broad in the same manner. In the next shade succeeding the lightest, the student must work in some light-blue tints, composed of verditer and white, intermixing with them some of the deeper vermilion tints, sweetening them together with great caution, insensibly melting them into one another, increasing the proportion of each colour as his judgment shall direct. Some brilliant yellows may also be used, but sparingly; and towards the roots of the hair strong verditer tints, intermixed with green, will be of singular service. Cooling crayons, composed of black and white, should succeed these, and melt into the hair. Beneath the eyes the sweet pearly tints are to be preserved, composed of verditer and white; and under the nose and on the temples the same may be used; beneath the lips tints of this kind also are proper, mixing them with the light greens and some vermilion.

In finishing the cheeks let the pure lake clear them from any dust contracted from the other crayons; then with the lake may be intermixed the bright vermilion; and last of all (if the subject should require it), a few touches of the orange-coloured crayon, but with extreme caution; after, sweeten that part with the finger as little as possible, for fear of producing a heavy disagreeable effect on the cheeks; as the beauty of a crayon-picture consists in one colour shewing itself through, or rather between, another; this the student cannot too often remark, it being the only method of imitating beautiful complexions.

The eye is the most difficult feature to execute in crayons, as every part must be expressed with the utmost nicety to appear finished; at the same time that the painter must preserve its breadth and solidity while he is particularizing the parts. To accomplish this, it will be a good general rule for the student to use his crayon in sweetening as much, and his finger as little, as possible. When he wants a point to touch a small part with, he may break off a little of his crayon against the box, which will produce a corner fit to work with in the minutest parts. If the eyelashes are dark, he must use some of the carmine and brown ochre, and the crayon of carmine and black; and with these he may also touch the iris of the eye (if brown or hazel), making a broad shadow, caused by the eyelash. Red tints of vermilion, carmine, and lake, will execute the corners of the eye properly; but if the eyelids are too red, they will have a disagreeable sore appearance. The pupil of the eye must be made of pure lamp-black: between this and the lower part of the iris the light will catch very strong, but it must not be made too sudden, but be gently diffused round the pupil till it is lost in shade. When the eyeballs are sufficiently prepared, the shining spect must be made with a pure white crayon, which should be first broken to a point, and then laid on firm; but as it is possible they may be defective in neatness, they should be corrected with a pin, taking off the redundant parts, by which means they may be formed as neat as can be required.

The difficulty with respect to the nose, is to preserve the lines properly determined, and at the same time so artfully blended into the cheek, as to express its projection, and yet no real line to be perceptible upon a close examination; in some circumstances it should be quite blended with the cheek, which appears behind it, and determined entirely with a slight touch of red chalk. The shadow caused by the nose is generally the darkest in the whole face, partaking of no reflection from its surroundnig parts. Carmine and brown ochre, carmine and black, and such brilliant crayons, will compose it best.

The student having before prepared the lips with the strongest lake and carmine, &c. must with these colours make them completely correct; and when finishing introduce the strong vermilions, but with great caution, as they are extremely predominant. This, if properly touched, will give the lips an appearance equal, if not superior, to those executed in oils, notwithstanding the seeming superiority the latter have by means of glazing, of which the former are entirely destitute.

When the student paints the neck, he should avoid expressing the muscles too strong in the stem, nor should the bones appear too evident on the chest, as both have an unpleasing effect, denoting a violent agitation of the body; a circumstance seldom necessary to express in portrait-painting. The most necessary part to be expressed, and which should ever be observed (even in the most delicate subjects), is a strong marking just above the place where the collar-bones unite; and if the head is much thrown over the shoulders, some notice should be taken of the large muscle that rises from behind the ear, and is inserted into the pit between the collar-bones. All inferior muscles should be, in general, quite avoided. The student will find this caution necessary, as most subjects, especially thin persons, have the muscles of the neck much more evident than it would be judicious to imitate. As few necks are too long, it may be necessary to give some addition to the stem, a fault on the other side being quite unpardonable, nothing being more ungraceful than a short neck. In colouring the neck, let the student preserve the stem of a pearly hue, and the light not so strong as on the chest. If any part of the breast appears, its transparency must also be expressed by pearly tints; but the upper part of the chest should be coloured with beautiful vermilions delicately blended with the other.

Of the drapery.—Dark blue, purple, black, pink, and all kinds of red draperies also, should be first tinged with carmine, which will render the colours much more brilliant than any other method; over this should be laid on the paper the middle tint (a medium between the light and dark tints, of which the drapery is to be painted), except the dark masses of shadow, which should be laid on at first as deep as possible: these, sweetened with the finger, being destitute of the smaller folds, will exhibit a masterly breadth which the lesser folds, when added, ought by no means to destroy. With the light and dark tints the smaller parts are next to be made with freedom, executing as much with the crayon, and as little with the finger, as possible; in each fold touching the last stroke with the crayon, which stroke the finger must never touch. In the case of reflections, the simple touch of the crayon will be too harsh, therefore fingering will be necessary afterwards, as reflected lights are always more gentle than those which are direct. With respect to reflections in general, they must always partake of the same colour as the object reflecting; but in the case of single figures it may be useful to make some particular observations.

In a blue drapery, let the reflections be of a greenish cast; in green draperies, make them of a yellow tint; in yellow, of an orange; in orange, reflect a reddish cast; in all reds, something of their own nature, but inclined to a yellow: black should have the reddish reflection; the reflection of a reddish tint will also present purples to the best advantage.

Of whatever colour the drapery is, the reflection of the face must partake of it; otherwise the picture, like paintings on glass, will have but a gaudy effect.

Linen, lace, fur, &c. should be touched spiritedly with the crayon, fingering very little, except the latter; and the last touches even of this, like all other parts, should be executed by the crayon, without sweetening by the finger.

The methods above-recommended have been practised by the most celebrated crayon-painters, whose works have been held in public estimation: but the knowledge of, and ability to execute, each separate part with brilliancy and truth, will be found very insufficient to constitute a complete painter, without his judgment enables him to unite them with each other, by correctness of drawing, propriety of light and shadow, and harmony of colouring. In order to accomplish this, the student should carefully avoid finishing one part in particular, till he has properly considered the connection it is to have with the rest. The neglect of this is the principal reason why the performances of indifferent painters are so destitute of what is termed breadth, so conspicuously beautiful in the works of great masters. It must be granted that this observation relates more particularly to large compositions, where a diversity of figures requires such a judicious disposition, that each may assist in the combination of a kind of universal harmony; yet, even in portrait-painting, the student should be particularly attentive to observe this idea of breadth, if he is desirous of acquiring that importance and dignity which constitute excellence in painting.

CREAM of tartar, called also chrystals of tartar. See PHARMACY.

CREDITORS shall recover their debts of executors, or administrators, who in their own wrong, waste, or convert to their use, the estate of the deceased. 30 C. II. c. 7. Wills and devises of lands, &c. as to creditors on bonds, or other specialties, are declared void: and the creditors may have actions of debt against the heir at law and devisees, 3 and 4 W. and M. c. 14: and in favour of creditors, whenever it appears to be the testator's intent, in a will, that his land should be liable for paying his debts, in such case

equity will make them subject, though there are no express words; but there must be more than a bare declaration, or it shall be intended out of the personal estate 2 Vern. Rep. 708

CREEPER. See CERTHIA.

CREEPER, at sea, a sort of grapnel, but without flooks, used for recovering things fallen overboard. See Pl. Miscel. fig. 23.

CRENATED. See BOTANY.

CRENCLES, in a ship, small ropes spliced into the bolt-ropes of the sails of the main-mast and fore-mast. They are fastened to the bow-line bridles; and are also to hold by, when a bonnet is shaken off.

CRENELLE', or embattled, in heraldry, is used when any honourable ordinary is drawn like the battlements on a wall.

CRENOPHYLAX, in antiquity, a magistrate at Athens, who had the inspection of fountains.

CREPIS, bastard hawk-weed, a genus of the polygamia order, in the syngenesia class of plants, and in the natural method ranking under the forty-ninth order, compositæ. The receptacle is naked; the calyx calyculated, with deciduous scales; the pappus feathery and stalked. There are twenty species, most of them herbaceous annuals, rising to the height of a foot or a foot and a half, and having their branches terminated by ligulated compound red and yellow flowers. These are very large, and consist of many flat florets spread over one another imbricatim, and when fully blown appear as if radiated. They are very conspicuous and beautiful; and appear in June, July, and August. They are succeeded by plenty of seed, which, if permitted to scatter on the ground, will produce a number of young plants without further trouble.

CREPITATION, that noise which some salts make over the fire in calcination, called also detonation.

CREPITATION is also used in surgery, for the noise made by the ends or pieces of bones, when the surgeon moves a limb to assure himself by his ear of the existence of a fracture.

CREPONDIA, in antiquity, a term used to express such things as were exposed along with children, as rings, jewels, &c. serving as tokens whereby they afterwards might be known.

CREPUSCULUM, in astronomy, twilight; the time from the first dawn or appearance of the morning to the rising of the sun; and again, between the setting of the sun and the last remains of day. The crepusculum is usually computed to begin and end when the sun is about eighteen degrees below the horizon; for then the stars of the sixth magnitude disappear in the morning, and appear in the evening. It is of longer duration in the solstices than in the equinoxes, and longer in an oblique than in a right sphere. The crepuscula are occasioned by the sun's rays refracted in our atmosphere.

CRESCENT, in heraldry, a bearing in form of a new moon.

CRESCENT is also an order of knights, instituted by Rennatus of Anjou, king of Sicily, about the year 1448; so called from the badge of this order, which was an enamelled crescent of gold.

CRESCENTIA, the calabash-tree; a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 25th order, putamineæ. The calyx is bipartite and equal; the corolla gibbous; the berry pedicellated or stalked, unilocular, and polyspermous; the seeds bilocular.

There are two species: 1. the cujete, with oblong narrow leaves and a large oval fruit, is a native of Jamaica and the Leeward islands. It has a thick trunk covered with a whitish bark, and rises from twenty to thirty feet high, and at the top divides into many branches, forming a large and regular head: the flowers are produced from the sides of the large branches, and sometimes from the trunk, standing upon long footstalks. They have but one petal, which is irregular; and are of a greenish-yellow colour, striped and spotted with brown. These are succeeded by very large fruit, generally spherical, sometimes oval; and at other times they have a contracted neck like a bottle; and are so large, that when the pulp and seeds are cleaned out, the shells will contain three pints or two quarts of liquid. The fruit is covered externally with a thin skin, of a greenish-yellow colour when ripe. When this is peeled off, there appears a hard ligneous shell, inclosing a pale-yellowish soft pulp of a tart unsavoury flavour, surrounding a great number of flat heart-shaped seeds. 2. The cucurbitina, or broad-leaved calabash, seldom rises more than 15 or 20 feet high, with an upright trunk, covered with a white smooth bark, sending out many lateral branches at the top, with leaves three inches in length, and one and a quarter broad, ranged alternately. The flowers come out as in the former species; but are smaller, and of a deeper yellow colour. The fruit of this sort is sometimes round, sometimes oval, but of very unequal sizes. Both these species are easily propagated by seeds; but the plants are too tender to live in this country, unless they are constantly kept in a stove.

The shells of calabashes are made use of for various purposes. At Barbadoes, besides drinking-cups and punch-bowls, there are made of them spoons, dishes, and other utensils for the slaves. Some of these shells are so large, as to be capable of holding fifteen pints of water. The pulp is seldom eaten, except by cattle in the time of drought. The wood, which is hard and smooth, is made into stools, chairs, and other furniture.

CRESSA, a genus of the class and order pentandria digynia. The essential character is, calyx five-leaved; corolla, salver-form; filaments sitting on the tube; capsules two-valved, one-seeded. There are 2 species.

CREST, in armoury, the top part of the armour, for the head, mounting over the helmet. It was for the most part made of feathers, or the hair of horses' tails or manes.

CREST, in heraldry, is the uppermost part of an armoury, or that part of the casque or helmet next to the mantle. It is esteemed a greater mark of nobility than the armoury, being borne at tournaments, to which none were admitted till such time as they had given proof of their nobility: sometimes it serves to distinguish the several branches of a family; and it has served, on occasion, as a distinguishing badge of factions: sometimes the crest is taken for the device; but more usually is formed of some piece of the arms. Families that exchange arms do not change their crest.

CREUX, a French term used among artificers, and literally signifying a hollow cavity, or pit, out of which something has been scooped or dug; whence it is used to signify that kind of sculpture, where the lines and figures are cut and formed within the face or plan of the plate, or matter engraved; and thus it stands in opposition to relievo, where the lines and figures are embossed, and rise prominent above the face of the matter engraved on.

CREW, the company of sailors belonging to a ship, boat, or other vessel. The sailors that are to work and manage a ship, are regulated by the number of lasts it may carry, each last making two ton. The crew of a Dutch ship, from forty to fifty lasts, is seven sailors and a swabber; from fifty to sixty lasts, the crew consists of eight men and a swabber; and thus increases at the rate of one man every ten lasts. English and French crews are usually stronger than Dutch, but always in about the same proportion. There are in a ship several particular crews or gangs, as the gun-room crew, the carpenter's crew, &c.

CRIBBAGE, a game at cards, in which no cards are to be thrown out, and the set to make sixty-one; and as it is an advantage to deal, on account of the crib, it is proper to cut for it, and he that has the least card deals. There are only two players at this game, in which the cards are dealt out one by one; the first to the dealer's antagonist, and the next to himself, and so on, till each has five; the rest being set down in view on the table. This done, the dealer lays down the two best cards he can for his crib; and his antagonist lays down the other two, the very worst in his hand, the crib being the property of the dealer. They next turn up a card from the parcel left after dealing, and then count their game thus: Any fifteen upon the cards is two; as king and five, ten and five, nine and six, eight and seven, &c. A pair is also two; a pair-royal, or three aces, kings, &c. six; a double pair-royal, or four aces, &c. twelve. Sequences of three cards, as four five and six, is three; sequences of four, four; five, five, &c. and the same holds of a flush. Knave-noddy, or of the suit turned up, is one in hand, and two to the dealer. If, after the cards for the crib are laid out, you have in your hand a nine and two sixes, that makes six, because there are two fifteens and a pair; and if a six chance to be turned up, then you have twelve in your hand, viz. the pair-royal, and three fifteens. These are to be marked with pegs, counters, or otherwise. If you happen to have sequents, as of four five and six, in your hand, and six is the turned up card, they are counted thus: first, the sequents in your hand make three; and the sequents of the four and five in your hand, added to the six turned up, make other three: there are likewise two fifteens, counting first with the six in your hand, and then with that turned up.

This done, the antagonist to the dealer plays first, suppose a six; and if the dealer can make it fifteen, by playing nine, he gains two; otherwise they play on, and he that reaches thirty-one exactly, or comes nearest

under it, gains two or one. Here too, in playing the cards, you may make pairs, pairs-royal, flushes, &c. which are all counted as above.

As to the crib, it is the dealer's; who may make as many as he can out of it, together with the card turned up, counted as above; if he can make none, he is said to be bilked. Thus they play and deal by turns, till the game of sixty-one is up; and if either of the gamesters reach this before the other is forty-five, this last is said to be lurched, and the other gains a double game.

CRIME, crimen, the transgression of a law, either natural or divine, civil or ecclesiastic. Civilians distinguish between crimen and delictum. By the first, they mean capital offences, injurious to the whole community, as murder, perjury, &c. the prosecution of which was permitted to all persons, though no ways immediately interested. By the latter, they understand private offences committed against individuals, as theft, &c. By the laws, nobody was allowed to prosecute in these, except those interested.

With us, crimes are distinguished into capital, as treason, murder, robbery, &c. and common, as perjuries, &c. Again, some crimes are cognizable by the king's judges, as the above-mentioned; and others are only cognizable in the spiritual courts, as simple fornication.

CRIMSON, one of the seven red colours of the dyers. See DYEING.

CRINGLE, a small hole made in the bolt-rope of a sail, by intertwisting one of the divisions of a rope, called a strand, alternately round itself and through the strands of the bolt-rope, till it becomes threefold, and assumes the shape of a wreath or ring. The use of the cringle is generally to contain the end of some rope, which is fastened thereto for the purpose of drawing up the sail to its yard, or of extending the skirts by the means of bridles, to stand upon a side-wind. The word seems to be derived from krinckelen (Belg.), "to run into twists."

CRINODENDRUM, a genus of the class and order monadelphia decandria. There is no calyx; the corolla is bell-shaped, six-petalled; capsule one-celled, gaping elastically at top. There is one species, a native of Chili.

CRINUM, a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the ninth order, spathaceæ. The corolla is funnel-shaped, monopetalous, and sexpartite, with three alternate segments having hooked appendages; the germen is covered in the bottom of the corolla, the stamina standing asunder. They are very beautiful greenhouse plants, rising two or three feet high; each of them crowned by a large umbellate cluster of spathaceous, monopetalous, long, funnel-shaped flowers, blue, white, or striped, having a very fragrant smell. They are propagated by offsets. There are six species.

CRITHMUM, samphire; a genus of the digynia order, in the pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The fruit is oval and compressed: the florets equal. There are three species, the principal of which is the maritimum, or common maritime samphire. It has a fibrous penetrating root; thick, succulent, branchy stalks, rising two feet high; winged fleshy leaves, consisting of many small spear-shaped lobes; with round yellow flowers growing in umbels. It is produced naturally on the sea-coasts, among the gravel and rocks. Its leaves are an excellent pickle used for sauces, and are by many eaten raw in salads. It is of a saltish relish, palatable, and comfortable to the stomach. It is not very easily preserved in gardens. It must be sown on gravelly or rocky ground, half an inch deep; in which situation the plants will come up, and last some years. The leaves of this plant are said also to be aperient and diuretic.

CRISP-LEAF, among botanists, is one folded over and over, at the edges, which are always serrated, dentated, or lacerated. It is otherwise called curled.

CRITICISM may be regarded as embracing three separate branches: 1st. The establishing rules and principles for correct composition; such are the incomparable treatises of Cicero and Quinctilian upon oratory, and of Longinus on the sublime. In English we have many valuable essays and treatises of this class. The prefaces of Mr. Dryden are a rich mine of critical principles finely illustrated. Some of Mr. Addison's papers in the Spectator, and Mr. Pope's and Dr. Johnson's prefaces to Shakspeare, are excellent specimens of rational criticism. In more modern times we have had some excellent compendiums of criticism: among which lord Kaimes's Elements of Criticism, Dr. Blair's Lectures, Dr. Priestley's Lectures on Oratory and Criticism, and particularly bishop Lowth's Lectures on the Sacred Poetry of the Hebrews, deservedly hold a very high rank. See the articles RHETORIC and POETRY.

The second branch of critical science relates to the commenting upon antient authors, explaining difficult passages, and elucidating their beauties. Eustathius and the scholiasts, Vida, Scaliger, the Stephenses, and, above all, the gentlemen of Port Royal, have been great benefactors to the public in this way. The delphin and variorum editions of the classics do great credit to the learned persons by whom they were edited. Many editions of Shakspeare have been published with critical notes in this country. Mr. Theobald's was better than Mr. Pope's, except for the preface. Dr. Warburton entirely failed, for the same reason as Dr. Bentley in his edition of Milton, viz. indulging too freely in conjectural criticism. Dr. Johnson's explanatory notes on Shakspeare are excellent; and the profound reading of Malone, Steevens, and Farmer, in British and Saxon literature, have been excellently applied to the illustration of the first of dramatic poets.

The third branch of criticism regards the forming a correct judgment of the merits and demerits of contemporary writers. In this every man of education ought to qualify himself to see with his own eyes, and determine with his own understanding; and this is to be effected by the attentive study of the best works, antient and modern, on the general principles of criticism (see above). For to form our judgment on that of any other men is a species of literary slavery. The various partialities and conflicting interests by which mankind are governed, render it also very unsafe to rest our opinion upon that of others; and it is peculiarly unfortunate that this department of literature is seldom exercised by persons adequate, from education and experience, to the task. Where it is, there is no reason why the name of the critic should not be as *public* as that of the author; when that is not the case, his motive will be suspected; nor can the reader assent to observations from an authority, of the competency of which he is not assured. For these reasons but little credit is attached, except in remote country places, to anonymous criticism.

The great vices of modern criticism are pertness and flippancy. Writers of this class seem to consider the study of Joe Miller as of more importance to their craft than that of Quinctilian; and a readiness in the art of punning, as the highest praise and principal qualification of a critic.

CROCODILE. See LACERTA.

CROCODILE, *fossil*, one of the greatest curiosities in the fossil world which late ages have produced. It is the skeleton of a large crocodile, almost entire, found at a great depth under ground, bedded in stone. This was in the possession of Linkius, who wrote many pieces of natural history, and particularly an accurate description of this curious fossil. It was found in the side of a large mountain in the midland part of Germany, and in a stratum of black fossile stone, somewhat like our common slate, but of a coarser texture, the same with that in which the fossil fish in many parts of the world are found. This skeleton had the back and ribs very plain, and was of a much deeper black than the rest of the stone; as is also the case in the fossile fishes which are preserved in this manner. The part of the stone where the head lay was not found, this being broken off just at the shoulder, but that irregularly; so that in one place a part of the back of the head was visible in its natural form. The two shoulder-bones were very fair, and three of the feet were well preserved; the legs were of their natural shape and size, and the feet preserved even to the extremities of the five toes of each.

CROCODILE, *crocodilus*, in rhetoric, a captious and sophistical kind of argumentation, contrived to seduce the unwary, and draw them speciously into a snare. It has its name crocodile from the following occasion, invented by the poets: A poor woman begging a crocodile, that had caught her son walking by the river-side, to spare and restore him, was answered, that he would restore him, provided that she should give a true answer to a question he should propose. The question was, Will I restore thy son or not? To this the poor woman, suspecting a deceit, sorrowfully answered, Thou wilt not; and demanded then to have him restored, because she had answered truly. Thou liest, says the crocodile; for if I restore him thou hast not answered truly: I cannot therefore restore him without making thy answer false. Under this head may be reduced the propositions called "mentientes," or "insolubiles," which destroy themselves. Such is that of the Cretan poet: "Omnes ad unum Cretenses semper mentiuntur:" "All the Cretans, to a man, always lie." Either, then, the poet lies when he asserts that the Cretans all lie, or the Cretans do not all lie.

CROCUS, *saffron*, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking under the

sixth order, ensatæ. The corolla is sexpartite and equal; the stigmata convoluted, or rolled spirally inwards. There are two species of this genus, which, however, comprehend many beautiful varieties.

1. The officinalis, saffron, or autumnal crocus, has a small, roundish, brown, bulbous root, compressed at the bottom. Directly from the root issue many narrow leaves, of a deep-green colour; and amidst them the flowers are protruded from a thin univalvular radical spatha; the tube of the flower is long, standing on the root, and serving as a foot-stalk to the limb or upper part, which is erect, six-parted, widens gradually upward, and grows from about three to five or six inches high. The saffron has a long-tubed blueish-purple flower, with three stigmata of a fine golden colour, which form the saffron of the shops. The varieties are the autumnal small blue crocus; deep blue, sky blue, whitish blue, many-flowered whitish blue, purple, autumnal white crocus, and autumnal yellow crocus.

2. The vernalis, or vernal crocus, the varieties of which are, small and large, and golden yellow crocuses, and the yellow black-striped, the yellow purple-striped, and double cloth of gold; the white, white purple-striped, white purple bottom, white black-striped, whitish cream-coloured, whitish ash-coloured, little narrow-leafed white, and white blue-striped crocuses. Besides these there are a great many others of a blue and purple colour finely variegated. The autumnal crocuses flower about the beginning of October, but never ripen their seeds in this country.

CROISADE, *crusade*, or *crusado*, a name given to the expeditions of the christians against the infidels, for the conquest of Palestine; so called because those who engaged in the undertaking wore a cross on their clothes, and bore one on their standard. This expedition was also called the holy war, to which people flocked in great numbers from pure devotion; the pope's bulls, and the preaching of the priests of those days, making it a point of conscience. The several nations engaged in the holy war were distinguished by the different colours of their crosses: the English wore white, the French red, the Flemish green, the Germans black, and the Italians yellow. From this enterprise several orders of knighthood took their rise. They reckon eight croisades for the conquest of the holy land; the first begun in the year 1095, at the solicitation of the Greek emperor and the patriarch of Jerusalem.

CROISIERS, *cross-bearers*, a religious order founded in honour of the invention or discovery of the cross by the empress Helena. They follow the rule of St. Augustine.

CROISSANTE, in heraldry, is said of a cross, the ends of which are fashioned like a crescent or half-moon.

CROMLECHS, in British antiquities, are huge, broad, flat stones, raised upon other stones set up on end to support them. They are common in Anglesey. These monuments are spoken of largely by Mr. Rowland, by Dr. Borlase, and by Wormius, under the name of ara, or altar. Mr. Rowland, however, is undecided in his opinion; for he partly inclines to the notion of their having been altars, partly to their having been sepulchres: he supposes them to have been originally tombs, but that in after-times sacrifices were performed upon them to the heroes deposited within. Mr. Keiller preserves an account of king Harold having been interred beneath a tomb of this kind in Denmark, and Mr. Wright discovered in Ireland a skeleton deposited under one of them. The great similarity of the monuments throughout the north, Mr. Pennant observes, evinces the same religion to have been spread in every part, perhaps with some slight deviations. Many of these monuments are both British and Danish; for we find them where the Danes never penetrated.

The cromlech, or cromleh, chiefly differs from the kist-vaen, in not being closed up at the ends and sides, that is, in not so much partaking of the chest-like figure; it is also generally of larger dimensions, and sometimes consists of a greater number of stones: the terms cromleh and kist-vaen are however indiscriminately used for the same monument. The term cromlech is by some derived from the Armoric word crum, "crooked or bowing," and leh, "stone," alluding to the reverence which persons paid to them by bowing. Rowland derives it from the Hebrew words carem-luach, signifying "a devoted or consecrated stone." They are called by the vulgar coetne Arthor, or Arthur's quoits, it being a custom in Wales, as in Cornwall, to ascribe all great and wonderful objects to prince Arthur, the hero of those countries. See Plate Miscel. fig. 24.

CROSIER, or *crozier*, a shepherd's crook; a symbol of pastoral authority, consisting of a gold or silver staff, crooked at the top, carried occasionally before bishops and abbots, and held in the hand when they gave the solemn benedictions.

CROSIER, in astronomy, four stars in the southern hemisphere, in the form of a cross, serving those who sail in southern latitudes to find the antarctic pole.

CROSLET, in heraldry, is when a cross is crossed again at a small distance from each of the ends.

CROSS, *invention of the*, a festival observed May 3, by the Latin church, in memory of the empress Helena (the mother of Constantine) finding the true cross of Christ, on mount Calvary, where she caused to be erected a church for the preservation of it.

CROSS, *order of the*, an order of ladies instituted in 1668, by the empress Eleanora de Gonzagua, wife of the emperor Leopold, on occasion of the miraculous recovery of a little golden cross, in which were inclosed two pieces of the true cross, out of the ashes of a part of the palace that had been burnt down: though the fire burnt the case wherein it was enclosed, and melted the crystal, it appears that the wood had not received the least damage.

CROSS, in heraldry, is defined by Guillim, an ordinary composed of fourfold lines, whereof two are perpendicular, and the other two transverse. The content of a cross is not always the same; for when it is not charged, it has only the fifth part of the field; but if it is charged, then it must contain the third part thereof. This bearing was bestowed on such as had performed, or at least undertaken, some service for Christ and the christian profession; and is therefore held by several authors the most honourable charge in all heraldry. What brought it into such frequent use, was the antient expeditions into the holy land, the cross being the ensign of that war.

CROSS, in surveying, an instrument consisting of a brass circle, divided into four equal parts, by two lines intersecting each other at the centre; at the extremity of each line there is a sight fixed, standing perpendicularly over the line, with holes below each slit, for the better discovery of distant objects. See SURVEYING.

CROSS-BAR SHOT, a bullet with an iron bar passing through it, and standing six or eight inches out at both sides: it is used at sea for destroying the enemy's rigging.

CROSS-TREES, in a ship, four pieces of timber, bolted and let into one another across, at the head of the mast. Their use is to keep and bear the top-mast up; for the foot of the top-mast is always fastened into them.

CROSSELET, a little or diminutive cross, used in heraldry, where the shield is frequently seen covered with crosselets; also fesses and other honourable ordinaries, charged or accompanied with crosselets. Crosses frequently terminate in crosselets.

CROSSOTYLUS, a genus of the polyandria order, in the monadelphia class of plants. The calyx is quadrifid; the corolla consists of four petals; the stamina are 20 filiform filaments, almost the length of the calyx; the antheræ small and roundish; the pericarpium an hemispherical, unilocular berry, with many striæ on its upper part; the seeds numerous and roundish. There is one species, a native of the Society Isles.

CROTALARIA, *rattle-wort*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The legumen is turgid, inflated, and pedicellated; the filaments are connate, with a fissure on the back. There are 32 species, all of them natives of warm climates. They rise from eighteen inches to five feet in height, and are adorned with flowers of a red, blue, or yellow colour. The most remarkable species is the retusa, with simple and oblong wedged leaves. It is a native of the island of Ceylon, and some other parts of the East Indies. The flowers are yellow; the pods smooth, cylindrical, inflated, and placed horizontally; they are filled with seeds, which, when dried, and shaken by the lightest wind, produce a rattling noise; and this, by the rude inhabitants of the countries where the plant is native, is attributed to the devil, who is thought to deliver his oracles in this whimsical manner.

CROTALUM (from the Greek), synonymous with cymbalum. The name of an antient musical instrument. See CYMBALUM.

CROTALUS, *rattlesnake*, a genus belonging to the order of amphibia serpentes, the generic character of which is, scuta on the abdomen; scuta and squamæ beneath the tail; rattle terminating the tail.

1. Crotalus horridus, or banded rattlesnake. The genus crotalus, or rattlesnake, affords the most signal examples of the powerfully destructive poison with which some of the serpent tribe are furnished; instances having frequently occurred in which the bite

of these snakes has proved fatal to mankind, in the space even of a very few minutes.

Till the discovery of the western hemisphere, the knowledge of these serpents was concealed from the rest of the world: and philosophers then first beheld with amazement a reptile of the most fatal nature, furnished, as if by a peculiar institution of Providence, with an instrument capable, in general, of warning mankind of their danger in too near an approach.

The different species of rattlesnakes seem to have been generally confounded with each other; and even Catesby, who travelled in those parts of North America where it is found, seems to have been unacquainted with one of the most remarkable species; and to have particularly described the banded rattlesnake only, which he has also figured with sufficient clearness to prevent its being confounded with any other kind, though not with that minute attention to all the particulars which the more improved state of natural history at present demands.

This species is found, in general, from three to four or five feet in length; and is of a yellowish-brown colour, marked throughout its whole length with several transverse and somewhat irregular fasciæ of deep brown, and from the head to some distance down the neck run two or three longitudinal stripes of the same colour; the head is large, flat, and covered with small scales; the rest of the upper parts with moderately large oval ones, all strongly carinated or furnished with a prominent line down the middle: the under parts are of a dingy yellowish-brown colour, marked with numerous dusky variegations and freckles: at the extremity of the tail is situated the rattle, consisting of several hard, dry, horny processes, the peculiar structure of which will be more amply described hereafter; and which, on the least disturbance or irritation, is elevated and shaken in such a manner as to cause a strong or brisk rattling sound.

"The largest rattlesnake," says Catesby, "which I ever saw, was about eight feet in length, and weighing between eight and nine pounds. They are the most inactive and slow-moving snake," adds this author, "of all others, and are never the aggressors, except in what they prey upon; for unless they are disturbed they will not bite; and when provoked they give warning by shaking their rattles."

The charming, as it is commonly called, or attractive power this snake is said to have, of drawing to it small animals, and devouring them, is generally believed in America. The manner of the process is said to be, that the animals, particularly birds and squirrels (which principally are their prey), no sooner spy the snake than they skip from spray to spray, hovering and approaching gradually nearer to their enemy, regardless of any other danger; but with distracted gestures and outcries, descend, though from the top of the loftiest trees, to the mouth of the snake, who opens his jaws, takes them in, and in an instant swallows them. This we believe to be merely an effect of fear in the victim, and the account is probably exaggerated. "With respect to the use of the rattle," says Dr. Mead, "a vulgar error has obtained, even among the learned, about it. It is commonly said that it is a kind contrivance of divine Providence, to give warning to passengers by the noise which this part makes, when the creature moves, to keep out of the way of its mischief. Now this is a mistake. It is beyond all dispute that wisdom and goodness shine forth in all the works of the creation; but the contrivance here is of another kind than is imagined. All the parts of animals are made either for the preservation of the individual, or for the propagation of its species: this before us is for the service of the individual. This snake lives chiefly upon squirrels and birds, which a reptile can never catch without the advantage of some management to bring them within its reach. The way is this. The snake creeps to the foot of a tree, and, by shaking his rattle, awakens the little creatures which are lodged in it. They are so frightened at the sight of their enemy, who fixes his lively piercing eyes upon one or other of them, that they have no power to get away, but leap about, from bough to bough, till they are quite tired, and at last, falling to the ground, they are snapped into his mouth. This is by the people of the country called charming the squirrels and birds."

Dr. Barton, professor of natural history in the university of Pennsylvania, in a memoir on the supposed fascinating power of the rattlesnake, imagines the whole to be no more than the fluttering of old birds in defence of their young, and which are themselves occasionally caught by the rattlesnake in consequence of too near an approach.

Rattlesnakes in general swarm in the less inhabited parts of North America; but are now almost extirpated in the more populous parts. None are found farther north than the mountains near lake Champlain; but they infest South America, even as far as Brasil. They love woods and lofty hills, especially where the strata are rocky or chalky: the pass near Niagara abounds with them. Being slow of motion, they frequent the sides of rills, to make prey of frogs, or such animals as resort there to quench their thirst: are generally found during summer in pairs; in winter collecting in multitudes, and retiring under ground, beyond the reach of frost: tempted by the warmth of a spring day, they are often observed to creep out weak and languid: a person has seen a piece of ground covered with them, and killed with a rod between sixty and seventy, till overpowered with the stench he was obliged to retire.

The rattlesnake is a viviparous animal, producing its young in the month of June, generally about twelve in number; and which by September acquire the length of twelve inches. It is said to practise the same extraordinary mode of preserving its young from danger as is attributed to the viper in Europe, viz. of receiving them into its mouth, and swallowing them. For this we have the attestation of M. de Beauvois, who declares himself an eye-witness of the process. This gentleman saw a large rattlesnake, which he happened to disturb in his walks, and which immediately coiled itself up, opened its jaws, and instantly five small ones, which were lying by it, rushed into its mouth. He retired, and watched the snake, and in a quarter of an hour saw her again discharge them. He then approached it a second time, when the young retired into its mouth with greater celerity than before, and the snake immediately moved off among the grass, and escaped. See Pl. N. H. fig. 150.

2. Crotalus durissus, or striped rattlesnake. This species may, in general, be readily distinguished from the former by the different disposition of its colours; being of a deep brown above, with a very regularly conducted pattern of pale-yellow streaks, so disposed as to form a continued series of large rhombs or lozenges down the back, the stripes growing somewhat less distinct as they descend on the sides. The size and general proportions of the animal resemble those of the former, with which indeed it appears to have been very frequently confounded. It is also a native of the same parts of America. Its bite, so far as can be ascertained by experiments made with such specimens as have been transported into Europe, appears to be equally fatal with that of the former species.

3. Crotalus dryinas, or wood rattlesnake. This is said to be of a paler or lighter tinge than the two former species, and to be variegated with yellowish marks on the back.

4. Crotalus miliarius, or miliary rattlesnake. Mr. Catesby, the first describer of this animal, seems to entertain some doubts whether it really differs from the common rattlesnake in any other respect than in colour, its prevailing tinge being grey-brown, shaded on the back with red, and marked by large black spots with white indented edges. It appears, however, to be a truly distinct species, differing not only in colour but in the smaller number of its abdominal scuta. This is the smallest species of rattlesnake yet known, rarely exceeding the length of two feet. In its general habits it resembles the preceding kinds.

CROTAPHITES, in anatomy, a muscle of the lower jaw, serving to draw it upwards.

CROTCHES, in ship-building, very crooked timbers in the hold or bread-room, from the mizen-step aft, fayed across the keelson, to strengthen the ship in the wake of the half-timbers.

CROTCHES, *iron*, crooked pieces of iron, used on board sloops and long-boats which go with shoulder-of-mutton sails, for the boom to lodge on.

CROTCHET, in music, one of the notes or characters of time, marked thus ♩, equal to half a minim, and double of a quaver. A dot added to the crotchet thus ♩., increases its time by one-half, that is, makes it equal to a crotchet and a half.

CROTCHETS, marks or characters, serving to inclose a word or sentence, which is distinguished from the rest, being generally in the form [ ], or this ( ).

CROTON, *wild ricinus*, a genus of the monadelphia order, in the monœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ. The male calyx is cylindrical and quinquedentated; the corolla is pentapetalous; the stamina from 10 to 15. The female calyx is polyphyllous; no corolla; three bifid styles; the capsule trilocular; one seed. There are 53 species, of which the most remarkable are:

1. The tinctorium, or plant from which the French turnsole is made. This grows naturally in the south of France; it is an annual plant, rising about nine inches high, with

an herbaceous branching stalk, with irregular or rhomboidal figured leaves, which are near two inches long. The flowers are produced in short spikes from the sides of the stalks, at the end of the branches; the upper part of the spike is composed of male flowers, having many stamina which coalesce at the bottom; the lower part has female flowers, which have each a roundish three-cornered germen; these afterwards become a roundish capsule with three lobes, having three cells, each including one roundish seed. This flowers in July; but unless the plants are brought forward on a hotbed, they do not ripen seeds in this country. From this plant is made the turnsole used for colouring wines and jellies. It is made of the juice which is lodged between the empalement and the seeds; which, if rubbed on cloths, at first appears of a lively green, but afterwards changes to a blueish-purple colour. If these cloths are put into water, and afterwards wrung, they will dye the water to a claret-colour. The rags thus dyed are brought to this country, and sold in the druggists' shops under the name of turnsole.

2. The seviferum, or tallow-tree, with rhomboidal egg-shaped leaves, pointed, smooth, and very entire. It is about the height of a cherry-tree; its leaves in form of a heart, of a deep shining red colour, and its bark very smooth. Its fruit is enclosed in a kind of pod, or cover, like a chesnut; and consists of three round white grains, of the size and form of a small nut, each having its peculiar capsule, and within that a little stone. This stone is encompassed with a white pulp, which however is not the tallow, as is erroneously supposed, for that is expressed from the kernels; and the Chinese make their candles of it; which would doubtless be as good as those in Europe, if they knew how to purify their vegetable tallow as well as we do our animal kind, and to make their wicks as well.

3. The aromaticum, with heart-shaped serrated leaves, and an arborescent stem. The bark of this tree is the same as the cascarilla and eleutheria, though these have been considered by some as distinct barks, and sold in the shops as different productions. It is a hot, acrid, aromatic bitter, resembling in appearance the Peruvian bark, but is more bitter and pungent, though not so rough and astringent. It was first introduced into Europe about the end of the last century, and seems first to have been used in Germany, where it is still in very high esteem. There it is frequently employed in intermittent fevers, in preference to the Peruvian bark, as being less subject to some inconveniences to which the latter is deemed liable. It is also said to have been employed with great success in some very dangerous epidemic fevers attended with petechiæ; and it is frequently employed with advantage in dysenteries, diarrhœas, &c. In Britain it has also been used by some practitioners. Its virtues are partly extracted by water, and totally by rectified spirit, but it is most effectual when given in substance.

4. The cascarilla, described by Linnæus as producing the officinal bark of that name, is, according to Dr. Wright, the wild-rosemary shrub of Jamaica, the bark of which has none of the sensible qualities of the true cascarilla or eleutheria above described.

CROTOPHAGA, in ornithology, a genus of birds belonging to the order of picæ. There are two species, the characters of which are: the bill is thin, compressed, greatly arched, half oval, and cultrated at top; the nostrils are round; the tongue flat, and pointed at the end; the tail consists of ten feathers; and the toes are placed two and two. The most remarkable species is the ani, which is about the size of a blackbird: the colour of the whole bird is black, in some parts glossed with purple, and about the neck faintly tinged with green on the margins: the base of the bill is furnished with black bristles, which turn forwards: the eyelids have long hair-like eyelashes: the tail is six inches long, and much cuneated; and the legs are black. This species is found in Jamaica, St. Domingo, and other islands in the West Indies; also at Cayenne, and other parts of South America. Contrary to all other birds, they have the singularity of many lying in the same nest; to make which they all unite in concert, and, after laying their eggs, sit on them close to each other to hatch them, each amicably striving to do the best for the general good; and when the young are hatched, the parents, without reserve, do their best to feed the whole flock. Still a greater singularity occurs, which is, that as soon as each female lays her eggs she covers them with leaves, doing the same thing whenever she is obliged to leave the nest for food: this might be necessary in a cold climate; but why it should be wanted in a hot one seems not clear, especially as it has not been observed in other birds. The female has two broods in a year, except accidents happen; in which case she has been known to make three nests. The eggs are about the size of those of a pigeon, of a sea-green colour, spotted at the ends. Their food is various; worms, insects, fruits, and grain, according to the season. There is a variety called the greater ani, which is about the size of a jay, differing no otherwise from the former but in size. They ought, however, to be considered as two distinct species: for they never mix together, though each has the same manners, with this difference only, that the smaller frequent the savannas, the larger only the salt-marshes near the sea-coasts. It is said that they are easily made tame, and will learn to talk like parrots. The male and female are both alike. Both species are easy to be shot, not being so wild as many other birds; but are known to chatter much on the sight of a man, though they do not fly to a great distance.

CROUP *of a horse*, in the manege, the extremity of the reins above the hips.

CROW. See CORVUS.

CROW, in mechanics, a kind of iron lever with a claw at one end, and a sharp point at the other: used for heaving or purchasing great weights.

CROW'S BILL, among surgeons, a kind of forceps, for drawing bullets and other foreign bodies out of wounds.

CROW'S FEET, in the military art, machines of iron, having four points, each about three or four inches long, so made that whatever way they fall there is still a point up: they are thrown upon breaches, or in passes where the enemy's cavalry are to march, proving very troublesome, by running into the horses' feet, and laming them.

CROW'S FEET, in a ship, small lines or ropes, sometimes eight or ten, reeved through the dead-men's-eyes; and scarcely of any other use than to make a shew of small rigging. They are usually placed at the bottom of the back-stays of the fore-top-mast, mizen-top-mast, and top-gallant-mast. See Plate Miscel. fig. 25.

CROW-NET, is an invention for catching wild-fowl in the winter season, and may be used in the day-time. This net is made of double thread, or fine packthread; the meshes should be two inches wide, the length about ten yards, and the depth three; it must be verged on the side with good strong cord, and stretched out very stiff on long poles prepared for that purpose. When you come to the place where you would spread your net, open it, and lay it out at its full length and breadth: then fasten the lower end of the net all along the ground, so as only to move it up and down; the upper end of the net must stand extended on the long cord, the further end being staked first to the earth by a strong cord about five yards distant, from the net. Place this cord in an even line with the lower edge of the net. The other end must be at least 25 yards distance, to reach into some natural or artificial shelter, by the means of which you may lie concealed from the fowl, otherwise no good success can be expected. The net must be placed in such exact order that it may give way to play on the fowl on the least pull of the cord, which must be done smartly, lest the fowl should prove too quick for you. This net may be used for pigeons, crows, or other birds, on corn-fields newly sown; as also in stubble-fields, provided the stubble conceals the net from the birds.

CROWN, in heraldry, is used for the representation of that ornament, in the mantling of an armoury, to express the dignity of persons.

CROWN, *the imperial*, is a bonnet or tiara, with a semicircle of gold, supporting a globe with a cross at top.

CROWN, *the British*, is adorned with four crosses, between which there are four fleurs-de-lis: it is covered with four diadems, which meet at a little globe supporting a cross.

CROWN, *the French*, was a circle of eight fleurs-de-lis, encompassed with six diadems, bearing at top a double fleur-de-lis, which was the crest of France.

CROWN, *the Spanish*, is adorned with large indented leaves, and covered with diadems terminating in a globe, surmounted with a cross.

The crowns of almost all other kings are adorned with large leaves, bordered with four, six, or eight diadems, with a globe and cross at top.

CROWN, *the papal*, is composed of a tiara and a triple crown encompassing it, with two pendants like the bishops' mitres. These crowns represent the pretended triple capacity of the pope, as high-priest, supreme judge, and sole legislator of Christians.

CROWN, *electoral*, or coronet, is a scarlet cap turned up with ermine, and closed with a semicircle of gold, all covered with pearls, with a globe at top, surmounted with a golden cross.

CROWNS *of British princes of the blood.* 1. The prince of Wales's crown consists alternately of crosses and fleurs-de-lis, with

one arch, in the middle of which are a ball and cross, as in the royal diadem. 2. That of all the younger sons and brothers of the king, consist likewise of crosses and fleurs-de-lis alternately, but without any arch, or being surmounted with a globe and cross at top. 3. That of the other princes of the blood consists alternately of crosses and leaves like those in the coronet of dukes.

CROWNS *of noblemen*, are a duke's, composed of leaves of smallage, or parsley: that of a marquis, of flowers and pearls placed alternately: an earl's has no flowers about the circle, like the duke's and marquis's, but only points rising, and a pearl on every one of them: a viscount has neither flowers nor points raised above the circle, like the other superior degrees, but only pearls placed on the circle itself without any limited number: a baron's has only six pearls on the golden border, not raised, to distinguish him from the earls; and the number of them limited, to shew he is inferior to the viscount.

CROWN, in commerce, a general name for coins both foreign and domestic, which are of, or very near, the value of five shillings sterling. See COIN.

CROWN, in architecture, denotes the uppermost member of the cornice, called also corona, and larmier.

CROWN, in astronomy, a name given to two constellations, the one called borealis, the other meridionalis.

CROWN is used also for the clerical tonsure, which is the mark and character of ecclesiastics of the Romish church. It is a little circle of hair shaved from the crown of the head, more or less large, according to the quality of the orders received. That of a mere clerk is the smallest, that of priests and monks the largest.

CROWN, in geometry, is a plane ring included between two concentric perimeters, and is generated by the motion of some part of a right line round the centre, the said moving part not being contiguous to the centre.

The area of a crown will be had by multiplying its breadth by the length of the middle periphery; for a series of terms in arithmetic progression being $n \times \frac{a + w}{2}$, that is, the sum of the first and last multiplied by half the number of terms, the middle terms must be $\frac{a + w}{2}$; therefore that multiplied by the breadth, or sum of all the two terms, will give the crown.

CROWN *of colours*, certain coloured rings which like halos appear about the body of the sun or moon, but of the colours of the rainbow, and at a less distance than the common halos. These crowns sir Isaac Newton has shewn to be made by the sun's shining in a fair day, or the moon in a clear night, through a thin cloud of globules of water or hail all of the same bigness. And according as the globules are greater or less, the diameters of these crowns will be larger or smaller; and the more equal these globules are to one another, the more crowns of colours will appear, and the colours will be the more lively.

CROWN-OFFICE. The court of king's bench is divided into the plea side and the crown side. In the plea side it takes cognizance of civil causes; in the crown side it takes cognizance of criminal causes, and is therefore called the crown-office. In the crown-office are exhibited informations in the name of the king, for crimes and misdemeanors at common law, as in the case of batteries, conspiracies, libelling, &c. for which the offender is liable to pay a fine to the king.

CROWN-POST, in architecture, a post which in some building stands upright in the middle between two principal rafters, and from it there go struts or braces to the middle of each rafter. It is sometimes called a king's piece, or joggle piece.

CROWN-WHEEL *of a watch*, the upper wheel next the balance, which by its motion drives the balance, and in royal pendulums is called the swing-wheel.

CROWN-WORK, in fortification, an outwork having a very large gorge, generally the length of the curtin of the place, and two long sides terminating towards the field in two demibastions, each joined by a particular curtin to a whole bastion, which is the head of the work. The crown-work is intended to inclose a rising ground, or to cover the head of a retrenchment.

CROWTH, or CRUTH, a musical instrument formerly much in use among the common people in Wales. It resembles in some respects the violin. See Pl. Miscel. fig. 26.

CRUCIANELLA, petty madder, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 47th order, stellatæ. The corolla is monopetalous and funnel-shaped, with a filiform tube and a tailed border; the calyx is diphyllous, and there are two linear seeds. There are nine species, natives of the southern parts of Europe; but none of them possessed of any remarkable quality.

CRUCIBLE, a chemical vessel made of earth, and so tempered and baked as to endure the greatest fire. They are used to melt metals, and to flux minerals, ores, &c. See CHEMISTRY.

CRUCITA, or cruzita, a genus of the digynia order, in the tetrandria class of plants, and in the natural method ranking with those the order which is doubtful. The interior calyx is tetraphyllous, the exterior calyx triphyllous; there is no corolla, and only one seed. There is one species.

CRURÆUS, or *cruræus musculus*. See ANATOMY.

CRURAL, in anatomy, an epithet given to the artery which conveys the blood to the crura or legs, and to the vein by which this blood returns towards the heart. See ANATOMY.

CRUSCA, an Italian term signifying bran, is in use among us to denote the celebrated academy called Della Crusca, established at Florence, for purifying and perfecting the Tuscan language.

CRUST. By crusts we understand those bony coverings of which the whole external surface of crabs, lobsters, and other similar sea-animals, is composed. These consist of, 1. Cartilaginous substance, possessing the properties of coagulated albumen. 2. Carbonate of lime. 3. Phosphat of lime. By the presence of the phosphat of lime, they are distinguished from bones. Thus the crusts lie as an intermediate substance between bones and shells, partaking of the properties and constitution of each. The shells of the eggs of fowls must be referred likewise to the class of crusts, since they contain both phosphat and carbonat of lime; the animal cement in them, however, is much smaller in quantity. From the experiments of Berniard and Hatchett, it is extremely probable that the shells of snails are composed likewise of the same ingredients, phosphat of lime having been detected in them by these chemists.

Mr. Hatchett examined the crust of crabs, lobsters, prawns, and cray-fish. When immersed in diluted nitric acid, these crusts effervesced a little, and gradually assumed the form of a yellowish-white soft elastic cartilage, retaining the form of the crust. The solution yielded a precipitate to acetat of lead, and ammonia threw down phosphat of lime. Carbonat of ammonia threw down a much more copious precipitate of carbonat of lime. On examining the crust which covers different species of echini, Mr. Hatchett found it correspond with the other crusts in its composition. Some species of star-fish yielded phosphat of lime, others none: hence the covering of that genus of animals seems to be intermediate between shell and crust.

With these observations of Mr. Hatchett the analysis of Merat-Guillot corresponds. From lobster-crust he obtained

60	carbonat of lime
14	phosphat of lime
26	cartilage
100.	

One hundred parts of cray-fish crust contain

60	carbonat of lime
12	phosphat of lime
28	cartilage
100.	

One hundred parts of hen's egg-shells contain

89.6	carbonat of lime
5.7	phosphat of lime
4.7	animal matter
100.0	

CRUSTACEOUS *fish*, in natural history, are those covered with shells consisting of several pieces or scales; as those of crabs, lobsters, &c. These are usually softer than the shells of the testaceous kind, which consist of a single piece, and generally are thicker and stronger than the former; such as those of the oyster, scallop, cockle, &c. Dr. Woodward observes, in his Natural History, that of all the shells found in beds, and of all the different matters dug out of the earth, there are scarcely any of the crustaceous kind: the reason he gives for it is, that these being much lighter than the rest, must have floated on the surface at the time of the Deluge, when all the strata were formed, and there have corrupted and perished.

CRYPSIS, a genus of the diandria digynia class and order. The calyx is a glume, two-valved, one-flowered; corolla glume, two-valved, awnless. There is one species, a grass of Siberia.

CRYPTOCEPHALUS, a genus of insects of the coleoptera class; antennæ filiform; feelers four; thorax margined; shells unmarginate; body somewhat cylindrical.

This is a very extensive genus, and consists of 268 species. See Pl. N. H. figs. 151, 152.

CRYPTOGAMIA, one of Linnæus's classes of plants, the organs of fructification of which are either concealed within the fruit itself, or so minute as to escape observation. It embraces 4 orders; filices, musci, algæ, and fungi, which see.

CRYPTOSTOMUM, a genus of the pentandria class and order. The calyx is five-cleft; tube of corolla inserted into the throat of the calyx; borders five-cleft; nect. five-toothed; berry, seeds scarred. There is one species, a shrub of Guiana.

CRYSTAL, in natural history, the name of a very large class of fossils, hard, pellucid, and naturally colourless.

CRYSTALLIZATION. The word crystal originally signified ice; but it was afterwards applied by the antients to crystallized silica, or rock crystal; because, as Pliny informs us, they considered that body as nothing else than water congealed by the action of cold. Chemists afterwards applied the word to all transparent bodies of a regular shape; and at present it is employed to denote in general the regular figures which bodies assume when their particles have full liberty to combine according to the laws of cohesion. These regular bodies occur very frequently in the mineral kingdom, and have long attracted attention on account of their great beauty and regularity. By far the greater number of the salts assume a crystalline form; and as these substances are mostly soluble in water, we have it in our power to give the regular shape of crystals in some degree at pleasure.

All the substances with which we are acquainted may be divided into solid, liquid, and gaseous. Crystals are obviously confined to the first set, the fluidity of the two last rendering them incapable of retaining a regular form; but many of them may be made to assume a solid state, and in that case they usually crystallize. Most solid bodies either occur in the state of crystals, or are capable of being made to assume that form. Now it has long been observed by chemists and mineralogists, that there is a particular form which every individual substance always affects when it crystallizes: this indeed is considered as one of the best marks for distinguishing one substance from another. Thus common salt is observed to assume the shape of a cube; and alum that of an octahedron, consisting of two four-sided pyramids, applied base to base. Saltpetre affects the form of a six-sided prism; sulphat of magnesia, that of a four-sided prism; and carbonat of lime is often found in the state of a rhomboid. Not that every individual substance always uniformly crystallizes in the same form; for this is liable to considerable variations, according to the circumstances of the case; but there are a certain number of forms peculiar to every substance; and the crystals of that substance, in every case, adopt one or other of these forms, and no other; and thus common salt, when crystallized, has always either the figure of a cube or octahedron, or some figure reducible to these.

As the particles of bodies must be at liberty to move before they crystallize, it is obvious that we cannot reduce any bodies to the state of crystals, except those which we are able to make fluid. Now there are two ways of rendering bodies fluid, namely, solution in a liquid, and fusion by heat. These of course are the only methods of forming crystals in our power.

Solution is the common method of crystallizing salts. They are dissolved in water: the water is slowly evaporated; the saline particles gradually approach each other, combine together, and form small crystals; which become constantly larger by the addition of other particles, till at last they fall by their gravity to the bottom of the vessel. Or a saturated solution being prepared in hot water, it is set by to cool. On the escape of the caloric, by which, in fact, the solution was in great part accomplished, the salt crystallizes. Such salts commonly form in groups, attached to the sides or bottom of the vessel, or depending from a pellicle. They usually contain more water of crystallization than the former class.

There are many substances, however, neither soluble in water nor other liquids, which, notwithstanding, are capable of assuming a crystalline form. This is the case with the metals, with glass, and some other bodies. The method employed to crystallize them is fusion, which is a solution by means of caloric alone. By this method particles are separated from one another; and if the cooling proceeds gradually, they are at liberty to arrange themselves in regular crystals.

To obtain large artificial crystals of a regular shape requires considerable address and much patient attention. This curious branch of practical chemistry has been much improved by Mr. Leblanc; who has not only succeeded in obtaining regular crystals of almost any size at pleasure, but has made many interesting observations on crystallization in general. His method is as follows: The salt to be crystallized is dissolved in water, and evaporated to such a consistency that it shall crystallize on cooling. Set it by, and when quite cold pour the liquid part from the mass of crystals at the bottom, and put it into a flat-bottomed vessel. Solitary crystals form at some distance from each other, and these may be observed gradually increasing. Pick out the most regular of these, and put them into a flat-bottomed vessel at some distance from each other, and pour over them a quantity of liquid obtained in the same way by evaporating a solution of the salt till it crystallizes on cooling. Alter the position of every crystal once at least every day with a glass rod, that all the faces may be alternately exposed to the action of the liquid: for the face on which the crystal rests never receives any increment. By this process the crystals gradually increase in size. When they have acquired such a magnitude that their form can easily be distinguished, the most regular are to be chosen, or those having the exact shape which we wish to obtain; and each of them is to be put separately in a vessel filled with a portion of the same liquid, and turned in the same manner several times a day. By this treatment they may be obtained of almost any size we think proper. After the crystal has continued in the liquid for a certain time, the quantity of salt held in solution becomes so much diminished, that the liquid begins to act upon the crystal and redissolves it. This action is first perceptible on the angles and edges of the crystal. They become blunted, and gradually lose their shape altogether. Whenever this begins to be perceived, the liquid must be poured off, and a portion of new liquid put in its place; otherwise the crystal is infallibly destroyed. Mr. Leblanc has observed, that this singular change begins first at the surface of the liquid, and extends gradually to the bottom; so that a crystal, if large, may be often perceived in a state of increase at its lower end, while it is disappearing at its upper extremity. Mr. Leblanc even affirms that saline solutions almost always increase in density according to their depth from the surface.

It has been observed, that those salts which crystallize upon cooling, do not assume a crystalline form so readily if they are allowed to cool in close vessels. If a saturated solution of sulphat of soda, for instance, in hot water, is put into a phial, corked up closely, and allowed to cool without being moved, no crystals are formed at all; but the moment the glass is opened the salt crystallizes with such rapidity that the whole of the solution in a manner becomes solid. It seems then that the caloric, or rather the last portions of it, cannot be carried off without the air or the atmospherical pressure in the liquid.

Not only salts, but water itself, which commonly crystallizes at 32°, may be made to exhibit the same phenomenon: it may be cooled much lower than 32 degrees without freezing. This, as Dr. Black has completely proved, depends entirely upon the retention of caloric.

The phenomena of crystallization seem to have attracted but little of the attention of the antient philosophers. Their theory, indeed, that the elements of bodies possess certain regular geometrical figures, may have been suggested by these phenomena; but we are ignorant of their having made any attempt to explain them. The schoolmen ascribed the regular figure of crystals to their substantial forms, without giving themselves much trouble about explaining the meaning of the term. This notion was attacked by Boyle; who proved that crystals are formed by the mere aggregation of particles. But it still remained to explain why that aggregation took place; and why the particles united in such a manner as to form regular figures.

The aggregation is evidently the consequence of attraction, but to explain the cause of the regular figures is a more difficult task. Newton has remarked, that the particles of bodies, while in a state of solution, are arranged in the solvent in regular order and at regular distances; the consequence of which must be, that when the force of cohesion becomes sufficiently strong to separate them from the solvent, they will naturally combine in groups, composed of those particles which are nearest each other. Now all the particles of the same body must be supposed to have the same figure: and the combination of a determinate number of similar bodies must produce similar figures. Hauy has made it exceedingly probable that these integrant particles always combine in the same body in the same way; that is to say, that the same faces, or the same edges, always attach themselves together; but that these differ in different crystals. This can scarcely be accounted for, without supposing that the particles of bodies are endowed with a certain polarity, which makes them attract

one part of a different particle and repel the other parts. This polarity would explain the regularity of crystallization; but it is itself inexplicable.

It is remarkable that crystals not only assume regular figures, but are always bounded by plane surfaces. It is very rarely indeed that curved surfaces are observed in these bodies; and when they are, the crystals always give unequivocal proofs of imperfection. But this constant tendency towards plane surfaces is inconceivable, unless the particles of which the crystals are composed are themselves regular figures, and bounded by plane surfaces.

If the figure of crystals depends upon the figure of their integrant particles, and upon the manner in which they combine, it is reasonable to suppose that the same particles when at full liberty, will always combine in the same way, and consequently that the crystals of every particular body will be always the same. Nothing at first sight can appear farther from the truth than this. The different forms which the crystals of the same body assume are often very numerous, and exceedingly different from each other. Carbonat of lime, for instance, has been observed crystallized in no fewer than forty different forms, fluat of lime in eight different forms, and sulphat of lime in nearly an equal number.

But this inconsistency is not so great as might at first sight appear. Romé de Lisle has shown that every body susceptible of crystallization has a particular form which it most frequently assumes, or at least to which it does most frequently approach. Bergman has demonstrated, that this primitive form, as Hauy has called it, very often lies concealed in those very crystals which appear to deviate farthest from it. And Hauy has demonstrated, that all crystals either have this primitive form, or at least contain it as a nucleus within them; for it may be extracted out of all of them by a skilful mechanical division. See Plate Crystallization.

Happening to take up an hexangular prism of calcareous spar, or carbonat of lime, which had been detached from a group of the same kind, he observed that a small portion of the crystal was wanting, and that the fracture presented a very smooth surface. Let *a b c d e f g h* (fig. 1.) be the crystal: the fracture lay obliquely as the trapezium *p s u t*, and made an angle of 135 degrees, both with the remainder of the base *a b c s p h*, and with *t u e f*, the remainder of the side *i n e f*. Observing that the segment *p s u t i n* thus cut off had for its vertex *i n*, one of the edges of the base *a b c n i h* of the prism, he attempted to detach a similar segment in the part to which the next edge *c n* belonged; he employed for that purpose the blade of a knife, directed in the same degree of obliquity as the trapezium *p s u t*, and assisted by the strokes of a hammer. He could not succeed: but on making the attempt upon the next edge *b c*, he detached another segment, precisely similar to the first, and which had for its vertex the edge *b c*. He could produce no effect on the next edge *a b;* but from the next following, *a h*, he cut a segment similar to the other two. The sixth edge likewise proved refractory. He then went to the other base of the prism, *d e f g h r*, and found that the edges which admitted sections similar to the preceding ones were not the edges *e f*, *d r*, *g k*, corresponding with those which had been found divisible at the opposite base, but the intermediate edges *d e*, *k r*, *g f*. The trapezium *l q y v* represents the section of the segment which had *k r* for its vertex. This section was evidently parallel to the section *p s u t*, and the other four sections were also parallel two and two. These sections were, without doubt, the natural joinings of the layers of the crystal; and he easily succeeded in making others parallel to them, without its being possible for him to divide the crystal in any other direction. In this manner he detached layer after layer, approaching always nearer and nearer the axis of the prism, till at last the bases disappeared altogether, and the prism was converted into a solid OX (fig. 2), terminated by twelve pentagons parallel two and two; of which those at the extremities, that is to say, ASRIO, IGEDO, BAODC, at one end, and FKNPQ, MNPXU, ZQPXY, at the other, were the results of mechanical division, and had their common vertices O, P, situated at the entrance of the bases of the original prism. The six lateral pentagons RSUXY, ZYRIG, &c. were the remains of the six sides of the original prism.

By continuing sections parallel to the former ones, the lateral pentagons diminished in length; and at last the points R G coinciding with the points Y Z, the points S R with the points U Y, &c. there remained nothing of the lateral pentagons but the triangles YIZ, UXY, &c. (fig. 3). By continuing the same sections, these triangles at last disappeared, and the prism was converted into the rhomboid *a e* (fig. 4).

So unexpected a result induced him to make the same attempt upon more of these crystals; and he found that all of them could be reduced to similar rhomboids. He found also, that the crystals of other substances could be reduced in the same manner to certain primitive forms; always the same in the same substances, but every substance having its own peculiar form. The primitive form of fluat of lime, for instance, was an octahedron; of sulphat of barytes, a prism with rhomboidal bases; of feltspar, an oblique-angled parallelopiped, but not rhomboidal; of adamantine spar, a rhomboid, somewhat acute; of blende, a dodecahedron, with rhomboidal sides; &c.

These primitive forms must depend upon the figures of the integrant particles composing these crystals, and upon the manner in which they combine with each other. Now by continuing the mechanical division of the crystal, by cutting off slices parallel to each of its faces, we must at last reduce it to so small a size that it shall contain only a single integrant particle; consequently this ultimate figure of the crystal must be the figure of the integrant particles of which it is composed. The mechanical division, indeed, cannot be continued so far, but it may be continued till it can be demonstrated that no subsequent division can alter its figure; consequently it can be continued till the figure which it assumes is similar to that of its integrant particles.

Hauy has found that the figure of the integrant particles of bodies, as far as experiment has gone, may be reduced to three; namely,

1. The parallelopiped, the simplest of the solids, whose faces are six in number, and parallel two and two.

2. The triangular prism, the simplest of prisms.

3. The tetrahedron, the simplest of pyramids. Even this small number of primitive forms, if we consider the almost endless diversity of size, proportion, and density, to which particles of different bodies, though they have the same figure, may still be liable, will be found fully sufficient to account for all the differences in cohesion, and heterogeneous affinity, without having recourse to different absolute forces.

These integrant particles, when they unite to form the primitive crystals, do not always join together in the same way. Sometimes they unite by their faces, and at other times by their edges, leaving considerable vacuities between each. This explains why integrant particles, though they have the same form, may compose primitive crystals of different figures.

Mr. Hauy has ascertained, that the primitive forms of crystals are six in number; namely,

1. The parallelopiped; which includes the cube, the rhomboid, and all solids terminated by six faces, parallel two and two.

2. The regular tetrahedron.

3. The octahedron with triangular faces.

4. The six-sided prism.

5. The dodecahedron terminated by rhombs.

6. The dodecahedron with isosceles triangular faces.

Each of these may be supposed to occur as the primitive form or the nucleus in a variety of bodies; but those only which are regular, as the cube or the octahedron, have hitherto been found in any considerable number.

But bodies, when crystallized, do not always appear in the primitive form; some of them indeed very seldom affect that form, and all of them have a certain latitude and a certain number of forms which they assume occasionally as the primitive form. Thus the primitive form of fluat of lime is the octahedron; but that salt is often found crystallized in cubes, in rhomboidal dodecahedrons, and in other forms. All these different forms which a body assumes, the primitive excepted, have been denominated by Hauy secondary forms. Now what is the reason of this latitude in crystallizing? why do bodies assume so often these secondary forms?

To this it may be answered:

1st, That these secondary forms are sometimes owing to the variations in the ingredients which compose the integrant particles of any particular body. Alum, for instance, crystallizes in octahedrons; but when a quantity of alumina is added, it crystallizes in cubes; and when there is an excess of alumina, it does not crystallize at all. If the proportion of alumina vary between that which produces octahedrons and what produces cubic crystals, the crystals become figures with fourteen sides, six of which are parallel to those of the cube and eight to those of the octahedron; and according as the proportions approach nearer to those which form cubes or octahedrons, the crystals assume more or less of the form of cubes or octahedrons. What is still more, if a cubic crystal of alum is put into a solution that would afford octa-

hedral crystals, it passes into an octahedron: and, on the other hand, an octahedral crystal put into a solution that would afford cubic crystals becomes itself a cube. Now, how difficult a matter it is to proportion the different ingredients with absolute exactness, must appear evident to all.

2d, The secondary forms are sometimes owing to the solvent in which the crystals are formed. Thus if common salt is dissolved in water, and then crystallized, it assumes the form of cubes; but when crystallized in urine, it assumes the form not of cubes, but of regular octahedrons. On the other hand, muriat of ammonia, when crystallized in water, assumes the octahedral form, but in urine it crystallizes in cubes.

3d, But even when the solvent is the same, and the proportion of ingredients, as far as can be ascertained, exactly the same, still there are a variety of secondary forms which are usually found to make their appearance. These secondary forms have been happily explained by the theory of crystallization for which we are indebted to the sagacity of Mr. Hauy; a theory which, for its ingenuity, clearness, and importance, must ever rank high, and which must be considered as one of the greatest acquisitions which mineralogy and even chemistry have hitherto attained.

According to this theory, the additional matter which envelopes the primitive nucleus consists of thin slices or layers of particles laid one above another upon the faces of that nucleus; and each layer decreasing in size, in consequence of the abstraction of one or more rows of integrant particles from its edges or angles.

Let us suppose that ABFG (fig. 6). is a cube composed of 729 small cubes: each of its sides will consist of 81 squares, being the external sides of as many cubic particles, which together constitute the cube. Upon ABCD, one of the sides of this cube, let us apply a square lamina, composed of cubes equal to those of which the primitive crystal consists. It will of course be composed of 49 cubes, 7 on each side; so that its lower base *o n f g* (fig. 7.) will fall exactly on the square marked with the same letters in fig. 6.

Above this lamina let us apply a second, *l m p u* (fig. 10), composed of 25; it will be situated exactly above the square marked with the same letters (fig. 6). Upon this second let us apply a third lamina, *v x y z* (fig. 8.), consisting only of 9 cubes; so that its base shall rest upon the letters *v x y z* (fig. 6). Lastly, on the middle square *r* let us place the small cube *r* (fig. 5.), which will represent the last lamina.

It is evident that by this process a quadrangular pyramid has been formed upon the face ABCD (fig. 6), the base of which is this face, and the vertex the cube *r* (fig. 5). By continuing the same operation upon the other five sides of the cube, as many similar pyramids will be formed; which will envelope the cube on every side.

It is evident, however, that the sides of these pyramids will not form continued planes, but that, owing to the gradual diminution of the laminæ of the cubes which compose them, these sides will resemble the steps of a staircase. We can suppose however (what must certainly be the case), that the cubes of which the nucleus is formed are exceedingly small, almost imperceptible; that therefore a vast number of laminæ are required to form the pyramids, and consequently that the channels which they perform are imperceptible. Now DCBE (fig. 9.) being the pyramid resting upon the face ABCD (fig. 6.), and CBOG (fig. 9.) the pyramid applied to the next face BCGH (fig. 6.), if we consider that every thing is uniform from E to O (fig. 9.), in the manner in which the edges of the laminæ of superposition (as the abbé Hauy calls the laminæ which compose the pyramids) project beyond each other, it will readily be conceived that the face CEB of the first pyramid ought to be exactly in the same plane with the face COB of the adjacent pyramid, and that therefore the two faces together will form one rhomb ECOB. But all the sides of the six pyramids amount to 24 triangles similar to CEB; consequently they will form 12 rhombs, and the figures of the whole crystal will be a dodecahedron.

Thus we see that a body which has the cube for the primitive form of its crystals, may have a dodecahedron for its secondary form. The formation of secondary crystals, by the superposition of laminæ gradually decreasing in size, was first pointed out by Bergman. But Hauy has carried the subject much farther: he has not only ascertained all the different ways by which these decrements of the laminæ may take place, but pointed out the method of calculating all the possible varieties of secondary forms which can result from a given primitive form; and consequently of ascertaining whether or not any given crystal can be the secondary form of a given species.

The decrements of the laminæ which cover the primitive nucleus in secondary crystals are of four kinds:

1. Decrements on the edges, that is, on the edges of the slices which correspond with the edges of the primitive nucleus.

2. Decrements on the angles; that is to say, parallel to the diagonals of the faces of the primitive nucleus.

3. Intermediate decrements; that is to say, parallel to lines situated obliquely between the diagonals and edges of the primitive nucleus.

4. Mixed decrements. In these the superincumbent slices, instead of having only the thickness of one integrant particle, have the thickness of two or more integrant particles; and the decrement, whether parallel to the edges or angles, consists not of the abstraction of one row of particles, but of two or more. Hauy denotes these decrements by fractions, in which the numerator indicates the number of rows of particles which constitutes the decrement, and the denominator represents the thickness of the laminæ. Thus $\frac{2}{3}$ denotes laminæ of the thickness of three integrant particles, decreasing by two rows of particles.

An example of the first law of decrement, or of decrement on the edges, has been given above in the conversion of the cubic nucleus to a rhomboidal dodecahedron. In that example the decrement consisted of one row of particles, and it took place on all the edges. But these decrements may be more rapid: instead of one, they may consist of two, three, four, or more rows; and instead of taking place on all the edges, they may be confined to one or two of them, while no decrement at all takes place on the others. Each of these different modifications must produce a different secondary crystal. Besides this, the laminæ may cease to be added before they have reached their smallest possible size; the consequence of which must be a different secondary form. Thus, in the example given above, if the superposition of laminæ had ceased before the pyramids were completed, the crystal would have consisted of 18 faces; 6 squares parallel to the faces of the primitive nucleus, and 12 hexahedrons parallel to the faces of the secondary dodecahedron. This is the figure of the barat of lime and magnesia found at Luneburg.

The second law in which the decrement is on the angles, or parallel to the diagonals of the faces of the primitive nucleus, will be understood from the following example: Let it be proposed to construct around the cube ABGF (fig. 11), considered as a nucleus, a secondary solid, in which the laminæ of superposition shall decrease on all sides by single rows of cubes, but in a direction parallel to the diagonals. Let ABCD (fig. 12), the superior base of the nucleus, be divided into 81 squares, representing the faces of the small cubes of which it is composed. Fig. 13 represents the superior surface of the first lamina of superposition; which must be placed above ABCD (fig. 12) in such a manner, that the points *a b c d* (fig. 13) answer to the points *a b c d* (fig. 12). By this disposition the squares *Aa*, *Bb*, *Cc*, *Dd* (fig. 12), which compose the four outermost rows of squares parallel to the diagonals AC, BC, remain uncovered. It is evident also, that the borders QV, ON, IL, GF (fig. 13), project by one range beyond the borders AB, AD, CD, BC (fig. 13); which is necessary, that the nucleus may be enveloped towards these edges: for if this were not the case, re-entering angles would be formed towards the parts AB, BC, CD, DA, of the crystal; which angles appear to be excluded by the laws which determine the formation of simple crystals, or, which comes to the same thing, no such angles are ever observed in any crystal. The solid must increase, then, in those parts to which the decrement does not extend. But as this decrement is alone sufficient to determine the form of the secondary crystal, we may set aside all the other variations which intervene only in a subsidiary manner; except when it is wished, as in the present case, to construct artificially a solid representation of a crystal, and to exhibit all the details which relate to its structure.

The superior face of the second lamina will be AGLK (fig. 14). It must be placed so that the points *a*, *b*, *c*, *d*, correspond to the points *a*, *b*, *c*, *d* (fig. 13); which will leave uncovered a second row of cubes at each angle, parallel to the diagonals AC and BD. The solid still increases towards the sides. The large faces of the laminæ of superposition, which in fig. 13 were octagons, in fig. 14 arrive at the form of a square; and when they pass that term they decrease on all sides; so that the next lamina has for its superior face the square RMLS (fig. 15) less by one range in every direction than the preceding lamina (fig. 14). This square must be placed so that the points *e*, *f*, *g*, *h* (fig. 15), correspond to the points *e*, *f*, *g*, *h* (fig. 14). Figures 16, 17, 18, and 19, represent the four laminæ which ought to rise succes-

sively above the preceding; the manner of placing them being pointed out by corresponding letters, as was done with respect to the first three laminæ. The last lamina *z* (fig. 20) is a single cube, which ought to be placed upon the square *z* (fig. 19).

The laminæ of superposition, thus applied upon the side ABCD (fig. 12), evidently produce four faces, which correspond to the points A, B, C, D, and form a pyramid. These faces, having been formed by laminæ which began by increasing, and afterwards decreased, must be quadrilaterals of the figure represented in fig. 21; in which the inferior angle C is the same point with the angle C of the nucleus (figs. 11 and 12), and the diagonal LQ represents LG of the lamina AGLK (fig. 14). And as the number of laminæ composing the triangle LQC (fig. 21), is much smaller than that of the laminæ forming the triangle ZLQ, it is evident that the latter triangle will have a much greater height than the former.

The surface, then, of the secondary crystal thus produced, must evidently consist of 24 quadrilaterals, for pyramids are raised on the other 5 sides of the primary cube exactly in the same manner, disposed three and three around each solid angle of the nucleus. But in consequence of the decrement by one range, the three quadrilaterals which belong to each solid angle, as C (fig 11.), will be in the same plane, and will form an equilateral triangle ZIN (fig. 22.). The 24 quadrilaterals then will produce 8 equilateral triangles; and consequently the secondary crystal will be a regular octahedron. This is the structure of the octahedral sulphuret of lead, and of muriat of soda.

The third law is occasioned by the abstraction of double, triple, &c. particles. Fig. 23. exhibits an instance of the subtractions in question: and the moleculæ which compose the range represented by that figure are assorted in such a manner as if of two there were formed only one; so that we need only to conceive the crystal composed of parallelopipedons having their bases equal to the small rectangles *a b c d, e d f g h i l*, &c. to reduce this case under that of the common decrements on the angles.

This particular decrement, as well as the fourth law, which requires no farther explanation, is uncommon. Indeed Hauy has met with mixed decrements only in some metallic crystals.

These different laws of decrement account for all the different forms of secondary crystals. But in order to see the vast number of secondary forms which may result from them, it is necessary to attend to the different modifications which result from their acting separately or together. These modifications may be reduced to seven:

1. The decrements take place sometimes on all the edges, or all the angles, at once.

2. Sometimes only on certain edges, or certain angles.

3. Sometimes they are uniform, and consist of one, two, or more rows.

4. Sometimes they vary from one edge to the other, or from one angle to another.

5. Sometimes decrements on the edges and angles take place at the same time.

6. Sometimes the same edge or angle is subjected successively to different laws of decrement.

7. Sometimes the secondary crystal has faces parallel to those of the primitive nucleus, from the superposition of laminæ not going beyond a certain extent.

Hence Mr. Hauy has divided secondary forms into two kinds, namely, simple and compound. Simple secondary crystals are those which result from a single law of decrement, and which entirely conceal the primitive nucleus. Compound secondary crystals are those which result from several laws of decrement at once; or from a single law which has not reached its limit, and which of course has left in the secondary crystal faces parallel to those of the primitive nucleus.

"If amidst this diversity of laws (observes Mr. Hauy) sometimes united by combinations more or less complex, the number of ranges subtracted was itself extremely variable; for example, were these decrements by 12, 20, 30, or 40 ranges, or more, as might absolutely be possible; the multitude of the forms which might exist in each kind of mineral would be immense, and exceed what could be imagined. But the power which effects the subtractions seems to have a very limited action. These subtractions, for the most part, take place by one or two ranges of molecules. I have found none which exceed four ranges, except in a variety of calcareous spar forming part of the collection of C. Gillet Laumont, the structure of which depends on a decrement by six ranges; so that if there exist laws which exceed the decrements by four ranges, there is reason to believe they rarely take place in nature. Yet notwithstanding these narrow limits by which the laws of crystallization are circumscribed, I have found, by confining myself to two of the simplest laws, viz. those which produce subtractions by one or two ranges, that calcareous spar is susceptible of 2044 different forms, a number which exceeds more than 50 times that of the forms already known: and if we admit into the combination decrements by three or four ranges, calculation will give 8,388,604 possible forms in regard to the same substance. This number may still be very much augmented in consequence of decrements either mixed or intermediary.

In the crystallization of metals, of salts, and other substances, soluble in caloric alone, as well as those soluble in water by the aid of caloric, the latter substance is given out in abundance (as in the freezing, or, more properly, crystallization of water): hence the temperature of large masses of hot saline solutions diminishes at last very slowly during the increase of the crystals which have begun to form in them.

CRYSTALLINE-HUMOUR. See Optics.

CUBÆA, a genus of the decandria monogynia class and order. The calyx is turbinate, five-parted, unequal, permanent; petals five, unequal; filaments villose, three shorter; germ pedicelled; legume villose, six or seven-seeded. There are two species.

CUBE, a regular or solid body, consisting of six equal sides or faces, which are squares. A die is a small cube.

It is also called a hexahedron, because of its six sides, and is the second of the five Platonic or regular bodies.

The cube is supposed to be generated by the motion of a square plane, along a line equal and perpendicular to one of its sides.

To describe a rete, or net, for forming a cube, or with which it may be covered.—Describe six squares as in figure 27, upon card, paper, pasteboard, or the like, of the size of the faces of the proposed cube; and cut it half through by the lines AB, CD, EF, AC, BD; then fold up the several squares till their edges meet, and so form the cube, or a covering over one, as in the figure annexed. See Pl. Miscel. fig. 27.

To determine the surface and solidity of a cube.—Multiply one side by itself, which will give one square or face: then this multiplied by 6, the number of faces, will give the whole surface. Also multiply one side twice by itself, that is, cube it, and that will be the solid content.

Cubes, or Cubic Numbers, are formed by multiplying any numbers twice by themselves. So the cubes of 1, 2, 3, 4, 5, 6, &c.
are 1, 8, 27, 64, 125, 216, &c.

The third differences of the cubes of the natural numbers are all equal to each other, being the constant number 6. For, let m^3, n^3, p^3, be any three adjacent cubes in the natural series as above, that is, whose roots m, n, p, have the common difference 1; then, because
$n = m + 1$, theref. $n^3 = m^3 + 3m^2 + 3m + 1$,
$p = n + 1$, theref. $p^3 = n^3 + 3n^2 + 3n + 1$;
so that the difference between the 1st and 2d, and between the 2d and 3d cubes, are
$n^3 - m^3 = 3m^2 + 3m + 1$,
$p^3 - n^3 = 3n^2 + 3n + 1$, } the 1st differences;
and the difference of these differences, is
$3 \cdot \overline{n^2 - m^2} + 3 \cdot \overline{n - m} = 3 \cdot \overline{n + m + 1} = 6 \cdot \overline{m + 1}$, the 2d difference.

In like manner the next 2d difference is $6 \cdot \overline{n + 1}$: hence the difference of these two 2d differences is $6 \cdot \overline{n - m} = 6$, which is therefore the constant 3d difference of all the series of cubes. And hence that series of cubes will be formed by addition only, viz. adding always the 3d difference 6 to find the column or series of 2d differences, then these added always for the 1st differences, and lastly, these always added for the cubes themselves, as below:

3d Difs.	2d Difs.	1st Difs.	Cubes.
6	6	1	0
6	12	7	1
6	18	19	8
6	24	37	27
6	30	61	64
6	36	91	125
6	42	127	216
6	48	169	343

Peletarius, among various speculations concerning square and cubic numbers, shews that the continual sums of the cubic numbers, whose roots are 1, 2, 3, &c. form the series of squares whose roots are 1, 3, 6, 10, 15, 21, &c.

Thus, $1 = 1 = 1^2$,
$1 + 8 = 9 = 3^2$,
$1 + 8 + 27 = 36 = 6^2$,
$1 + 8 + 27 + 64 = 100 = 10^2$, &c.
Or, in general, $1^3 + 2^3 + 3^3 + 4^3$ &c. to $n^3 = \overline{1 + 2 + 3 + 4 \cdots n}^2 = \frac{1}{2}n \cdot \overline{n + 1}$.

It is also a curious property, that any number, and the cube of it, being divided by 6, leave the same remainder; the series of remainders being 0, 1, 2, 3, 4, 5, continually repeated. Or that the differences between the numbers and their cubes, divided by 6, leave always 0 remaining; and the quotients, with their successive differences, form the several orders of figurate numbers. Thus,

Num.	Cubes.	Difs.	Quot.	1 Dif.	2 Dif.
1	1	0	0	0	0
2	8	6	1	1	1
3	27	24	4	3	2
4	64	60	10	6	3
5	125	120	20	10	4
6	216	210	35	15	5
7	343	336	56	21	6

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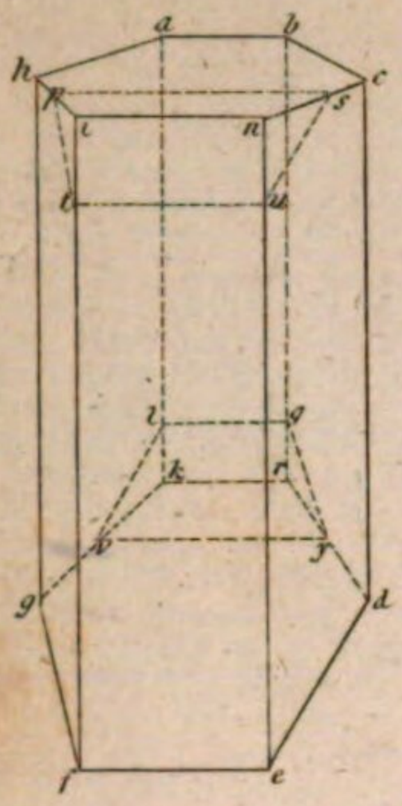

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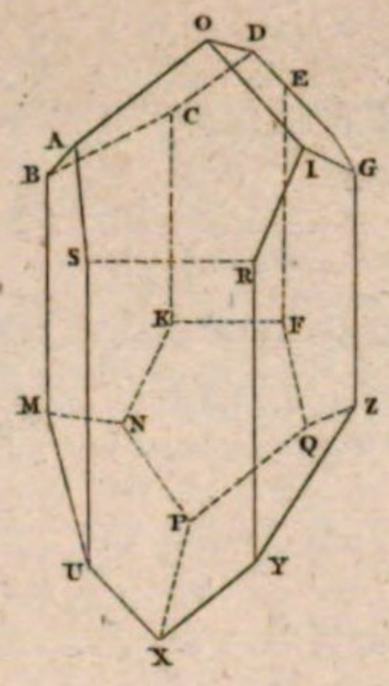

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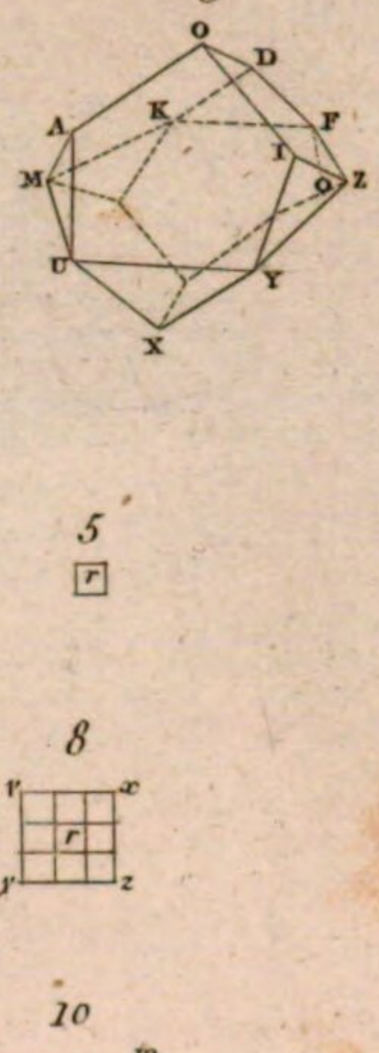

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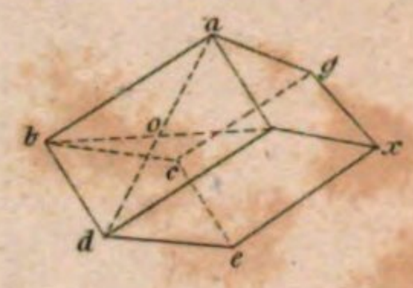

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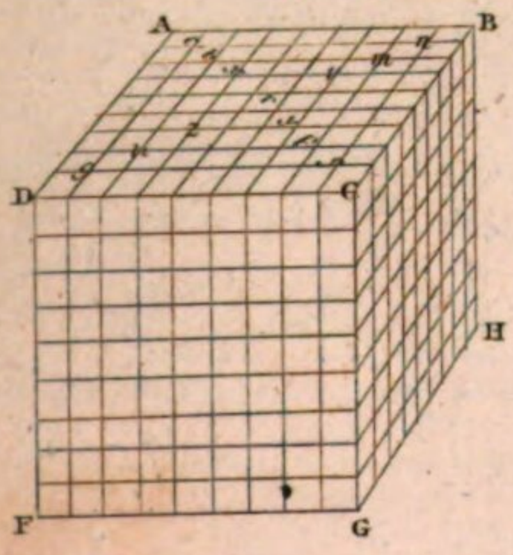

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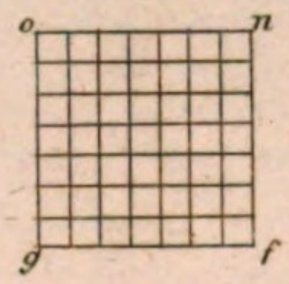

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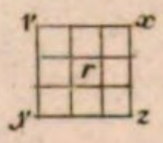

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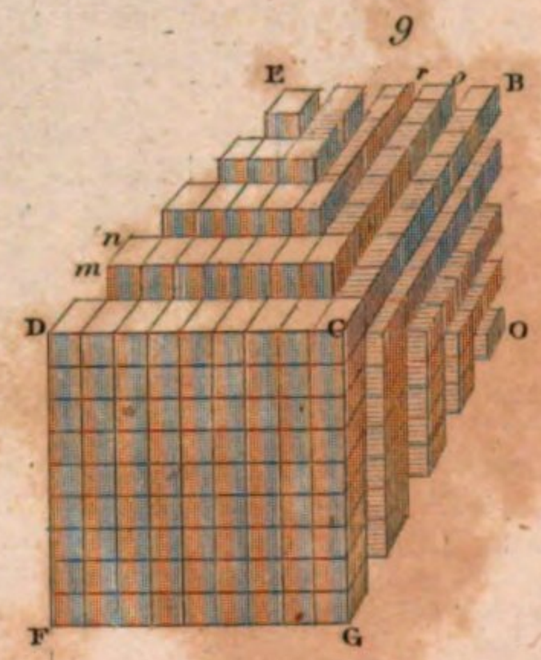

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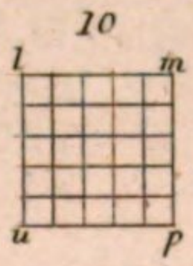

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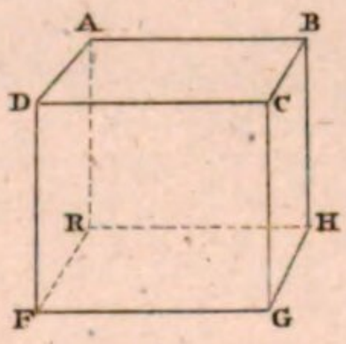

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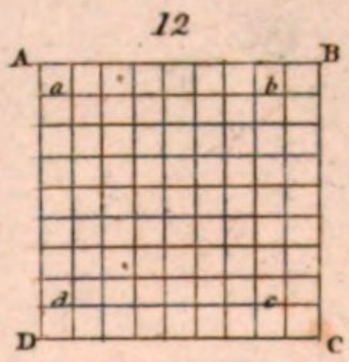

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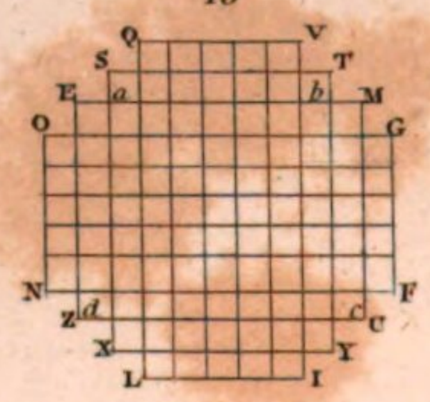

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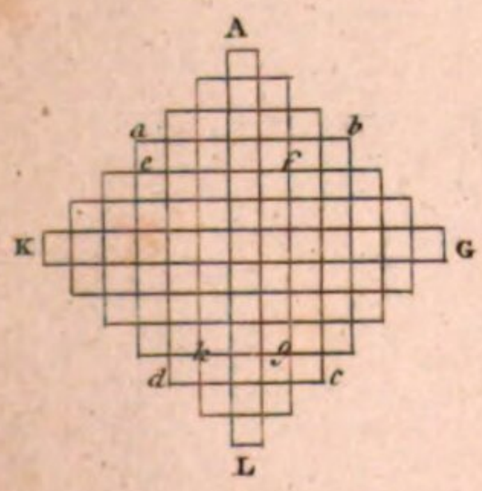

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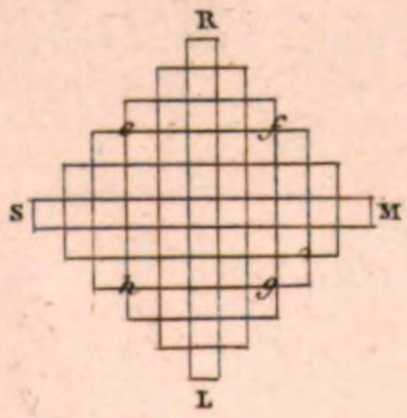

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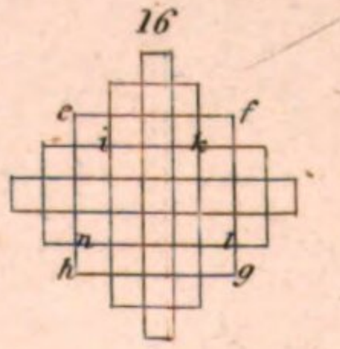

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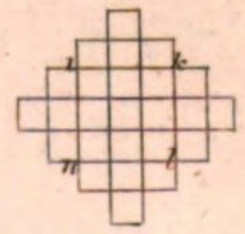

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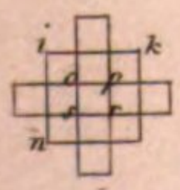

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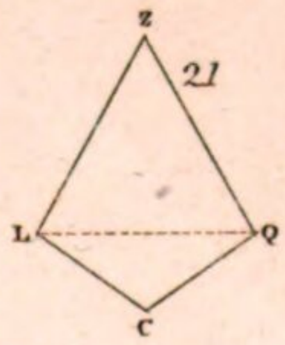

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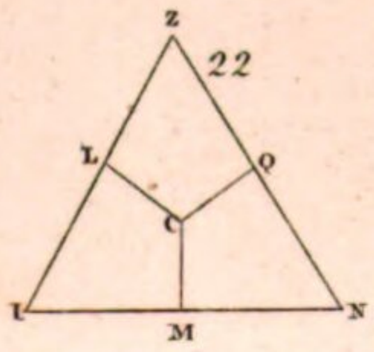

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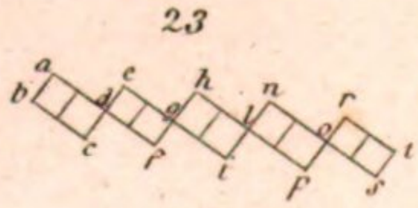

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CUBE, *duplication of*, is the finding the side of a cube that shall double in solidity a given cube, which is a celebrated problem, much discussed by ancient geometricians. It was first proposed by the oracle of Apollo at Delphos, which declared that the plague, then raging at Athens, should cease when Apollo's altar, a cube, was doubled. Upon this the mathematicians applied themselves seriously to seek the duplicature of the cube; hence it is called the Delian problem. It cannot, however, be effected geometrically, as it requires the solution of a cubic equation, or requires the finding of two mean proportionals, viz. between the side of the given cube and the double of the same, the first of which two mean proportions is the side of the double cube, as was first observed by Hippocrates of Chios. For, let a be the side of the given cube, and z the side of the double cube sought; then it is $z^3 = 2a^3$, or $a^2 : z^2 :: z : 2a$; so that, if a and z be the first and 2d terms of a set of continued proportionals, then $a^2 : z^2$ is the ratio of the square of the first to the square of the 2d, which, it is known, is the same as the ratio of the first term to the 3d, or of the 2d to the 4th, that is, of z to $2a$; therefore z being the 2d term, $2a$ will be the 4th. So that z, the side of the cube sought, is the 2d of four terms in continued proportion, the first and 4th being a and $2a$, that is, the side of the double cube is the first of two mean proportionals between a and $2a$. The thing has been frequently done mechanically by Archimedes, Eutochius, Pappus, &c.

CUBE, or *Cubic number*, in arithmetic, that which is produced by the multiplication of a square number by its root: thus, 64 is a cube number, and arises by multiplying 16, the square of 4, by the root 4.

CUBE, or *Cubic quantity*, in algebra, the third power in a series of geometrical proportionals continued; as a is the root, aa the square, and aaa the cube. All cubic numbers may be ranged into the form of cubes; as 8 or 27, whose sides are 2 and 3, and their bases 4 and 9; whence it appears, that every true cubic number, produced from a binomial root, consists of these parts, viz. The cubes of the greater and lesser parts of the root, and of three times the square of the greater part multiplied by the lesser, and of three times the square of the lesser multiplied by the greater, as,

$$\begin{array}{r} aa + 2ab + bb \\ a + b \\ \hline aaa + 2aab + abb \\ \quad aab + 2abb + bbb \\ \hline aaa + 3aab + 3abb + bbb \end{array}$$

From hence it is easy to understand both the composition of any cubic number, and the reason of the method for extracting the cube root out of any number given. See the following article.

CUBE *root of any number, or quantity*, such a number, or quantity, which, if multiplied into itself, and then, again, the product thence arising, by that number or quantity, being the cube root, this last product shall be equal to the number or quantity whereof it is the cube root: as 2 is the cube root of 8, because two times 2 are 4, and two times 4 are 8; and $a + b$ is the cube root of $a^3 + 3a^2b + 3ab^2 + b^3$.

Every cube number has three roots, one real root, and two imaginary ones; as the cube number 8 has one real root 2, and two imaginary roots, viz. $\sqrt{-3} - 1$, and $\sqrt{-3} + 1$; and generally if a be the real root of any cube number, one of the imaginary roots of that number will be $\frac{a + \sqrt{-3aa}}{2}$, and the other $\frac{a - \sqrt{-3aa}}{2}$. See ALGEBRA.

CUBEBS, cubeba of the shops, in the materia medica, a small dried fruit, resembling a grain of pepper, but often somewhat longer, brought into Europe from the island of Java. See MATERIA MEDICA.

CUBIC, or CUBICAL, EQUATION, in algebra, one whose highest power consists of three dimensions, as $x^3 = a^3 - b^3$, or $x^3 + rxx = p^6$, &c.

CUBIT, in the mensuration of the antients, a long measure, equal to the length of a man's arm, from the elbow to the tip of the fingers. Dr. Arbuthnot makes the English cubit equal to 18 inches; the Roman cubit equal to one foot, 5,406 inches; and the cubit of the scripture equal to one foot, 9,888 inches.

CUBITÆUS. See ANATOMY.

CUBITUS, in anatomy, a bone of the arm, reaching from the elbow to the wrist, otherwise called the ulna.

CUCKING-STOOL, antiently called tumbrel, an engine invented for the punishment of scolds and unquiet women, by ducking them. This instrument was a sort of chair, placed at the end of a plank, in which the offender was placed, and so ducked: it was formerly made use of to punish bakers and brewers, upon transgressing the laws made in relation to their several trades; for upon offending in this respect, they were ducked, or plunged in some stinking muddy pond, by means of this chair.

CUCUBALUS, berry-bearing chickweed, a genus of the trigynia order in the decandria class of plants, and in the natural method ranking under the 22d order, caryophylei. The calyx is inflated, the petals 5, unguiculated without; a nectariferous corona at the throat; the capsule is trilocular. There are 17 species; the most remarkable of which are,

1. The behen, Swedish lychnis, or gumsepungar, a native of several parts of Europe. The empalement of its flower is curiously wrought like a network, and is of a purplish colour. The leaves have somewhat of the flavour of peas, and proved of great use to the inhabitants of Minorca in 1685, when a swarm of locusts had destroyed the harvest. The Gothlanders apply the leaves to erysipelatous eruptions. Horses, cows, sheep, and goats, eat this plant.

2. The catholicus, or night-flowering lychnis, grows naturally in Spain and Italy. It is a perennial plant, rising with an upright branching stalk, a foot and a half high, with very narrow leaves placed opposite. The flowers stand upon long naked footstalks, each supporting three or four flowers which have long tubes with striped empalements: the petals are large, deeply divided at top, and of a pale-blueish colour. The flowers are closed all the day; but when the sun leaves them, they expand, and then emit a very agreeable scent. It may be propagated by seeds sown in the spring on a bed of light earth, and will flower the following year.

3. The otites, or catch-fly, is a native of Britain and other European countries. It has a thick, fleshy, perennial root, which strikes into the ground, whence rises a jointed stalk three or four feet high. At the joints there exudes a viscous clammy juice, that sticks to the fingers when handled; and the small insects which settle upon those parts of the stalks are so fastened that they cannot get off. The flowers are small, and of a greenish colour.

CUCUJUS, a genus of insects of the coleoptera order: antennæ filiform; feelers four, equal, the last joint truncate and thicker; lip short, bifid; the divisions linear and distant; body depressed. There are 11 species belonging to this genus.

CUCULLANUS, a genus of worms of the order intestina: body sharp, pointed behind and obtuse before; mouth orbicular, with a striated hood. They are most of them viviparous. There are eight species, which take their names from the animal in which they are found. Thus, the cucullanus talpæ inhabits the common mole, is gregarious, inclosed in a membrane, spirally twisted, white, and found in the fat about the peritoneum.

CUCULLARIS, see ANATOMY.

CUCULUS, the cuckow, in ornithology, a genus belonging to the order of picæ; the essential characters of which are: the bill is smooth, and more or less bending; the nostrils are bounded by a small rim; the tongue is short and pointed; the feet and toes form for climbing. See Pl. N. H. fig. 153. There are 46 species. The most remarkable are:

1. The canorus, or common cuckow, weighs about five ounces, and is in length 14 inches, in breadth 25. The bill is black, and about two-thirds of an inch in length. The head, hind part of the neck, coverts of the wings and rump, are of a dove-colour, darker on the head and paler on the rump. The legs are short, and the toes disposed two backwards and two forwards, like those of the woodpecker, though it is never observed to run up the sides of trees. The female differs in some respects.

This bird appears in our country early in the spring, and makes the shortest stay with us of any bird of passage. It is directed hither by that constitution of the air which causes the fig-tree to put forth its fruit; though it has been supposed that some of these birds do not quit this island during the winter, but that they seek shelter in hollow trees, and lie torpid, unless animated by unusually warm weather. Mr. Pennant gives two instances of their being heard in February; one in 1771, in the end of that month; the other in 1769, on the fourth day; but after that they were heard no more, being probably chilled into torpidity. There is a remarkable coincidence between the song of these birds, and the mackarels continuing in full roe; that is, from about the middle of April to the latter part of June. The cuckow is silent for some time after his arrival. His note is so uniform, that his name in all languages seems to have been derived from it; and in all countries it is used in the same reproachful sense.

On the natural history of this singular bird, we have a very curious paper by Dr. Jenner, published in the Philosophical Transactions for 1788, part II. art. 14. The first appearance of cuckows in the county of Gloucester is about the middle of April. The song of the male, which is well known, soon proclaims its arrival. The song of the female (if the peculiar notes of which it is composed may be so called) is widely different, and has been so little attended to, that perhaps few are acquainted with it; the cry of the dabchick bears some resemblance to it.

Unlike the generality of birds, cuckows do not pair. When a female appears on

the wing, she is often attended by two or three males. From the time of her appearance till after the middle of summer, the nests of the birds selected to receive her egg are to be found in great abundance; but, like the other migrating birds, she does not begin to lay till some weeks after her arrival.

It is on all hands allowed that the cuckow does not hatch its own eggs; for which different reasons have been given, as will be afterwards noticed. The hedge-sparrow, the water-wagtail, the titlark, the redbreast, the yellow-hammer, the green-linnet, or the winchat, is generally the nurse of the young cuckow: but Buffon enumerates 20 sorts of nests at least in which they have deposited their eggs. It may be supposed that the female cuckow lays her egg in the absence of the bird in whose nest she intends to deposit it; as it has been known that on sight of one of these, a redbreast and its mate jointly attacked her on approaching the nest, putting her to flight; and so effectually drove her away, that she did not dare to return. Among the birds above-mentioned, it generally, according to Dr. Jenner's observations, selects the first three, but shews a much greater partiality to the hedge-sparrow. This last commonly takes up four or five days in laying her eggs. During this time (generally after she has laid one or two) the cuckow contrives to deposit her egg among the rest, leaving the future care of it entirely to the hedge-sparrow. This intrusion often occasions some discomposure: for the old hedge-sparrow at intervals, whilst she is sitting, not unfrequently throws out some of her own eggs, and sometimes injures them in such a way that they become addle; so that it more frequently happens that only two or three hedge-sparrow's eggs are hatched with the cuckow's than otherwise. But whether this is the case or not, she sits the same length of time as if no foreign egg had been introduced, the cuckow's egg requiring no longer incubation than her own.

When the hedge-sparrow has sat her usual time, and disengaged the young cuckow and some of her own offspring from the shell, her own young ones, and any of her eggs that remain unhatched, are soon turned out, the young cuckow remaining possessor of the nest, and the sole object of her future care. The young birds are not previously killed, nor are the eggs demolished; but all are left to perish together, either entangled about the bush which contains the nest, or lying on the ground under it.

"The early fate of the young hedge-sparrows (Dr. Jenner observes) is a circumstance that has been noticed by others, but attributed to wrong causes. A variety of conjectures have been formed upon it. Some have supposed the parent cuckow the author of their destruction; while others, as erroneously, have pronounced them smothered by the disproportionate size of their fellow-nestling. Now the cuckow's egg being not much larger than the hedge-sparrow's, it necessarily follows, that at first there can be no difference in the size of the birds just burst rom the shell. Of the fallacy of the former assertion also I was some years ago convinced by having found that many cuckows' eggs were hatched in the nests of other birds after the old cuckow had disappeared; and by seeing the same fate then attend the nestling sparrows as during the appearance of old cuckows in this country." But before he enters on the facts relating to the death of the young sparrows, our author proceeds to state various examples of the incubation of the egg, and the rearing of the young cuckow; a point which had been controverted by the hon. Daines Barrington, and disbelieved by others. For these, however, on account of their great length, we refer the reader to the original paper.

It appears a little extraordinary that two cuckows' eggs should ever be deposited in the same nest, as the young one produced from one of them must inevitably perish; yet two instances of this kind fell under our author's observation, one of which he thus relates: "June 27, 1787. Two cuckows and a hedge-sparrow were hatched in the same nest this morning; one hedge-sparrow's egg remained unhatched. In a few hours after, a contest began between the cuckows for the possession of the nest, which continued undetermined till the next afternoon; when one of them, which was somewhat superior in size, turned out the other, together with the young hedge-sparrow and the unhatched egg. This contest was very remarkable. The combatants alternately appeared to have the advantage, as each carried the other several times nearly to the top of the nest, and then sunk down again, oppressed by the weight of its burden; till at length, after various efforts, the strongest prevailed, and was afterwards brought up by the hedge-sparrows."

But the principal circumstance that has agitated the mind of the naturalist respecting the cuckow is, why, like other birds, it should not build a nest, incubate its eggs, and rear its own young? There is no apparent reason, Dr. Jenner thinks, why this bird, in common with others, should not perform all these several offices; for it is in every respect perfectly formed for collecting materials, and building a nest. Neither its external shape nor internal structure prevents it from incubation; nor is it by any means incapacitated from bringing food to its young. It would be needless to enumerate the various opinions of authors on this subject from Aristotle to the present time. Those of the antients appear to be either visionary or erroneous; and the attempts of the moderns towards its investigation have been confined within very narrow limits: for they have gone but little further in their researches than to examine the constitution and structure of the bird; and having found it possessed of a capacious stomach, with a thin external covering, concluded that the pressure upon this part, in a sitting posture, prevented incubation. They have not considered that many of the birds which incubate have stomachs analogous to those of cuckows. The stomach of the owl, for example, is proportionably capacious, and is almost as thinly covered with external integuments. Nor have they considered that the stomachs of nestlings are always much distended with food; and that this very part, during the whole time of their confinement to the nest, supports in a great degree the weight of the whole body: whereas, in a sitting bird, it is not nearly so much pressed upon; for the breast in that case fills up chiefly the cavity of the nest; for which purpose, from its natural convexity, it is admirably well fitted. These observations sufficiently show that the cuckow is not rendered incapable of sitting through any peculiarity either in the situation or formation of the stomach.

In considering to what causes may be attributed the singularities of the cuckow, Dr. Jenner suggests the following as the most probable: "The short residence this bird is allowed to make in the country where it is destined to propagate its species; and the call that nature has upon it, during that short residence, to produce a numerous progeny." The cuckow's first appearance here is about the middle of April, commonly on the 17th. Its egg is not ready for incubation till some weeks after its arrival, seldom before the middle of May. A fortnight is taken up by the sitting-bird in hatching the egg. The young bird generally continues three weeks in the nest before it flies, and the foster parents feed it more than five weeks after this period; so that if a cuckow should be ready with an egg much sooner than the time pointed out, not a single nestling, even one of the earliest, would be fit to provide for itself before its parent would be instinctively directed to seek a new residence, and be thus compelled to abandon its young one; for old cuckows take their final leave of this country the first week in July.

There seems to be no precise time fixed for the departure of young cuckows. Our author believes they go off in succession, probably as soon as they are capable of taking care of themselves; for although they stay here till they become nearly equal in size and growth of plumage to the old cuckow, yet in this very state the fostering care of the hedge-sparrow is not withdrawn from them.

It is supposed that there are more male cuckows than females; since two are often seen in dispute where a third has been in sight; which, no doubt, was of the opposite sex. Mr. Pennant observed, that five male birds were caught in a trap in one season; and Mr. Latham says, that "out of at least half a dozen that I have attended to, my chance has never directed me to a female; and it is to be wished that future observers may determine whether our observations have risen only in chance, or are founded on general circumstances." He believes that the male birds are more liable to be shot, their note directing the gunner where to take aim, while the female is secured by her silence.

Cuckows may be, and often are, brought up tame, so as to become familiar. They will eat in this state bread and milk, fruit, insects, eggs, and flesh either cooked or raw; but in a state of nature chiefly live on caterpillars of the smooth kind. Some have fed on vegetable matter, beetles, and small stones. When fat, they are said to be as good eating as a land-rail. The French and Italians eat them to this day. The antient Romans admired them greatly as food; and Pliny says that there is no bird which can be compared to them for delicacy.

In migrating, the major part of these birds are supposed to go into Africa; since they are observed to visit the island of Malta twice in a year in their passage backwards and forwards, as is supposed, to that part of the world. The cuckow is well known also at Aleppo. To the north, it is said to be com-

mon in Sweden; but not to appear so early by a month as with us. Russia is not destitute of this bird; and Mr. Latham has seen a specimen brought from Kamtschatka, now in the possession of sir Joseph Banks.

2. The indicator, or honey-guide, is a native of America. See Plate N. H. fig. 154. The following description is given of it by Dr. Sparrman, in the Philosophical Transactions for 1777. "This curious species of cuckow is found at a considerable distance from the Cape of Good Hope, in the interior parts of Africa, being entirely unknown at that settlement. The first place I heard of it was in a wood called the Groot-Vaader's Bosch, the Grandfather's Wood, situated in a desert near the river which the Hottentots call T'kaut'kai. The Dutch settlers thereabout have given this bird the name of honiguyzer, or honey-guide, from its quality of discovering wild honey to travellers. Its colour has nothing striking or beautiful: its size is smaller than that of our cuckow in Europe; but in return, the instinct which prompts it to seek its food in a singular manner is truly admirable. Not only the Dutch and Hottentots, but likewise a species of quadruped named ratel (probably a new species of badger), are frequently conducted to wild bee-hives by this bird, which, as it were, pilots them to the very spot. The honey being its favourite food, its own interest prompts it to be instrumental in robbing the hive, as some scraps are commonly left for its support. The morning and evening are its times of feeding, and it is then heard calling in a shrill tone, *cherr, cherr*, which the honey-hunters carefully attend to as the summons to the chace. From time to time they answer with a soft whistle, which the bird hearing always continues its note. As soon as they are in sight of each other, the bird gradually flutters towards the place where the hive is situated, continually repeating its former call of *cherr, cherr;* nay, if it should happen to have gained a considerable way before the men (who may easily be hindered in the pursuit by bushes, rivers, or the like), it returns to them again, and redoubles its note, as if to reproach them with their inactivity. At last the bird is observed to hover for a few moments over a certain spot; and then silently retiring to a neighbouring bush or resting-place, the hunters are sure of finding the bees' nest in that identical spot; whether it be in a tree or in the crevice of a rock, or (as is most commonly the case) in the earth. Whilst the hunters are busy in taking the honey, the bird is seen looking on attentively to what is going forward, and waiting for its share of the spoil. The bee-hunters never fail to leave a small portion for their conductor: but commonly take care not to leave so much as would satisfy his hunger. The bird's appetite being whetted by this parsimony, he is obliged to commit a second treason, by discovering another bees' nest, in hopes of a better salary. It is further observed, that the nearer the bird approaches the hidden hive, the more frequently it repeats its call, and seems the more impatient. I have had frequent opportunities of seeing this bird, and have been witness to the destruction of several republics of bees by means of its treachery. I had, however, but two opportunities of shooting it, which I did to the great indignation of my Hottentots. It is about seven inches in length, and is of a rusty-brown colour on the back, with a white breast and belly." A nest which was shown to Dr. Sparrman for that of this bird, was composed of slender filaments of bark, woven together in the form of a bottle; the neck and opening hung downwards, and a string, in an arched shape, was suspended across the opening, fastened by the two ends, perhaps for the bird to perch on.

3. The capensis or Cape cuckow (Buffon) is a trifle smaller than ours. It inhabits the Cape of Good Hope; and is most likely the same bird which is called edolio, from its pronouncing that word frequently in a low melancholy tone. Voyagers also mention another cuckow, which is common to Loango in Africa. It is larger than ours, but of the same colour, and repeats the word *cuckow* like that bird, but in a different inflection of voice. It is said that the male and female together go through the whole eight notes of the gamut; the male, beginning by itself, sounds the first three, after which he is accompanied by the female through the rest of the octave.

4. The honoratus, or sacred cuckow, is somewhat less than our cuckow. This species inhabits Malabar, where the natives hold it sacred. It feeds on reptiles, which perhaps may be such as are the most noxious: if so, this seeming superstition may have arisen from a more reasonable foundation than many others of the like sort.

5. The vetula is rather larger than a blackbird. This species inhabits Jamaica, where it is frequent in the woods and hedges all the year round. It feeds on seeds, small worms, and caterpillars, and is very tame. This bird has the name *tacco* from its cry, which is like that word; the first syllable of this is pronounced hardly, the other following in a full octave lower than the first. It has also another cry like *qua, qua, qua,* but that only when alarmed by an enemy. Besides insects, it will also eat lizards, small snakes, frogs, young rats, and sometimes even small birds. The snakes they swallow head foremost, letting the tail hang out of the mouth till the fore parts are digested. This bird, it is most likely, might be easily tamed, as it is so gentle as to suffer the negro children to catch it with their hands. Its gait is that of leaping like a magpie, being frequently seen on the ground; and its flight but short, chiefly from bush to bush. At the time when other birds breed, they likewise retire into the woods, but their nests have never yet been found; from which we should be inclined to think that they were indebted to other birds for the rearing of their young, in the manner of the common cuckow. It has the name of rain-bird, as it is said to make the greatest noise before rain. It is common all the year at Jamaica. In another species or variety, common in Jamaica, the feathers on the throat appear like a downy beard, whence probably the name of old-man rain-bird, given it there, and by Ray, Sloane, and others.

6. The cayanus, or Cayenne cuckow, is the size of a blackbird. This inhabits Cayenne, where it goes by the name of piaye or devil. The natives give it that name, as a bird of ill omen. The flesh they will not touch; and indeed not without reason, as it is very bad and lean. It is a very tame species, suffering itself to be almost touched by the hand before it offers to escape. Its flight is almost like that of a king's-fisher, and it frequents the borders of rivers on the low branches, feeding on insects, and often wagging its tail on changing place.

CUCUMIS, the cucumber, a genus of the syngenesia order, in the monœcia class of plants, and in the natural method ranking under the 34th order, cucurbitaceæ. The male calyx is quinquedentated, the corolla quinquepartite, the filaments three. The female calyx is also quinquedentated, the corolla quinquepartite, the pistil trifid; the sides of the apple sharp-pointed. In this genus Linnæus includes also the melon.

There are 13 species, of which the following are the most remarkable.

1. The sativa, or common cucumber, has roots composed of long, slender, white fibres; long slender stalks, very branchy at their joints, trailing on the ground, or climbing by their claspers, adorned at every joint by large angular leaves on long erect footstalks, with numerous and monopetalous bell-shaped flowers of a yellow colour, succeeded by oblong rough fruit. The varieties of this kind are, 1. The common rough green prickly cucumber; a middle-sized fruit, about six or seven inches long, having a dark-green rough rind, closely set with very small prickles: the plant is of the hardiest sort, but does not show its fruit early. 2. The short green prickly cucumber is about three or four inches long, the rind rather smooth, and set with small prickles. It is valuable chiefly for being one of the earliest and hardiest sorts. 3. The long green prickly cucumber, grows from six to nine inches in length, and is rather thinly set with prickles: and as there are an early and a late cucumber, it is considerably the best variety for the main crops, both in the frames and hand-glass, as well as in the open ground for picklers. Of this there is another variety with white fruit. 4. The early green cluster cucumber, is a shortish fruit, remarkable for growing in clusters, and appearing early. 5. The long smooth green Turkey cucumber is a smooth green-rinded fruit, growing from 10 to 15 inches in length, without prickles. The plants are strong growers, with very large leaves. 6. The long smooth white Turkey cucumber, is a smooth-rinded fruit, from 10 to 15 inches long without prickles. 7. The large smooth green Roman cucumber is a very large and long smooth green fruit, produced from a strong-growing plant. 8. The long white prickly Dutch cucumber is a white fruit, eight or ten inches long, set with small black prickles. The plants are but bad bearers in this country.

2. The chata, or hairy cucumber. According to Mr. Hasselquist this grows in the fertile earth near Cairo, after the inundation of the Nile, and not in any other place in Egypt, nor does it grow in any other soil. The fruit is a little watery; the flesh almost of the same substance with the melons; it tastes somewhat sweet and cool, but is far from being so cool as the water-melons. This the grandees and Europeans in Egypt eat as the most pleasant fruit they find, and that from which they have the least to apprehend. It is the most excellent fruit of this tribe, of any yet known.

3. The melo, or melon. The varieties of

this species are almost endless. The most esteemed are, 1. The canteloupe, a small melon good for early culture. 2. The Roman. 3. The galloway, or Portugal melon. The grand mistake in the culture of melons is, planting them early; for without sun to ripen them well, melons are not worth the trouble of eating.

Cucumbers in this country are raised at three different seasons of the year: 1. on hotbeds, for early fruit; 2. under bell or hand glasses, for the middle crop; 3. on the common ground, which is for a late crop or to pickle. The cucumbers which are ripe before April are unwholesome, being raised wholly by the heat of the dung without the assistance of the sun. Those raised in April are good.

Besides the above-mentioned species, which are proper for the table, this genus affords also two articles for the materia medica. 1. The elaterium of the shops, is the inspissated fæcula of the juice of a kind of wild cucumber, called also the elatinum or ass's cucumber. It comes to this country from Spain and the southern parts of France, where the plant is very common. It is brought to us in small flat whitish lumps or cakes that are dry, and break easily between the fingers. It is of an acrid, bitter, and nauseous taste, and has a strong offensive smell when newly made: but these, as well as its other qualities, it loses after being kept some time. Elaterium is a violent purge and vomit, and is now very seldom used. The plant is commonly called spirting cucumber, from its casting out its seeds with great violence, together with the viscid juice in which they are lodged, if touched when ripe: from this circumstance it has obtained the appellation of *noli me tangere*, or *touch-me-not*. 2. The colocynthis, colocynth, coloquintida, or bitter apple of the shops, is brought to us from Aleppo and the island of Crete. The leaves of the plant are large, placed alternate, almost round, and stand upon footstalks four inches long. The flowers are white; and are succeeded by a fruit resembling the gourd, of the size of a large apple, and which is yellow when ripe. The shelly or husky outside incloses a bitter pulp interspersed with flattish seeds. If a hole is made in one of these ripe gourds, and a glass of rum poured in and suffered to remain 24 hours, it proves a powerful purgative. The pulp itself dried and powdered is commonly used as a purgative in this country, but is one of the most drastic, and if taken in a large dose, somewhat hazardous.

CUCURBIT, in chemistry, an earthen or glass vessel, so called from its resemblance to a gourd, arising gradually from a wide bottom, and terminating in a narrow neck.

CUCURBITA, the gourd and pompion, a genus of the syngenesia order, in the monœcia class of plants, and in the natural method ranking under the 34th order, cucurbitaceæ. The calyx of the male is quinquedentated, the corolla quinquefid, the filaments three: the calyx of the female is quinquedentated, the corolla quinquefid, the pistil quinquefid, the seeds of the apple with a tumid margin.

There are seven species, viz.

1. The lagenaria, or bottle-gourd, rises with thick trailing downy stalks, branching into many spreading runners. These extend along the ground sometimes 15 or 20 feet in length. The leaves are large; the flowers are large and white, succeeded by long incurvated whitish yellow fruit, attaining from about two to five or six feet in length, and from about nine to twenty-four inches in circumference, having a ligneous and durable shell.

2. The pepo or pompion, commonly called pumpkin, has strong trailing rough stalks, branching into numerous runners. These are much larger than the former, extending from ten to forty or fifty feet each way. They have yellow flowers. The flowers are succeeded by large, round, smooth fruit, of different forms and sizes; some as large as a peck, others as big as half a bushel measure; some considerably less, and others not exceeding the bulk of an orange, ripening to a yellow, and sometimes to a whitish, colour. This species is the most hardy of any, as well as the most extensive in their growth. A single plant, if properly encouraged, will overspread 10 or 15 roods of ground, and produce a great number of fruit, which, when young, are generally a mixture between a deep blue and pale white, but change as they increase in bulk.

3. The verrucosa, or warted gourd, has trailing stalks very branchy, and running upon the ground 10 or 15 feet each way; large lobated leaves, and yellow flowers, succeeded by roundish, knobby, warted, white fruit, of a moderate size.

4. The melopepo, erect gourd, or squash, rises with an erect strong stalk several feet high, rarely sending forth side-runners, but becoming bushy upward. It is adorned with large lobated leaves; and the flowers are succeeded by depressed knotty fruit, both white and yellow, commonly of a moderate size.

5. The hispida.

6. The ovifera.

7. The citrullus, or water-melon, the fruit of which is often a foot or a foot and a half in diameter. It is much admired in hot climates for its refreshing coolness; but to an English palate it is always insipid.

Of all these species there are a great many varieties, and the fruit of every species is observed to be surprisingly apt to change its form.

All the species of gourds and pompions, with their respective varieties, are raised from seed sown annually in April or the beginning of May, either with or without the help of artificial heat. But the plants forwarded in a hotbed till about a month old, produce fruit a month or six weeks earlier on that account, and ripen proportionably sooner.

In this country these plants are cultivated chiefly for curiosity; though, mixed with apples, their pulp makes excellent tarts. In the places where they are natives, they answer many important purposes. In both the Indies, bottle-gourds are very commonly cultivated and sold in the markets. They make the principal food of the common people, particularly in the warm months of June, July, and August. The Arabians call this kind of gourd *charrah*. It grows commonly on the mountains in their deserts. The natives boil and season it with vinegar; and sometimes, filling the shell with rice and meat, make a kind of pudding of it. The hard shell is used for holding water, and some of them are capacious enough to contain 22 gallons; these, however, are very uncommon. The fruit of the pompion constitutes a great part of the food of the common people during the hot months, in those places where it grows. If gathered when not much bigger than a hen or goose egg, and properly seasoned with butter, vinegar, &c. it makes a tolerable good sauce for butcher's meat, and is also used in soups. In England it is seldom used till grown to maturity. The third species is also used in North America for culinary purposes. The fruit is gathered when about half-grown, boiled, and eaten as sauce to butcher's meat. The squashes are also treated in the same manner, and by some people esteemed delicate eating.

CUDDY, in great ships, a place lying between the captain-lieutenant's cabin and the quarter-deck, under the poop. It is divided into partitions for the master and other officers.

CUI *ante divortium*, a writ that a woman divorced from her husband has to recover her lands and tenements, which, before her coverture, she held in fee simple, in tail, or for life, from a person to whom her husband had alienated them during the marriage, when it was not in her power to gainsay it.

CUI *in vita*, a writ of entry which a widow may have against him to whom her husband in his life-time alienated her lands or tenements, without her consent first had, and her lawfully joining therein.

CUIRASS, a piece of defensive armour, made of iron plate, well hammered, serving to cover the body from the neck to the girdle, both before and behind: whence,

CUIRASSIERS, cavalry armed with cuirasses, as most of the Germans formerly were.

CULDEES, in church history, a sort of monkish priests, formerly inhabiting Scotland and Ireland. Being remarkable for the religious exercises of preaching and praying, they were called, by way of eminence, *cultores Dei*; whence is derived the word culdees. They made choice of one of their own fraternity to be their spiritual head, who was afterwards called the Scots bishop.

CULEUS, in Roman antiquity, the largest measure of capacity for things liquid, equal to 20 amphoræ, or 40 urnæ. It contained 143 gallons three pints, English wine measure, or 11.095 solid inches.

CULEX, the gnat, a genus of insects belonging to the order of diptera. The mouth is formed by a flexible sheath, inclosing bristles pointed like stings. The antennæ of the males are filiform; those of the females feathered. There are seven species. These insects, too well known by the severe punctures they inflict, and the itchings thence arising, afford a most interesting history. Before they turn to flying insects, they have been in some measure fishes, under two different forms. "You may observe in stagnate waters," says Barbut, "from the beginning of May till winter, small grubs with their heads downwards, and their hinder parts on the surface of the water; from which part arises sideways a kind of vent-hole, or small hollow tube like a funnel; and this is the organ of respiration. The head is armed with hooks that serve to seize on insects and bits of grass, on which it feeds. On the sides are placed four small fins, by the help of which the insect swims about, and dives to the bottom.

These larvæ retain their form during a fortnight or three weeks, after which period they turn to chrysalids. All the parts of the winged insect are distinguishable through the outward robe that shrouds them. The chrysalids are rolled up into spirals. The situation and shape of the windpipe is then altered; it consists of two tubes near the head, which occupy the place of the stigmata, through these the winged insect is one day to breathe. These chrysalids, constantly on the surface of the water in order to draw breath, abstain now from eating; but upon the least motion are seen to unroll themselves, and plunge to the bottom, by means of little paddles situated at their hinder part. After three or four days of strict fasting, they pass to the state of a gnat. A moment before, water was its element; but now it becomes an aerial insect, he can no longer exist in it. He swells his head, and bursts his inclosure. The robe he lately wore turns to a ship, of which the insect is the mast and the sail. If at the instant when the gnat displays his wings there arises a breeze, it proves to him a dreadful hurricane; the water gets into the ship, and the insect, who is not yet loosened from it, sinks, and is lost. But in calm weather, the gnat forsakes his slough, dries himself, flies into the air, and seeks to pump the alimentary juice of leaves, or the blood of men and beasts. The sting which our naked eye discovers, is but a tube, containing five or six spicula of exquisite minuteness; some dentated at their extremity like the head of an arrow, others sharp-edged like razors. These spicula, introduced into the veins, act as pump-suckers, into which the blood ascends by reason of the smallness of the capillary tubes. The insect injects a small quantity of liquor into the wound, by which the blood becomes more fluid, and is seen through the microscope passing through those spicula. The animal swells, grows red, and does not quit his hold till it has gorged itself. The liquor it has injected causes by its irritation that disagreeable itching which we experience; and which may be removed by volatile alkali, or by scratching the part newly stung, and washing it with vinegar. Rubbing one's self at night with fullers' earth and water, lessens the pain and inflammation. Gnats perform their copulation in the air. The female deposits her eggs on the water, by the help of her moveable hinder part and her legs, placing them one by the side of another in the form of a little boat. This vessel, composed of two or three hundred eggs, swims on the water for two or three days, after which they are hatched. If a storm arises, the boats are sunk. Every month there is a fresh progeny of these insects. Were they not devoured by swallows, other birds, and by several carnivorous insects, the air would be darkened by them."

Gnats in this country, however troublesome they may be, do not make us feel them so severely as the musketo flies (culex pipiens) do in foreign parts. Both day and night these come into the houses; and when the people are gone to bed, they begin their disagreeable humming, approach always nearer to the bed, and at last suck up so much blood that they can hardly fly away. The bite causes blisters in people of a delicate constitution. When the weather has been cool for some days, the musketoes disappear; but when it changes again, and especially after rain, they gather frequently in such quantities about the houses, that their number is astonishing. In sultry evenings they accompany the cattle in great swarms from the woods to the houses or to town; and when they are driven before the houses, the gnats fly in wherever they can. In greatest heat of summer, they are so numerous in some places, that the air seems to be quite full of them, especially near swamps and stagnate waters, such as the river Morris in New Jersey. The inhabitants therefore make a fire before their houses to expel these disagreeable guests by the smoke.

CULMINATION, in astronomy, the passage of any heavenly body over the meridian, or its greatest altitude for that day. See GLOBES, *use of*.

CULPRIT, is not (as is vulgarly imagined) an opprobrious name given to the prisoner before he is found guilty, but it is the reply of the clerk of arraigns to the prisoner, after he had pleaded Not Guilty; which plea was antiently entered upon the minutes in an abbreviated form, *non cul'*; upon which the clerk of the arraigns, on behalf of the crown, replies that the prisoner is guilty, and that he is ready to prove him so; which is done by a like kind of abbreviation, cul'prit, signifying that the king is ready to prove him guilty (from cul, that is, culpabilis, guilty; and prit, præsto sum, I am ready to verify it). 4 Black. 339.

CULM, or CULMUS. See BOTANY.

CULTURE *of lands*. See HUSBANDRY.

CULVERIN, a long slender piece of ordnance or artillery, serving to carry a ball to a great distance. Manege derives the word from the Latin colubrina; others from coluber, "snake;" either on account of the length and slenderness of the piece, or of the ravages it makes. There are three kinds of culverins, viz. the extraordinary, the ordinary, and the least-sized. 1. The culverin extraordinary has 5½ inches bore; its length 32 calibers, or 13 feet; weighs 4800 pounds; its load above 12 pounds; carries a shot 5¼ inches diameter, of twenty pounds weight. 2. The ordinary culverin is 12 feet long; carries a ball of 17 pounds 5 ounces; caliber 5½ inches; its weight 4500 pounds. 3. The culverin of the least size has its diameter 5 inches; is 12 feet long; weighs about 4000 pounds; carries a shot 3¾ inches diameter, weighing 14 pounds 9 ounces.

CULVERTAIL, among shipwrights, signifies the fastening or letting of one timber into another, so that they cannot slip out, as the corlings into the beams of a ship.

CUMINUM, *cummin*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The fruit is ovate and striated; there are four partial umbels, and the involucra are quadrifid. There is but one species, viz. the cyminum. It is an annual plant, perishing soon after the seed is ripe. It rises nine or ten inches high in the warm countries, where it is cultivated, but seldom rises above four in this country. It has sometimes flowered very well here, but never brings its seeds to perfection. The leaves are divided into long narrow segments, like those of fennel, but much smaller: they are of a deep green, and generally turned backward at their extremity. The flowers grow in small umbels at the top of the stalks: they are composed of five unequal petals, of a pale blueish colour, which are succeeded by long, channeled, aromatic seeds. The plant is propagated for sale in the island of Malta. The seeds have a bitterish warm taste, accompanied with an aromatic flavour, not of the most agreeable kind. They are retained in the revised Pharmacopœia of the college, particularly in the emplastrum cumini.

CUNICULUS, in mining, a term used by authors in distinction from puteus, to express the several sorts of passages and cuts in these subterranean works. The cuniculi are those direct passages in mines where they walk on horizontally; but the putei are the perpendicular cuts or descents. The miners in Germany call these by the name stollen and schachts; the first word expressing the horizontal, and the second the perpendicular cuts.

CUNILA, in botany, a genus of the monogynia order, in the monandria class of plants, and in the natural method ranking under the 42d order, verticillatæ. The corolla is ringent, with its upper lip erect and plain; there are two filaments, castrated, or wanting antheræ; the seeds are four. There are four species, none of which has any remarkable property.

CUNNINGHAMIA, a genus of the tetrandria monogynia class and order. The calyx is four-toothed; the corolla four-cleft, with a short tube; berry crowned with a two-seeded nut. There is one species.

CUNONIA, a genus of the digynia order, in the decandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is pentapetalous; the calyx pentaphyllous; the capsule bilocular, acuminated, polyspermous; the styles longer than the flower. There is one species, a native of the Cape.

CUOGOLO, in natural history, the name of a stone much used by the Venetians in glass-making, and found in the river Fesino. It is a small stone of an impure white, of a shattery texture, and is of the shape of a pebble.

CUP-*galls*, in natural history, a name given by authors to a very singular kind of galls, found on the leaves of the oak and some other trees. They are of the figure of a cup, or drinking-glass without its foot, being regular cones adhering by their point or apex to the leaf; and the top or broad part is hollowed a little way, so that it appears like a drinking-glass with a cover, which was made so small as not to close it at the mouth, but fall a little way into it. This cover is flat, and has in the centre a very small protuberance, resembling the nipple of a woman's breast. This is of a pale green, as is also the whole of the gall, excepting only its rim that runs round about the top: this latter is of a scarlet colour, and that very beautiful. See CYNIPS.

CUPANIA, a genus of the monadelphia order, in the monœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ. The calyx of the male is triphyllous; the corolla pentapetalous; the stamina five. The calyx of the female is triphyllous; the corolla tripetalous; the style trifid; and a pair of seeds. There are three

species, small trees of the West Indies, which possess no remarkable property.

CUPEL, in metallurgy, a small vessel which absorbs metallic bodies when changed by fire into a fluid scoria; but retains them as long as they continue in their metallic state. One of the most proper materials for making a vessel of this kind is the ashes of animal bones; there is scarcely any other substance which so strongly resists vehement fire, and which so readily imbibes metallic scoriæ. See CHEMISTRY.

CUPELLATION, the act of refining gold or silver by means of a cupel. For this purpose another vessel called a muffle is made use of, within which one or more cupels are placed. The muffle is placed upon a grate in a proper furnace, with its mouth facing the door, and as close to it as may be. The furnace being filled up with fuel, some lighted charcoal is thrown on the top, and what fuel is afterwards necessary is supplied through a door above. The cupels are set in the muffle; and being gradually heated by the successive kindling of the fuel, they are kept red-hot for some time, that the moisture which they strongly retain may be completely dissipated; for if any vapours should issue from them after the metal is put in, they would occasion it to sputter, and a part of it to be thrown off in little drops. In the sides of the muffle are some perpendicular slits, with a knob over the top of each, to prevent any small pieces of coals or ashes from falling in. The door, or some apertures in it, being kept open, for the inspection of the cupels, fresh air enters into the muffle, and passes off through these slits; by laying some burning charcoal on an iron plate before the door, the air is heated before its admission; and by removing the charcoal, or supplying more, the heat in the cavity of the muffle may be somewhat diminished or increased more speedily than can be effected by suppressing or exciting the fire in the furnace on the outside of the muffle. The renewal of the air also is necessary for promoting the scorification of the lead. See CHEMISTRY.

The cupel being of a full red heat, the lead, cast into a smooth bullet that it may not scratch or injure the surface, is laid lightly in the cavity; it immediately melts, and then the gold or silver to be cupelled is cautiously introduced, either by means of a small iron ladle, or by wrapping them in paper, and dropping them on the lead with a pair of tongs. The quantity of lead should be at least three or four times that of the fine metal; but when gold is very impure, it requires 10 or 12 times its quantity of lead for cupellation. It is reckoned that copper requires for its scorification about 10 times its weight of lead; that when copper and gold are mixed in equal quantities, the copper is so much defended by the gold, as not to be separable with less than 20 times its weight of lead; and that when copper is in very small proportion, as a 20th or 30th part of the gold or silver, upwards of 60 parts of lead are necessary for one of the copper. The cupel must always weigh at least half as much as the lead and copper, for otherwise it will not be sufficient for receiving half the scoria; there is little danger, however, of cupels being made too small for the quantity of a gold assay.

The mixture being brought into thin fusion, the heat is to be regulated according to the appearances, and in this consists the principal nicety of the operation. If a various-coloured skin rises at the top, which liquefying, runs off to the sides, and is there absorbed by the cupel, visibly staining the parts it enters; if a fresh scoria continually succeeds, and is absorbed nearly as fast as it is formed, only a fine circle of it remaining round the edge of the metal; if the lead appears in gentle motion, and throws up a fume a little way from the surface; then the fire is of the proper degree, and the process goes on successfully

Such a fiery brightness of the cupel as prevents its colour from being distinguished, and the fumes of the lead rising up almost to the arch of the muffle, are marks of too strong a heat: though it must be observed, that the elevation of the fumes is not always in proportion to the degree of heat; for if the heat greatly exceeds the due limits, both the fumes and ebullition will entirely cease. In these circumstances the fire must necessarily be diminished; for while the lead boils and smokes vehemently, its fumes are apt to carry off some part of the gold; the cupel is liable to crack, from the hasty absorption of the scoria; and part of the gold and silver is divided into globules, which lying discontinued on the cupel after the process is finished, cannot easily be collected; if there is no ebullition or fumes, the scorification does not appear to go on. Too weak a heat is known by the dull redness of the cupel, by the fume not rising from the surface of the lead, and the scoria appearing like bright drops in languid motion, or accumulated, or growing consistent all over the metal. The form of the surface affords also an useful mark of the degree of heat; the stronger the fire the more convex is the surface, and the weaker the more flat; in this point, however, regard must be had to the quantity of metal; a large quantity being always flatter than a small one in an equal fire.

Towards the end of the process, the fire must be increased; for the greatest part of the fusible metal lead being now worked off, the gold and silver will not continue melted in the heat that was sufficient before. As the last remains of the lead are separating, the rainbow colours on the surface become more vivid, and variously intersect one another with quick motions. Soon after, disappearing all at once, a sudden luminous brightness of the button of gold and silver shows the process to be finished. The cupel is then drawn forwards towards the mouth of the muffle; and the button, as soon as grown fully solid, taken out.

CUPOLA, in architecture, a spherical vault; or the round top of the dome of a church, in form of a cup inverted.

CUPPING, in surgery, the operation of applying cupping-glasses for the discharge of blood, and other humours, by the skin. See SURGERY.

CUPRESSUS, the cypress-tree, a genus of the monadelphia order, in the monœcia class of plants, and in the natural method ranking under the 51st order, coniferæ. The male calyx is a scale of the catkin; there is no corolla; the antheræ are four, sessile, and without filaments. The calyx of the female is a scale of the strobilus, and uniflorous; instead of the stylus there are hollow dots; the fruit is an angulated nut. There are seven species; the most remarkable are the following: 1. The sempervirens, or evergreen, with an upright straight stem, closely branching all round, almost from the bottom upwards, into numerous quadrangular branches, rising in the different varieties from 15 to 40 or 50 feet in height, with small, narrow, erect evergreen leaves, placed imbricatim, and flowers and fruit from the sides of the branches. 2. The thyoides, or evergreen American cypress, commonly called white cedar, has an upright stem branching out into numerous two-edged branches, rising 20 or 30 feet high, ornamented with the flat evergreen leaves, imbricated like the arbor vitæ, and small blue cones, the size of juniper-berries. 3. The disticha, or deciduous American cypress, has an erect trunk, retaining a large bulk, branching wide and regular; grows 50 or 60 feet high, with small spreading deciduous leaves, arranged distichous, or along two sides of the branches. All these species are raised from seeds, and will sometimes also grow from cuttings; but those raised from seeds prove the handsomest plants. The seeds are procured in their cones from the seedsmen, and by exposing them to a moderate heat, they readily open, and discharge their seeds freely. The season for sowing them is any time in March; and they grow freely on a bed of common light earth, especially the first and third species.

The wood of the first species is said to resist worms, moths, and putrefaction, and to last many centuries. The coffins in which the Athenians were used to bury their heroes, were made, says Thucydides, of this wood; as were likewise the chests containing the Egyptian mummies. The doors of St. Peter's church at Rome were originally of the same materials. These, after lasting upwards of 600 years, at the end of which they did not discover the smallest tendency to decay, were removed by order of pope Eugenius IV. and gates of brass substituted in their place. The same tree has been extolled as a remedy in pulmonic diseases, from its supposed property of meliorating the air by its balsamic exhalations; upon which account many antient physicians of the eastern countries used to send their patients to the island of Candia, where these trees grew in great abundance. In that island, says Miller, the cypress-trees were so lucrative a commodity, that the plantations were called dos filiæ; the felling of one of them being reckoned a daughter's portion. Cypress, says Mr. Pococke, is the only tree that grows towards the top of mount Lebanon, and being nipped by the cold, grows like a small oak. Noah's ark is commonly supposed to have been made of this kind of wood.

CURATE, is he who represents the incumbent of a church, parson, or vicar, and performs divine service in his stead; and in case of pluralities of livings, or where a clergyman is old and infirm, it is requisite there should be a curate to perform the cure of the church. He is to be licensed and admitted by the bishop of the diocese, or by an ordinary having episcopal jurisdiction: and when a curate has the approbation of the bishop, he usually appoints the salary too; and in such case, if he is not paid, the curate has a proper remedy in the ecclesiatical

court, by a sequestration of the profits of the benefice; but if he has no licence from the bishop, he is put to his remedy at common law, where he must prove the agreement.

CURATELLA, a genus of the digynia order, belonging to the polyandria class of plants, and in the natural method ranking with those of which the order is doubtful. The calyx is pentaphyllous; the petals four; the styles two; the capsules bipartite, with the cells dispermous.

CURATOR, among civilians, a person regularly appointed to manage the affairs of minors, or persons mad, deaf, dumb, &c. In countries where the civil law prevails, minors have tutors assigned them till they are of the age of 14, between which and 25 they have curators appointed them. There are also curators for the estate of debtors, and of persons dying without heirs.

CURCULIO, in zoology, a genus of insects belonging to the order of coleoptera. The feelers are subclavated, and rest upon the snout, which is prominent and horny. These insects are divided into the following families: 1. Those which have the rostrum longer than the thorax, and whose thighs are simple. 2. Those which have the rostrum longer than the thorax, and the thighs thicker and made for leaping. 3. Those which have the rostrum longer than the thorax, and the thighs dentated. 4. Those which have dentated thighs, and a rostrum shorter than the thorax. 5. Those whose thighs are without teeth or spines, and the rostrum shorter than the thorax. There are no less than 95 species, principally distinguished by their colour.

The larvæ of the curculiones do not differ from those of most coleopterous insects. They bear a resemblance to oblong soft worms. They are provided anteriorly with six scaly legs, and the head likewise is scaly. But the places where those larvæ dwell, and their transformations, afford some singularities. Some species of them, that are dreaded for the mischief they do in granaries, find means to introduce themselves, while yet small, into grains of corn, and there make their abode. It is very difficult to discover them, as they lie concealed within the grain. There they grow at leisure, enlarging their dwelling-places as they grow, at the expence of the interior meal of the grain on which they feed. Corn-lofts are often laid waste by these insects, whose numbers are sometimes so great as to devour and destroy all the grain. When the insect, after having eaten up the meal, is come to its full size, it remains within the grain, hidden under the empty husk, which subsists alone: and there transformed, it becomes a chrysalis, nor does it leave it till a perfect insect, making its way through the husk of the grain. It is no easy matter to discover by the eye the grains of corn thus attacked and hollowed out by these insects, as they outwardly appear large and full: but the condition the curculio has reduced them to, renders them much lighter; and if you throw corn infested by these insects into water, all the spoiled grains will swim, and the rest sink to the bottom. Other larvæ of curculiones are not so fond of corn, but fix in the same manner on several other seeds. Beans, peas, and lentils, that are preserved dry, are liable to be eaten by these little animals; which prey upon the inward part of the grain, where they have taken up their habitation, and do not come forth till they have completed their transformation, by breaking through the outward husk of the grain: this is discoverable by casting those grains into water; those that swim are generally perforated by the curculiones. Other species are lodged in the inside of plants. The heads of artichokes and thistles are often bored through and eaten away by the larvæ of large curculiones. Another species smaller, but singular, pierces and inwardly consumes the leaves of elms. It frequently happens that almost all the leaves of an elm appear yellow, and, as it were, dead towards one of their edges, while the whole remainder of the leaf is green. Upon inspecting these leaves, the dead part appears to form a kind of bag or small bladder. The two laminæ or outward pellicles of the leaf, as well above as below, are entire, but distant and separated from each other; whilst the parenchyma that lies between them has been consumed by several small larvæ of the curculio, which have made themselves that dwelling, in which they may be met with. After their transformation they come forth, by piercing a kind of bladder, and give being to a curculio that is brown, small, and hard to catch, from the nimbleness with which it leaps. The property of leaping, allotted to this single species, depends on the shape and length of its hinder legs.

CURCUMA, *turmeric*, a genus of the monogynia order, in the monandria class of plants, and in the natural method ranking under the eighth order, scitamineæ. It has four barren stamina, with a fifth fertile. There are three species: 1. The rotunda, with a round root, having a fleshy-jointed root like that of ginger, but round; which sends up several spear-shaped oval leaves; that rise upwards of a foot high, and are of a sea-green colour. From between these arise the flower-stalks, supporting a loose spike of flowers of a pale yellowish colour, inclosed in several different spathæ, or sheaths, which drop off. The flowers are never succeeded by seeds in this country. 2. The longa has long fleshy roots of a deep-yellow colour, which spread under the surface of the ground like those of ginger; they are about the thickness of a man's finger, having many round knotty circles, from which arise four or five large spear-shaped leaves, standing upon long footstalks. The flowers grow in loose scaly spikes on the top of the footstalks, which rise from the larger knobs of the roots, and grow about a foot high; they are of a yellowish-red colour, and shaped somewhat like those of the Indian reed. 3. The pallida, which differs from the others in being an annual plant. These plants grow naturally in India, whence the roots are brought to Europe for use. They are very tender, so will not live in this country unless kept constantly in a stove. They are propagated by parting the roots. The root communicates a beautiful but perishable yellow dye, with alum, to woollen, cotton, or linen. In medicine it is esteemed an aperient and emmenagogue, and of singular efficacy in the jaundice.

CURIA, in Roman antiquity, a certain division, or portion of a tribe. Romulus divided the people into 30 curiæ, or wards, whereof there were 10 in every tribe, that each might keep the ceremonies of their feasts and sacrifices in the temple, or holy place, appointed for every curia. The priest of the curia was called curio.

CURIA, in the English law, generally signifies a court; and has been taken for the customary tenants, who do their suit and service at the court of the lord.

CURIA *advisare vult*, a deliberation which a court of justice takes upon some point of difficulty that arises in a cause, before they give judgment.

CURIA *aquæ cursus*, a court held by the lord of the manor of Gravesend, for the better management of barges and boats that use the passage on the Thames between that place and London, &c.

CURIA *claudenda*, a writ that lies to compel a man to make a fence, or wall, between his lands and that of the plaintiff.

CURIOSUS, an officer of the Roman empire, during the middle age; when one or two were dispatched annually into each province to take care that no frauds or abuses were committed with regard to the posts and roads, and to bring intelligence to court of what passed in all the provinces. They answer nearly to what we call comptrollers.

CURRANS, or CURRANTS. See RIBES.

CURRANTS also signify a smaller kind of grapes brought principally from Zante and Cephalonia. They are gathered off the bunches, and laid to dry in the sun, and so put up in large butts. They are opening and pectoral, but are more used in the kitchen than in medicine.

CURRENT, in hydrography, a stream or flux of water in any direction. In the sea currents are either natural, occasioned by the diurnal motion of the earth round its axis, or accidental, caused by the waters being driven against promontories, or into gulphs and streights, where wanting room to spread, they are driven back, and thus disturb the ordinary flux of the sea. Dr. Halley makes it highly probable that in the Downs there are under-currents, by which as much water is carried out as is brought in by the upper currents.

CURRENTS, in navigation, are certain settings of the stream, by which ships are compelled to alter their course or velocity, or both, and submit to the motion impressed upon them by the current. The knowledge of them being so necessary an article in navigation, we shall shew a more accurate way of discovering the way they set, together with their strength, than that of guessing by the ripplings of the water, and by the driving of the froth along shore. Take your ship's boat, with three or four men, a compass, a log-line with a large log to it, and a kettle or iron pot, with a coil or two of inch-rope fastened to its bale. When at a proper distance from the ship, heave your kettle overboard, and let it sink 80 or 100 fathoms, which will ride the boat nearly as fast as if at anchor. Heave your log, and turn your half-minute glass, observing at the same time to set the drift of the log by the compass: then will the knots run out during the half-minute, give the current's strength, and the compass its setting. Now to know how to make proper allowances for currents, it is evident, if a current sets just with the course of the ship, then the motion of the ship is increased by as much as is the drift or velocity of the current;

and if a current sets directly against the ship's course, then the motion is retarded in proportion to the velocity of the current. Hence it is plain, 1. If the velocity of the current be less than that of the ship, then the ship will get so much ahead, as is the difference of these velocities. 2. If the velocity of the current be greater than that of the ship, then the ship will fall so much astern as is the difference of these velocities. 3. If the velocity of the current be equal to that of the ship, then the ship will stand still, the one velocity destroying the other.

If the current thwarts the course of a ship, then it not only lessens or augments her velocity, but gives her a new direction; compounded of the course she steers, and the setting of the current. Suppose a ship sails by the compass directly south, 96 miles in 24 hours, in a current that sets east 45 miles in the same time: required the ship's true course and distance. It is evident that the ship will run upon the diagonal of a parallelogram, of which the sides are 96 and 45: the length of this diagonal is found to be 106 miles, equal to $\sqrt{96^2 + 45^2}$. See NAVIGATION.

CURRIERS. No currier shall use the trade of a butcher, tanner, &c. or shall curry skins insufficiently tanned, or gash any hide of leather, on pain of forfeiting for every hide or skin, 6*s*. 8*d*. If any currier do not curry leather sent to him, within 16 days between Michaelmas and Lady-day, and in eight days at other times, he shall on conviction thereof forfeit 5*l*. 12 Geo. II. c. 25. Every currier or dresser of hides in oil, shall annually take out a licence from the commissioners or officers of excise.

CURRYING, the method of preparing leather with oil, tallow, &c. The chief business is to soften and supple cows' and calves' skins, which make the upper-leathers and quarters of shoes, coverings of saddles, coaches, and other articles which must keep out water. 1. These skins, after coming from the tanner's yard, having many fleshy fibres on them, the currier soaks them some time in common water. 2. He takes them out, and stretches them on a very even wooden horse; then with a paring knife, he scrapes off the superfluous flesh, and puts them into soak again. 3. He puts them wet on a hurdle, and tramples them with his heels, till they begin to grow soft and pliant. 4. He soaks them in train oil, which, by its unctuous quality, is the best liquor for this purpose. 5. He spreads them on large tables, and fastens them at the ends. Then, with the help of an instrument called a pummel, which is a thick piece of wood, the under side of which is full of furrows crossing each other, he folds, squeezes, and moves them forwards and backwards several times, under the teeth of this instrument, which breaks their too great stiffness. This is what is properly called currying. The order and number of these operations are varied by different curriers, but the material part is always the same. 6. After the skins are curried, there may be occasion to colour them. The colours are black, white, red, yellow, and green: the other colours are given by the skinners, who differ from curriers in this, that they apply their colours on the flesh side, the curriers on the hair side. In order to whiten skins, they are rubbed with lumps of chalk, or white lead, and afterwards with pumice-stone. 7. When a skin is to be made black, after having oiled and dried it, he passes over it a puff dipt in water impregnated with iron; and after this first wetting, he gives it another in a water prepared with soot, vinegar, and gum arabic. These different dyes gradually turn the skin black, and the operations are repeated till it is of a shining black. The grain and wrinkles which contribute to the suppleness of calves' and cows' leather, are made by the reiterated folds given to the skin in every direction, and by the care taken to scrape off all hard parts on the coloured side.

CURSING *and swearing*, an offence against God and religion, and a vice of all others the most extravagant and unaccountable, as having no benefit or advantage attending it. By the last statute against this crime, 19 Geo. II. which repeals all former ones, every labourer, sailor, or soldier, profanely cursing or swearing, shall forfeit 1*s*.; every other person under the rank of a gentleman, 2*s*.; and every gentleman or person of superior rank, 5*s*. to the poor of the parish; and on a second conviction double; and for every subsequent offence treble the sum first forfeited, with all charges of conviction; and in default of payment, shall be sent to the house of correction for 10 days. Any justice of the peace may convict upon his own hearing, or the testimony of one witness; and any constable or peace-officer, upon his own hearing, may secure any offender, and carry him before a justice, and there convict him. If the justice omits his duty, he forfeits 5*l*. and the constable 40*s*. And the act is to be read in all parish-churches and public chapels the Sunday after every quarter-day, on pain of 5*l*. to be levied by warrant from any justice. Besides this punishment for taking God's name in vain in common discourse, it is enacted, by stat. 3 Jac. I. c. 21. that if in any stage-play, interlude, or show, the name of the Holy Trinity, or any of the persons therein, be jestingly or profanely used, the offender shall forfeit 10*l*. one moiety to the king, and the other to the informer.

CURSITOR, an officer or clerk belonging to the chancery, who makes out original writs; of these there are 24 in number, and to each are allotted several counties.

CURSOR, in mathematical instruments, is any small piece that slides: as the piece in an equinoctial ring-dial that slides to the day of the month; the little label of brass divided like a line of sines, and sliding in a groove along the middle of another label, representing the horizon in the analemma; and likewise a brass point screwed on the beam-compasses, which may be moved along the beam for the striking of greater or less circles.

CURTATE *distance*, in astronomy, the distance of a planet from the sun to that point where a perpendicular let fall from the planet meets with the ecliptic.

CURTEYN, *curtana*, in the British customs, king Edward the Confessor's sword, borne before the prince at coronations. Its point is said to be broken off, as an emblem of mercy.

CURTIN, CURTAIN, or COURTIN, in fortification, is that part of the rampart of a place which is betwixt the flanks of two bastions bordered with a parapet five feet high, behind which the soldiers stand to fire upon the covered way and into the moat. As it is the best defended of any part of the rampart, besiegers never carry on their attacks against the curtain, but against the faces of the bastions, because of their being defended only by one flank.

CURTISA, a genus of the tetrandria monogynia class and order. The calyx is four-parted; petals four; drupe superior, roundish, succulent, with a four or five celled nut. There is one species, a tree of the Cape.

CURVATURE *of a line*, is the peculiar manner of its bending or flexure, by which it becomes a curve of such and such peculiar properties.

Any two arches of curve lines touch each other when the same right line is the tangent of both at the same point; but when they are applied upon each other in this manner, they never perfectly coincide, unless they are similar arches of equal and similar figures; and the curvature of lines admits of indefinite variety. Because the curvature is uniform in a given circle, and may be varied at pleasure in them by enlarging or diminishing their diameters, the curvature of circles serves for measuring that of other lines.

Of all the circles that touch a curve in any given point, that is said to have the same curvature with it, which touches it so closely, that no circle can be drawn through the point of contact between them: and this circle is called the circle of curvature; its centre, the centre of curvature; and its semidiameter, the ray of curvature belonging to the point of contact. As in all figures, rectilinear ones excepted, the position of the tangent is continually varying, so the curvature is continually varying in all curvilinear figures, the circle only excepted. As the curve is separated from its tangent by its curvature, so it is separated from the circle of curvature in consequence of the increase or decrease of its curvature; and as its curvature is greater or less, according as it is more or less inflected from the tangent, so the variation of curvature is greater or less, according as it is more or less separated from the circle of curvature.

When any two curve lines touch each other in such a manner that no circle can pass between them, they must have the same curvature; for the circle that touches the one so closely that no circle can pass between them, must touch the other in the same manner. And it can be made appear, that circles may touch curve lines in this manner; that there may be indefinite degrees of more or less intimate contact between the curve and the circle of curvature; and that a conic section may be described that shall have the same curvature with a given line at a given point, and the same variation of a curvature, or a contact of the same kind with the circle of curvature. The rays of curvature of similar arcs, in similar figures, are in the same ratio as any homologous lines of these figures, and the variation of curvature is the same.

CURVE, in geometry, a line which, running on continually in all directions, may be cut by one right line in more points than one.

In a curve, the line AD (See Pl. Miscel. fig. 28), which bisects all the parallel lines MN, is called a diameter, and the point A, where the diameter meets the curve, is called the vertex; if AD bisect all the parallels at

right angles, it is called the axis. The parallel lines MN are called ordinates, or applicates, and their halves P M, or P N, semi-ordinates. The portion of the diameter A P, between the vertex, or any other fixed point, and an ordinate, is called the absciss; also the concourse of all the diameters, if they meet all in one point, is the centre. This definition of the diameter, as bisecting the parallel ordinates, respects only the conic sections, or such curves as are cut only in two points by the ordinates; but in the lines of the 3d order, which may be cut in three points by the ordinates, then the diameter is that line which cuts the ordinates so, that the sum of the two parts that lie on the one side of it, shall be equal to the part on the other side; and so on for curves of higher orders; the sum of the parts of the ordinates on one side of the diameter, being always equal to the sum of the parts on the other side of it.

Curve lines are distinguished into algebraical or geometrical, and transcendental or mechanical.

Algebraical or geometrical curves are those in which the relation of the abscisses A P, to the ordinates P M, can be expressed by a common algebraic equation.

And transcendental or mechanical curves are such as cannot be so defined or expressed by an algebraical equation.

Thus suppose, for instance, the curve be the circle, (Pl. Mis. fig. 28) and that the radius A C $=r$, the absciss A P $=x$, and the ordinate P M $=y$; then, because the nature of the circle is such, that the rectangle A P $\times$ P B is always $=$ P M^2, therefore the equation is $x \cdot \overline{2r-x} = y^2$, or $2rx-x^2=y^2$, defining this curve, which is therefore an algebraical or geometrical line. Or suppose C P $=x$, then is C M^2 $-$ C P^2 $=$ P M^2, that is, $r^2-x^2=y^2$; which is another form of the equation of the curve.

The doctrine of curve lines in general, as expressed by algebraical equations, was first introduced by Des Cartes, who called algebraical curves geometrical ones, as admitting none else into the construction of problems, nor consequently into geometry. But Newton, and after him Leibnitz and Wolfius, are of another opinion; and think, that in the construction of a problem, one curve is not to be preferred to another for its being defined by a more simple equation, but for its being more easily described.

Algebraical or geometrical lines are best distinguished into orders according to the number of dimensions of the equation expressing the relation between its ordinates and abscisses, or, which is the same thing, according to the number of points in which they may be cut by a right line. And curves of the same kind or order are those whose equations rise to the same dimension. Hence, of the first order, there is the right line only; of the second order of lines, or the first order of curves, are the circle and conic sections, being four species only, viz. $dx - x^2 = y^2$ the circle $\frac{c^2}{d^2} \cdot \overline{dx - x^2} = y^2$ the ellipse, $\frac{c^2}{d^2} \cdot dx + x^2 = y^2$ the hyperbola, and $dx = y^2$ the parabola; the lines of the third order, or curves of the second order, are expressed by an equation of the third degree, having three roots; and so on. Of these lines of the third order, Newton wrote an express treatise, under the title of Enumeratio Linearum Tertii Ordinis, shewing their distinctive characters and properties, to the number of 72 different species of curves; but Mr. Stirling afterwards added four more to that number, and Mr. Nic. Bernouilli and Mr. Stone added two more.

As to the curves of the second order, sir Isaac Newton observes, they have parts and properties similar to those of the first: thus, as the conic sections have diameters and axes, the lines cut by these are called ordinates, and the intersection of the curve and diameter, the vertex. So in curves of the second order, any two parallel lines being drawn so as to meet the curve in three points, a right line cutting these parallels, so as that the sum of the two parts between the secant and the curve on one side, is equal to the third part terminated by the curve on the other side, will cut in the same manner all other right lines parallel to these, and meet the curve in three parts, so as that the sum of the two parts on one side will be still equal to the third part on the other side.

These three parts, therefore, thus equal, may be called ordinates or applicates; the secant may be styled the diameter; the intersection of the diameter and the curve the vertex; and the point of concourse of any two diameters the centre. And if the diameter be normal to the ordinates, it may be called axis; and that point where all the diameters terminate, the general centre. Again, as an hyperbola of the first order has two asymptotes, that of the second three, that of the third four, &c. and as the parts of any right line lying between the conic hyperbola and its true asymptotes are every where equal, so in the hyberbola of the second order, if any right line be drawn cutting both the curve and its three asymptotes in three points, the sum of the two parts of that right line being drawn the same way from any two asymptotes to two points of the curve, will be equal to a third part drawn a contrary way from the third asymptote to a third point of the curve. Again, as in conic sections not parabolical, the square of the ordinate, that is, the rectangle under the ordinates drawn to contrary sides of the diameter, is to the rectangle of the parts of the diameter which are terminated at the vertices of the ellipsis or hyperbola, as the latus rectum is to the latus transversum; so in nonparabolic curves of the second order, a parallelopiped under the three ordinates is to a parallelopiped under the parts of the diameter, terminated at the ordinates, and the three vertices of the figure, in a certain given ratio; in which ratio, if you take three right lines situated at the three parts of the diameter between the vertices of the figure, one answering to another, then these three right lines may be called the latera recta of the figure, and the parts of the diameter between the vertices, the latera transversa. And, as in the conic parabola, having to one and the same diameter but one only vertex, the rectangle under the ordinates is equal to that under the part of the diameter cut off between the ordinates and the vertex and the latus rectum; so in curves of the second order, which have but two vertices to the same diameter, the parallelopiped under three ordinates, is equal to the parallelopiped under the two parts of the diameter cut off between the ordinates and those two vertices and a given right line, which therefore may be called the latus rectum. Moreover, as in the conic sections, when two parallels terminated on each side of the curve, are cut by two other parallels terminated on each by the curve, the first by the third, and the second by the fourth; as here the rectangle under the parts of the first is to the rectangle under the parts of the third, as the rectangle under the parts of the second is to that under the parts of the fourth; so when four such right lines occur in a curve of the second kind, each in three points, then shall the parallelopiped under the parts of the first right line, be to that under the parts of the third, as the parallelopiped under the parts of the second line, to that under the parts of the fourth. Lastly, the legs of curves, both of the first, second, and higher kinds, are either of the parabolic or hyperbolic kind; an hyperbolic leg being that which approaches infinitely towards some asymptote; a parabolic, that which has no asymptote. These legs are best distinguished by their tangents; for if the point of contact go off to an infinite distance, the tangent of the hyperbolic leg will coincide with the asympote; and that of the parabolic leg recede infinitely and vanish. The asymptote, therefore, of any leg is found by seeking the tangent of that leg to a point infinitely distant; and the bearing of an infinite leg is found by seeking the position of a right line parallel to the tangent, when the point of contact is infinitely remote; for this line tends the same way towards which the infinite leg is directed. For the other properties of curves of the second order, we refer the reader to Mr. Maclaurin's treatised De Linearum Geometricarum Proprietatibus generalibus.

Sir Isaac Newton reduces all curves of the second order to the four following particular equations, still expressing them all. In the first, the relation between the ordinate and the absciss, making the absciss x and the ordinary y, assumes this form, $xy^2 + cy = ax^3 + bx^2 + cx + d$. In the second case, the equation takes this form, $xy = ax^3 + bx^2 + cx + d$. In the third case, the equation is $y^3 = ax^3 + bx^2 + cx + d$. And in the fourth case, the equation is of this form, $y = ax^3 + bx^2 + cx + d$.

Curves, *family of*, according to Wolfius, is a congeries of several curves of different kinds, all defined by the same equation of an indeterminate degree, but differently, according to the diversity of their kinds. For example: let the equation of an indeterminate degree be $a^{m-1}x = y^m$. If $m=2$, ax will be equal to y^2. If $m=3$, then will $a^2x = y^3$. If $m=4$, then will $a^3x = y^4$, &c. all which curves are said to be of the same family. The equations, however, by which the families of curves are defined, must not be confounded with transcendental ones; though with regard to the whole family they be of an indeterminate degree, yet with respect to each several curve of the family, they are determinate; whereas transcendental equations are of an indefinite degree with respect to the same curve. The genesis and properties of particular curves, as the conchoid, cycloid, &c. see under their proper heads Conchoid, Cycloid, &c.

Curule *chair*, in Roman antiquity, a chair adorned with ivory, wherein the great magistrates of Rome had a right to sit, and be carried.

CUSCUTA, *dodder*, a genus of the digynia order, in the tetrandria class of plants, and in the natural method ranking under those of which the order is doubtful. The calyx is quadrifid; the corolla monopetalous; the capsule bilocular. There are four species, one of which is a native of Britain, viz. the Europæa, dodder, hell-weed, or devil's-guts. This is a very singular plant, almost destitute of leaves, parasitical, creeping, fixing itself to whatever is next to it. It decays at the root, and afterwards is nourished by the plant which supports it. Hops, flax, and nettles, are its common support, but principally the common nettle. Its blossoms are white. As soon as the shoots have twined about an adjacent plant, they send out from their inner surface a number of little vesicles or papillæ, which attach themselves to the bark or rind of the plant. By degrees the longitudinal vessels of the stalk, which appear to have accompanied the vesicles, shoot from their extremities, and make their way into the softer plant, by dividing the vessels, and insinuating themselves into the tenderest part of the stalk; and so intimately are they united with it, that it is easier to break than to disengage them from it. The whole plant is bitter. It affords a pale reddish colour. Cows, sheep, and swine, eat it; horses refuse it; goats eat it reluctantly.

CUSSONIA, a genus of the pentandria digynia class and order. The petals are three-cornered; margin of the receptacle divided into a five-toothed calyx. There are two species, natives of the Cape.

CUSTODE *admittendo*, and *custode amovendo*, are writs for the admitting or removing of guardians.

CUSTOM, is a law or right, not written, which being established by long use, and the consent of our ancestors, has been and is daily practised. If it is to be proved by record, the continuance of a hundred years will serve. Custom is either general or particular. General, when allowed through all England. Particular is that which belongs to this or that county, as gavelkind to Kent. See GAVELKIND

General customs which are used throughout England, and are the common law, are to be determined by the judges: but particular customs, such as are used in some certain towns, boroughs, cities, &c. shall be determined by a jury. 1 Inst. 110. But the judges of the courts of king's-bench and common-pleas, can overrule a custom, though it be one of the customs of London, if against natural reason. 1 Mod. 212.

CUSTOM of London. The ancient city of London, being the metropolis and chief town for trade and commerce within the kingdom, it was necessary, that it should have certain customs and privileges for its better government, which though derogatory from the general law of the realm, yet, being for the benefit of the citizens, and for the advantage of those who trade to and from the city, have not only been allowed good by the judgments in the superior courts, but have also been confirmed by several acts of parliament.

The customs of London differ from all others in point of trial, for if any of the customs are pleaded and denied, and issue is taken thereupon, the existence of such customs shall be tried by a writ directed to the mayor and aldermen, to certify whether there is such a custom or not, and they shall make their certificate by the mouth of the recorder.

These customs of London relate to divers particulars with regard to trade, apprentices, widows, orphans, and a variety of other matters; the custom relative to the distribution of a freeman's estate, extends only to cases of intestacy, or express agreements made in consideration of marriage. It is a custom of London, that where a person is educated in one trade, he may set up another; that where a woman uses a trade, without her husband, she is chargeable alone, as a feme sole merchant, and if condemned, shall be put in prison till she pays the debt; likewise the bail for her are liable, if she absent herself, and the husband, in these cases, shall not be charged. If a debtor be a fugitive, by the custom of London, he may be arrested before the day, in order to find better security, &c. These are customs of this city, different from those of other places.

CUSTOM of merchants. If a merchant gives a character of a stranger to one who sells him goods, he may be obliged to satisfy the debt of the stranger for the goods sold, by the custom of merchants. And when two persons are found in arrears, upon an account grounded on the custom of merchants, either of them may be charged to pay the whole sum due. See BILLS OF EXCHANGE, BANKRUPTS, INSURANCE, &c.

CUSTOMS, taxes levied upon goods when exported from or imported into a state. This mode of raising a public revenue is of great antiquity, as it may be traced back to the time of Solomon; but in modern times it has been extended by different states to almost every article of commerce. It is a mode of taxation generally less objected to than any other, as most persons pay their share of the duty in the price of the article from which it arises, without distinguishing the tax; if, however, these duties are high, they become a great impediment to foreign trade, and give rise to smuggling; of this truth the Dutch were well convinced, and long derived great commercial advantages from the very low duties they imposed on the importation and exportation of merchandize. Duties on goods imported into a country were originally laid upon the subjects of the realm under the pretence of defraying the charges of guarding the coasts from pirates; and upon foreign merchants for the liberty given them by the sovereign of trading in his dominions. The custom-house duties in Great Britain are principally levied either according to the supposed value of the different commodities conformably to particular rates, or in proportion to the weight or measurement of the articles, making some difference according to the country whence the goods are brought, and giving advantages to the ships belonging to and manned by British subjects over those of a different description.

The customs of England were formerly divided into three branches: viz. 1st, The duties upon wool and leather; 2. A duty upon wine, which being imposed at so much a ton was called a tonnage; and 3. A duty upon all other goods, which being imposed at so much in the pound of their supposed value, was called a poundage. In the 47th Edward III. a duty of sixpence in the pound was imposed on all goods exported or imported, except wool, wool-fells, leather, and wine, on which particular duties had been granted before. In 14th Rich. II. it was raised to one shilling in the pound, but three years afterwards was again reduced to sixpence. It was raised to eight-pence in 2d Hen. IV. and in the fourth year of the same prince to one shilling, from which time to the 9th of Wil. III. it continued at one shilling in the pound. The duties of tonnage and poundage were generally granted by the same act, and were called the subsidy of tonnage and poundage. The subsidy of poundage having continued so long at 1*s.* in the pound or at five per cent. a subsidy came in the language of finance to denote a general duty of this kind at five per cent. These duties on the estimated value of goods imported or exported being liable to great inaccuracy and irregularity, the value of the different articles of commerce was ascertained by a book of rates, and computed on the quantities: there was a mode also by which duties were imposed on goods not rated; this was by a proportion on the real value as sworn to by the merchant. These principles once adopted, were pursued in every new subsidy; till the various additional duties imposed on articles of foreign trade in almost every year of war since the Revolution, with the occasional repeal of some of the old duties, and the different bounties and drawbacks allowed on exportation, caused an accumulation of perplexity, which in time had rendered the custom-duties a complete mass of confusion, attended with infinite inconvenience and delay in business. To remedy this evil, in the beginning of 1787, all the old duties were abolished, and a single duty on each article substituted in their stead. This arrangement, which was at the same time extended to the excise and stamp duties, may perhaps be recorded as the most useful financial measure of Mr. Pitt's administration; and it is much to be regretted that although the same principle has been since resorted to, the many new duties which the exigencies of the state have rendered necessary, have again destroyed in some degree the simplicity effected, which had been attended with great practical convenience.

The progress of this branch of revenue shews the vast importance of foreign trade, if considered merely as furnishing a convenient mode of taxation. In the reign of king John, the whole of the duties payable by merchants in this country were farmed for 1000 marks. From some acts of Henry III. it appears that considerable frauds were committed in the revenue of customs; it began however to increase, and in the reign of Edward III. the customs of the port of London alone amounted to 12,000 marks per annum. In 1590, the produce of the customs was considerably improved; and in 1613 it amounted to £148,075 7*s.* 8*d.* of which £109,572 18*s.* 4*d.* was collected in the port of London, while only £38,502 9*s.* 4*d.* was received from all the other ports of England. Of the total, £16,794 16*s.* 2*d.* arose from duties outward, and £61,280 11*s.* 6*d.* from duties inward. By the act of union in 1706, the customs of Scotland are stated

at £30,000 per annum, and those of England at £1,341,559 per annum; since which period, the great increase of foreign trade, and the many new duties which have been imposed, have swelled the revenue of the customs to a far more important magnitude.

The following account shews the total gross receipt of the customs of Great Britain, for the year ending 5th January 1805, with the various payments to which it was subject, and the nett amount paid into the exchequer.

Balance in the hands of the collector, and of the receiver-general of Scotland, on 5th January 1804	£65,166	8	5¼
Bills arising and remitted out of the revenue of 1803, but which were not brought to account till 1804	200,003	3	5½
Gross receipt within the year	10,949,087	11	5¼
Total	£11,214,257	3	4½
Paid drawbacks on exportation	355,768	11	7¼
Repayments on over-entries and damaged goods	98,513	0	5½
Bounties on exportation	1,132,678	16	2¼
Bounties for promoting national objects	304,056	3	8
Money imprest in the hands of out-port collectors	1,465	6	5
Paid towards the expences of the civil government of Scotland	54,476	1	6¼
Advanced for the purchase of legal quays	76,689	12	6
Charges of management	566,999	6	10
Payments into the exchequer	8,357,871	5	8½
Balances in the hands of the collectors, and the receiver-general of Scotland, on the 5th January 1805	98,059	10	6½
Bills arising and remitted out of the revenue of 1804, but which were not brought to account till 1805	167,678	12	10¼
Total	£11,214,257	3	4½

Deducting from the gross receipt of £10,949,087 11*s.* 5¼*d.* the sums paid for drawbacks on exportation, and as bounties for promoting national objects, together £659,824 15*s.* 3¼*d.*, the total nett produce of the year will be £10,289,262 16*s.* 2*d.* arising as follows:

From duties inwards	£8,640,425	10	1¼
Duties outwards	658,968	14	5¾
Duties coastways	934,464	0	1
Quarantine tonnage duty	13,295	0	4
Remittances from the plantations	23,634	7	8
Condemned tobacco, wine, &c.	18,475	3	6
	£10,289,262	16	2

The total produce of the customs of Ireland for the year ending 5th January 1805, may be stated thus:

From duties inwards	£1,850,776	16	2¼
Duties outwards	22,237	15	3
Storage	1,794	13	4¼
Prizage	799	6	3
Light-money	5,944	16	0½
Fines and seizures, &c.	17,096	4	6¼
	£1,898,649	11	7¼
Deduct appropriated duties	14,927	8	9
	£1,883,722	2	10¼

The total produce of the customs of the united kingdom will therefore be as follows:

England	£9,606,584	9	7¼
Scotland	682,678	6	6¼
Ireland	1,883,722	2	10¼
	£12,172,984	19	0¼

The expence of collecting the customs of Great Britain is at the rate of £5 1*s.* 1*d.* per cent. on the gross revenue, or £6 5*s.* 2*d.* per cent. on the nett produce.

CUSTOM-HOUSE, an office established by the king's authority in maritime cities, or port-towns, for the receipt and management of the customs and duties of importation and exportation, imposed on merchandises, and regulated by books of rates. There are several custom-houses in the several parts of England, but the most considerable is that of London. It is under the direction of commissioners, appointed by patent, who have the charge and management of all the customs in all the ports of England. Other officers are a secretary, solicitor, receiver-general, comptroller-general, surveyor-general, &c. all holding their places by patents; with other inferior officers, appointed by warrant from the board of the treasury.

CUSTOM-OFFICERS shall not have any ships of their own, nor may they use merchandise, factorage, nor keep a tavern, &c. They are prohibited to trade in brandy, coffee, &c. or any excisable liquor, on pain of 50*l.* For taking a bribe they shall forfeit 100*l.*, and 500*l.* for making collusive seizures, &c. Every merchant, making an entry of goods, either inwards or outwards, shall be dispatched in such order as he comes in; and if any officer or his clerk shall, for favour or reward, put any merchant or his servant, duly attending to make entries, by his turn, to draw any reward or gratuity from him, besides what is limited in the act of tonnage and poundage, &c. he shall be strictly admonished to his duty; or, if found faulty, he shall be discharged, and not permitted to sit any more in the custom-house. The officers who sit above in the custom-house of London, shall attend their several places, from nine to twelve in the forenoon; and one officer, or clerk, shall attend with the book, in the afternoon, during such time as the officers are appointed to wait at the water-side.

CUSTOS BREVIUM, the principal clerk belonging to the court of common pleas, whose business it is to receive and keep all the writs made returnable in that court, filing every return by itself; and, at the end of each term, to receive of the prothonotaries all the records of the nisi prius, called the posteas. The posteas are first brought in by the clerks of assize of every circuit to that prothonotary who entered the issue in the causes, in order to enter judgment; and after the prothonotary has entered the verdict and judgment thereupon into the rolls of the court, he delivers them over to the custos brevium, who binds them into a bundle. The custos brevium makes likewise entries of writs of covenant, and the concord upon every fine; by him also are made out exemplifications and copies of all writs and records in his office, and of all fines levied, which being engrossed, are divided between him and the chirographer, which last keeps the writ of covenant and the note, and the former the concord and foot of the fine. The custos brevium is made by the king's letters patent.

CUSTOS ROTULORUM, an officer who has the custody of the rolls and records of the sessions of peace, and also of the commission of the peace itself. He usually is some person of quality, and always a justice of the peace, of the quorum, in the county where he is appointed. This officer is made by writing under the king's sign manual, being the lord chancellor's warrant to put him in commission. He may execute his office by a deputy, and is empowered to appoint the clerk of the peace, but he may not sell the place under divers penalties.

CUT-WATER, or knee of the head, the sharpness of the head of the ship, below the beak; so called because it cuts or divides the water before it comes to the bow.

CUTICLE, *cuticula*, in anatomy, a thin membrane closely lying upon the skin, or cutis, of which it seems a part, and to which it adheres very firmly, being assisted by the intervention of the corpus reticulare.

CUTIS, the skin, in anatomy, is that strong thick covering which envelopes the whole external surface of animals. It is composed chiefly of two parts: a thin white elastic layer on the outside, which is called the epidermis, or cuticle; and a much thicker layer, composed of a great many fibres, closely interwoven, and disposed in different directions; this is called the cutis, or true skin. The epidermis is that part of the skin which is raised in blisters.

1. The epidermis is easily separated from the cutis by maceration in hot water. It possesses a very great degree of elasticity. It is totally insoluble in water and in alcohol. Pure fixed alkalies dissolve it completely; as does lime likewise, though slowly. Sulphuric and muriatic acids do not dissolve it, at least they have no sensible action on it for a considerable time; but nitric acid soon deprives it of its elasticity, and causes it to fall to pieces. It is well known that the living epidermis is tinged yellow almost instantaneously by nitric acid; but this effect does not take place, at least so speedily, when the dead cuticle is plunged in nitric acid altogether. If the cuticle is tinged with nitric acid, the application of ammonia to it is well known to give it instantaneously a deep orange-colour. Now as Mr. Hatchett has shewn that this change is also produced upon coagulated albumen in the same circumstances, and as the epidermis resembles that sub-

stance in all the properties above detailed, it can scarcely be doubted that it is nothing else than a peculiar modification of coagulated albumen.

2. The cutis is a thick dense membrane, composed of fibres interwoven like the texture of a hat. When it is macerated for some hours in water, and agitation and pressure are employed to accelerate the effect, the blood, and all the extraneous matter with which it was loaded, are separated from it, but its texture remains unaltered. On evaporating the water employed, a small quantity of gelatine may be obtained. No subsequent maceration in cold water has any farther effect. When distilled it yields the same products as fabrina. The concentrated alkalies dissolve it, converting it into oil and ammonia. Weak acids soften it, render it transparent, and at last dissolve it. Nitric acid converts it into oxalic acid and fat, while, at the same time, azotic gas and prussic acid are emitted. When heated it contracts, and then swells, exhales a fetid odour, and leaves a dense charcoal, difficult to incinerate. By spontaneous decomposition in water or moist earth, it is converted into a fatty matter, and into ammonia, which compose a kind of soap. When allowed to remain long in water, it softens and putrefies, being converted into a kind of jelly. When long boiled in water it becomes gelatinous, and dissolves completely, constituting a viscid liquor, which, by proper evaporation is converted into glue. Hence the cutis of animals is commonly employed in the manufacture of glue.

From these facts the cutis appears to be a peculiar modification of gelatine enabled to resist the action of water, partly by the compactness of its texture, and partly by the viscidity of the gelatine of which it is formed; for those skins which dissolve most readily in boiling water afford the worst glue. Mr. Hatchett has observed, that the viscidity of the gelatine obtained from skins is nearly inversely as their flexibility, the supplest hides always yielding the weakest glue; but this glue is very soon obtained from them by hot water. The skin of the eel is very flexible, and affords very readily a great proportion of gelatine. The skin of the shark also readily yields abundance of gelatine; and the same remark applies to the skins of the hare, rabbit, calf, and ox; the difficulty of obtaining the glue and its goodness always increasing with the toughness of the hide. The hide of the rhinoceros, which is exceedingly strong and tough, far surpasses the rest in the difficulty of solution and in the goodness of its glue. When skins are boiled they gradually swell and assume the appearance of horn, then they dissolve slowly.

It is from the skin or cutis of animals that leather is formed; and the goodness of the leather, or at least its strength, depends in some measure on the toughness of the hides. Those easily soluble, as seal-skins, afford a weaker leather than those which are more difficultly soluble in water. The process by which the skins of animals are converted into leather is called tanning. It seems to have been known and practised in the earliest ages; but its nature was totally unknown till after the discovery of the tanning principle by Seguin. That chemist ascertained that leather is a compound of tan and skin; that it is to the tan that leather owes its insolubility and its power of resisting putrefaction. The subject has lately engaged the attention of Mr. Davy, who has examined it with his usual ingenuity, and added several important facts to our former knowledge.

When skins are to be tanned, the first step of the process is to deprive them of their hair and cuticle. This is either done by steeping them in water till they begin to putrefy, or by steeping them in lime and water. The lime seems to combine with the cuticle, and to render it brittle and easily detachable from the hide. It produces the same effect upon the hair and the matter at its root. When the hides have been steeped for a sufficient time, they are taken out, the hair, cuticle, &c. scraped off, and then they are washed in water.

After this preliminary process, the skins are subjected to different treatment according to the kind of leather which is to be made.

The large and thick hides are introduced for a short time into a strong infusion of bark. They are then said to be coloured. After this they are put into water slightly impregnated with sulphuric acid, or with the acid evolved during the fermentation of barley and rye. This renders them harder and denser than they were before, and fits them for forming sole-leather. Mr. Davy thinks, that by this process a triple compound is formed of the skin, tan, and the acid. The light skins of cows, those of calves, and all small skins, are steeped for some days in a lixivium made by the infusion of pigeon's dung in water. This lixivium is called the grainer. By this process they are rendered thinner, and softer and more proper for making flexible leather. Mr. Davy considers the effect of this lixivium to depend upon the fermentation which it undergoes; for dung that has undergone fermentation does not answer the purpose. After these preliminary processes, the skins are exposed to the action of the infusion of bark till they are converted into leather. The infusion of oak-bark contains two ingredients, namely tan and an extractive. The first is more soluble than the second. Hence in saturated infusions there is a much smaller proportion of tan than of extractive; whereas in weak infusions, the extractive bears a greater proportion to the tan. Mr. Davy considers it as doubtful whether the infusion of oak-bark contains any gallic acid. This chemist has ascertained, that the hides extract both the tan and extractive from the infusion, and leave nothing behind but pure water, provided they are employed in sufficient quantity. Hence it is obvious, that both the tan and extractive must enter into the composition of leather. The extractive gives the hide a brown colour, but does not render it insoluble in boiling water; the tan renders it insoluble, but its colour continues whitish. Hence it is likely that the lightest kinds of leather contain little else than tan, while the brown kinds contain both tan and extractive. While the hides are allowed to remain in the infusion of bark, they combine of course with tan and extractive, and the new compound is leather. Hence the reason of the increase of its weight.

Calf-skins, and those hides which are prepared by the grainer, are first steeped in weak infusions of oak-bark, and gradually removed to stronger and stronger, till they are completely impregnated, which takes up from two to four months. As the weak infusions contain a greater proportion of extractive, the consequence of this process is, that the skin combines in the first place with a portion of it, and afterwards with the tan. When saturated solutions of tan are employed, the leather is formed in a much shorter time. This was the process recommended by Seguin; but it has been observed, that leather tanned in this way is more rigid and more liable to crack than leather tanned in the usual way. Hence it is likely, as Mr. Davy has observed, that the union of the extractive is requisite to form pliable and tough leather. Leather rapidly tanned must be less equable in its texture than leather slowly tanned, as the surface must be saturated with tan before the liquid has time to penetrate deep. Mr. Davy has ascertained that skins, while tanning, seldom absorb more than one-third of their weight of vegetable matter.

Skins intended for sole leather are generally kept from the first in an infusion preserved nearly saturated by means of the strata of bark, with which they alternate. The full impregnation requires from ten to eighteen months. It is likely from this process that sole leather contains a greater proportion of tan than soft leather. While drying, it is smoothed with a rolling-pin, and beaten with a mallet, which must add considerably to its density.

3. As to the rete mucosum, or the mucous substance situated between the cutis vera and epidermis, its composition cannot be determined with precision, because its quantity is too small to admit of examination. It is known that the black colour of negroes depends upon a black pigment, situated in this substance. Oxymuriatic acid deprives it of its black colour, and renders it yellow. A negro, by keeping his foot for some time in water impregnated with that acid, deprived it of its colour, and rendered it nearly white; but in a few days the black colour returned again with its former intensity. This experiment was first made by Dr. Beddoes on the fingers of a negro. See ANATOMY, PHYSIOLOGY, and TANNING.

CUTTER of the tallies, an officer of the exchequer, whose business is to provide wood for the tallies, to cut or notch the sum paid upon them; and then to cast them into court to be written upon.

CUTTING, in heraldry, is used for the dividing a shield into two equal parts, from right to left, parallel to the horizon, or in the fesse-way.

CUTTING *in wood*, a particular kind of sculpture, or engraving, denominated from the matter on which it is employed. That sort of engraving which is called cutting in wood, was the first invented. It is used for initial letters, head and tail pieces of books, and even for schemes and other figures, to save the expence of engraving on copper: and for prints and stamps for paper, calicoes, linen, &c. The art of cutting in wood was certainly carried to very great perfection about one hundred and fifty years ago, and has since been revived with very great success

by Mr. Bewick, whose engravings of animals, &c. on wood may vie in beauty and excellence with the choicest copper-plates. The cutter in wood needs no other instruments than little sharp knives, chisels, and gravers of different sizes. The first thing he does, is to take a plank or block of pear-tree, or box, which he prepares of the size and thickness intended, and makes it very even and smooth on the side to be cut: on this block he draws the design with a pen or pencil just as it ought to be printed. Those who cannot draw their own designs, make use of those done by another, which they fasten on the block with paste, the strokes or lines being turned towards the wood: when the paper is dry, they wash it gently over with a spunge dipped in water; which done, they take off the paper by degrees, still rubbing it a little with the tip of the finger, till there is nothing left on the block but the strokes of ink that form the design, which mark out so much of the block as is to be spared, or left standing; the rest they cut off and take away as curiously as they can, with the point of their sharp instruments.

CYANELLA, a genus of the hexandria monogynia class and order. The cor. is six-petalled; stamens lower, declined larger than the rest. There are three species, natives of Africa.

CYANILE, a stone commonly found in granite rocks. The primitive form of its crystals is a four-sided oblique prism, the sides of which are inclined at an angle of 130°. The base forms with one side of the prism an angle of 103°, with another an angle of 77°. It is sometimes crystallized in six-sided prisms. Its texture is foliated; fracture radiated; rays curved and interlaced; fragments long and splintery. It causes single refraction, and its specific gravity is from 3.5 to 3.6: feels somewhat greasy. Its colour is white, with shades of sky or Prussian blue.

CYATHUS, in Roman antiquity, a liquid measure, containing four ligulas, or half a pint English wine-measure, being 469$\frac{2}{3}$ solid inches.

CYCAS, in botany, a genus of plants belonging to the first natural order, palmæ. The fruit is a dry plum with a bivalved kernel. There are two species: 1. The circinalis, or sago-tree, grows spontaneously in the East Indies, and particularly on the coast of Malabar. It runs up with a straight trunk to 40 feet or more, having many circles the whole length, occasioned by the old leaves falling off; for, standing in a circular order round the stem, and embracing it with their base, whenever they drop, they leave the marks of their adhesion behind. The leaves are pinnated, and grow to the length of seven or eight feet. The pinnæ or lobes are long, narrow, entire, of a shining green, all the way of a breadth, lance-shaped at the point, are closely crowded together, and stand at right angles on each side the mid-rib, like the teeth of a comb. The flowers are produced in long bunches at the foot-stalks of the leaves, and are succeeded by oval fruit, about the size of large plums, of a red colour when ripe, and a sweet flavour. Each contains a hard brown nut, inclosing a white meat, which tastes like a chesnut.

This is a valuable tree to the inhabitants of India, as it not only furnishes a considerable part of their constant bread, but also supplies them with a great article of trade. The trunk contains a farinaceous substance, which they extract from it and make into bread in this manner: They saw the body into small pieces, and after beating them in a mortar, pour water upon the mass; this is left for some hours to settle. When fit, it is strained through a cloth; and the finer particles of the mealy substance running through with the water, the gross ones are left behind and thrown away. After the farinaceous part has sufficiently subsided, the water is poured off, and the meal being properly dried, is occasionally made into cakes and baked. These cakes are said to eat nearly as well as wheaten bread, and are the support of the inhabitants for three or four months in the year.

The same meal more finely pulverized, and reduced into granules, is what is called sago, which is sent into all parts of Europe, and sold in the shops as a great strengthener and restorative. There is a sort of sago made in the West Indies, and sent to Europe, in the same manner as that from the East; but the West India sago is far inferior in quality to the other. It is supposed to be made from the pith of the areca oleracea. See ARECA.

2. The cycas revoluta, or brood boom (or bread-tree) of the Hottentos, a plant discovered by professor Thunberg. The pith, or medulla, which abounds in the trunk of this little palm, Mr. Sparman informs us, is collected and tied up in dressed calf or sheep-skins, and then buried in the earth for the space of several weeks, till it becomes sufficiently mellow and tender to be kneaded up with water into a paste, of which they afterwards make small loaves or cakes, and bake them under the ashes. Other Hottentots not quite so nice, nor endued with patience enough to wait this tedious method of preparing it, are said to dry and roast the pith or marrow, and afterwards make a kind of frumenty of it. See Pl. N. H. fig. 154.

CYCLAMEN, SOWBREAD, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 21st order, preciæ. The corolla is verticillated, with the tube very short, and the throat prominent; the berry is covered with the capsule. There are five species, which produce many beautiful varieties. They are low, herbaceous, flowery perennials, of the tuberous-rooted kind, with numerous angular, heart-shaped, spotted, marbled leaves; with many fleshy footstalks six inches high, carrying monopetalous, five-parted, reflexed flowers, of various colours. All the varieties are extremely ornamented, and some of the flowers very fragrant. They may be planted in any of the common borders, but require to be sheltered from hard frosts by being covered with mats. They should also have a light dry soil, otherwise their roots are apt to rot. The species are propagated by seeds, and the particular varieties by dividing their roots. The root of the cyclamen has, when fresh, an extremely acrimonious taste, which it loses upon being dried.

CYCLAS, a genus of the decandria monogynia class and order. The cal. is four-parted; cor. none; filaments inserted in the neck of the style, flexuose; legume roundish, winged, one-seeded. There are two species, trees of Guiana.

CYCLAS, a genus of testacea of the class of bivalves; shells somewhat transverse, without a fold on the anterior side: exterior ligament recurved; hinge of three teeth; lateral teeth elongated, lamelliform, and let into a groove in the opposite valve.

This genus contains seven or eight species, mostly inhabiting fresh water pools. Animal acephalous, with two tubes projecting on one side, and on the other, a foot linguiform, or tongue-shaped. According to Geoffroy, it is viviparous: the species most common in Europe is the *cyclas cornea*, which is globous, smooth, horn-coloured, with transverse furrows, size of a large pea, inhabits pools of fresh water. See Plate Nat. Hist. fig. 155.

CYCLE, in chronology, a certain period or series of years, which regularly proceed from the first to the last, and then return again to the first, and circulate perpetually. The most considerable cycles are those of the sun, of the moon, and of the Roman indiction.

The cycle of the sun consists of twenty-eight years, which contain all the possible combinations of the dominical letters, in respect to their successive order, as pointing out the common years and leap-years; so that, after the expiration of the cycle, the days of the month return in the same order to the same days of the week, throughout the next cycle; except that upon every centesimal year which is not a leap-year, the letters must always be removed one place forward, to make them answer to the years of the cycle. For instance, if the year 1800 was a leap-year, as every centesimal year is in the Julian account, the dominical letters would be E D, and C would be the dominical letter of the next year; but as it is a common year in the Gregorian account, D is the dominical letter of 1801, which answers to the eighteenth of the cycle, C to the nineteenth, &c. until the next centesimal year. See DOMINICAL LETTER.

To find the year of this cycle for any year of the christian æra, add 9 to the current year of Christ, because the cycle commenced nine years before the christian æra, and divide the sum by 28, the quotient will shew the number of cycles which have revolved since the beginning of that in which the christian æra commenced; and the remainder, if any, shews the current year of the cycle: but if there be no remainder, it it shews that it is the last or twenty-eighth year of the cycle.

CYCLE of the moon, or lunar cycle, called also the golden number, is a period of nineteen years, after which the new and full moons return on the same days of the months, only one hour twenty-eight minutes sooner; so that, on whatever days the new and full moon fall this year, they will happen nineteen years hence on the same days of the months, except when a centesimal common year falls within the cycle, which will move the new and full moons a day later in the calendar than otherwise they would have fallen; insomuch that a new moon which fell, before the centesimal year, suppose on March 10, will fall nineteen years afterwards on March 11. The number of years elapsed in this cycle is called the prime, from its use in pointing out the day of the new moon, primum lunæ; and the golden

number, as deserving to be written in letters of gold.

The golden numbers are those placed in the first column of the calendar, betwixt March 21 and April 18, both inclusive, to denote the days upon which those full moons fall, which happen upon, or next after, March 21, in those years of which they are respectively the golden numbers. See CALENDAR.

For finding the golden number, add one to the current year of our Lord, because one year of this cycle was elapsed before the christian æra began, and divide by nineteen, the remainder is the current year of this cycle, or the golden number; but if nothing remains, it shews that it is the last year of the cycle, and consequently the golden number is 19.

CYCLE of the Roman indiction, is a period of fifteen years, in use among the Romans, commencing from the third year before Christ. This cycle has no connection with the celestial motions; but was instituted, according to Baronius, by Constantine; who, having reduced the time which the Romans were obliged to serve to fifteen years, was consequently obliged, every fifteen years, to impose, or *indicere* according to the Latin expression, an extraordinary tax for the payment of those who were discharged; and hence arose this cycle.

To find the cycle of indiction for any given year, add 3 to the given year, and divide the sum by 15, the remainder is the current year of the cycle of indiction; if there be no remainder, it is the fifteenth or last year of the indiction.

These three cycles multiplied into one another, that is, $28 \times 19 \times 15$, amount to 7980, which is called the Julian period, after which the three foregoing cycles will begin again together. This period had its imaginary beginning 710 years before the creation, according to the common opinion among chronologers concerning the age of the world, and is not yet complete. It is much used in chronological tables. See CHRONOLOGY.

CYCLOID. The Cycloid is a curve of such importance. that the honour of its invention has been much contested among mathematicians. The French ascribe it to their countryman Robervall; but there is sufficient evidence that he was not the original inventor of it. Torricellius informs us, in a treatise containing a demonstration of one of the properties of this curve, viz. that its area is triple that of the generating circle, and published in 1644, that this curve was known forty-five years before this period, or in 1599, to his master Galileo, and distinguished by the appellation of Cycloid. Besides, Dr. Wallis has discovered among the mathematical works of Bovillus, published at several times between the years 1501 and 1510, that this curve had been considered in his time: and he has also found, that it was known to cardinal Cusanus, who gave an account of it in a copy of his works transcribed in 1451. But its various properties have been gradually discovered; and the method of regulating the motion of a pendulum by this curve, which is the most useful application of it, was the invention of Huygens in the last century.

The cycloid is a curve generated by the motion of any point in the periphery of a circle, whilst the periphery itself revolves on a right line, till that point which touched the line at the beginning of the motion be brought to touch it again.

Let the rolling circle be HFI (Plate Miscel. fig. 29); F the point in the periphery, which at the beginning of the motion touched the line BC in B; and the curve BGC described by that point, whilst it is moving from B to C, will be the cycloid, or trochoid, so called from the manner of its formation. The circle HFI, by the revolution of which the curve is formed, is called the generating circle; the right line BC is the base; the line GA bisecting the base in A is the axis; and G is the vertex: a line OF parallel to the base, and intercepted between the curve and the axis, is an ordinate; and the space included by the curve and base, viz. BGCAB, is the cycloidal space.

The curve BGC is called the primary cycloid, to distinguish it from the protracted cycloid MN, and from the contracted cycloid QR, described by the contemporary motion of the corresponding points p and π, in the circles OpN less, and OπR greater, than the circle OPG respectively. The protracted cycloid is applied by Dr. Wallis to the solution of Kepler's problem for dividing the area of an ellipse in a given ratio, of which an account is given in Keill's Astronomy, Lect. 23 and 24.

We shall now enumerate the chief properties of the common cycloid. (1) The whole base BC (fig. 30), is equal to the periphery of the generating circle; and any part of the base BH is equal to the arc FH of the same circle in the position HFI. (2) Any right line FD intercepted between the curve and the generating circle in the position GAD, where AB is $=$ AC, is equal to the corresponding arc DG of the generating circle. For AB $=$ HFI, and BH $=$ FH. $\because$ HA $=$ FI $=$ DG, and HA $=$ FD; $\therefore$ FD $=$ DG. (3) The ordinate FO $=$ FD $+$ DO $=$ DG $+$ DO $=$ to the sum of the arc intercepted between the ordinate and the vertex, and its right sine. (4) The line LI drawn parallel to the chord MG, is a tangent to the cycloid in L.

Draw an ordinate LMN, and another ordinate Pπ indefinitely near to it; and draw Lp and Mm parallel to GA. From the centre O draw OM. Then Pp $+$ LM $-$ mn $=$ Pn $=$ MG $+$ Mn, and LM $=$ MG; $\therefore$ Pp $-$ mn $=$ Mn, and Pp $=$ Mn $+$ mn. But if the ordinate Pπ be supposed to approach to LN, and at last to coincide with it, when Mn and Mm vanish, the triangles Mnm and MNO will be similar; $\because$ Mn : nm :: OM : ON, and Mn $+$ mn : Mn :: OM $+$ ON $=$ AN : OM, i. e. Pp : Mn :: AN : OM. But Mn : Mm (Lp) :: OM : MN; $\because$ Pp : Lp (:: AN : MN) :: MN : NG. Consequently the triangles PLp and MNG, having the sides about the equal angles p and N proportional, are similar, and PLI is parallel to MG; i. e. the tangent to the cycloid at the point L is parallel to the chord MG.

(5) The arc of a cycloid is equal to twice the chord of the corresponding arc of the generating circle: i. e. GQ $=$ 2GS.

Let ST be an infinitely small arc of the circle, and let the ordinates NQ and πR, infinitely near to each other, be drawn. Produce the chord GS to meet πR in V; let Tτ be perpendicular to SV; and let the tangents to the circle at S and G, viz. SW and GW, meet each other in W. The arc ST, being infinitely small, may be considered as a right line, or as part of the tangent WS produced; and therefore the triangles GSW and STV will be similar. But GW $=$ WS; See Simpson's Gometry, B. 3. $\because$ ST $=$ TV, and the perpendicular Tτ bisects the base SV; consequently SV $=$ 2Sτ. But QR is parallel to SV, and equal to it; and therefore equal to 2Sτ: and QR is the increment of the curve GQ, generated whilst the chord GS increases by Sτ, because Gτ $=$ GT when T and S coincide. Since then the cycloidal curve, and the chord of the corresponding arc of the circle, begin to increase together at G, and the curve increases with a velocity double of that with which the chord increases, and this is every where the case, the arc of the cycloid GQ will be always double of the chord GS.

Corollary. Hence the semicycloid GC is equal to 2GA, or double of the diameter of the generating circle; and the whole cycloid BGC $=$ 4GA $=$ four times the diameter of the generating circle.

(6) If GX be parallel to BAC, the base of the cycloid, and LX parallel to its axis, GA: the space GXL, terminated by the cycloidal arc GL, and the right lines GX and LX, will be equal to the circular area GMN.

Let Px be parallel to LX; and by what has been shewn above, Pp : Lp :: MN : NG; $\therefore$ NG $\times$ Pp $=$ MN $\times$ Lp, i. e. Xx $\times$ LX $=$ MN $\times$ Nπ, or the small space LXxP $=$ the small space MNπm. Consequently the areas GXL and GMN increasing by equal increments, are equal. Hence, if BY be perpendicular to the base BC at B, and meet GX produced at Y, the space GYBPG will be equal to the semicircle GMA: and the rectangle GABY under the diameter GA and BA $=$ $\frac{1}{2}$ the circumference of the generating circle, will be four times the semicircle GMA; and therefore the area GLBAG $=$ three times the area of the generating semicircle GMA, and the whole cycloidal area BLGCAB will be equal to three times the area of the generating circle GMAT. Also, if GB be drawn, the area intercepted between the cycloid GLB, and the right line GB, will be equal to the semicircle GMA; for the area GLBAG $=$ 3GMA, and the triangle GBA $=$ $\frac{1}{2}$GA $\times$ AB $=$ the rectangle of the radius and semicircumference $=$ the area of the generating circle GMAT $=$ 2GMA; and therefore GLBAG $-$ GBA $=$ 3GMA $-$ 2 GMA $=$ GMA.

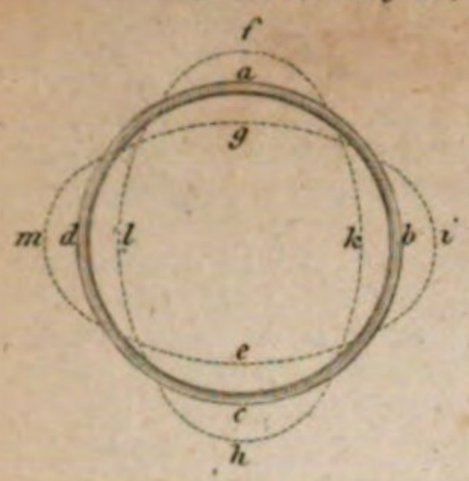
(7) The cycloid is the curve of swiftest descent; or a heavy body, descending by the force of its own gravity, will move from one point of this curve to any other point in less time, than it will move by any other line joining these points.

(8) A body falls through any arc, FG, LG, &c. (fig. 30), of an inverted cycloid, whether it be great or small, in the same time. Hence, if a pendulum be made to vibrate in the arc of a cycloid, all the vibrations will be performed in the same time.

CYCLOPTERUS, the sucker, in ichthyology, a genus belonging to the order of amphibia nantes. The head is obtuse, and furnished with saw-teeth; there are four rays in the gills; and the belly-fins are connected together in an orbicular form. There are three species:

1. The lumpus, or lump-fish, grows to the length of nineteen inches, and weighs seven pounds. The shape of the body is like that of the bream, deep and very thick, and it swims edge-ways. The back is sharp and elevated; the belly flat, of a bright crimson colour. Along the body there run several rows of sharp and bony tubercles, and the whole skin is covered with small ones. The tail and vent-fins are purple. The pectoral fins are large and broad, almost uniting at their base. Beneath these is the part by which it adheres to the rocks, &c. It consists of an oval aperture, surrounded with a fleshy, muscular, and obtuse substance; edged with many small threaded appendages, which concur as so many claspers. By means of this part it adheres with vast force to any thing it pleases. As a proof of its tenacity, it has been known, that in flinging a fish of this species into a pail of water, it fixed itself so firmly to the bottom, that on taking the fish by the tail, the whole pail by that means was lifted, though it held some gallons, without once making the fish

11 Bell, theory of.



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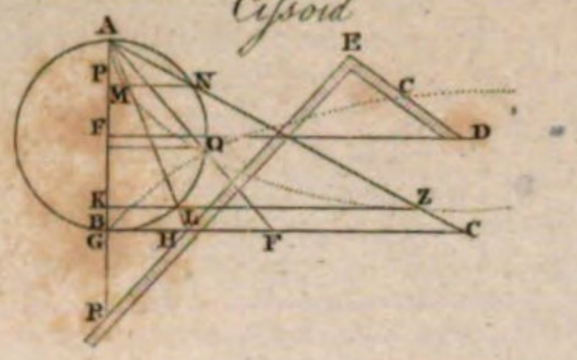

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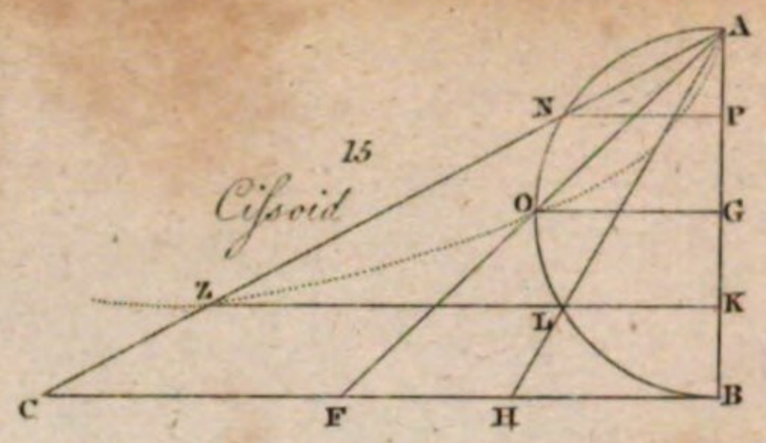

Construction of Equations

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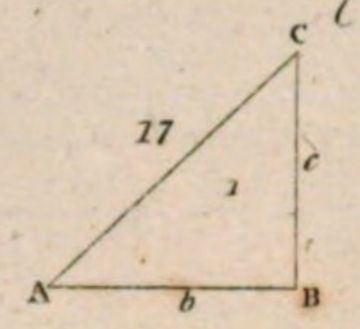

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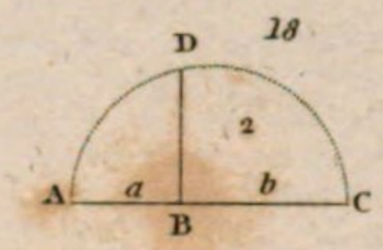

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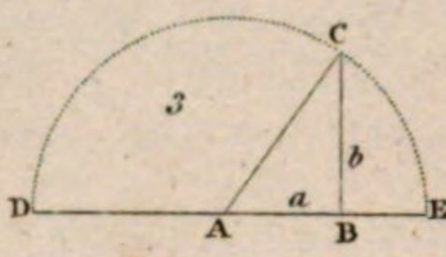

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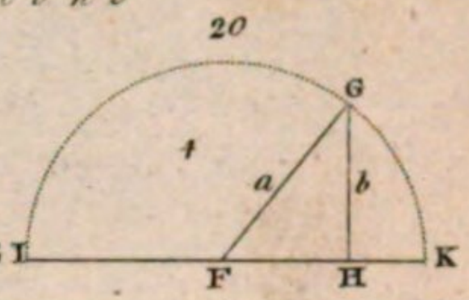
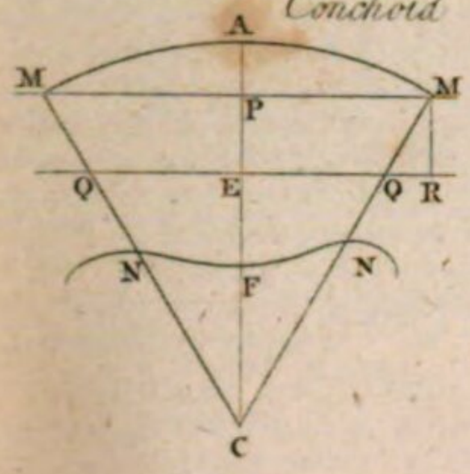


16 Conchoid



Cotesian Theorem

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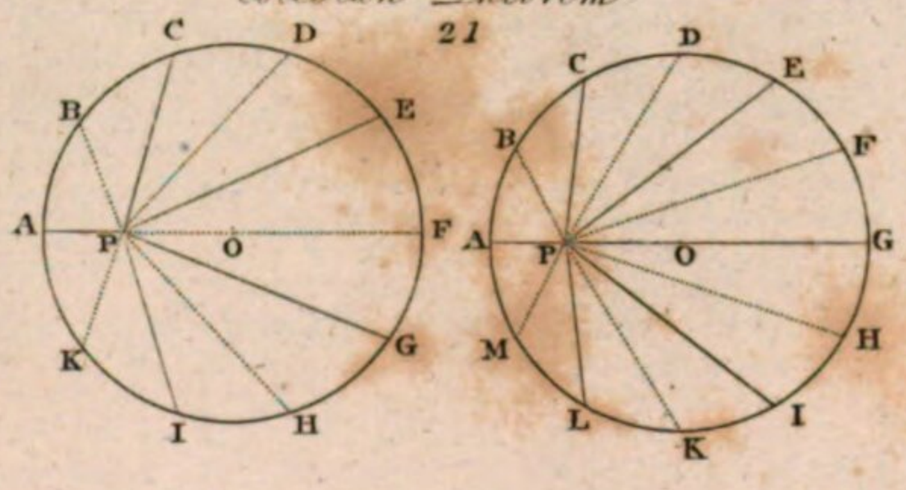
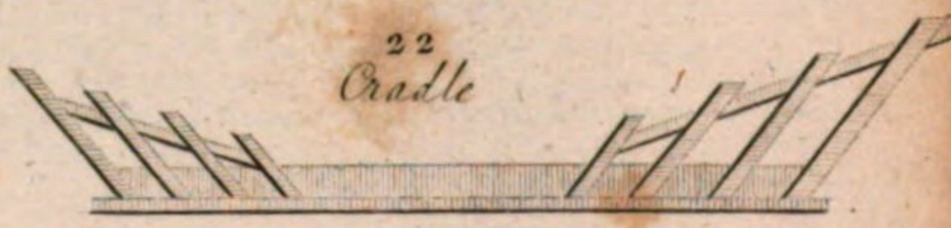
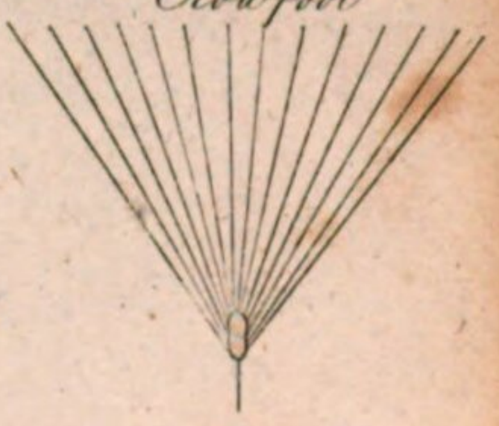


22 Cradle



23 Creeper

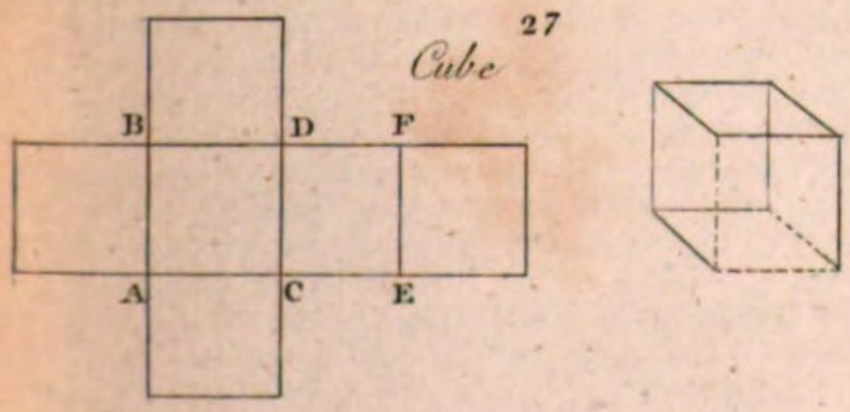
25 Crowfoot



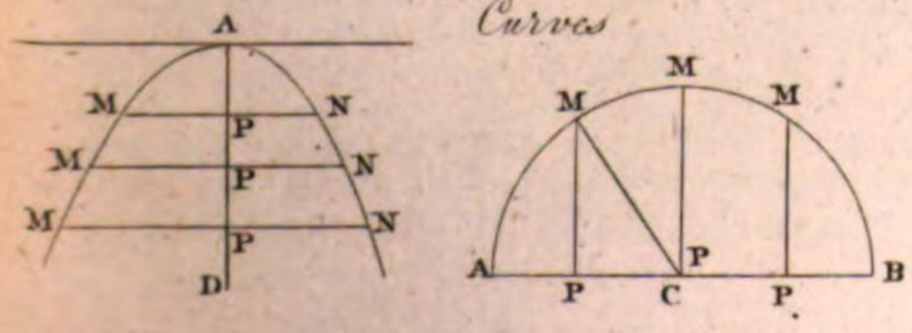
26 Crowth

24 Cromlech

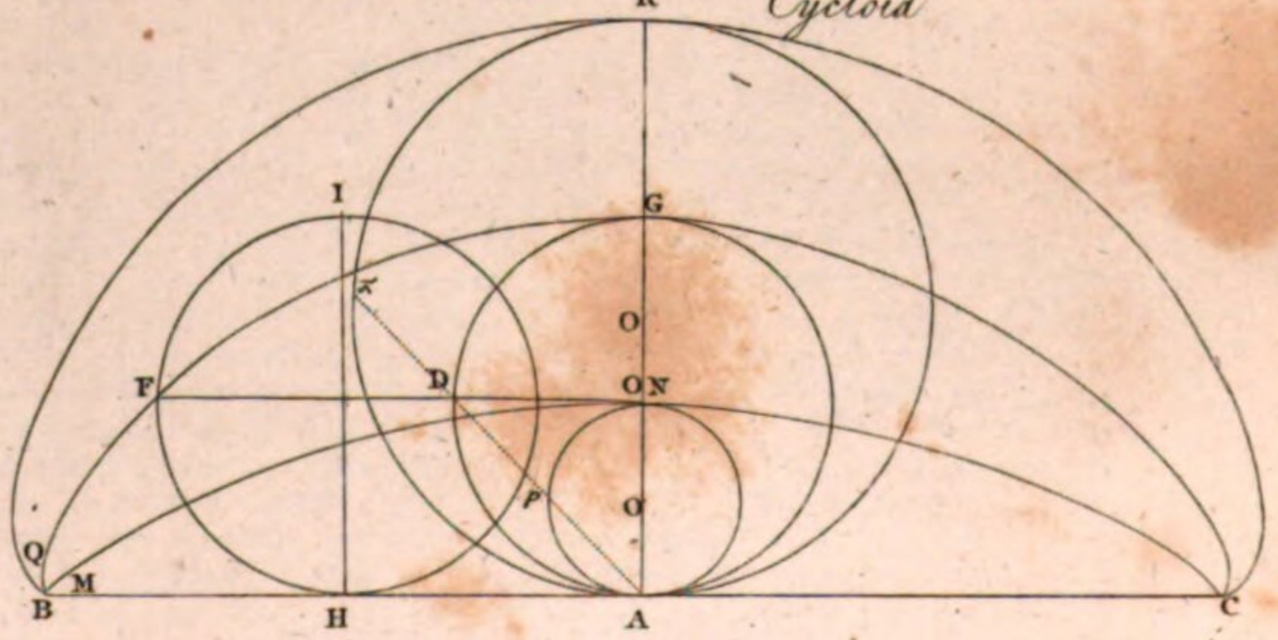
27 Cube



28 Curves



20 Cycloid



Cycloid

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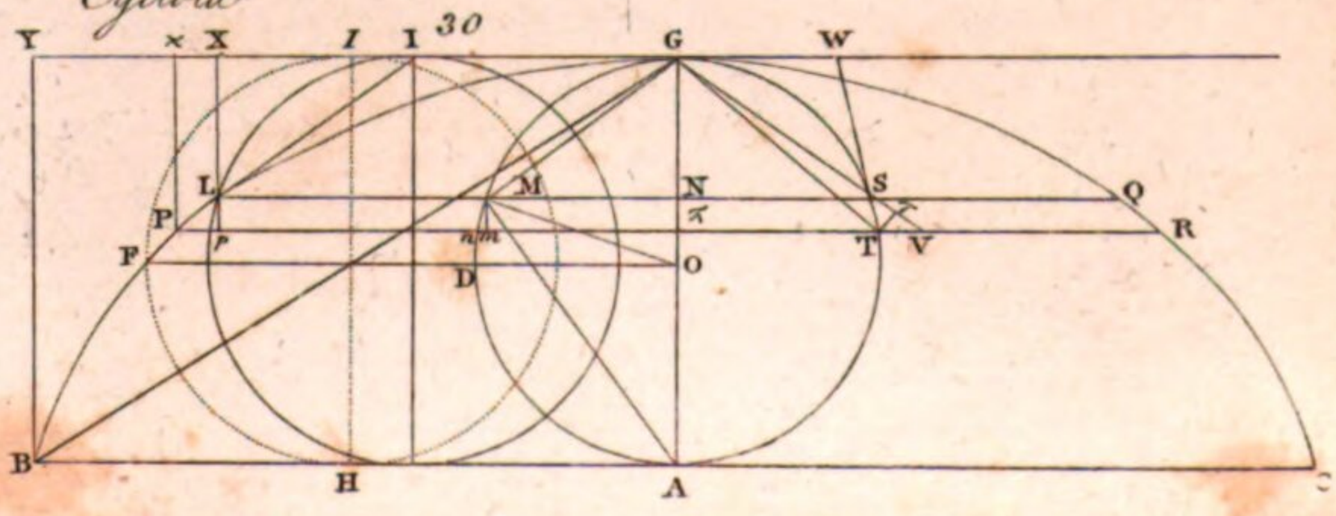

quit its hold. These fish resort in multitudes during spring to the coast of Sutherland near the Ord of Caithness. The seals which swarm beneath, prey greatly upon them, leaving the skins; numbers of which, thus emptied, float ashore at that season. Great numbers of lump-fish are found in the Greenland seas during the months of April and May, when they resort near the shore to spawn. See Plate Nat. Hist. fig. 156.

2. The liparis takes the name of sea-snail from the soft and unctuous texture of its body, resembling that of the land-snail. It is almost transparent, and soon dissolves and melts away. It is found in the sea near the mouths of great rivers, and has been seen full of spawn in January. The length is five inches: the colour a pale brown, sometimes finely streaked with a darker. Beneath the throat is a round depression of a whitish colour like the impression of a seal, surrounded by twelve small pale yellow tubera, by which probably it adheres to the stones like the other species.

3. C. minor, or the lesser sucking-fish, is found in different parts of the British seas. It is about four inches in length; the skin without scales, slippery, and of a dusky colour. It has also an apparatus for adhering to stones and rocks, similar to the others.

CYDER, or CIDER, an excellent drink made of the juice of apples. In making this drink, it has long been thought necessary in every part of England, to lay the harder cyder fruits in heaps for some time before breaking their pulps; but the Devonshire people have much improved this practice: in other counties the method is, to make these heaps of apples in a house, or under some covering, inclosed on every side; this method has been found defective, because, by excluding the free air, the heat soon became too violent, and a great perspiration ensued, by which, in a short time, the loss of juice was so great as to reduce the fruit to half their former weight, attended with a general rottenness, rancid smell, and disagreeable taste. In the southern parts a middle way has been pursued; to avoid the inconveniences attending the above, they make their heaps of apples in an open part of an orchard; where by means of a free air and less perspiration, the desired maturity is brought about, without any considerable waste of the juices, or decay of the fruit, and entirely free of rankness; and though some apples rot even in this manner, they are very few, and are still fit for use, all continue plump and full of juices, and very much heighten the colour of the cyder, without ill-taste or smell. In pursuing the Devonshire method it is to be observed: first, all the promiscuous kind of apples that have dropped from the trees from time to time, are to be gathered up and laid in a heap by themselves, to be made into cyder after having so lain about ten days; secondly, such apples as are gathered from the tree, having already acquired some degree of maturity, are likewise to be laid in a heap by themselves for about a fortnight; thirdly, the later hard fruit, which are to be left on the trees till the approach of frost is apprehended, are to be laid in separate heaps, where they are to remain a month or six weeks, by which, notwithstanding frost, rain, &c. their juices will receive such a maturation as will prepare them for a kindly fermentation, and which they could not have attained on the trees from the coldness of the season.

It is observable, that the riper and mellower the fruits are at the time of collecting them into heaps, the shorter should be their continuance there; and on the contrary, the harsher, more immature, and harder they are, the longer they should rest. These heaps should be made in an even and open part of the orchard, without any regard to covering from rain, dews, or what else may happen during the apples staying there; and whether they be carried in and broken in wet or dry weather, the effect is all the same. If it should be objected, that during their having lain together in the heaps, they may have imbibed great humidity, as well from the air, as from the ground, rain, dews, &c. which are mixed with their juices; the answer is, that this will have no other effect, than a kindly diluting natural to the fruits, by which means a speedier fermentation ensues, and all heterogeneous humid particles are thrown off. The apples are then ground, and the pumices received in a large open-mouthed vessel, capable of containing as much thereof as is sufficient for one making or one cheese, though it has been a custom to let the pumice remain some hours in the vessel appropriated to contain it: yet this practice is by no means commendable; for if the fruits did not come ripe from the trees, or otherwise matured, the pumice remaining in the vat too long, will acquire such harshness and coarseness from the skins as is never to be got rid of; and if the pumice is of well-ripened fruit, the continuing too long there will occasion it to contract a sharpness that very often is followed with want of spirit and pricking; nay, sometimes it even becomes vinegar, or always continues of a wheyish colour, all which proceeds from the heat of fermentation, that it almost instantly falls into on lying together; the pumice, therefore, should remain not longer in the vat than until there may be enough broken for one pressing, or that all be made into a cheese and pressed the day it is broken.

The stooming or stumming of cyder, is done by burning a match or scent in a clean hogshead, moist from recent rinsing, and racking the cyder on the fret into it. If much on the fret, when the cyder is half-racked into the matched or scented cask, burn another match in each cask, roll and tumble them well about (if there are no lees) for a couple of hours, and then finish the racking. Stum is the rich must of good cyder, blended with the vapour of the burning match or scent, stoomed as above, which prevents its fermenting; and when disposed to fret, must be racked into another cask well matched; if this is neglected, and it once ferments, it is no longer stum, but becomes good cyder. Stum is used to mend declining cyder, make it ferment afresh, and give life and sweetness to it, a kind of reanimation. Boiled cyder makes the best keeping stum.

It would doubtless be a great improvement to many estates to cultivate the land not fit for corn, by planting the proper sorts of apples and pears, for the production of so wholesome and pleasant a beverage as cyder or perry. In the preparation of this very estimable liquor, there is no expence of fuel to brew it; and the labour is but once a year, and when sold it yields a very encouraging profit. The larger quantity there is made together, the better it succeeds; in large vessels it will keep sound and good for many years. Besides, it is a pursuit in which any gentleman can engage, without being considered as a trader. A man may exercise or amuse himself in any manufacture from the produce of his own land, as a necessary or usual mode of reaping or enjoying that produce, and bringing it advantageously to market; and he shall not be considered as a trader, though he buy necessary ingredients or materials to fit it for the market; for this is the way of enjoying the land in cyder countries: but where the produce of the land is merely the raw materials of a manufacture, and used as such, and not according to the usual mode of enjoying the land; in short, where the produce of the land is an insignificant article, in comparison with the whole expence of the manufacture; there he ought to be considered as a trader, and so the law decides.

The manufacturing of cyder and perry forms a capital branch in our fruit counties, and of which the improvement must be considered as of great importance to the public, but particularly so to the inhabitants of those districts where these liquors constitute the common beverage.

Cyder and perry, when genuine, and in high perfection, are excellent vinous liquors, and are certainly far more wholesome than many others which are at present in higher estimation. When the must is prepared from the choicest fruit, and undergoes the exact degree of vinous fermentation requisite to its perfection, the acid and the sweet are so admirably blended with the aqueous, oily, and spirituous principles, and the whole so imbued with the grateful flavour of the rinds and the agreeable aromatic bitter of the kernels, that it assumes a new character; grows lively, sparkling, and exhilarating: and when completely mellowed by time, the liquor becomes at once highly delicious to the palate, and friendly to the constitution; superior, in every respect, to most other English wines; for such (says Dr. Fothergill) would it be pronounced by all competent judges, was it not for the popular prejudice annexed to it, as a cheap home-brewed liquor, and consequently within the reach of the vulgar. To compare such a liquor with some of the foreign, fiery, sophisticated mixtures, sometimes imported, would be no credit to it; for it certainly surpasses them in flavour and pleasantness, as much as it excels them in cheapness: but rarely do we meet with perry or cyder of this superior quality; for what is generally sold by dealers and innkeepers, is a poor, meagre, vapid liquor, disposed to the acetous fermentation, and, of course, very injurious to the constitution. It is very mortifying, after the experience of so many centuries, that the art of preparing those ancient British liquors should still be so imperfectly understood as to seem to be in their very infancy; that, throughout the principal cyder districts, the practice should still rest on the most vague undeterminate principles; and

that the excellence of the liquor should depend rather on a lucky accident than on good management: yet such appears to be really the case, even amongst the most experienced cyder-makers of Herefordshire and Gloucestershire.

Mr. Marshall, that nice observer of rural affairs, in his late tour through those counties (expressly undertaken for the purpose of inquiry on this subject), informs us, that scarcely two of the professional makers are agreed as to the management of some of the most essential parts of the process; that palpable errors are committed, as to the time and manner of gathering the fruit, in laying it up, in neglecting to separate the unsound, and to grind properly the rinds, kernels, &c. that the method of conducting the vinous fermentation, the most critical part of the operation, and which stamps the future value of the liquor, is by no means ascertained; for while some promote the fermentation in a spacious open vat, others repress it, by inclosing the liquor in a hogshead, or strive to prevent it altogether; that no determinate point of temperature is regarded, and that the use of the thermometer is unknown or neglected; that they are as little consistent as to the time of racking off, and whether this ought to be done only once, or five or six times repeated; that for fining down the liquor many have recourse to that odious article bullock's blood, when the intention might be much better answered by whites of eggs or isinglass; and finally, that the capricious taste of particular customers is generally consulted, rather than the real excellence of the liquor; and consequently that a very imperfect liquor is often vended, which tends to reduce the price, to disgrace the vender, and to bring the use of cyder and perry into disrepute.

The art of making vinous liquors is a curious chemical process: and its success chiefly depends on a dextrous management of the vinous fermentation, besides a close attention to several minute circumstances, the theory of which is not, perhaps, yet fully understood by the ablest chemists.

The general method of preparing cyder and perry is very much the same. The mill is not essentially different from that of a common tanner's mill for grinding bark; it consists of a mill-stone from two feet and a half to four and a half in diameter, running on its edge on a circular stone-trough, from nine to twelve inches in thickness, and from one to two tons in weight: the bottom of the trough in which this stone runs is somewhat wider than the thickness of the stone itself; the inner side of the groove rises perpendicularly, but the outer is bevelled in such a manner as to make the top of the trough six or eight inches wider than the bottom, by which means there is room for the stone to run freely, and likewise for putting in the fruit, and stirring it up while grinding. The bed of a middle-sized mill is about nine feet, some ten, and some twelve; the whole being composed of two, three, or four stones, cramped together, and finished after being cramped in this manner: the best stones are found in the forest of Dean, generally a dark-reddish gritstone, not calcareous; for if it was of a calcareous quality the acid juice of the fruits would act upon it and spoil the liquor; a clean-grained grindstone grit is the fittest for the purpose. The runner is moved by means of an axle passing through the centre, with a long arm reaching without the bed of the mill, for a horse to draw by; on the other side is a shorter arm, passing through the centre of the stone, as represented in the figure. An iron bolt, with a large head, passes through an eye in the lower part of the swivel, on which the stone turns into the end of the inner arm of the axis; and thus the double motion of it is obtained, and the stone kept perfectly upright. There ought also to be fixed on the inner arm of the axis, about a foot from the runner, a cogged wheel, working in a circle of cogs fixed upon the bed of the mill; the use of these is to prevent the runner from sliding, which it is apt to do when the mill is full; it likewise makes the work more easy for the horse: these wheels ought to be made with great exactness. Mr. Marshall observes, that it is an error to make the horse draw by traces. "That acting point of draught (says he), the horse's shoulders, ought, for various reasons, to be applied immediately at the end of the arm of the axis; not two or three yards before it, perhaps in a small mill near one-fourth of its circumference." The building in which the mill is inclosed ought to be of such a size that the horse may have a path of three feet wide betwixt the mill and the wall, so that a middling-sized mill, with its horse-path, takes up a space of fourteen or fifteen feet every way. The whole dimensions of the mill-house, according to our author, to render it any way convenient, are twenty-four feet by twenty; it ought to have a floor thrown over it at the height of seven feet, with a door in the middle of the front, and a window opposite, with the mill on one side and the press on the other side of the window: the latter must be as near the mill as convenience will allow, for the more easy conveying the ground fruit from the one to the other. The press, of which the principle will be understood from the figure, has its bed or bottom about five feet square: this ought to be made entirely either of wood or of stone, the practice of covering it with lead being now universally known to be pernicious. It has a channel cut a few inches within its outer edges, to catch the liquor as it is expressed, and convey it to a lip formed by a projection on that side of the bed opposite the mill; having under it a stone trough or wooden vessel, sunk within the ground, when the bed is fixed low, to receive it. The press is worked with levers of different lengths, first a short, and then a moderately long one, both worked by hand; and lastly, a bar, eight or nine feet long, worked by a capstan or windlass. The expence of fitting up a mill-house is not very great. Mr. Marshall computes it from twenty to twenty-five pounds, and on a small scale from 10 to 15 pounds, though much depends on the distance and carriage of the stone: when once fitted up it will last many years.

The making of the fruit-liquors under consideration requires an attention to the following particulars:

I. The fruit. II. The grinding. III. Pressing. IV. Fermenting. V. Correcting. VI. Laying up. VII. Bottling. Each of these heads is subdivided into several others.

I. In the management of the fruit, the following particulars are to be considered:

1. The time of gathering;—which varies according to the nature of the fruit. The early pears are fit for the mill in September; but few apples are ready for gathering before Michaelmas; though, from accidental circumstances, they are frequently manufactured before that time; for sale cyder and keeping drink, they are suffered to hang upon the trees till fully ripe; and the middle of October is generally looked upon to be a proper time for gathering the stire apples. The criterion of a degree of ripeness is, the fruit falling from the tree; and to force it away before that time, in Mr. Marshall's opinion, is robbing it of some of its most valuable properties; "the harvesting of fruit (says he) is widely different in this respect from the harvesting of grain, which has the entire plant to feed it after the separation from the soil; while fruit, after it is severed from the tree, is cut off from all possibility of a further supply of nourishment; and although it may have reached its wonted size, some of its more essential particles are undoubtedly left behind in the tree." Sometimes, however, the fruits which are late in ripening are apt to hang on the tree until spoiled by frosts, though weak watery fruits seem to be most injured in this manner; and Mr. Marshall relates an instance of very fine liquor being made from golden pippins, after the fruit had been frozen as hard as ice.

2. The method of gathering. This, as generally practised, is directly contrary to the principles laid down by Mr. Marshall, viz. beating them down with long slender poles. An evident disadvantage of this method is, that the fruit is of unequal ripeness; for the apples on the same tree will differ many days, perhaps even weeks in their time of coming to perfection, whence some part of the richness and flavour of the fruit will be effectually and irremediably cut off. Nor is this the only evil to be dreaded; for as every thing depends on the fermentation it has to undergo, if this is interrupted, or rendered complex by a mixture of ripe and unripe fruits, and the liquor is not, in the first instance, sufficiently purged from its feculencies, it is difficult to clear it afterwards. The former defect the cyder-makers attempt to remedy, by a mixture of brown sugar and brandy, and the latter by bullock's blood and brimstone; but neither of these can be expected to answer the purpose very effectually. The best method of avoiding the inconveniences arising from an unequal ripening of the fruit is, to go over the trees twice, once with a hook when the fruit begins to fall spontaneously; the second time when the latter are sufficiently ripened, or when the winter is likely to set in, when the trees are to be cleared with the poles above-mentioned.

3. Maturing the gathered fruit. This is usually done by making it into heaps, as has been already mentioned: but Mr. Marshall entirely disapproves of the practice; because, when the whole are laid in a heap together, the ripe fruit will begin to rot before the other has arrived at that degree of artificial ripeness which it is capable of acquiring. "The due degree of maturation of fruit for liquor," he observes, "is a subject about which men, even in this district, differ much in their ideas. The prevailing

practice of gathering into heaps until the ripest begin to rot, is wasting the best of the fruit, and is by no means an accurate criterion. Some shake the fruit, and judge by the rattling of the kernels; others cut through the middle, and judge by their blackness: but none of these appear to be a proper test. It is not the state of the kernels, but of the flesh; not of a few individuals, but of the greater part of the prime fruit; which renders the collective body fit or unfit to be sent to the mill; the most rational test of the ripeness of the fruit is, that of the flesh having acquired such a degree of mellowness, and its texture such a degree of tenderness, as to yield to moderate pressure; thus, when the knuckle or the end of the thumb can with moderate exertion be forced into the pulp of the fruit, it is deemed in a fit state for grinding.

4. Preparation for the mill. The proper management of the fruit is to keep the ripe and unripe fruit separate from each other; but this cannot be done without a considerable degree of labour; for as, by numberless accidents, the ripe and unripe fruit are frequently confounded together, there cannot be any effectual method of separating them except by hand; and Mr. Marshall is of opinion, that this is one of the grand secrets of cyder-making, peculiar to those who excel in the business; and he is surprised that it should not before this time have come into common practice.

5. Mixing fruit for liquor. Our author seems to doubt the propriety of this practice; and informs us, that the finer liquors are made from select fruits; and he hints, that it might be more proper to mix liquors after they are made, than to put together the crude fruits.

II. Grinding, and management of the fruit when ground.—For the greater convenience of putting fruit into the mill, every mill should have a fruit-chamber over it, with a trap-door to lower the fruit down into the mill. The best manner in which this can be accomplished is to have the valve over the bed of the mill, and furnished with a hose or tunnel reaching down to the trough in which the stone moves; no straw is used in the lofts, but sometimes the fruit is turned. In Herefordshire it is generally believed, that grinding the rinds and seeds of the fruit as well as the fleshy part to a pulp, is necessary towards the perfection of the cyder, whence it is proper that every kind of pains should be taken to perform the grinding in the most perfect manner. Mr. Marshall complains, that the mills are so imperfectly finished by the workmen, that for the first years they cannot perform their work in a proper manner. Instead of being nicely fitted to one another with the square and chisel, they are hewn over with a rough tool, in such a careless manner that horse-beans might lie in safety in their cavities. Some even imagine that to be an advantage, as if the fruit was more effectually and completely broken by rough than smooth stones. Some use fluted rollers of iron, but these will be corroded by the juice, and thus the liquor might be tinged. Smooth rollers will not lay hold of the fruit sufficiently to force it through.

Another improvement requisite in the cyder mills, is to prevent the matter in the trough from rising before the stone in the last stage of grinding, and a method of stirring it up in the trough more effectually than can be done at present. To remedy the former of these defects, it might perhaps be proper to grind the fruit first in the mill to a certain degree; and then put it between two smooth rollers to finish the operation in the most perfect manner. It is an error to grind too much at once, as this clogs up the mill, and prevents it from going easily. The usual quantity for a middle-sized mill is a bag: containing four corn-bushels; but our author had an opportunity of seeing a mill in which only half a bag was put, and thus the work seemed to go on more easily and more quickly than when more was put in at once. The quantity put in at one time is to be taken out when ground. The usual quantity of fruit ground in a day is as much as will make three hogsheads of perry or two of cyder.

Management of the ground fruit. Mr. Marshall condemns in very strong terms the practice of pressing the pulp of the fruit as soon as the grinding is finished, because thus neither the rind nor seeds have time to communicate their virtues to the liquor, or to extract these virtues in the most proper manner; some allow the ground fruit to lie twenty-four hours or more after grinding, and even regrind it, in order to have, in the most perfect manner, the flavour and virtues of the seeds and rind.

III. Pressing the fruit, and management of the residuum. This is done by folding up the ground fruit in pieces of hair-cloth, and piling them up above one another, in a square frame or mould, and then pulling down the press upon them, which squeezes out the juice, and forms the matter into thin and almost dry cakes. The first runnings come off foul and muddy, but the last, especially in perry, will be as clear and fine as if filtred through paper. It is common to throw away the residuum as useless; sometimes it is made use of, when dry as fuel; sometimes the pigs will eat it, especially when not thoroughly squeezed; and sometimes it is ground a second time with water, and pressed for an inferior kind of liquor used for the family. Mr. Marshall advises to continue the pressure as long as a drop can be drawn. "It is found (says he) that even by breaking the cakes of the refuse with the hands only, gives the press fresh power over it: for, though it has been pressed to the last drop, a gallon or more of additional liquor may be got by this means: regrinding them has a still greater effect; in this state of the materials, the mill gains a degree of power over the more rigid parts of the fruits, which in the first grinding it could not reach. If the face of the runner, and the bottom of the trough, were dressed with a broad chisel, and made true to each other, and a moderate quantity of residuum ground at once, scarcely a kernel would escape unbroken, or a drop of liquor remain undrawn."

But though the whole virtue of the fruit cannot be extracted without grinding it very fine, some inconveniences attend this practice, as a part of the pulp thus gets through the hair-cloth, and may perhaps be injurious to the subsequent fermentation. This, however, may be in a great measure remedied by straining the first runnings through a sieve: the whole should also be allowed to settle in a cask, and drawn off into a fresh vessel previous to the commencement of the fermentation. The reduced fruit ought to remain some time between the grinding and pressing, that the liquor may have an opportunity of forming an extract with the rind and kernels; but this must not be pushed too far, as in that case the colour of the cyder would be hurt; and the most judicious managers object to the pulp remaining longer than twelve hours without pressure; "thence (says our author) upon the whole, the most eligible management in this stage of the process appears to be this: grind one press-full a day; press, and regrind the residuum in the evening; infuse the reduced matter all night among part of the first runnings, and in the morning repress while the next press-full is grinding."

IV. Fermentation. The common practice is, to have the liquor tunned, that is, put into casks or hogsheads, immediately from the press, and to fill them quite full; but it is undoubtedly more proper to leave some space empty to be filled up afterwards. No accurate experiment has been made with regard to the temperature of the air proper to be kept up in the place where the fermentation goes on.

Frost is prejudicial; but when the process usually commences, that is, about the middle of October, the liquor is put into airy sheds, where the warmth is scarcely greater than in the open atmosphere; nay, it is frequently exposed to the open air without any covering farther than a piece of tile or flat stone over the bung-hole, propped up by a wooden pin on one side to cause the rain-water to run off. In a complete manufactory of fruit liquor, the fermenting room should be under the same roof with the mill-house, a continuation of the press-room, or at least opening into it with windows or doors on every side, to give a free admission of air into it, with sufficient defence against frost; fruit-lofts over it, and vaults underneath, for laying up the liquors after fermentation, with small holes in the crown of the arch to admit a hose or pipe for the purpose of conveying the liquors occasionally from the one to the other.

In making of fruit-liquors no ferment is used, as in making of beer; though, from Mr. Marshall's account of the matter, it seems far from being unnecessary. Owing to this omission, the time of the commencement of the fermentation is entirely uncertain; it takes place sometimes in one, two, or three days, sometimes not in a week or a month, after tunning; but it has been observed, that liquor which has been agitated in a carriage, though just taken from the press, will sometimes pass almost immediately into a state of fermentation. The continuance of the fermentation is no less uncertain than the commencement of it. Liquors, when much agitated, will go through it perhaps in one day; but when allowed to remain at rest, the fermentation commonly goes on two or three days, and sometimes five or six. The fermenting liquor, however, puts on a different appearance according to circumstances; when produced from fruits properly matured, it generally throws up a thick scum, resembling that of malt liquor, and of a thickness proportioned to the species and ripeness of the fruit; the riper the fruit, the more scum is thrown up. Perry gives but little

scum, and cyder will also sometimes do the same: sometimes it is intentionally prevented from doing it.

After having remained some time in the fermenting-vessel, the liquor is racked or drawn off from the lees, and put into fresh casks. In this part of the operation also Mr. Marshall complains greatly of the little attention that is paid to the liquor. The ordinary time for racking perry is before it has done hissing, or sometimes when it begins to emit fixed air in plenty. The only intention of the operation is, to free the liquor from its fæculencies, by a cork placed at a little distance from the bottom, after which the remainder is to be filtred through a canvas or flannel bag; this filtred liquor differs from the rest in having a higher colour, having no longer any tendency to ferment, but, on the contrary, checking the fermentation of that which is racked off; and if it loses its brightness, it is no longer easily recovered. A fresh fermentation usually commences after racking, and if it becomes violent, a fresh racking is necessary in order to check it, in consequence of which the same liquor will be racked off five or six times: but if only a small degree of fermentation takes place, which is called fretting, it is allowed to remain in the same cask, though even here the degree of fermentation which requires racking is by no means determined. Mr. Marshall informs us, that the best manufacturers, however, repeat the rackings until the liquor will lie quiet, or nearly so; or if it be found impracticable to accomplish this by the ordinary method of fermentation, recourse must be had to fumigation with sulphur, which is called stumming the casks. For this fugimation, it is necessary to have matches made of thick linen-cloth, about ten inches long, and an inch broad, thickly coated with brimstone for about eight inches of their length. The cask is then properly seasoned, and every vent, except the bung-hole, tightly stopped; a match kindled is lowered down into the cask, and held by the end undipped until it is well lighted, and the bung driven in; thus suspending the lighted match within the cask. Having burnt as long as the contained air will supply the fire, the match dies, the bung is raised, the remnant of the match drawn out, and the cask suffered to remain before the liquor is put into it for two or three hours, more or less, according to the degree of power the sulphur ought to have. The liquor retains a smell of the sulphureous acid; but this goes off in a short time, and no bad effect is ever observed to follow.

In some places the liquor is left to ferment in open casks, in which it stands till the first fermentation is pretty well over; after which the froth or yeast collected upon the surface is taken off, it being supposed that it is this yeast mixing with the clear liquor which causes it to fret after racking. The fermentation having totally ceased, and the lees subsided, the liquor is racked off into a fresh cask, and the lees filtred, as above directed. Our author mentions a way of fermenting fruit-liquors in broad shallow vats, not less than five feet in diameter, and little more than two feet deep, each vat containing about two hogsheads. In these the liquor remains until it has done rising, or till the fermentation has nearly ceased; when it is racked off without skimming, the critical juncture being caught before the yeast falls, the whole sinking gradually together as the liquor is drawn off. In this practice also the liquor is seldom drawn off a second time.

Cyder is made of three different kinds, viz. rough, sweet, and of a middle richness. The first kind, being usually destined for common use, is made with very little ceremony; if it is but *cyder* (says Mr. Marshall), and has body enough to keep, no matter for the richness and flavour. The rougher it is the further it will go; and the more acceptable custom has rendered it, not only to the workmen but to their masters. A palate accustomed to sweet cyder, would judge the rough cyder of the farm-houses to be a mixture of vinegar and water, with a little dissolved alum to give it roughness. The method of producing this austere liquor is, to grind the fruit in a crude under-ripe state, and subject the liquor to a full fermentation; for the sweet liquor, make choice of the sweeter fruits, mature them fully, and check the fermentation of the liquor. To produce liquors of a middle richness, the nature of the fruit, as well as the season in which it is matured, must be considered. The fruits to be made choice of are such as yield juices capable of affording a sufficiency both of richness and strength; though much depends on a proper management. Open vats, in our author's opinion, are preferable to close vessels; but if casks are used at all, they ought to be very large, and not filled; nor ought they to lie upon their sides, but to be set on their ends, with their heads out, and to be filled only to such a height as will produce the requisite degree of fermentation; but in whatever way the liquor be put to ferment, Mr. Marshall is of opinion that the operation ought to be allowed to go on freely for the first time, though after being racked off any second fermentation ought to be prevented as much as possible.

V. Correcting, provincially called doctoring. The imperfections which art attempts to supply in these liquors are, 1. Want of strength. 2. Want of richness. 3. Want of flavour. 4. Want of colour and brightness.

The want of strength is supplied by brandy, or any other spirit, in sufficient quantity to prevent the acetous fermentation. The want of richness is supplied by what are generally termed sweets, but prepared in a manner which our author says has never fallen within his notice. To supply the want of flavour, an infusion of hops is sometimes added, which is said to communicate an agreeable bitter, and at the same time a fragrance; whence it becomes a substitute for the juices of the rinds and kernels thrown away to the pigs and poultry, or otherwise wasted. The want of colour is sometimes supplied by elder-berries, but more generally by burnt sugar, which gives the desired colour, and a degree of bitter which is very much liked; the sugar is prepared either by burning it on a salamander, and suffering it to drop as it melts, or by boiling it over the fire (in which case brown sugar is to be used) until it acquires an agreeable bitter, then pouring in boiling water in the proportion of a gallon to two pounds of sugar, and stirring it until the liquor becomes uniform: a pint of this preparation will colour a hogshead of cyder. Brightness is obtained by a mixture of the blood of bullocks or sheep, that of swine being rejected, though it does not appear to be more unfit for the purpose than either of the other two; the only thing necessary to be done here is, to stir the blood well as it is drawn from the animal, to prevent the parts from separating, and it ought to be stirred both ways for a quarter of an hour: the liquor, however, is not always in a proper condition for being refined with this ingredient, on which account a little of it ought frequently to be tried in a phial: a quart, or less, will be sufficient for a hogshead. After the blood is poured in, the liquor should be violently agitated, to mix the whole intimately together: this is done by a stick slit into four, and inserted into the bung-hole, working it briskly about in the liquor until the whole be thoroughly mixed; in about 24 hours the blood will have subsided, and the liquor ought instantly to be racked off, as by remaining upon the blood even for two or three days, it will receive a taint not easily to be got rid of. It is remarkable that this refinement with the blood carries down not only the fæculencies, but the colour also, rendering the liquor, though ever so highly coloured before, almost as limpid as water. Isinglass and eggs are sometimes made use of in refining cyder as well as wine.

VI. Laying up, or shutting up the cyder in close casks, according to Mr. Marshall, is as little understood as any of the rest of the parts; the bungs being commonly put in at some certain time, or in some particular month, without any regard to the state the liquor itself is in. "The only criterion (says he) I have met with for judging the critical time for laying up, is when a fine white cream-like matter first begins to form upon the surface. But this may be too late; it is probably a symptom at least of the acetous fermentation, which, if it take place in any degree, must be injurious: yet if the casks be bunged tight some criterion is necessary; otherwise if the vinous fermentation have not yet finally ceased, or should recommence, the casks would be endangered, and the liquor injured, Hence, in the practice of the most cautious manager, whose practice I have had an opportunity of observing, the bungs are first driven in lightly, when the liquor is fine, and the vinous fermentation is judged to be over; and some time afterwards, when all danger is past, the casks are filled up, and the bung driven securely with a rag, and both rosined over at top. Most farmers are of opinion, that after the liquor has done fermenting, it ought to have something to feed upon; that is, to prevent it from running into the acetous fermentation. For this purpose some put in parched beans, others egg-shells, some mutton-suet," &c. Mr. Marshall does not doubt that something may be useful, and thinks that isinglass may be as proper as any thing that can be got.

VII. Bottling. This depends greatly on the quality of the liquors themselves: good cyder can seldom be bottled with propriety until a year old; sometimes not till two. The proper time is, when it has acquired the utmost degree of richness and flavour in the casks; and this it will preserve for many years in bottles. It ought to be quite fine at the time of bottling, or if not so naturally, ought to be fined artificially with isinglass and eggs.

The liquor called cyderkin, purre, or perkin, is made of the mark, or gross matter remaining after the cyder is pressed out. To make this liquor, the mark is put into a large vat, with a proper quantity of boiled water, which has stood till it is cold again; if half the quantity of water is used that there was of cyder, it will be good; if more, the cyderkin will be small. The whole is left to infuse 48 hours, and then well pressed: what is squeezed out by the press is immediately tunned up and stopped; it is fit to drink in a few days. It clarifies of itself, and serves in families instead of small beer. It will keep, if boiled after pressing with a convenient quantity of hops.

We must not conclude this subject without particular notice of the liquor called cyder-wine, which is made from the juice of the apples taken from the press and boiled; and which, being kept three or four years, is said to resemble rhenish. The method of preparing this wine, as communicated by Dr. Rush, of America, where it is much practised, consists in evaporating in a brewing-copper the fresh apple-juice, till half of it is wasted; the remainder is then immediately conveyed into a wooden cooler, and afterwards put into a proper cask, with an addition of yeast: and is fermented in the ordinary way. The process has been evidently borrowed from what has long been practised on the recent juice of the grape, under the term of vina cotta, or boiled wine, not only in Italy, but also in the islands of the Archipelago from time immemorial.

This process has lately become an object of imitation in the cyder counties, and particularly in the west of England, where it is asserted, that many hundred hogsheads of this wine have been already made; and it is said to betray no sign of an impregnation of copper by the usual chemical tests; it is considered as perfectly wholesome, and is accordingly drunk without apprehension by the common people. Others, however, suspect its innocence; whence it appeared an object of no small moment to determine, in so doubtful a matter, whether or not the liquor acquires any noxious quality from the copper in which it is boiled. With this view Dr. Fothergill made a variety of experiments, and the result seemed to afford a strong presumption that the cyder-wine does contain a minute impregnation of copper, not very considerable indeed, but yet sufficient, in the doctor's opinion, to put the public on their guard concerning a liquor that comes in so very questionable a shape.

In the present process the liquor is properly directed to be passed into a wooden cooler as soon as the boiling is completed. But as all acids, and even common water, acquire an unpleasant taste from standing in copper vessels in the cold, why may not the acid juice of apples act in some degree on the copper before the boiling commences? Add to this, that brewing coppers, without far more care and attention than is generally bestowed on them in keeping them clean, are extremely apt to contract verdigris (a real poison), as appears from the blue or green streaks very visible when these vessels are minutely examined; should the unfermented juice be thought incapable of acting on the copper either in a cold or boiling state, yet no one will venture to deny its power of washing off, or dissolving, verdigris already formed on the internal surface of the vessel. Suppose only one-eighth part of a grain of verdigris to be contained in a little of this wine,* a quantity that may elude the ordinary tests, and that a bottle should be drunk daily by a person without producing any violent symptom of internal uneasiness; yet what person in his senses would knowingly choose to hazard the experiment of determining how long he could continue even this quantity of slow poison, in his daily beverage, with impunity? And yet, it is to be feared, that the experiment is but too often unthinkingly made, not only with cyder-wines, but also with many of the foreign wines prepared by a similar process; for the grape-juice, when evaporated in a copper vessel, under the denomination of vina cotta, or boiled wine, cannot but acquire an equal, if not yet stronger, impregnation of the metal, than the juice of apples; since verdigris itself is manufactured merely by the application of the acid husks of grapes to plates of copper.

Perry is a most wholesome pleasant liquor of the cyder kind, some of which is so excellent as to pass for champaign in taverns and other places of public resort: indeed more wines than this have been imitated with cyder and perry, particularly by the Hollanders, and sometimes by the Flemings. Dr. Halley observes, that the London market alone took off upwards of 20,000 hogsheads of Devonshire cyder annually. It was in the year 1721 he made this remark, and then suggested it was not all sold as cyder. Whether the demand has increased we cannot say. We have drunk in Flanders some perry that might pass on ordinary judges for mantling champaign. Perry is prepared from pears in the same manner cyder is from apples. The harsher sorts of pears make the best perry. They are infinitely too harsh and acerb, or tart, for eating, so much so that even hungry swine reject them. The most esteemed for the purpose are the Bosbury pear, the Bauland and the horse pear in Worcestershire, and the squash pear, as it is called, in Gloucestershire; in both which counties, as well as in some of the adjacent parts, they are planted in the hedge-rows, and most common fields. There is this advantage attending pear-trees, that they will thrive on land where apples will not so much as live; and that some of them grow to such a size, that a single pear-tree, particularly of the Bosbury and the squash kinds, has been frequently known to yield in one season from one to four hogsheads of perry. The Bosbury pear is thought to yield the most lasting and most vinous liquor. The John-pear, the Harpary-pear, the drake-pear, the Mary-pear, the Lullum-pear, and several others of the harshest kind, are esteemed the best for perry; and the redder or more tawny they are, the more they are preferred. Pears as well as apples should be fully ripe before they are ground. Crab-apples are frequently mixed with the pears, and are said to improve the perry.

* The one-hundredth part of a grain may be discovered in a quart, by adding a few drops of volatile alkali to a glass-full, which will immediately strike a blue, darker or lighter, in proportion to the impregnation; a quantity too minute to do any injury.

CYGNUS, in astronomy, a constellation of the northern hemisphere, consisting of 17 stars according to Ptolemy's catalogue, of 19 in Tycho's, and in the Britannic catalogue of 107.

CYLINDER, in geometry, a solid body, supposed to be generated by the rotation of a parallelogram. See GEOMETRY.

CYLINDER, *properties of the.* 1. The section of every cylinder by a plane oblique to its base is an ellipsis. 2. The superficies of a right cylinder is equal to the periphery of the base multiplied into the length of its side. 3. The solidity of a cylinder is equal to the area of its base multiplied into its altitude. 4. Cylinders of the same base, and standing between the same parallels, are equal. 5. Every cylinder is to a spheroid inscribed in it as 3 to 2. 6. If the altitudes of two right cylinders be equal to the diameters of their bases, those cylinders are to one another as the cubes of the diameters of their bases.

To find a circle equal to the surface of a cylinder we have this theorem: the surface of a cylinder is equal to a circle whose radius is a mean proportional between the diameter and height of the cylinder. The diameter of a sphere, and altitude of a cylinder equal thereto, being given, to find the diameter of the cylinder, the theorem is: the square of the diameter of the sphere is to the square of the diameter of the cylinder equal to it, nearly as triple the altitude of the cylinder to double the diameter of the sphere.

CYLINDER, *resistance of.* See the article RESISTANCE.

CYLINDER, *rolling*, or *loaded*, in philosophy, a cylinder which rolls up an inclined plane. See MECHANICS.

CYLISTA, a genus of the class and order diadelphia decandria. The calyx is large, four-parted, upper division cleft at the end; corolla permanent. There is one species.

CYMATIUM, in architecture, a member or moulding of the cornice, the profile of which is waved, that is, concave at the top, and convex at bottom.

CYMBACHNE, a genus of the class and order polygamia monœcia. The inflorescence is half-spiked. There is one species, a grass of Bengal.

CYMBAL, or *cymbalum*, a musical instrument of antiquity, similar to the tympanum or drum. The cymbal was round, and made of brass, like our kettle-drums; but is generally thought to have been smaller. The Jews had their cymbals, or instruments which translators render by that name. Ovid gives cymbals the epithet genialia, because they were used at weddings.

CYMBARIA, a genus of the class and order didynamia angiospermia. The calyx is ten-toothed; capsule cordate, two-celled. There is one species, an herbaceous plant of the mountains of Dauria.

CYMOPHANE, the oriental chrysolite of jewellers. This stone has been found only in Brazil, the island of Ceylon, and at Northschink in Siberia. It is usually met with in round masses about the size of a pea, but it is sometimes crystallized. The primitive form of its crystals is a four-sided rectangular prism, the height of which is to the breadth as $\sqrt{3}$ to 1, and to its thickness as $\sqrt{2}$ to 1.

The most common variety is an eight-sided prism, terminated by six summits. Two of the faces of the prism are hexagons, two are rectangles, and four trapezia: two faces of the summits are rectangles, and the other four trapezia. Sometimes two of the edges of the prism are wanting, and small faces in their place. Its texture is foliated: it causes double refraction. Its specific gravity from 3.7 to 3.8. The colour yellowish-green, surface sparkling. It is infusible by the blowpipe per se, and also with soda. By analysis it is found by Klaproth to contain,

71.5 alumina,
18.0 silica,
6.0 lime,
1.5 oxide of iron.

97.0

CYNANCHE, among physicians, denotes an inflammation of the larynx. See MEDICINE.

CYNANCHUM, *bastard dogsbane*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 30th order, contortæ. The nectarium is cylindrical and quinquedentated. There are 27 species, of which the following are the most remarkable:

1. The acutum, commonly called Montpellier scammony; and,

2. The monspeliacum, or round-leaved Montpellier scammony. They abound with a milky juice like the spurge, which issues out wherever they are broken; and this milky juice when concreted has frequently been sold for scammony. These plants propagate so fast by their creeping roots, that few people care to admit them into their gardens.

CYNARA, the *artichoke*, a genus of the polygamia æqualis order, in the syngenesia class of plants. The calyx is dilated, imbricated with carnous squamæ, and emarginated with a sharp point. Of this genus there are six species, but only two are cultivated for use.

1. The scolynius, or garden artichoke, has large, thick, perennial roots, crowned by a considerable cluster of large, pinnatifid, erect leaves. In the middle are upright stalks rising a yard high, on the top of which is a large round scaly head, composed of numerous, oval, calycinal scales, inclosing the florets, sitting on a broad fleshy receptacle, which, with the fleshy base of the scales, is the only eatable part of the plant. The varieties of this species are, 1. The conical green-headed French artichoke, having the small leaves terminated by spines, the head of a light-green colour, with the scales pointed at top, opening, and turning outward. 2. The globular-headed Dutch artichoke, having leaves without spines, a strong stalk, the head large, globular, a little compressed at top, and of a brown colour; broad obtuse scales emarginated at top, growing close, and turning inward. Of these varieties the last is deservedly the most esteemed, both on account of its superiority in size and the agreeableness of its flavour. Both varieties are perennial in their root: but the leaves and fruit-stem die to the ground in winter; and their roots remaining, send up fresh leaves and stems every summer, producing a supply of artichokes for 20 years if required. The flowers and seed of all the plants of this genus are produced in the centre of the head; the scales of which are the proper calyx of the flower, which consists of numerous small blueish florets, succeeded by downy seeds sitting naked on the receptacle.

2. The cardunculus, or cardoon, greatly resembles the artichoke, but is of larger and more regular growth; the leaves being more upright, taller, broader, and more regularly divided; and the stalks of the leaves blanched are the only eatable parts of the plant.

Both the above varieties of the artichoke are propagated by slips or suckers, arising annually from the stool or root of the old plants in spring, which are to be taken from good plants of any present plantation in March, or the beginning of April, and planted in the open quarters of the kitchen-garden, in rows five feet asunder; and they will produce artichokes the same year in autumn. It should, however, be remarked, that though artichokes are of many years duration, the annual produce of their fruit will gradually lessen in the size of the eatable parts after the third or fourth year, so that a fresh plantation should be made every three or four years. The cardoon is a very hardy plant, and prospers in the open quarters of the kitchen-garden. It is propagated by seed sown annually in the full ground in March: either in a bed for transplantation, or in the place where they are designed to remain. The plants are very large, so must stand at considerable distances from one another. By this means you may have some small temporary crops between the rows, as of lettuce, spinach, endive, cabbage, savoy, or brocoli plants. In the latter part of September, or in October, the cardoons will be grown very large, and their footstalks have acquired a thick substance; you must then tie up the leaves of each plant, to admit of earthing them closely all round for blanching, which will take up six or eight weeks; and thus the plants will come in for use in November and December, and continue all winter.

CYNIPS, in zoology, a genus of insects belonging to the hymenoptera order. The mouth is armed with jaws, but has no proboscis: the sting is spiral, and mostly concealed within the body. The quercus folii, or oak-leaf cynips, is of a burnished shining brown colour. It is in the little, smooth, round, hard galls, found under the oak-leaves, generally fastened to the fibres, that this insect is produced, a single one in each gall. These latter are ligneous, of a hard compact substance, formed like the rest by the extravasation of the sap of the leaf, occasioned by the puncture of the gall-fly when it deposits its eggs. Sometimes, instead of the cynips, there is seen to proceed from the gall a larger insect of a brown colour, which is an ichneumon. This ichneumon is not the real inmate of the gall, or he that formed it. He is a parasite, whose mother deposited her eggs in the yet tender gall; which, when hatched, brings forth a larva that destroys the larva of the cynips, and then comes out when it has undergone its metamorphosis and acquired its wings.

The quercus gemmæ, or oak-bud cynips, is of a very dark green, slightly gilded. It deposits its eggs in oak-buds, and produces one of the finest galls, leafed like a rose-bud beginning to blow. When the gall is small, a great quantity of the leaves is compressed, and they are set upon one another like the of a roof. In the centre of the gall there is a kind of ligneous kernel, in the middle of which is a cavity; and in that is found the little larva, who feeds there, takes its growth, undergoes its metamorphosis, and breaks through the inclosure of that kind of cod in order to get out. The whole gall is often near an inch in diameter, sometimes more when dried; and it holds to a branch by a pedicle. There are 19 species of this insect.

CYNOGLOSSUM, hound's-tongue; a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 41st order, asperifoliæ. The corolla is funnel shaped, with its throat closed up by little arches formed in it; the seeds depressed, and affixed to the style of the receptacle only on their inner side. There are 12 species, none of them remarkable for their beauty. The root of one of them, the officinale, or common greater hound's-tongue, was formerly used in medicine, and supposed to possess narcotic virtues; but it is now discarded from practice. The smell of the whole plant is very disagreeable. Goats eat it: sheep, horses, and swine, refuse it.

CYNOMETRA, a genus of the monogynia order, in the decandria class of plants; and in the natural method ranking with those of which the order is doubtful. The calyx is tetraphyllous; the antheræ bifid at top; the legumen carnous, crescent-shaped, and monospermous.. There are two species.

CYNOMORIUM, a genus of the monandria order, in the monœcia class of plants; and in the natural method ranking under the 50th order, amentaceæ. The male calyx is an imbricated catkin; there is no corolla; the calyx of the female is in the same catkin; no corolla; one style; and one roundish seed. There are three species, of no note.

CYNOSORUS, a genus of the digynia order, belonging to the triandria class of plants; and in the natural method ranking under the 4th order, gramina. The calyx is bivalved and multiflorous; the receptacle proper, unilateral, and foliaceous. There are 20 species, four of which are natives of Britain, viz. the cristatus, or crested dog-tail grass; the echinatus, or rough dog-tail grass: the cæruleus, or blue dog-tail grass; and the paniceus, or bearded dog-tail grass.

CYPERUS, a genus of the monogynia order, in the triandria class of plants; and in the natural method ranking under the 3d order, calamariæ. The glumes are paleaceous, and imbricated towards each side; the corolla is wanting, and there is one naked seed. There are 53 species; the only remarkable are the round, the long sweet cyperus, and the papyrus. The former is a native of the East Indies, and grows by the sides of rivulets, ditches, &c. The root is knotty, wrapped round with fibrous strings not easy to break, of a brown colour without, and grey within: of a pleasant scent, especially when well dried; the leaves are green, and resemble those of the reed and leek.

2. The long-leaved, commonly called English or Flemish cyperus, grows in the water, and along the banks and river sides. Its root is as thick as an olive, full of little knots or specks, of an oblong figure, grey colour, sweet and somewhat sharp tasted, and

almost without smell when it is newly taken out of the ground. The roots of both plants are esteemed cordial and diuretic, and the long cyperus is much used by perfumers and glovers.

3. The papyrus is famous both in antient and modern history, and a very minute description of it is given by Pliny. It grows in the lakes of Ethiopia and Egypt. It was very early in use as paper, Numa having left a number of books written on paypyrus. The paper was made from the pellicle between the pith and the bark. Boats were also made of the whole plant together, a piece of acacia wood being used as a keel. It was also used for cordage. Cups, moulds, &c. were made of the lower part.

CYPRÆA, or *gowrie*, in zoology, a genus of insects belonging to the order of vermes testacea. It is an animal of the limax or snail kind; the shell is one involuted, subovated, obtuse, smooth valve. The aperture on each side is linear, longitudinal, and toothed. There are 44 species, distinguished by the form of their shells. This genus is called cypræa, and venerea, from its being peculiarly dedicated to Venus; who is said to have endowed a shell of this genus with the powers of a remora, so as to impede the course of the ship which was sent by Periander, tyrant of Corinth, with orders to destroy the young nobility of Corcyra. See Pl. Na. Hist. fig. 157.

CYPRESS. See CUPRESSUS.

CYPRINUS, in ichthyology, a genus of fishes belonging to the order of abdominales. The mouth is toothless; there are three rays in the gills; the body is smooth and white, and the belly-fins have frequently nine rays. There are 31 species, principally distinguished by the number of rays in the vent-fin. The most remarkable are:

1. The carpio, or carp. This was introduced into England about the year 1514, by Leonard Maschal, to whom we are also indebted for that excellent apple the pepin. Russia wants these fish at this day. Sweden has them only in the ponds of people of fashion. They chiefly abound in the rivers and lakes of Polish Prussia, where they are sometimes taken of a vast size. They are there a great article of commerce, and sent in well-boats to Sweden and Russia. The merchants purchase them out of the waters, of the noblesse of the country, who draw a good revenue from this article.

Carp are very long lived. Gesner brings an instance of one that was near 100 years old. They grow also to a very great size. Some authors speak of carp weighing 200 pounds, and five feet in length. The carp is a prodigious breeder; its quantity of roe has been sometimes found so great, that when taken out and weighed against the fish itself, the former has been found to preponderate. From the spawn of this fish, caviare is made for the Jews, who hold the sturgeon in abhorrence. The carp is extremely cunning, and on that account is sometimes styled the river-fox. They will sometimes leap over the nets, and escape that way; at other times they will immerse themselves so deep in the mud as to let the net pass over them. They are also very shy in taking a bait; yet at the spawning-time they are so simple, as to suffer themselves to be tickled, handled, and caught, by any body that will attempt it. This fish is apt to mix its milt with the roe of other fish, from which is produced a spurious breed, as has been observed in the offspring of the carp and tench, which bore the greatest resemblance to the first. The same has also been observed of the carp and bream.

In Polish Prussia, and many other parts of Germany, the sale of carp constitutes a part of the revenue of the nobility and gentry, so that the proper management of that fish is reduced to a kind of system, founded on the experience of several generations. Of the methods there practised, we have an account in the Philosophical Transactions for 1771, communicated by Mr. J. Reinhold Forster; who says he has seen carp treated and maintained according to those methods, "above a yard long, and of 25 pounds weight;" but had no opportunity of ascertaining their age. "In the pond, however, at Charlottenburg, (he adds,) a palace belonging to the king of Prussia, I saw more than two or three hundred carp, between two and three feet long; and I was told by the keeper they were between 50 and 60 years standing. They were tame, and came to the shore in order to be fed." Mr. Forster, in this paper, also vouches for a most extraordinary circumstance, namely, the possibility of the carp's not only living for a considerable time out of water, but of its growing fat in its new element. The author has seen the experiment successfully tried, and attended to the whole process, in a nobleman's house, where he then resided, in the principality of Anhalt-Dissau. The fish being taken out of the water, is wrapped up in a large quantity of wet moss, spread on a piece of net, which is then gathered into a purse, in such a manner however as to allow him room to breathe. The net is then plunged into water, and hung up to the ceiling of a cellar. At first the dipping must be repeated every three or four hours, but afterwards the carp need only be plunged into the water once in about six or seven hours. Bread soaked in milk is first given him in small quantities. In a short time, the fish will bear more, and grow fat under this seemingly unnatural treatment. Mr. Daines Barrington, in a note, confirms a part of the preceding account, by mentioning the practice of a certain fishmonger near Clare-market, who, in the winter, frequently exposed a bushel, at least, of carp and tench for sale, in the same dry vessel, for six or seven hours, many of which were not sold, and yet continued in health, though breathing nothing but air during the time above-mentioned, for several days successively.

2. The barbus, or barbel, is so extremely coarse, as to be overlooked by the antients till the time of the poet Ausonius, who gives it no great character. They frequent the still and deep parts of rivers, and live in society, rooting like swine with their noses in the soft banks. It is so tame as to suffer itself to be taken by the hand; and people have been known to take numbers by diving for them. In summer, they move about during night in search of food; but towards autumn, and during winter, confine themselves to the deepest holes. The barbel is about the length of three feet, and will weigh 18 pounds; the belly white; the dorsal fin is armed with a remarkably strong spine, sharply serrated, with which it can inflict a very severe and dangerous wound on the incautious handler, and even do much damage to net. They are the worst and coarsest fresh-water fish, and seldom eaten but by the poorer sort of people, who sometimes boil them with a bit of bacon, to give them a relish. Their roe is very noxious, affecting those who unwarily eat of it, with a nausea, vomiting, purging, and a slight swelling.

3. The tinea, or tench, was treated with the same disrespect by the antients as the barbel; but is now in much more repute. It has by some been called the physician of the fish; and its slime has been said to be of so healing a nature, that the wounded fishes apply it as a styptic. In this country it is reckoned a wholesome and delicious food; but the Germans are of a different opinion. By way of contempt, they call it the shoemaker. Gesner even says, that it is insipid and unwholesome. It does not commonly exceed four or five pounds in weight, though some have been known to weigh 10 or 20. They love still waters, and are rarely found in rivers. They are very foolish, and easily caught. The tench is thick, and short in proportion to its length. The colour of the back is dusky; the dorsal and ventral fins of the same colour; the head, sides, and belly, of a greenish cast, most beautifully mixed with gold, which is in its greatest splendour when the fish is in the highest season.

4. The gobio, or gudgeon, is generally found in gentle streams, and is of a small size, the largest not exceeding ½ lb. weight. They bite eagerly; and are assembled by raking the bed of the river: to this spot they immediately crowd in shoals, in expectation of food.

5. The brama, or bream, is an inhabitant of lakes, or the deep parts of still rivers. It is a fish that is very little esteemed, being extremely insipid.

6. The rutilus, or roach, is a common fish, found in many of the still deep rivers of this country. They are gregarious, keeping in large shoals. It has never been known to exceed five pounds in weight.

7. The leuciscus, or dace, like the roach, is gregarious, haunts the same place, is a great breeder, very lively, and during summer is very fond of frolicking near the surface of the water. It never exceeds the weight of a pound and a half; the scales are smaller than those of the roach.

8. The cephalus, or chub, is a very coarse fish, and full of bones. It frequents the deep holes of rivers, and in summer commonly lies on the surface beneath the shade of some tree or bush. It is very timid, sinking to the bottom on the least alarm, even at the passing of a shadow; but it will soon resume its former situation. It feeds on worms, caterpillars, grasshoppers, and other coleopterous insects that happen to fall into the water; and it will even feed on cray-fish. It will rise to a fly. Some of this kind have been known to weigh eight or nine pounds.

9. The alburnus, or bleak. These fish are very common in many of our rivers, and keep together in large shoals. At certain seasons they seem to be in great agonies; they tumble about near the surface of the water, and are incapable of swimming far from the place: but in about two hours they recover and disappear. Fish thus affected, the Thames fishermen call mad bleaks. They seem to be troubled with a species of gordius, or hair-worm, which torments them so, that they rise to the surface

and then die. The bleak seldom exceeds five or six inches in length. Artificial pearls are made with the scales of this fish; and probably also with those of the dace. They are beaten into a fine powder, then diluted with water, and introduced into a thin glass bubble, which is afterwards filled with wax. The French were the inventors of this art. During the month of July there appear in the Thames, near Blackwall and Greenwich, innumerable multitudes of small fish, known to the Londoners by the name of white-bait. They are esteemed very delicious when fried with fine flour, and occasion, during the season, a vast resort of the lower order of epicures to the taverns at the places where they are taken. There are various suppositions concerning these fishes, all of which terminate in reckoning them the fry of some other fish. Mr. Pennant thinks they are of the carp kind; though he cannot determine the species to which they belong. They have a greater similarity to the bleak than to any other, but he thinks they cannot be the young fry of this species; because the bleak is found in many of the British streams, but the white-bait only in the Thames. The usual length of this fish is only two inches.

10. The auratus, or golden fish, a small fish, domesticated by the Chinese, and generally kept for ornament by great people in their courts and gardens. They breed them in small ponds made for the purpose, in basons, and even in porcelain vessels. This fish is no larger than our pilchard. The male is of a bright red colour, from the top of the head to the middle of the body: the rest is of a gold colour; but it is so bright and splendid, that the finest gilding, according to F. le Comte, cannot approach it. The female is white, but its tail and half of its body resemble the lustre of silver. F. du Halde, however, observes, that a red and a white colour are not always the distinguishing marks of the male and female; but that the females are known by several white spots, which are seen round the orifice that serves them as organs of hearing; and the males, by having these spots much brighter. Gold-fish are light and lively; they love to sport on the surface of the water, soon become familiarized, and may even be accustomed to come and receive their food on sounding a small rattle. Great care is necessary to preserve them; for they are extremely delicate, and sensible of the least injuries of the air; a loud noise, such as that of thunder or cannon; a strong smell, a violent shaking of the vessel, or a single touch, will often destroy them. These fish live with little nourishment; those small worms which are engendered in the water, or the earthy particles that are mixed with it, are sufficient for their food. The Chinese, however, take care from time to time, to throw into the basons and reservoirs where they are kept, small balls of paste, which they are very fond of when dissolved; they give them also lean pork, dried in the sun, and reduced to a fine and delicate powder, and sometimes snails: the slime which these insects leave at the bottom of the vessel is a great delicacy for them, and they eagerly hasten to feed on it. In winter they are removed from the court to a warm chamber, where they are kept generally shut up in a porcelain vessel. During that season they receive no nourishment; however, in spring, when they are carried back to their former bason, they sport and play with the same strength and liveliness as they did the preceding year.

In warm countries these fish multiply fast, provided care is taken to collect their spawn, which floats on the water, and which they almost entirely devour. This spawn is put into a particular vessel, exposed to the sun, and preserved until vivified by the heat. Gold-fish, however, seldom multiply when they are kept in close vases, because they are then too much confined. In order to render them fruitful, they must be put into reservoirs of considerable depth in some places at least, and which are constantly supplied with fresh water. At a certain time of the year, a prodigious number of barks may be seen in the great river Yangtsekiang, which go thither to purchase the spawn of these fish. Towards the month of May, the neighbouring inhabitants shut up the river in several places with mats and hurdles, which occupy an extent of almost 9 or 10 leagues; and they leave only a space in the middle sufficient for the passage of barks. The spawn of the fish, which the Chinese can distinguish at first sight, although a stranger could perceive no traces of it in the water, is stopped by these hurdles. The water mixed with spawn is then drawn up, and after it has been put into large vessels, it is sold to merchants, who transport it afterwards to every part of the empire. This water is sold by measure, and purchased by those who are desirous of stocking their ponds and reservoirs with fish.

Notwithstanding the tenderness of these fish even in their native climates, they are now naturalized in Britain, where they even breed. They were first introduced into England about the year 1691; but were not generally known till 1728, when a great number were brought over, and presented first to sir Matthew Dekker, and by him circulated round the neighbourhood of London, whence they have been distributed to most parts of the country.

Nothing can be more amusing than a glass bowl, containing such fishes: the double refractions of the glass and water represent them, when moving, in a shifting and changeable variety of dimensions, shades, and colours; while the two mediums, assisted by the convex shape of the vessel, magnify and distort them vastly; not to mention that the introduction of another element and its inhabitants into our parlours, engages the fancy in a very agreeable manner. See Plate Nat. Hist. fig. 158.

CYPRIPEDIUM, *lady's slipper*, a genus of the diandria order, in the gynandria class of plants, and in the natural method ranking under the 7th order, orchideæ. The nectarium is ventricose, inflated, and hollow. There are five species; of which only one, viz. the calceolous, is a native of Britain. It grows in rough ground in different parts of the island. The other species are natives of America. None of them are easily propagated in gardens, and therefore must be transplanted from those places where they are natives. They are curious and beautiful flowers. The English species is yellow.

CYPRUS, *knights of*, an order instituted by Guy de Lusignan, titular king of Jerusalem, to whom Richard I. of England, after conquering this island, made over his right.

CYRILLA, a genus of the class and order didynamia angiospermia. The calyx is five-leaved; the cor. funnel-form; filaments inserted in the margin of the corolla; anth. cohering; germ inferior; style bent down; stigma two-lobed; caps. half two-celled; seeds numerous. There is one species, a handsome plant of the West Indies.

CYRTANTHUS, a genus of the class and order hexandria monogynia. The corolla is tubular, inserted in the tube. There are two species, bulbs of the Cape.

CYST, the bag or tunic including all incysted tumors, as the scirrhus, atheroma, steatoma, meliceris. See SURGERY.

CYTINUS, a genus of the dodecandria order, in the gynandria class of plants, and in the natural method ranking under the 11th order, sarmentaceæ. The calyx is quadrifid, superior; there is no corolla; the antheræ are 16, and sessile; the fruit an octolocular polyspermous berry. There is one species.

CYTISUS, *tree trefoil*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is bilabiated, with the upper lip bifid; inferior tridentate; the legumen attenuated at the base. There are eight species, of which the most remarkable are: 1. The laburnum, or large deciduous cytisus; has a large upright tree-stem, branching into a full-spreading head, 20 or 30 feet high, having smooth greenish branches, from the sides of which numerous yellow flowers collected into long spikes hang loosely downward, and appear in May. 2. The sessilifolius, often called cytisus secundus clusii, has a slow shrubby stem dividing into numerous erect brownish branches, forming a bushy head five or six feet high, with small oval leaves growing by threes; and bright yellow flowers in short erect spikes at the end of the branches, in June. 3. The nigricans grows with a short shrubby stem, dividing low into many erect slender branches, forming a bushy head four or five feet high, with oblong, oval, trifoliate leaves, and yellow flowers terminating all the branches in upright spikes, appearing in July. 4. The hirsutus, or hairy evergreen Neapolitan cytisus, rises with an upright shrubby grey stem, sending out many erect greenish hairy branches, forming a fine head six or eight feet high, with small hairy trifoliated leaves, and yellow flowers from the sides of the branches in short pendulous spikes, appearing in June. 5. The austriacus, Austrian, or Tartarean evergreen cytisus, has a shrubby stem, dividing low into many greenish branches, forming a bushy head three or four feet high, having smooth whitish-green leaves, and bright yellow flowers in close umbellate heads at the ends of the branches, having a cluster of leaves under each head. These flowers appear in May. All the sorts are hardy, and will prosper in any common soil and exposure: though, as the hirsutus is sometimes affected by severe frost, it should have a dry soil, and a somewhat sheltered situation. They may all be propagated by seeds or cuttings, and all the culture they require in the nursery is to have the ground kept clear from weeds, and dug annually be-

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Coryphæna velifera

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Cottus cataphractus

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Crax pauxi

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Crax alector

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Crotalus horridus
Rattle snake

151

Cryptocephalus gigantæus

152

Cryptocephalus hirtus

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153

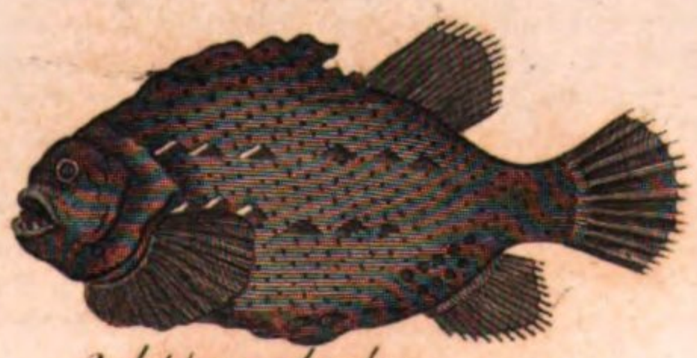
Cuculus persa
Mexican Cuckow

157

Cypræa stercoraria

Cycas revoluta

156



Cyclopterus lumpus
Lump sucker

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Cydas cornea

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tween the rows. Though they are generally considered only as ornamental shrubs, yet the first species, if originally trained to a stem, and suffered to stand, will grow to a size of pretty large timber-trees. They grow naturally on the Alps, the mountains of Dauphiny, and in the Highlands of Scotland; and the timber being very hard, and taking a fine polish, is frequently used for making household furniture, and is said to equal the finest mahogany in beauty. A species of cytisus, called by Linnæus cytisus cajan, is known in the West Indies, where it is a native, by the name of the pigeon-pea, from the seeds being the common food of these birds in that part of the world. These seeds are also sometimes used as food for the human species; and as they are of a very binding quality, afford a wholesome nourishment during the wet season, when dysenteries are so frequent.

D.

D, the fourth letter of the alphabet, as a numeral denotes 500; and with a dash over it, thus $\overline{D}$, 5000. Used in abbreviation, it has various significations: thus, D. stands for doctor, as M. D. doctor of medicine; D. T. doctor of theology; D. D. signifies doctor of divinity; D. D. D. is used for dat, dicat, dedicat; and four D. D. D. D. for dignum deo donum dedit. In music D marks in thorough-basses what the Italians call descanto, and intimates, that the treble ought to play alone, as T does the tenor, and B the bass. D C, in the Italian music, an abbreviation of da capo, that is, from the head, or beginning. Among Roman writers D stands for divus, decimus, devotus, diebus, and diutius.

DAB. See PLEURONECTES.

DACTYL, δακτυλος, dactylus, in antient poetry, a metrical foot, consisting of one long and two short syllables, as αλκιμος, and cāndĭdŭs. The dactyle and spondee are the only feet or measure used in hexameter verses, the former being esteemed more sprightly, and the latter more solemn and grave. Accordingly, where great activity is signified, we find the dactyls used with much propriety, as in the following verses of Virgil.

Quadrupedante putrem sonitu quatit ungula campum;

and,

Ferte cito ferrum, date tela, scandite muros.

DACTYLIS, *cock's-foot grass*, a genus of the digynia order, in the triandria class of plants, and in the natural method ranking under the 4th order, gramina. The calyx is bivalved and compressed, with one valve longer than the other, carinated, or having the rachis prominent and sharp. There are seven species. The cynosuroides, or smooth cock's-foot grass, and the glomeratus, or rough cock's-foot grass, are natives of Britain; the first grows on marshy places, and the latter is common in meadows and pasture-grounds. This last is eaten by horses, sheep, and goats, but refused by cows.

DACTYLONOMY, the art of counting by the fingers. The rule is this; the left thumb is 1, the forefinger 2, and so on to the right thumb, which is the tenth, or last, and is denoted by the cypher.

DACZAJIE, a silver money current in Persia, and worth five mamoudis. See MAMOUDI.

DÆMON, a name given by the antients to certain spirits, or genii, which appeared to men, either to do them service, or to hurt them. The Platonists distinguish between gods, dæmons, and heroes. The gods are those whom Cicero calls dii majorum gentium. The dæmons are those whom we call angels. Christians, by the word dæmon, understand only evil spirits, or devils. Justin Martyr speaks of the nature of dæmons as if he thought them not absolutely spiritual and incorporeal, for which reason he attributes such actions to them as cannot be performed without the intervention of a body.

The Mahometans allow several sorts of dæmons; and the miners of Hungary pretend that while they are at work in the mines, they often see dæmons in the shape of little negro-boys, doing them no other harm than often extinguishing their lights.

DÆMONIACS, in church-history, a branch of the anabaptists, whose distinguishing tenet is, that the devils shall be saved at the end of the world.

DAGGYSA, a genus of the vermes class, and mollusca order, of which there is only a single species. The body is loose, noyant, angular, tubular, and open at each extremity: it is marked at one end with a brown spot. The dagysa inhabits the Spanish sea, is about three inches long, and one inch thick. They adhere to each other by the sides, and so nearly resemble the genus salpa, that it is thought they might, with propriety, be incorporated into one.

DAIS, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 31st order, vepreculæ. The involucrum is tetraphyllous; the corolla quadrifid or quinquefid; the fruit a monospermous berry. There are three species, natives of India and the Cape.

DAKIR, in our statutes, is used for the twentieth part of a last of hides. According to the statute of 51 Hen. III. de compositione ponderum & mensurarum, a last of hides consists of 20 dakirs, and every dakir of 10 hides. But by 1 Jac. cap. 33. one last of hides or skins is 12 dozen.

DALBERGIA, a genus of the decandria order, in the diadelphia class of plants. There are two filaments or stamina quadrifid at top. The fruit is pedicellated, not gaping, leguminous, membrano-compressed, and bearing seeds. There are two species, trees of Malabar and Surinam.

DALECHAMPIA, a genus of the monadelphia order, in the monœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ. The involucrum of the male is common and quadripartite; the calyces hexaphyllous; corolla none; the nectarium laminated or scaly; the stamina monadelphous or coalited at the base, and polyandrous or numerous. The female involucrum is common and triphyllous; corolla none; style one; the capsule tricoccous. There are two species, of which the scandens is a native of Jamaica. It is a climbing plant, which rises to a considerable height, and is remarkable for nothing but having its leaves armed with bristly hairs, which sting the hands of those who touch them.

DALLE, a nominal money, used in keeping books of account in many cities of Germany. It is worth 32 sols lubs, which make 40 French sols.

DAMAGE, generally signifies any hurt or hindrance that a man receives in his estate; but in the plural in common law, are the recompence that is given to a man by a jury as a satisfaction for some injury sustained; as for battery, imprisonment, slander, or trespass. 2 Black. 438.

In actions upon the case, the jury may find less damages than the plaintiff lays in his declaration, though they cannot find more; but costs may be increased beyond the sum mentioned in the declaration for damages; for costs are given in respect of the plaintiff's suit to recover his damages, which may be sometimes greater than the damage. 10 Co. 115. A jury may, and now frequently do, give interest on book-debts, in the name of damages.

For a more general account of damages, see 7 Vin. Abr. and 2 Bac. Abr. title Damage.

DAMAGE-*feasant* or *faisant*, is where the beasts of another come upon a man's land, and there feed, tread, or spoil his corn or grass there growing; in which case the owner of the ground may distrain and impound them, till satisfaction be made. Wood, b. 4. c. 4.

DAMAGE *cleer*, was formerly a fee or gratuity (generally a tenth part of the damages recovered) paid to the prothonotaries or clerks of the king's-bench, common-pleas and exchequer. But this is abolished by 17 C. II. c. 6. s. 2. and if any officer shall take any money in the name of damage cleer, or in lieu thereof, or shall delay to sign any judgment until damage cleer is paid, he shall forfeit treble the sum so taken or demanded to the party grieved.

DAMASK, a silk stuff, with a raised pattern, so that the right side of the damask is that which has the flowers raised or saturated. Damasks should be of dressed silk, both in warp and woof; and in France, half an ell in breadth: they are made at Chalons in Champagne, and in some places in Flanders, as at Tournay, &c. entirely of wool, 3-8ths of an ell wide, and 20 ells long.

DAMASK is also a kind of wrought linen made in Flanders and in this country. It takes its name on account of its resemblance

to damasks. It is chiefly used for table linen.

DAMASK is also applied to a very fine steel, in some parts of the Levant, chiefly at Damascus in Syria; whence its name. It is used for sword and cutlass-blades, and is finely tempered. See STEEL.

DAMASKEENING, or DAMASKING, the art or operation of beautifying iron, steel, &c. by making incisions in them, and filling them up with gold and silver wire; chiefly used for adorning sword-blades, guards, and gripes, locks of pistols, &c. Damaskeening partakes of the mosaic, of engraving, and of carving: like the mosaic, it has inlaid work; like engraving, it cuts the metal representing different figures; and as in chasing, gold and silver are wrought in relievo. There are two ways of damasking: the one, which is the finest, is when the metal is cut deep with proper instruments, and inlaid with gold and silver wire; the other is superficial only.

DAMASONIUM, a genus of the hexandria class and order. The spathe is one-leafed; perianthium one-leafed, three-parted; berry ten-celled, inferior. There is one species, a native of India.

DAMELOPRE, a kind of bilander, used in Holland for conveying merchandize from one canal to another, being very commodious for passing under the bridges.

DAMIANISTS, in church history, a branch of the antient acephali severitæ. They agreed with the catholics in admitting the fourth council, but disowned any distinctions of persons in the Godhead; and professed one single nature, incapable of any difference; and yet they called God the Father, Son, and Holy Ghost.

DAMPS, in natural history, are certain noxious exhalations issuing from some parts of the earth, and which prove almost instantly fatal to those who breathe them. These damps are chiefly observed in mines and coal-pits: though vapours of the same kind often issue from old lavas of burning mountains; and in those countries where volcanoes are common, will frequently enter houses, and kill people suddenly without the least warning of their approach. In mines and coal-pits they are chiefly of two kinds, called by the miners and colliers the choke and fire damps (see AIR); and both go under one general name of foul air. The choke-damp is carbonic acid gas; and usually infests those places which have been formerly worked, but long neglected, and are known to the miners by the name of wastes. No place, however, can be reckoned safe from this kind of damp, except where there is a due circulation of air; and the procuring of this is the only proper means of preventing accidents from damps of all kinds. The choke-damp suffocates the miners suddenly. Being heavy, it descends towards the lowest parts of the workings, and thus is dangerous to the miners, who can scarcely avoid breathing it. The fire-damp, which seems chiefly to be composed of hydrogen gas, rises to the roof of the workings, as being specifically lighter than the common atmosphere; and hence, though it will suffocate as well as the other, it seldom proves so dangerous in this way as by its inflammable property, by which it often takes fire from the candles, and explodes with great violence.

In the Philosophical Transactions, No. 119, there is an account of some explosions by damps of this kind, on which we have the following observations: 1. Those who are in the place where the vapour is fired, suddenly find themselves surrounded with flames, but hear little or no noise; though those who are in places adjacent, or above-ground, hear a very great one. 2. Those who are surrounded by the inflamed vapour feel themselves scorched or burnt, but are not moved out of their places, though such as unhappily stand in the way of it are commonly killed by the violence of the shock, and often thrown with great force out at the mouth of the pit; nor are the heaviest machines found able to resist the impetuosity of the blast. 3. No smell is perceived before the fire, but a very strong one of brimstone is afterwards felt. 4. The vapour lies towards the roof, and is not perceived if the candles are held low; but when these are held higher, the damp descends like a black mist, and catches hold of the flame, lengthening it to two or three handfuls; and this appearance ceases when the candles are held nearer the ground. 5. The flame continues in the vault for several minutes after the explosion. 6. Its colour is blue, something inclining to green, and very bright. 7. On the explosion of the vapour, a dark smoke like that proceeding from fired gunpowder is perceived. 8. Damps are generally observed to come about the end of May, and to continue during the heat of summer. They return several times during the summer season, but observe no certain rule.

Among the other uses to which oxygen might be applied, Mr. Cavallo reckons that of securing people from the dangerous effects of damps in mines, and other subterraneous places. "If a large bladder," says he, "into which a solution of lime in water is introduced, is filled with dephlogisticated air (oxygen gas), and a small wooden or glass pipe is adapted to its neck, a man may hold that pipe in his mouth, and may breathe the dephlogisticated air; and thus equipped, he may venture into these subterranean places, amidst the various elastic fluids contained in them. A large bladder of dephlogisticated air will serve for above a quarter of an hour, which is a length of time sufficient for various purposes; besides, if longer time is required to be spent in these places, a person may have two or more bladders of dephlogisticated air along with him, and may shift as soon as the air of one is contaminated. Without the necessity of any more complicated apparatus, the bladders full of dephlogisticated air may be kept stopped by putting corks into the glass or wooden pipes that are tied to their necks. This air might also be used for diving-bells."

DANAE, in antiquity, a coin somewhat more than an obolus, used to be put into the mouths of the dead, to pay their passage over the river Acheron.

DANCE, a silly amusement of the idle and thoughtless.

DANCETTE, in heraldry, is when the outline of any bordure or ordinary is indented very largely, the largeness of the indentures being the only thing that distinguishes it from indented.

DANK, a piece of silver current in Persia, and some parts of Arabia, weighing the 16th part of a drachm. It is also a weight used by the Arabians to weigh jewels and drugs.

DAPHNE, spurge-laurel, a genus of the monogynia order, in the octandria class of plants, and in the natural method ranking under the 31st order, veprecula. There is no calyx; the corolla is quadrifid and withering, inclosing the stamina. The fruit is a monospermous berry. There are 28 species, of which the following are the most remarkable:

1. Mezereum, the mezereon or spurge-olive, is a low deciduous shrub. It is a native of Germany, and has been discovered in this country in some woods near Andover in Hampshire. Of this elegant plant there are four varieties: 1. the white; 2. the pale red; 3. the crimson; and 4. the purple-flowering. Hanbury is very lavish in praise of these shrubs. He says, "they have each every perfection to recommend them as flowering shrubs. In the first place, they are of low growth, seldom rising to more than three or four feet in height, and therefore are proper even for the smallest gardens. In the next place they will be in bloom when few trees, especially of the shrubby tribe, present their honours. It will be in February, nay sometimes in January; then will the twigs be adorned with flowers all around from one end to the other. Each twig has the appearance of a spike of flowers of the most consummate lustre; and as the leaves are not yet out, whether you behold this tree near or at a distance, it has a most enchanting appearance. But this is not all: the sense of smelling is peculiarly regaled by the flowers; their spicy sweetness is diffused around, and the air is perfumed with their odours to a considerable distance. Many flowers, deemed sweet, are not liked by all; but the agreeable inoffensive sweetness of the mezereon has ever delighted the sense of smelling, whilst the lustre of its blow has feasted the eye. Neither is this the only pleasure the tree bestows; for besides the beauty of the leaves, which come out after the flowers are fallen, and which are of a pleasant green colour and an oblong figure, it will be full of red berries in June, which will continue growing till the autumn. Of these berries the birds are very fond; so that whoever is delighted with those songsters, should have a quantity of them planted all over the outsides of his wilderness quarters."

2. Cnidium, the flax-leaved daphne, is a low deciduous shrub; a native of Italy, Spain, and about Montpellier. This species seldom grows higher than three feet. The branches are very slender, and ornamented with narrow, spear-shaped, pointed leaves, much like those of the common flax. The flowers are produced in panicles at the ends of the branches: they are small, come out in June, but are rarely succeeded by seeds in England.

3. Cneorum, the spear-leaved daphne, is a very low deciduous shrub; a native of Switzerland, Hungary, the Alps, and the Pyrenean mountains. This rises with a shrubby branching stalk, to about a foot or a foot and a half high. The leaves are narrow, spear-shaped, and grow irregularly on the branches. The flowers are produced in clusters at the ends of the little twigs: they make their appearance in March, are of a purple colour, and possessed of a fragrance

superior even to that of the mezereon; but they are seldom succeeded by seeds in England.

4. Tartonraira, the oval-leaved daphne or tartonraire, a very low deciduous shrub, is a native of France and Italy. This rises with a woody stalk to the height of about two feet. The branches are numerous, irregular, tough, and covered with a light-brown-coloured bark. The leaves are oval, very small, soft to the touch, and shining. The flowers are produced in clusters from the sides of the stalks: they are white, come out in June, and are succeeded by roundish berries, which seldom ripen in England.

5. Alpina, the alpine daphne or chamelæa, is a low deciduous shrub; native of the Alps, Geneva, Italy, and Austria. This will grow to the height of about a yard. The leaves are spear-shaped, obtuse, and hoary underneath. The flowers come out in clusters from the sides of the branches, and are very fragrant: they appear in March, and are succeeded by red berries, that ripen in September.

6. Thymelæa, the milkwort-leaved daphne, or the thymelæa, a low deciduous shrub, native of Spain and the south of France. The thymelæa will grow to the height of a yard. The stalks of this species are upright, branched, and covered with a light-brown bark. The leaves are spear-shaped, smooth, and in some respect resemble those of milkwort. The flowers are produced in clusters from the sides of the stalks: they are of a greenish colour, have no footstalks, appear in March, and are succeeded by small yellowish berries, which will be ripe in August. This and the two former sorts require a dry soil, and a warm situation.

7. Villosa, the hairy-leaved daphne, a very low deciduous shrub, native of Spain and Portugal. The stalks are ligneous, about two feet high. The flowers have very narrow tubes, are small, and make no great show: they come out in June, and are not succeeded by ripe seeds in England. This shrub, in some situations, retains its leaves all winter in such beauty, as to cause it to be ranked among the low-growing evergreens; but as in others it is sometimes shattered with the first bleak winds, it is left to the gardener whether to place this shrub among the deciduous trees or evergreens.

8. Laureola, the spurge-laurel or evergreen daphne, a low evergreen shrub, common in some parts of this kingdom, also in Switzerland and France. This shrub seldom grows more than a yard or four feet high; and is also valuable on account of its flowers; not because they make any great show, but from their fragrance, and the time they appear; for it will be in flower the beginning of January, and will continue so until the middle or end of April before the flowers fall off.

9. The odora is a charming shrub, which has its specific name from the delightful fragrance of its flowers. In appearance it much resembles the common spurge-laurel, but must be treated as a greenhouse plant.

The root of the mezereon was long used in the Lisbon diet-drink, a remedy said to be good for several complaints, particularly nodes and other symptoms resisting the use of mercury. The composition of this diet-drink is described in the Edinburgh Physical Essays, by Dr. Donald Monro of London. On chewing the root of the mezereon, it proves very pungent, and its acrimony is accumulated about the fauces, and is very durable. It is employed chiefly under the form of decoction, and it enters the decoctum sarsaparillæ compositum of the London college; but it has also been used in powder combined with some inactive one, as that of liquorice-root. It is apt to occasion vomiting and purging; so must be begun in grain-doses, and gradually increased. It is often usefully combined with mercury. The bark of the root, which is the most acrimonious part, is recommended in the Pharmacopœia Chirurgica, to be steeped in vinegar, and applied to promote the discharge of issues. Mezereon has also been of use in tumours and cutaneous eruptions not venereal. The whole plant is very corrosive; and six of the berries, it is said, will kill a wolf. A woman gave 12 grains of the berries to her daughter, who had a quartan ague: she vomited blood, and died immediately.

DARAPTI, among logicians, one of the modes of syllogisms of the third figure, whose premises are universal affirmatives, and the conclusion is a particular affirmative: thus,

DAR- Every body is divisible:
AP- Every body is a substance;
TI. Therefore some substance is divisible.

DARIC, in antiquity, a famous piece of gold, first coined by Darius the Mede about 538 years before Christ; probably during his stay at Babylon, out of the vast quantity of gold which had been accumulated in the treasury. It was dispersed over the East, and also into Greece; so that the Persian daric, which was also called stater, was the gold coin best known in Athens in antient times. According to Dr. Bernard, it weighed two grains more than one of our guineas; but as it was very fine, and contained little alloy, it may be reckoned worth about 25*s*. of our money.

DARII, in logic, one of the modes of syllogisms of the first figure, in which the major proposition is an universal affirmative, and the minor and conclusion particular affirmatives: thus,

DA- Every thing that is moved, is moved by another:
RI- Some body is moved;
I. Therefore, some body is moved by another.

DARRIEN, in law, a corruption of the French word dernier, *last*, is used in this sense in our law, as *darrien continuance*, &c.

DARRIEN *presentment*, the last presentation to a church, on which an assize lies.

DASYPUS, *armadillo*, a genus of quadrupeds of the bruta order. The generic character is: grinders several, without either cutting or canine teeth; body coated with a shelly armour, divided into zones.

The armadillos are natives of South America, and are readily distinguished from all other quadrupeds by the singular covering with which nature has ornamented them; and which forms a complete suit of armour, divided into bands or shelly zones, in such a manner as to accommodate itself to the various postures of the body; and exhibiting a most beautiful example of deviation from the general structure and appearance in quadrupeds. The armadillos are innoxious animals, and inhabit subterraneous retreats or burrows, which they readily excavate by means of their large and strong claws. They wander about chiefly by night, and devour various roots and grain; and are therefore considered as injurious to plantations. They also occasionally prey on the smaller animals of different kinds; as worms, insects, &c. In a state of captivity, they readily eat animal food, and that in considerable quantity.

They are themselves considered as excellent food, and are therefore dug out of their subterraneous cavities, and sold for the table. When old, however, their flesh acquires a strong musky scent, and becomes unfit for use. When attacked, the armadillos roll themselves up into the form of a ball, and thus become, in a great degree, invulnerable. Nothing can exceed the curious mechanism by which this is performed; nor is it possible to view without admiration the appearance of the animal thus coiled up, and secured from common contingencies.

Armadillos are said to drink frequently, and they often grow extremely fat. They are very prolific animals; and are said to breed three or four times a year, and to bring several young at a birth. The species are determined by the number of shelly zones on the body. In enumerating these, however, it is remarkable that most authors vary; and the exact discrimination of all the species seems yet a desideratum in natural history. This, perhaps, arises partly from the inattention of draughtsmen and engravers, when representing the animals, and partly from different authors counting differently the bands on some of the species; which are so placed as to make it difficult in some instances to distinguish the ultimate or bounding zones of the body, from the scaly divisions on the fore and hind parts of the animal; and which, like the bands, are disposed into a kind of zones, though less strongly marked. Some species, however, are so clearly defined by this mode of distinction, as to be at all times readily ascertained.

1. Dasypus tricinctus, or three-banded armadillo, may be considered, perhaps, as the most elegant of the whole species; the pattern of the armour being peculiarly neat and well defined, and the colour of the animal more pleasing than in most other species, viz. a clear yellowish-white. The head, shoulders, and hind part of the body, are coated with regular hexagonal divisions, curiously studded or tuberculated on the surface; and the zones of the body are extremely distinct, and only three in number. The ears are rather large, and the claws smaller than in most other species. It is a native of Brazil.

2. Dasypus sexcinctus, or six-banded armadillo, is also a species of great elegance; and much resembles the former, but is furnished with six bands instead of three. The tail is very thick at the base, and is short in proportion to the animal; the claws are very large and strong. The bands are marked into oblong squares, as in the former.

3. Dasypus septemcinctus, or seven-banded armadillo. It is impossible to consider this in any other light than as a mere variety of the nine-banded armadillo, in which the pattern of the armour, and the relative proportions of the parts, are sufficient to ascertain the species, whatever may happen to be the number of the zones.

4. Dasypus novemcinctus, or nine-banded

armadillo. The number of bands or zones in this species is generally nine: they are extremely distinct or well defined, and are transversely marked by very numerous wedge-shaped or acutely-triangular figures alternating with smaller opposite ones: and the head is smaller, longer in proportion, and sharper-snouted, than in any other species; the fore and hind parts of the shield or covering are marked by very numerous flat rounded scales or tubercles, with smaller ones interposed; the ears are moderately large, and upright; the tail is longer than in any other species, and tapers gradually to the tip. It is marked by transverse rows of longish hexagonal divisions on each joint; on the fore feet are four toes, and five on the hind; the claws moderately large and strong.

5. Dasypus cingulis duodecim. This, according to the character generally given in authors, should have twelve zones or bands; but it is certain that this number is not very accurately observed by nature, and perhaps 13 or 14 is the more general number. The individuals also appear to vary in some other particulars. That described by Buffon and Mr. Pennant, under the title of the twelve-banded armadillo, has broad upright ears; the head is thick and broad, and is marked above into large angular divisions; the crust on the shoulders into oblong pieces inclining to a squarish form; that on the rump into hexagonal ones. The length of this animal, from the nose to the tail, is about a foot; the tail about seven inches or less.

6. Dasypus cingulis octodecim, or eighteen-banded armadillo, was first described by Grew, in the last century, under the name of the weezle-headed armadillo. This species seems most allied to the twelve-banded armadillo.

DATA, among mathematicians, a term for such things or quantities as are given or known, in order to find other things that are unknown. Euclid uses the word data for such spaces, lines, and angles, as are given in magnitude, or to which we can assign others equal.

In algebra the given quantities or data are expressed by the first letters of the alphabet, and the unknown quantities by the last letters; thus, if the problem be from the sum and product of two quantities given, to find the quantities themselves, the quantities are represented by y and z; and $y + z = a$ the sum given, and $y z = b$ the product given. See ALGEBRA.

DATE, in law, is the description of the day, month, year of our Lord, and year of the reign of the king, in which a deed or other writing was made. Antiently deeds had no dates but only of the month and year, and now, if in the date of any deed, the year of our Lord is right, though the year of the king's reign is wrong, it shall not hurt the same. A deed is good, though it has no date of the day, or if that be mistaken, or though it contains an impossible date; but then he that pleads such a deed must set forth the time when it was delivered: for every deed or writing has a date in law, and that is the day of the delivery; and where there is none, a plaintiff, it is said, may count it of any date.

In writings of importance, the date should be written in words at length. An antedate is a date prior to the real time when the instrument was signed. A post-date is that posterior to the real time when the instrument was passed.

DATE. See PHŒNIX.

DATISCA, a genus of the dodecandria order, in the diœcia class of plants, and in the natural method ranking under the 54th order, miscellaneæ. The male calyx is pentaphyllous; there is no corolla; the antheræ are sessile, long, and 15 in number. The female calyx is bidented; no corolla; the styles three; the capsule triangular, three-horned, unilocular, pervious, polyspermous, inferior. There are two species.

DATISI, in logic, a mode of syllogism in the third figure, in which the major is an universal affirmative, and the minor and conclusion particular affirmative propositions. For example,

DA- All who serve God are kings:
TI- Some who serve God are poor;
SI. Therefore some who are poor are kings.

DATIVE, among grammarians, the third case in the declension of nouns, expressing the relation of a thing to whose profit or loss some other thing is referred. It is called dative, because usually governed by a verb, implying something to be given to some person. In English the dative is expressed by the signs *to* or *for*.

DATURA, the thorn-apple, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 28th order, luridæ. The corolla is funnel-shaped and plaited; the calyx tubular, angulated, and deciduous; the capsule quadrivalved. There are eight species: the most remarkable are,

1. The stramonium, or common thorn-apple, rises about a yard high, with an erect, strong, round, hollow, green stalk, branching luxuriantly, having the branches widely extended on every side; large, oval, irregularly angulated, smooth, dark-green leaves; and from the divisions of the branches, large white flowers singly, succeeded by large, oval, prickly capsules, growing erect, commonly called thorn-apples. At night the upper leaves rise up and inclose the flowers. The blossoms have sometimes a tinge of purple or violet. The flowers consist of one large funnel-shaped petal, having a long tube, and spreading pentagonal limb, succeeded by large roundish capsules of the size of middling apples, closely beset with sharp spines. An ointment prepared from the leaves gives ease in external inflammations and in the hæmorrhoids. The seeds were recommended by Dr. Storck to be taken internally in cases of madness; but they seem to be a very unsafe remedy. Taken even in a small dose, they bring on a delirium, and in a large one would certainly prove fatal. Cows, horses, sheep, and goats, refuse this plant.

2. Datura arborea, is a stove-plant, much esteemed for the beauty and fragrance of its large white flowers.

DAUCUS, the carrot, a genus of the digynia order in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The corolla is a little radiated, all hermaphrodite; the fruit bristly with short hairs. There are seven species, but the only one which merits attention is the carota or common carot. This is so well known as to need no description. There are several varieties, as the white, the orange, and the purple carrot; but of these the orange carrot is the most esteemed. It grows longer, larger, and is commonly more handsome, than the others, being often 15 or 18 inches long in the eatable part, and from two to four in diameter at top. Carrots are propagated by seeds; which are sown at different seasons of the year, in order to procure a supply of young roots for the table at all times. The season for sowing for the earliest crop is soon after Christmas; the manner of cultivating them is too well known to need any particular description.

Carrots have been greatly recommended as proper for fattening hogs; but from some experiments mentioned in the Georgical Essays it appears, that though the bacon thus fed is of excellent quality, the feeding is considerably dearer than when fed with peas, pollard, &c. In the same essays, an experiment is mentioned by Dr. Hunter, concerning the propriety of raising carrots for the use of the distiller. From a gross calculation he is induced to think that a good acre of carrots so manufactured will leave a profit of 40*l.* after deducting the landlord's rent, cultivation, distillation, and other incidental expences. In this calculation he presumes that the spirit is worth 6*s.* per gallon, and not excised. An acre of barley will by no means produce so much spirit. A rich sandy loam is the best land for carrots; which, after the crop is removed, will be in high cultivation for corn. Attempts have also been made to prepare sugar from carrots. A poultice of carrots mitigates the pain and abates the stench of foul and cancerous ulcers. Crickets are very fond of carrots; and are easily destroyed by making a paste of powdered arsenic, wheat-flower, and scraped carrots, which must be placed near their habitations. The seeds have been reckoned diuretic; and were formerly much used as a remedy for the stone, but are at present little regarded. Carrots were first introduced into England by the Flemings in the reign of queen Elizabeth.

DAVIDISTS, in church history, a sect of Christian heretics in the 16th century; so called from David George, their leader, who began by giving out that he was the Messiah, and was sent into the world in order to people the kingdom of heaven, which was quite empty of inhabitants for want of virtuous and good men: he rejected marriage and denied the resurrection.

DAVIT, in a ship, a long beam of timber, represented by *a*, *a*, Plate Miscel. fig. 31, and used as a crane to hoist the flukes of the anchor to the top of the bow, without injuring the sides of the ship as it ascends; an operation which by mariners is called fishing the anchor. The anchors being situated on both the bows, the davit may be occasionally shifted, so as to project over either side of the ship, according to the position of that anchor on which it is employed. The inner end of the davit is secured by being thrust into a square ring of iron *b*, which is bolted to the deck, and forelocked under the beams. This ring, which is called the span-shackle, exhibited by the figure, is fixed exactly in the middle of the deck, and close behind the foremast. Upon the outer end of the davit is hung a large block *c*, through which a strong rope traverses, called the fish-pendant, *d*; to whose foremost end is fitted a large iron hook *e*, and to its after-end a tackle or

complication of pulleys *f*; the former of which is called the fish-hook, and the latter the fish-tackle. The davit, therefore, according to the sea-phrase, is employed to fish the anchor; which being previously catted, the fish-hook is fastened upon its flukes; and the efforts of the tackle being transmitted to the hook by means of the fish-pendant, it draws up that part of the anchor sufficiently high upon the bow to fasten it, which is done by the shank-painter. There is also a davit of a smaller kind occasionally fixed in the long-boat, and employed to weigh the anchor.

DAY, according to the most natural and obvious sense of the word, signifies that space of time during which it continues to be light; in contradistinction to night, being that partition of time wherein it is dark; but the space of time in which it is light, being somewhat vague and indeterminate, the time between the rising and setting of the sun is usually looked on as the day, and the time which lapses from its setting to its rising again the night.

The word day is often taken in a larger sense, so as to include the night also; or to denote the time of a whole apparent revolution of the sun round the earth, in which sense it is called by some a natural day, and by others an artificial one: but to avoid confusion it is usual to call it in the former sense simply the day, and in the latter a nychthemeron, by which term that acceptation of it is aptly denoted, as it implies both day and night.

The nychthemeron is divided into 24 parts, called hours: which are of two sorts; equal, and unequal or temporary.

Different nations begin their day at a different hour: thus the Egyptians began their day at midnight, from whom Hipparchus introduced that way of reckoning into astronomy; and Copernicus and others have followed him: but the greater part of astronomers reckon the day begun at noon, and so count 24 hours, till the noon of the next day; and not twice twelve, according to the vulgar computation. The method of beginning the day at midnight prevails also in Great Britain, France, Spain, and most parts of Europe. The Babylonians began their day at sun-rising, reckoning the hour immediately before its rising again the 24th hour of the day, whence the hours reckoned in this way are called the Babylonic. In several parts of Germany, they begin their day at sun-setting, and reckon on till it sets next day, calling that the 24th hour: these are generally termed Italian hours. The Jews also began their nychthemeron at sun-setting; but then they divided it into twice twelve hours, as we do; reckoning twelve for the day, be it long or short, and twelve for the night; so that their hours continually varying with the day and night, the hours of the day were longer than that of the night for one half-year, and the contrary the other; whence their hours are called temporary: those at the time of the equinoxes became equal, because then those of the day and night are so. The Romans also reckoned their hours after this manner, as do the Turks at this day. This kind of hours are called planetary, because the seven planets were antiently looked upon as presiding over the affairs of the world, and taking it by turns each of these hours, according to the following order: Saturn first, then Jupiter, Mars, the Sun, Venus, Mercury, and last of all the Moon; hence they denominated each day of the week from that planet whose turn it was to preside the first hour of the nychthemeron. Thus assigning the first hour of Saturday to Saturn, the second will fall to Jupiter, the third to Mars, and so the 22d of the same nychthemeron will fall to Saturn again; and therefore the 23d to Jupiter, and the last to Mars: so that on the first hour of the next day it will fall to the Sun to preside; and by the like manner of reckoning, the first hour of the next will fall to the moon; of the next, to Mars; of the next, to Mercury; of the next, to Venus: hence the days of the week came to be distinguished by the Latin names of *dies Saturni, Solis, Lunæ, Martis, Mercurii, Jovis,* and *Veneris;* and among us, by the names of Saturday, Sunday, Monday, &c.

DAY, in a legal sense, relates to the day of appearance of parties, or the continuance of suits, where a day is given. In real actions there are common days, and special days given by the judges in an assise, &c.

DAYS *in bank*, are days set down by statute or order of the court, when writs shall be returned, or when the party shall appear on the writ served. They say also, if a person is dismissed without day, he is finally discharged.

DAYS *of grace*, are those granted by the court at the prayer of the defendant or plaintiff, in whose delay it is.

DAYS *of grace*, in commerce, are a customary number of days allowed for the payment of a bill of exchange, &c. after the same becomes due. Three days of grace are allowed in England; ten in France and Dantzic; eight at Naples; six at Venice, Amsterdam, Rotterdam, and Antwerp; four at Frankfort; five at Leipsic; twelve at Hamburgh; six in Portugal; fourteen in Spain; thirty in Genoa, &c.

DAY-LIGHT, in our law, the time after sun-rising and before sun-setting, being accounted part of the day, when the hundred is liable for any robberies committed within that time.

DEACON, διακονος, one of the three sacred orders of the christian church. In its restrained sense, it is taken for the third order of the clergy.

In the Romish church it is the deacon's office to incense the officiating priest or prelate; to lay the corporal on the altar; to receive the paten or cup from the sub-deacon, and present them to the person officiating; to incense the choir; to receive the pax from the officiating prelate, and carry it to the sub-deacon; and at the pontifical mass, when the bishop gives the blessing, to put the mitre on his head, and to take off the archbishop's pall, and lay it on the altar. In England, the form of ordaining deacons declares that it is their office to assist the priest in the distribution of the holy communion; in which, agreeably to the practice of the antient church, they are confined to the administering of the wine to the communicants. A deacon with us is not capable of any ecclesiastical promotion; yet he may be a chaplain to a family, curate to a beneficed clergyman, or lecturer to a parish-church. He may be ordained at 23 years of age, *anno currente;* but it is expressly provided, that the bishop shall not ordain the same person a priest and deacon in the same day.

DEACONESS, a female deacon, an order of women who had their distinct offices and services in the primitive church.

DEACONRY, *diaconia*, is also the name of the chapels and oratories in Rome, under the direction of the several cardinal deacons in their respective quarters. Antiently they were seven in number; as the deaconry of St. Maria in the broad-way, the deaconry of St. Eustachio near the Pantheon, &c. answering to the seven regions of the city. They had hospitals annexed to them for the distribution of alms, and an administrator for temporal concerns, called the father of the deaconry, who was sometimes a priest and sometimes a layman. At present, there are 14 of these deaconries, or hospitals, under the direction of as many cardinals.

DEAD-MEN'S-EYES, in the sea-language, a kind of blocks with many holes in them, but no sheevers, by which the shrowds are fastened to the chains: the crow-feet reeve also through these holes; and, in some ships, the main-stays are set tawt in them; but then they have only one hole, through which the lanyards are passed several times. See Plate Miscel. fig. 32.

DEAD-RECKONING, in navigation, the calculation made of a ship's place by means of the compass and log; the first serving to point out the course she sails on, and the other the distance run. From these two things given, the skilful mariner, making proper allowances for the variation of the compass, lee-way, currents, &c. is enabled, without any observations of the sun or stars, to ascertain the ship's place tolerably well.

DEAD-RISING, among sailors, that part of a ship which lies aft, between the keel and the floor-timbers, next adjoining to the stern-post, under the bread-room, in a ship of war.

DEAD-ROPES, on board a ship, such ropes as do not run in any block.

DEAD-WATER, at sea, the eddy-water just astern of a ship, so called because it does not pass away so swift as the water running by her sides does. They say that a ship makes much dead water when she has a great eddy following her stern.

DEADLY FEUD, in law, a profession of an irreconcilable hatred, till a person is revenged even by the death of his adversary. This enmity was allowed in the old Saxon laws; for where any person was killed, if a pecuniary satisfaction was not made to the kindred of the slain, it was lawful for them to revenge themselves by arms on the murderer.

DEADS, among miners, denotes the earth or other fossil substances which inclose the ore on every side. Hence, breaking up the deads is the removing these substances for the conveniency of carrying on their work.

DEAF, DUMB, and BLIND: a man born deaf, dumb, and blind, is considered by the law as an idiot; he being supposed incapable of understanding, as not having those senses which furnish the mind with ideas. Black. 308.

DEAFFORESTED, a term found in law-books, signifying that a place is discharged from being a forest, or freed from the forest-laws.

DEAFNESS, the state of a person who either wants the sense of hearing or has it greatly impaired.

The causes of deafness are a cutting off the external ear, or an obstruction of the audi-

tory passage, from wax or other things; a rupture of the membrane of the tympanum; or when it is corroded, or ulcerated, or the auditory nerve is obstructed or compressed. External causes are, great falls; excessive noise, such as the explosion of cannon; likewise acute diseases or inflammations, which are likely to terminate by a critical hæmorrhage.

Those born deaf are also dumb, as not being able to learn any language, at least in the common way. As the eyes, however, in some measure serve them for ears, they may understand what is said by the motion of the lips, tongue, &c. of the speaker; and even accustom themselves to move their own as they see other people do, and by this means learn to speak. This fact was observed by bishop Burnet with respect to a young lady, the daughter of a Mr. Goddy, minister of St. Gervais' church in Geneva. At two years of age it was observed that she had lost her hearing; and was ever afterwards, though she had some perception of great noises, incapable of hearing an articulate sound. Being, however, of quick parts, she carefully observed the motions of the lips of those who spoke to her; and by an imitation of these she enabled herself to articulate a number of words so as to hold a conversation with those who were in habits of familiarity with her. She however was incapable of this in the dark, as she could not distinguish the motions of their lips. But the most extraordinary of all is, that she had a sister with whom she was accustomed to sleep; and by laying her hand on her sister's mouth, she was able to perceive what was spoken even in the dark.

Like the blind, this unfortunate class of persons were long neglected; they were considered as idiots, and confirmed as such by this cruel inattention. The author of this article, however, knew a most beautiful and accomplished young lady in the north of England, who, by the force of an extraordinary genius, though labouring under this misfortune, taught herself to read and write, and various other branches of science, with no regular instruction. She wrote a fine hand, and her composition in her letters was easy and rather elegant though not perfect or quite free from errors. She was an excellent arithmetician, and at the age of twenty actually kept her father's books, who was a man in a considerable line of business. Dr. Wallis is said to have taught two young gentlemen who were deaf and dumb to understand what was said to them, and to return pertinent answers. A Swiss physician, at Amsterdam, of the name of Ammen, was equally successful with several children; and reduced the art to a system, which was published at Amsterdam in 1692, under the title of Surdus Loquens. It was probably upon these hints that the celebrated Abbé de l'Epée instituted his school for the deaf and dumb. The plan has also been most successfully pursued in England by the late Mr. Braidwood, Mr. Telfair, and others; and a public charity has even been established in Southwark, for the benevolent purpose of instructing such of the children of the poor, as through this misfortune would otherwise have been lost to society.

It is observed, that deaf persons, or rather those who are hard of hearing, hear better and more easily if a loud noise be raised at the time when we speak to them: which is owing, no doubt, to the greater tension of the ear-drum on that occasion. Dr. Wallis mentions a deaf woman, who if a drum was beaten in the room could hear any thing very clearly; so that her husband hired a drummer for a servant, that by this means he might hold conversation with his wife. But with regard to this opinion there may be much deception; the sense of feeling being so nearly allied to that of hearing as to convey certain vibrations which afford information to the mind, although the party be completely deaf. See MEDICINE, and DUMBNESS.

DEAL, a thin kind of fir-planks, of great use in carpentry: they are formed by sawing the trunk of a tree into a great many longitudinal divisions, of more or less thickness, according to the purposes they are intended to serve. Deals are rendered much harder, by throwing them into salt-water as soon as they are sawed, keeping them there three or four days, and afterwards drying them in the air or sun; but neither this nor any other method yet known will preserve them from shrinking.

DEAN, an ecclesiastical officer, or dignitary: he is next under the bishop, and chief of the chapter, ordinarily in a cathedral church. There are four sorts of deans and deanries. The first is a dean who has a chapter consisting of prebendaries or canons, subordinate to the bishop, as a council assistant to him in matters spiritual, relating to religion, and in matters temporal, relating to the temporalities of his bishopric. The second is a dean who has no chapter, and yet is presentative and has cure of souls: he has a peculiar, and a court wherein he holds ecclesiastical jurisdiction, but is not subject to the visitation of the bishop or ordinary; such is the dean of Battle in Sussex. The third dean is also ecclesiastical, but the deanry is not presentative, but donative; nor has he any cure of souls, but is only by covenant or condition; and he has also a court and peculiar, in which he holds plea and jurisdiction, of all such matters and things as are ecclesiastical, and which arise within his peculiar, which often extends over many parishes; such deans constituted by commission from the metropolitan of the province, are the dean of the Arches, and the dean of Bocking in Essex. The fourth sort of dean, is he who is usually called the rural dean; having no absolute judicial power in himself, but being to order the ecclesiastical affairs within his deanry and precinct, by the direction of the bishop or of the archdeacon; he is a substitute of the bishop in many cases.

DEATH of persons. There are a natural death of a man, and a civil death; natural where nature itself expires and extinguishes, and civil where a man is not actually dead but is adjudged so by law. If any person, for whose life any estate has been granted, remain beyond sea, or is otherwise absent, seven years, and no proof is made of his being alive, such person shall be accounted naturally dead; though if the party be afterwards proved living at the time of eviction of any person, then the tenant, &c. may reenter, and recover the profits. Stat. 19. C. II. c. 6. And persons in reversion or remainder after the death of another, upon affidavit that they have cause to believe such other dead, may move the lord chancellor to order the person to be produced; and if he be not produced, he shall be taken as dead, and those claiming may enter, &c. 6 Anne, c. 18.

DEATH'S PART, or dead-man's part, is that portion of his personal estate, which remained after his wife and children had received thereout their respective reasonable parts; which was, if he had both a wife and a child or children, one-third part; if a wife and no child, or a child or children and no wife, one-half; if neither wife nor child, he had the whole to dispose of by his last will and testament: and if he made no will, the same was to go to his administrators. And within the city of London, and throughout the province of York, at this day, in case of intestacy, the wife and children are entitled to their said reasonable part, and the residue only is disputable, by the statute of distribution.

DEATH-WATCH, in natural history, a little insect famous for a ticking noise, like the beat of a watch, which superstitious people take for a presage of death in the family where it is heard: whence it is also called pediculus fatidicus, mortisaga, pulsitorius, &c. There are two kinds of death-watches. Of the first we have a good account in the Phil. Trans. by Mr. Allen. It is a small beetle, 5-16ths of an inch long, of a dark-brown colour, spotted; having pellucid wings under the vagina, a large cap or helmet on the head, and two antennæ proceeding from beneath the eyes, and doing the office of proboscides. The part it beats with, he observed, was the extreme edge of the face, which he chooses to call the upper-lip; the mouth being protracted by this bony part, and lying underneath out of view. This account is confirmed by Dr. Derham; with this difference, that instead of ticking with the upper lip, he observed the insect to draw back its mouth, and beat with its forehead. That author had two death-watches, a male and a female, which he kept alive in a box several months; and could bring one of them to beat whenever he pleased, by imitating its beating. By this ticking noise, he could frequently invite the male to coition with the other. When the male found he got up in vain, he would get off again, beat very eagerly, and then up again; whence the ingenious author concludes those pulsations to be the way whereby these insects woo one another, and find out and invite each other to copulation.

The second kind of death-watch is an insect in appearance quite different from the first. The former only beats seven or eight strokes at a time, and quicker: the latter will beat some hours together without intermission; and his strokes are more leisurely, and like the beat of a watch. This latter is a small greyish insect, much like a louse when viewed with the naked eye.

It is very common in all parts of the house in the summer months. It is very nimble in running to shelter, and shy of beating when disturbed; but will beat very freely before you, and also answer the beating, if you can view it without giving it disturbance, or shaking the place where it lies, &c. The author cannot say whether they beat in

any other thing, but he never heard their noise except in or near paper. As to their noise, the same person is in doubt whether it is made with their heads, or rather snouts, against the paper; or whether it is not made after some such manner as grasshoppers and crickets make their noise. He inclines to the former opinion. The reason of his doubt is, that he observed the animal's body to shake and give a jerk at every beat, but he could scarcely perceive any part of its body to touch the paper. But its body is so small and near the paper, and its motion in ticking so quick, that he thinks it might be, yet he did not perceive it. The ticking, as in the other, he judges to be a wooing act; as having observed another, after much beating, come and make offers to the beating insect; who, after some offers, left off beating, and got upon the back of the other. When they were joined he left off again; and they continued some hours joined tail to tail, like dog and bitch in coition. Whether or not this insect changes its shape, and becomes another animal, he cannot say; though he has some cause to suspect that it becomes a sort of fly. It is at first a minute white egg, much smaller than the nits of lice; though the insect is nearly as big as a louse. In March it is hatched, and creeps about with its shell on. When it first leaves its shell, it is even smaller than its egg; though that is scarce discernible without a microscope. In this state it is perfectly like the mites in cheese. From the mite-state they grow gradually to their mature perfect state. When they become like the old ones, they are at first very small, but run about much more swiftly than before.

DE BENE ESSE, in law signification, is to accept or allow a thing as well done for the present: thus judges frequently take bail, and declarations are frequently delivered, de bene esse, or conditionally, until special or common bail be filed.

DEBENTURE, is a certificate delivered at the custom-house, when the exporter of any goods or merchandize has complied with the regulations prescribed by certain acts of parliament, in consequence of which he is entitled to a bounty or drawback on the exportation. Stealing debentures was made felony by 2 Geo. II. chap. 25. s. 3.

DEBET ET DETINET, are Latin words used in the bringing of writs and actions. And an action shall always be in the debet et detinet, when he who makes a bargain or contract, or lends money to another, or he to whom a bond is made, brings the action against him who is the bounden party to the contract or bargain.

DEBET ET SOLET. If a man sues to recover any right by writ, whereof his ancestor was disseised by the tenant or his ancestor, then he uses only the word debet in his writ; because solet is improper, as his ancestor was disseised, and the custom discontinued: but if he sues for any thing that is now first of all denied, then he uses both these words debet et solet; because his ancestor before him, and he himself usually, enjoyed the thing sued for.

DEBT, a sum due from one person to another, in consequence of work done, goods delivered, or money or other value, for which reimbursement has not been made. The non-payment in these cases is an injury, for which the proper remedy is by action of debt, to compel the performance of the contract, and recover the special sum due. 4 Co. 90.

Actions of debt are now seldom brought but upon special contracts under seal, wherein the sum due is clearly and precisely expressed: for in case of such an action upon simple contract, the plaintiff labours under two difficulties; first, the defendant has here the same advantage as in an action of detinue, that of waging his law, namely, purging himself of the debt by oath, if he thinks proper; secondly, in an action of debt, the plaintiff must recover the whole debt he claims, or nothing at all. For the debt is one single cause of action, fixed and determined: but in an action upon the case, or what is called an indebitatus assumpsit, which is not brought to compel a specific performance of the contract, but to recover damages for its non-performance, these damages are in their nature indeterminate, and will therefore adapt and proportion themselves to the truth of the case which shall be proved, without being confined to the precise demand stated in the declaration. 3 Black. 154.

DEBT, national. See NATIONAL DEBT.

DEBTOR. The gaoler shall not put, keep, or lodge, prisoners for debt, and felons, together in one room or chamber, on pain of forfeiting his office, and treble damages to the party grieved. 22 and 23 C. II. c. 20. But every gaoler ought to keep such prisoner in safe and close custody; safe, that he cannot escape; and close, without conference with others, or intelligence of things abroad. Dalt. c. 170.

DECACHORDON, in antiquity, a musical instrument with ten strings, called by the Hebrews hasur; being almost the same as our harp, of a triangular figure, with a hollow belly, and sounding from the lower part.

DECAGON, in geometry, a plane figure with ten sides and ten angles: it is called a regular decagon, when all the sides and angles are equal.

If we suppose the radius of a circle to be r, then will $\sqrt{\frac{5}{4}r^2} - \frac{1}{2}r$, or $\frac{\sqrt{5}-1}{2} \times r$, be the side of a decagon inscribed in that circle. Again, supposing the side of a decagon to be 1, the area will be 8.69; whence as 1 to 8.69, so is the square of a side of any given decagon to the area of that decagon.

DECALITRON, in antiquity, a coin equivalent to $10\frac{2}{3}$ Attic oboli.

DECANDRIA, in the Linnæan system of botany, a class of plants, the great characteristic of which is, that they have hermaphrodite flowers, with ten stamina in each.

DECAPROTI, decemprimi, in Roman antiquity, officers for gathering the tributes and taxes. The decaproti were also obliged to pay for the dead; or to answer to the emperor for the quota parts of such as died, out of their own estates.

DECEIT is an offence both by common law and by statute. All practices of defrauding, or endeavouring to defraud, another of his right, are punishable by fine and imprisonment, and sometimes pillory, &c. and there is a writ called deceptione, that lies for one who receives injury or damage, &c. A writ of deceit lies against attorneys for losses sustained by their default; also against bakers, brewers, and artificers, for not selling good commodities, or refusing to perform a bargain: in all which cases, they are, by statute, liable to penalties in proportion to their offence.

DECEMPEDA, in antiquity, a rule or rod divided into ten feet, each of which was subdivided into inches, and those into digits; used in measuring of land, and by architects in giving the proper dimensions and proportions to the parts of their buildings.

DECEMVIRI, in Roman antiquity, ten magistrates chosen annually at Rome, to govern the commonwealth instead of consuls, with an absolute power to draw up and make laws for the people. One of the decemviri had all the ensigns and honours of the function, and the rest had the like in their turn, during the year of their decemvirate. In them was vested all the legislative authority ever enjoyed by the kings, or after them by the consuls. The decemviri drew up the laws of the twelve tables, thence called leges decemvirales, which were the whole of the Roman law for a considerable time.

DECENNARY, was originally a district of ten men with their families, the inhabitants whereof living together, were sureties or pledges for each others' good behaviour. See CONSTABLE.

DECEPTIONE, a writ that lies properly against him who deceitfully does any thing in the name of another, for one that receives damage or hurt thereby.

DECIDUOUS, an appellation chiefly used in respect to plants: thus, the calyx or cup of a flower is said to be deciduous, when it falls along with the flower-petals; and, on the contrary, it is called permanent, when it remains after they are fallen. Again, deciduous leaves are those which fall in autumn; in contradistinction to those of the evergreens, which remain all the winter.

DECIES TANTUM, a writ which lies against a juror who has taken money for giving his verdict; called so of the effect, because it is to recover ten times as much as he took. Stat. 98 Edw. III. c. 12 and 13. Decies tantum lies against sheriffs taking a reward for arraying a pannel. 11 H. VI. c. 14. See Vin. Abr. 378 and 382.

DECIMAL ARITHMETIC, the art of computing by decimal fractions. See ARITHMETIC.

DECK of a ship, is a planked floor from stem to stern, upon which the guns lie, and where the men walk to and fro. Great ships have three decks, first, second, and third, beginning to count from the lowermost. Half-deck reaches from the main-mast to the stem of the ship. Quarter-deck is that aloft the steerage, reaching to the round house. Flush-deck is that which lies even in a right line fore and aft, from stem to stern. A rope-deck is made of cordages, interwoven and stretched over a vessel, through which it is easy to annoy an enemy who comes to board her. They are little used but by small vessels, to defend them from privaees. See SHIPBUILDING.

DECLARATION, an exposure in writing, of the grief and complaint of the demandant, or plaintiff, against the defendant or tenant, wherein he is supposed to have done some wrong. And this ought to be plain and certain, because it both impeaches

the defendant, and also compels him to answer to it. Such a declaration in an action real, is termed a count; and it is essential that the count or declaration ought to contain demonstration, declaration, and conclusion; and in the conclusion the plaintiff ought to aver, and offer to prove, his suit, and shew the damages he has sustained by the wrong done him. Declaration must be certain, containing: 1. Such sufficient certainty whereby the court may give a peremptory and final judgment upon the matter in controversy. 2. That the defendant may make a direct answer to the matter contained therein. 3. That the jury, after issue joined, may give a complete verdict thereupon. 4. No blank or space to be left therein. Brown's Annal. 3. By the general rules of law, a plaintiff must declare against a defendant within twelve months after the return of the writ; but by the rules of court, if he does not deliver his declaration within two terms, the defendant may sign judgment of non pros.; though unless he takes such advantage of the plaintiff's neglect, the plaintiff may still deliver a declaration within a year.

Declaration is also used for a confession which the quakers are obliged to make and subscribe, instead of the oaths of supremacy.

Declaration of war, a public proclamation made by the herald at arms to the members or subjects of a state, declaring them to be at war with any foreign power, and forbidding all and every one to aid or assist the common enemy at their peril.

DECLENSION, in grammar, an inflection of nouns according to their cases, as nominative, genitive, dative, &c. It is a different thing in the modern languages, which have not properly any cases, from what it is in the antient Greek and Latin. With respect to languages where the nouns admit of changes either in the beginning, the middle, or ending, declension is properly the expression of all those changes in a certain order, and by certain degrees called cases. With regard to languages where the nouns do not admit of changes in the same number, declension is the expression of the different states a noun is in, and the different relations it has; which difference of relations is marked by particles, as of, to, from, by, &c.

DECLINATION, in astronomy, the distance of any celestial object from the equinoctial, either northward or southward. It is either true or apparent, according as the real or apparent place of the object is considered. See Globes, use of.

Declination of the sea-compass, or needle, is its variation from the true meridian.

DECLINATOR, or Declinatory, an instrument contrived for taking the declinations, inclinations, and reclinations, of planes. It is constructed in the following manner: On a square wooden board, A B C D (Plate Miscel. fig. 33) describe a semicircle A E D; and divide the two quadrants A E and E D into 90° each, beginning from E, as in the figure: then having fixed a pin in the centre F, fit a ruler H I upon the same, moveable thereon, with a box and needle K (fig. 34). In order to take the declination of a plane, apply the side A D to the plane proposed, as M N (fig. 35.); and move the ruler F G, with the compass G, about the centre F, till the needle rest upon the line of the magnetical meridian of the place: if the ruler cut the quadrant in E, the plane is either directly northern or southern; but if it cut between D and E, the plane declines to the west, and if between A and E, to the east, by the quantity of the angle G F E.

Would you take the inclinations and reclinations of planes with this instrument, instead of the ruler and needle, a thread with a plummet is fitted on a pin in the centre F; then the side B C of the declinator A B C D (fig. 36.) being applied to the proposed plane, as I L, if the plum-line F G cut the semicircle A E D in the point E, the plane is horizontal; or if it cut the quadrant E D, in any point at G, then will E F G be the angle of inclination: lastly, if applying the side A B to the plane, the plummet cut E, the plane is vertical. Hence if the quantity of the angle of inclination be compared with the elevation of the pole and equator, it is easily known whether the plane be inclined or reclined. See Inclination and Reclination.

DECOCTION, in pharmacy, the boiling simples or other drugs, in order to extract their virtues for some medicinal purpose. See Pharmacy.

DECOMPOSITION, in chemistry. Caloric not only increases the bulk of bodies, and changes their state from solids to liquids, and from liquids to elastic fluids, but its action decomposes a number of bodies. Thus when ammonia is heated to redness, it is resolved into azotic and hydrogen gases. Alcohol, by the same heat, is converted into carbureted hydrogen and water.

1. This decomposition is in many cases owing to the difference between the volatility of the ingredients of a compound. Thus when weak spirits, or a combination of alcohol and water, are heated, the alcohol separates, because it is more volatile than the water.

2. In general, the compounds which are but little or not at all affected by heat, are those bodies which have been formed by combustion. Thus water is not decomposed by any heat which can be applied to it; neither are sulphuric, phosphoric, or carbonic acids.

3. Almost all the combinations into which oxygen enters without having occasioned combustion, are decomposable by heat. This is the case with nitric acid, hyperoxymuriatic acid, and many of the metallic oxides.

4. All bodies that contain combustibles as component parts are decomposed by heat. Perhaps the metallic alloys are exceptions to this rule; at least it is not in our power to apply a temperature high enough to produce their decomposition, except in a few cases.

5. When two combustible ingredients and likewise oxygen occur together in bodies, they are always very easily decomposed by heat. This is the case with the greater number of animal and vegetable substances. But it is unnecessary to enlarge any farther on this subject, as no satisfactory theory can be given.

DECOUPLE', in heraldry, the same as uncoupled: thus a chevron decouplé, is a chevron wanting so much of it towards the point, that the two ends stand at a distance from one another, being parted and uncoupled.

DECREE, in civil law, is a determination that the emperor pronounces upon hearing a particular cause between plaintiff and defendant.

Decrees of councils, are the laws made by them, to regulate the doctrine and policy of the church.

Decree is a sentence pronounced by the lord chancellor in the court of chancery, and it is equally binding upon the parties as a judgment in a court of law.

By the laws of England, a decree (notwithstanding any contempts thereof) shall not bind the goods or moveables, but only charge the persons. Chan. Rep. 193.

If a decree is obtained and inrolled, so that the cause cannot be reheard, then there is no remedy but by bill of review; which must be on error appearing on the face of the decree, or on matters subsequent thereto, as a release or a receipt discovered since. 3 M'm's. Rep. 371.

DECOY, in naval affairs, a stratagem employed by a ship of war to betray a vessel of inferior force into an incautious pursuit, till she has drawn her within the range of her cannon, or what is called within gunshot. It is usually performed by painting the stern and sides in such a manner as to disguise the ship, and represent her either much smaller and of inferior force, or as a friend to the hostile vessel, which she endeavours to ensnare, by assuming the emblems and ornaments of the nation to which the stranger is supposed to belong. When she has provoked the adversary to chase, in hopes of acquiring a prize, she continues the decoy, by spreading a great sail, as endeavouring to escape; at the same time that her course is considerably retarded by an artful alteration of her trim till the enemy approaches. Decoying is also performed to elude the chase of a ship of a superior force in a dark night, by throwing out a lighted cask of pitch into the sea, which will burn for a considerable time and misguide the enemy. Immediately after the cask is thrown out, the ship changes her course, and may easily escape, if at any tolerable distance from the foe.

Decoy, in military affairs, a stratagem to carry off the enemy's horses in a foraging party, or from the pasture; to execute which, you must be disguised, and mix on horseback in the pasture, or amongst the foragers on that side on which you propose to fly: you must then begin by firing a few shots, which are to be answered by such of your party as are appointed to drive up the rear, and are posted at the opposite extremity of the pasture or foraging-ground; after which they are to gallop from their different stations towards the side fixed for the flight, shouting and firing all the way: the horses, being thus alarmed and provoked by the example of others, will break loose from their pickets, throw down their riders and the trusses, and setting up a gallop, will naturally direct their course to the same side; insomuch, that if the number of them was ever so great, you might lead them in that manner for several leagues together:

when you are got into some road, bordered by a hedge or ditch, you must stop as gently as possible, and without making any noise; the horses will then suffer themselves to be taken without any opposition. It is called in French haraux, and count Saxe is the only author that mentions it.

DECOY, among fowlers, a place made for catching wild-fowl. A decoy is generally made where there is a large pond surrounded with wood, and beyond that a marshy and uncultivated country: if the piece of water is not thus surrounded, it will be attended with noises and other accidents which may be expected to frighten the wild-fowl from a quiet haunt, where they mean to sleep, in the day-time, in security. If these noises or disturbances are wilful, it has been held that an action will lie against the disturber. As soon as the evening sets in, the decoy rises, and the wild-fowl feed during the night. If the evening is still, the noise of their wings during their flight is heard at a very great distance, and is a pleasing, though rather melancholy, sound. This rising of the decoy in the evening is, in Somersetshire, called *radding*.

The decoy-ducks are fed with hempseed, which is thrown over the screens in small quantities, to bring them forwards into the pipes or canals, and to allure the wild-fowl to follow, as this seed is so light as to float. There are several pipes, as they are called, which lead up a narrow ditch that closes at last with a funnel-net. Over these pipes (which grow narrower from their first entrance) is a continued arch of netting suspended on hoops. It is necessary to have a pipe or ditch for almost every wind that can blow, as upon this circumstance it depends which pipe the fowl will take to; and the decoy-man always keeps on the leeward side of the ducks, to prevent his scent reaching their sagacious nostrils. All along each pipe, at intervals, are placed screens made of reeds, which are so situated that it is impossible the wild-fowl should see the decoy-man before they have passed on towards the end of the pipe, where the purse-net is placed. The inducement to the wild-fowl to go up one of these pipes is, because the decoy-ducks trained to this lead the way, either after hearing the whistle of the decoy-man, or enticed by the hemp-seed; the latter will dive under water, whilst the wild-fowl fly on and are taken in the purse.

It often happens, however, that the wild-fowl are in such a state of sleepiness and dozing, that they will not follow the decoy-ducks. Use is then generally made of a dog that is taught his lesson: he passes backwards and forwards between the reed-screens (in which are little holes, both for the decoy-man to see, and the little dog to pass through); this attracts the eye of the wild-fowl, who, not choosing to be interrupted, advance towards the small and contemptible animal, that they may drive him away. The dog all the time, by the direction of the decoy-man, plays among the screens of reeds, nearer and nearer the purse-net; till at last perhaps the decoy-man appears behind a screen, and the wild-fowl not daring to pass by him in return, nor being able to escape upwards on account of the net-covering, rush on into the purse-net. Sometimes the dog will not attract their attention if a red handkerchief, or something very singular, is not put about him.

The general season for catching fowl in decoys is from the end of October till February; the taking of them earlier is prohibited by an act 10 Geo. II. c. 32, which forbids it from June 1st to October 1st, under the penalty of five shillings for each bird destroyed within that space.

The Lincolnshire decoys are commonly let at a certain annual rent, from five to twenty pounds a year; and there is one in Somersetshire that pays thirty pounds. The former contribute principally to supply the markets in London. Amazing numbers of ducks, wigeons, and teal, are taken: by an account of the number caught a few winters past, in one season, and in only ten decoys, in the neighbourhood of Wainfleet, it appeared to amount to 31,200, in which are included several other species of ducks. It is also to be observed, that in the above particular a couple of wigeon or teal are reckoned but as one, and consequently sell, but at half-price of the ducks.

It was customary formerly to have in the fens an annual driving of the young ducks before they took wing. Numbers of people assembled, who beat a vast tract, and forced the birds into a net placed at the spot where the sport was to terminate. Thus a hundred and fifty dozens have been taken at once; but this practice, being supposed detrimental, has been abolished by act of parliament.

DECRETE, in the law of Scotland, a final decree or judgment of the lords of session, from which an appeal lies only to parliament, where we find them but too often reversed, a circumstance surely not much to the honour of the august bench whence the appeal lies.

DECREMENT, in heraldry, signifies the wane of the moon from the full to the new.

DECREPITATION. See CHEMISTRY.

DECRETAL, in the canon-law, a letter of a pope determining some point or question in the ecclesiastical law. The decretals composed the second part of the canon-law. The first genuine one acknowledged by all the learned as such, is a letter of pope Siricius, written in the year 385, to Himerus bishop of Tarragona in Spain, concerning some disorders which had crept into the churches of Spain. Gratian published a collection of decretals, containing all the ordinances made by the popes till the year 1150. Gregory IX. in 1227, following the example of Theodosius and Justinian, formed a constitution of his own; collecting into one body all the decisions, and all the causes, which served to advance the papal power: which collection of decretals was called the Pentateuch, because it contained five books.

DECURIO, in Roman antiquity, a commander of ten men in the army, or the chief of a decury.

DECUSSORIUM a surgeon's instrument, which, by pressing gently on the dura matter, causes an evacuation of the pus collected between the cranium and the before-mentioned membrane, through the perforation made by the trepan.

DEDIMUS POTESTATEM, in law, a commission granted to one or more persons, for the forwarding and dispatching some act appertaining to a judge, or some court; as to take answers in chancery, depositions of witnesses in a cause depending in that court, and levy a fine in the common pleas, &c. where persons live in the country, or cannot travel.

DEED, is a written contract sealed and delivered. It must be written before the sealing and delivery, otherwise it is no deed; and after it is once formally executed by the parties, nothing can be added or interlined; and therefore, if a deed is sealed and delivered with a blank left for the sum, which the obligee fills up after sealing and delivery, this will make the deed void.

A deed must be made by parties capable of contracting, and upon a good consideration; and the subject must be legally and formally set out.

The formal parts of a deed are:

The premises, containing the number, names, additions, and titles, of the parties.

The habendum, which determines the estate and interest intended to be granted by the deed.

The reddendum, or reservation, whereby the grantor reserves to himself something out of the thing granted.

A condition, which is a clause of contingency, on the happening of which the estate granted may be defeated.

The warranty, whereby the grantor, for himself and heirs, warrants or secures to the grantee the estate so granted.

The covenants, which are clauses of agreement contained in the deed, whereby the contracting parties stipulate for the truth of certain facts, or bind themselves to the performance of some specific acts.

The conclusion, which mentions the execution and date of the deed, or the time of its being given or executed, either expressly, or with reference to some day and year before mentioned.

A deed may be either an indenture or a deed-poll. The former derives its name from being indented or cut in an uneven manner, so as to tally with the counterparts, of which there ought to be as many as there are parties; the latter, or deed-poll, of which there is one part only, is so called from its being polled or shaved quite even.

A deed is the most solemn act of law which a man can perform with respect to the disposition of his property, and therefore no person shall be permitted to aver or prove any thing against his own deed.

All the parts of a deed indented, constitute in law but one entire deed; but every part has the same operative force as all the parts taken together; and they are deemed the mutual or reciprocal acts of either of the parties, who may be bound by either part of the same, and the words of the indenture may be considered as the words of either party.

If the name of baptism or surname of a party to a deed be mistaken, as John for Thomas, &c. this has been held to be dangerous. 2 Bulst. 70.

But any mistake as spelling, &c. not deviating from the substance of the deed, will not render it void.

If a man gets another name in common esteem than his right name, any deed made to him under such name will be valid.

Every deed must be founded upon good

and sufficient consideration; not upon an usurious contract, nor upon fraud or collusion, either to deceive bona fide purchasers, or just and lawful creditors; any of which considerations will vacate the deed, and subject the parties to forfeiture, and in some cases to imprisonment.

A deed also without any consideration is void, and is construed to enure only to the benefit of the party making it.

Considerations may be express or implied. An express consideration, is where a man contracts to do a certain act for a certain sum of money, or other equivalent act; and an implied consideration is, when it may be enforced by law; thus if a person does any work, or receives any goods from another, the law implies a consideration, which it will enforce although there was no specific agreement for remuneration.

A deed must be written upon the proper stamps prescribed by the legislature, otherwise it cannot be given in evidence. See STAMPS.

The written matter of a deed must be set forth in a legal and orderly manner, so that there are words sufficient to explain the meaning of the parties, and at the same time to bind them to the execution of their contract; and of this sufficiency the courts of law are to determine. Although it is not indeed absolutely necessary in law, to have all the formal words which are usually drawn out in deeds, provided there are sufficient words legally and clearly to explain the meaning of the parties; yet as these formal or orderly parts are calculated to convey the meaning of the parties in the most clear, distinct, and effectual manner, and have been well considered and sanctioned by the wisdom of successive ages, it is prudent not to depart from them without good reason, and the most urgent necessity.

The force and effect which the law of England gives to a deed under seal, cannot exist, unless such deed is executed by the party himself, or by another for him, in his presence, or with his direction; or in his absence by an agent authorised so to do, by another deed also under seal, and in every such case the deed must be made and executed in the name of the principal.

A deed takes effect only from the day of delivery: and therefore if it has no date, or a date impossible, the delivery will in all cases ascertain the date of it; and if another party seals the deed, yet if the party delivers it himself, he adopts the sealing and signing, and by such delivery makes them both his own.

The delivery of a deed may be alleged at any time after the date; but unless it is sealed, and regularly delivered, it is no deed.

Another requisite of a deed is, that it be properly witnessed or attested; the attestation is, however, necessary rather for preserving the evidence, than as intrinsically essential to the validity of the instrument.

There are four principles adopted by the courts of law for the exposition of deeds, viz.

That they be beneficial to the grantee, or person in whose favour they are intended to operate.

That where the words may be employed to some interest, they shall not be void.

That the words be construed according to the meaning of the parties, and not otherwise; and the intent of the parties shall be carried into effect, provided such intent can possibly stand at law.

That they are to be consonant to the rules of law; and deeds shall be expounded reasonably without injury to the grantor, and to the greatest advantage of the grantee. Deeds are further expounded upon the whole; and if the second part contradicts the first, such second part shall be void; but if the latter expounds or explains the former, which it may, both parts may stand.

In construction of law, the first deed and the last will stand in force; and where a deed is by indenture between parties, none can have an action upon such deed, but the person who is a party to it. In a deed-poll however, one person may covenant with another who is not a party, to do certain acts, for the nonperformance of which he may bring his action.

Where a man justifies title under any deed, he ought to produce that deed; if it be alleged in pleading, it must be produced to the court, that it may determine whether the deed contains sufficient words to make a valid contract.

DEED-POLL, is a deed polled, or shaved, quite even; in contradistinction from an indenture, which is cut unevenly, and answerable to another writing that comprehends the same words. A deed-poll is properly single, or of one part, and is intended for the use of feoffee, grantee, or lessee; an indenture always consists of two or more parts and parties. Every deed that is pleaded, shall be intended to be a deed-poll, unless it is alleged to be indented.

DEEMSTERS, or *demsters*. All controversies in the Isle of Man are decided without process, writings, or any charges, by certain judges chosen yearly from among themselves, called deemsters; there being two of them for each division of the island: they sit as judges in all courts, either for life or property; and with the advice of the twenty-four keys, declare what is law in uncommon emergencies.

DEEP SEA-LINE, or *dip sea-line*, in the sea-language, a small line to sound with: some a hundred and fifty fathoms long, with a hollow plummet at the head, and tallow put into it, to bring up stones, gravel, sand, shells, and the like, from the bottom, in order to know the differences of the ground; which being entered from time to time in their books, by comparing of observations, they guess by their soundings, &c. what coasts they are on, though they cannot see land.

DEER. See CERVUS.

DEER-STEALERS are punishable by various laws and statutes, made from time to time. Any offender convicted of deer-stealing, before a judge of gaol-delivery, may be transported, by 5 Geo. I. cap. xxviii. And it is felony for persons to appear armed and disguised in a forest or park, and hunt or kill the deer, by 6 Geo. I. cap. xxii.

DE ESSENDO QUIETEM DE TOLONIO, in law, a writ which lies for those who, by privilege, are free from the payment of toll.

DE EXPENSIS MILITUM, in law, an antient writ, commanding the sheriff to levy the expences of a knight of the shire, for his attendance in parliament, being four shillings a day. There is also another writ of the like nature, *de expensis civium & burgenisum*, for levying two shillings a day for the expences of every citizen and burgess of parliament.

DE FACTO, something actually in fact, or existing; in contradistinction to de jure, where a thing is only so in justice, but not in fact: as a king de facto is a person that is in actual possession of a crown, but has no legal right to the same; and a king de jure is the person who has just right to the crown, though he is out of possession of it.

DEFAMATION, the offence of speaking slanderous words of another; and where any person circulates any report injurious to the credit or character of another, the party injured may bring an action to recover damages proportioned to the injury he has sustained; but it is incumbent upon the party to prove he sustained an injury, to entitle him to damages. In some cases however, as for words spoken which by law are in themselves actionable, as calling a tradesman a bankrupt, cheat, or swindler, &c. there is no occasion to prove any particular damage; but the plaintiff must be particularly attentive to state words precisely as they were spoken, otherwise he will be nonsuited.

DEFAULT, is commonly taken for nonappearance in court at a day assigned. If a plaintiff make default in appearance in a trial at law, he will be nonsuited; and where a defendant makes a default, judgment shall be had against him by default.

DEFAULT IN CRIMINAL CASES. If an offender, being indicted, appears at the capias, and pleads to issue, and is let to bail to attend his trial, and then makes default; here the inquest, in case of felony, shall never be taken by default: but a capias ad audiendum juratum shall issue, and if the party is not taken, an exigent; and if he appear on that writ, and then makes default, an exigi facias de novo may be granted: but where, upon the capias on exigent, the sheriff returns cepi corpus, and at the day has not his body, the sheriff shall be punished; but no new exigent awarded, because in custody of record. 2 H. H. 202.

DEFAULT OF JURORS. If jurors make default in their appearance for trying of causes, they shall forfeit their issues, unless they have any reasonable excuse proved by witnesses, in which case the justices may discharge the issues for default. Stat. 35 H. VIII. c. 6.

DEFEASANCE, a condition relating to a deed; as to a recognizance or statute, which being perfomed by the recognizor, the deed is defeated, and made void, as if it had never been done. The difference between a proviso or a condition in a deed, and a defeasance, is, that the condition is annexed to, or inserted in, the deed or grant; and a defeasance is a deed by itself concluded and agreed on between the parties, and having relation to another deed.

DEFENCE, in fortification, all sorts of works that cover and defend the opposite posts; as flanks, casemates, parapets, and faussebrays. It is almost impossible to fix the miner to the face of a bastion, till the defences of the opposite one are ruined, that is,

till the parapet of its flank is beaten down, and the cannon, in all parts that can fire upon that face which is attacked, are dismounted.

DEFENCE, *line of*, a supposed line drawn from the angle of the curtin, or from any other part in the curtin, to the flanked angle of the opposite bastion. A line of defence represents the flight of a musquet-ball from the place where the musqueteers stand, to scour the face of the bastion, and ought never to exceed the reach of a musquet. It is either fichant or rasant; the first is when it is drawn from the angle of the curtin to the flanked angle; the last when it is drawn from a point in the curtin, rasing the face of the bastion.

DEFENCE, in law, signifies a plea, or what the defendant ought to make after the plaintiff's count, or declaration, viz. that he defends all the wrong, force, and damages, where and when he ought, &c. If the defendant would plead to the jurisdiction, he must omit the words "where and when he ought;" and if he would shew any disability in the plaintiff, and demand judgment if the plaintiff shall be answered, then he ought to omit the defence of the damage. There is a full defence usually in personal actions.

DEFERENTIA VASA. See ANATOMY.

DEFICIENT NUMBERS, those whose parts or multiples added together fall short of the integer, of which they are the parts: such is 8, its parts, 1, 2, 4, making only 7. See the article NUMBER.

DEFILE, in fortification, a straight narrow passage, through which a company of horse or foot can pass only in file, by making a small front; so that the enemy may take an opportunity to stop their march, and to charge them with so much the more advantage, as those in the front and rear cannot reciprocally come to the relief of one another.

To DEFILE, is to reduce an army to a small front, in order to march through a defile.

DEFINITION, in rhetoric, is described by Cicero, a short comprehensive explanation.

The special rules for a good definition are these: 1. A definition must be universal, or adequate, that is, it must agree to all the particular species or individuals that are included under the same idea. 2. It must be proper, and peculiar to the thing defined, and agree to that alone. These two rules being observed will always render a definition reciprocal with the thing defined, that is, the definition may be used in the place of the thing defined: or they may be mutually affirmed concerning each other. 3. A definition should be clear and plain; and indeed it is a general rule concerning the definition both of names and things, that no word should be used in either of them which has any difficulty in it, unless it has been before defined. 4. A definition should be short, so that it must have no tautology in it, nor any words superfluous. 5. Neither the thing defined, nor a mere synonymous name should make any part of the definition.

DEFLAGRATION. See CHEMISTRY.

DEFOLIATION (from *de*, and *folium* a leaf), the fall of the leaves; a term opposed to frondescentia, the annual renovation of the leaves, produced by the unfolding of the buds in spring. Most plants in cold and temperate climates shed their leaves every year: this happens in autumn, and is generally announced by the flowering of the common meadow-saffron. The term is only applied to trees and shrubs; for herbs perish down to the root every year, losing stem, leaves, and all.

All plants do not drop their leaves at the same time. Among large trees, the ash and the walnut, although latest in unfolding, are soonest divested of them: the latter seldom carries its leaves above five months. On the oak and hornbeam the leaves die and wither as soon as the cold commences; but remain attached to the branches till they are pushed off by the new ones, which unfold themselves in the following spring. These trees are doubtless a kind of half evergreens: the leaves are probably destroyed only by cold; and perhaps would continue longer on the plant but for the force of the spring-sap, joined to the moisture.

In mild and dry seasons the lilac, privet, yellow jessamine of the woods, and maple of Crete, preserve their leaves green until spring, and do not drop them till the new leaves are beginning to appear. The fig-tree, and many other trees that grow between the tropics, are of this particular class of evergreens. The trees in Egypt, says doctor Hasselquist, cast their leaves in the end of December and the beginning of January, having young leaves ready before all the old ones are fallen off; and to forward this operation of nature few of the trees have buds: the sycamore and willow, indeed, have some, but with few and quite loose stipulæ or scales. Nature did not imagine buds so necessary in the southern as in the northern countries: this occasions a great difference between them.

Lastly, some trees and shrubs preserve their leaves constantly through the whole year, and are not in the least influenced by clemency or inclemency of seasons. Such are the firs, juniper, yew, cedar, cypress, and many other trees, hence denominated evergreens. These preserve their old leaves a long time after the formation of the new, and do not drop them at any determinate time. In general, the leaves of evergreens are harder, and less succulent, than those which are renewed annually. These trees are generally natives of warm climates; as the alaternuses of France and Italy, the evergreen oak of Portugal and Suabia.

The following table, respecting the mean times in which different trees shed their leaves, is founded upon observation:

Gooseberry-tree and bladder-sena,	Generally shed their leaves about	Oct. 1.
Walnut and ash,		— 15.
Almond-tree, horse-chesnut, and lime-tree,		— 20.
Maple, hazel-nut, black poplar, and aspen-tree,		— 25.
Birch, plane-tree, mountain osier, false acacia, pear, and apple-tree,		Nov. 1.
Vine, mulberry, fig, sumac, and angelica-tree,		— 10.
Elm-tree and willow,		— 15.
Apricot and elder-trees,		— 20.

It deserves to be remarked, that an evergreen tree grafted upon a deciduous, determines the latter to retain its leaves. This observation is confirmed by repeated experiments, particularly by grafting the laurel, or cherry-bay, an evergreen, on the common cherry; and the ilex, or evergreen oak, on the oak.

DEFORCEMENT, in law, the casting any one out of his land, or a withholding of lands and tenements by force from the right owner.

DEFORCEMENT, in the law of Scotland, is used for resisting, or offering violence to the officers of the law, while they are actually employed in the exercise of their functions, by putting its orders and sentences in execution. The punishment of this crime is confiscation of moveables, joined with some arbitrary punishment, as fine, imprisonment, banishment, or corporal pains, according to the degree of violence, and other circumstances which aggravate the crime.

DEFORCEOR, in law, is a person that overcomes and casts forth another from his lands and tenements by force, and differs from a disseisor on this account: 1. That a man may be disseised without force. 2. A man may deforce another that never was in possession; as where many have a right to lands, as common heirs, and one of them enters and keeps out the rest. A deforceor likewise differs from an intruder, who is made by a wrongful entry only into land, &c. void of a possessor, whilst a deforceor is he that holds out against the right heir.

DEFTERDAR, or *deftardar*, in the Turkish and Persian polity, an officer of state, answering to our lord treasurer, who appoints deputies in every province.

DEGLUTITION, in medicine, the act of swallowing the food: performed by means of the tongue driving the aliment into the œsophagus, which, by the contraction of the sphincter, protrudes the contents downwards.

DEGRADATION, a punishment of delinquent ecclesiastics. The canon-law distinguishes it into two sorts: the one summary, by word only; the other solemn, by stripping the person degraded of those ornaments and rights which are the ensigns of his order or degree. The canonists likewise distinguish degradation from deposition; understanding by the latter the depriving a man of his clerical orders, but by the former only the removing him from his rank or degree. In the antient primitive church, degrading a clergyman was reducing him to the state and communion of laymen. The full import of the phrase, however, is the depriving him of his orders, and reducing him to the simple condition of a layman; a punishment inflicted for several offences, as adultery, theft, or fraud: and clergymen thus reduced were seldom allowed to recover their antiént station, except upon some great necessity, or very pressing reason. Degradation in the Romish church is attended with a great deal of ceremony. The offender is stripped of his pontifical vestments, and at the same time the person who degrades him scrapes his fingers with a knife, or a little piece of glass, declaring to him that the power of conse-

crating, blessing, and sanctifying, is taken from him: he erases the marks of the tonsure in the same manner, which a barber completes by shaving his head all over.

DEGRADATION, in painting, expresses the lessening the appearance of distant objects in a landscape, in the same manner as they would appear to an eye placed at that distance from them. See the articles PERSPECTIVE and PAINTING.

DEGRADED CROSS, in heraldry, a cross divided into steps at each end, diminishing as they ascend towards the centre, called by the French peronnée.

DEGREE, in geometry, a division of a circle, including a three hundred and sixtieth part of its circumference.

Every circle is supposed to be divided into three hundred and sixty parts, called degrees, and each degree divided into sixty other parts, called minutes; each of these minutes being again divided into sixty seconds, each second into thirds, and each third into fourths, and so on. See the articles MINUTE, SECOND, &c.

By this means no more degrees or parts are reckoned in the greatest circle than in the least that is; and therefore if the same angle at the centre be subtended by two concentrical arches, as many degrees are counted in the one as in the other; for these two arches have the same proportion to their whole peripheries.

A degree of the meridian on the surface of the globe is variously determined by various observers.

Ptolemy fixes the degree at $68\frac{2}{3}$ Arabic miles, counting $7\frac{1}{2}$ stadia to a mile. The Arabs themselves, who made a computation of the diameter of the earth, by measuring the distance of two places under the same meridian, in the plains of Sennar, by order of Almamon, make it only 56 miles. Kepler, determining the diameter of the earth by the distance of two mountains, makes a degree 13 German miles; but his method is far from being accurate. Snell, seeking the diameter of the earth from the distance between two parallels of the equator, finds the quantity of a degree by one method 57,064 Paris toises, or 342,384 feet; by another method 57,057 Paris toises, or 342,342 feet. The mean between which two numbers M. Picard found by mensuration, in 1669, from Amiens to Malvoisin, the most certain; and he makes the quantity of a degree 57,060 toises, or 342,360 feet. However, M. Cassini, at the king's command, in the year 1700, repeated the same labour; and measuring the space of 6° 18′, from the observatory at Paris, along the meridian, to the city of Collioure in Roussillon, that the greatness of the interval might diminish the error, found the length of the degree equal to 57,292 toises, or 343,742 Paris feet, amounting to 365,184 English feet.

And with this account nearly agrees that of our countryman Norwood, who, about the year 1635, measured the distance between London and York, and found that distance 905,761 English feet; the difference of latitude being 2° 28′, hence he determined the quantity of one degree at 367,196 English feet, or 57,300 Paris toises, or 69 miles, 288 yards.

M. Cassini, the son, completed the work of measuring the whole arc of the meridian through France, in 1718. For this purpose he divided the meridian of France into two arcs, which he measured separately. The one from Paris to Collioure gave him 57,097 toises; the other, from Paris to Dunkirk, 56,960; and the whole arc from Dunkirk to Collioure 57,060; the same as M. Picard's.

M. Muschenbroek, in 1700, resolving to correct the errors of Snell, found by particular observations, that the degree between Alcmaer and Bergen-op-zoom contained 57,033 toises.

Messieurs Maupertuis, Clairaut, Camus, Monnier, and Outheir, of France, were sent on a northern expedition; and began their operations, assisted by M. Celsus, an eminent astronomer of Sweden, in Swedish Lapland, in July 1736, and finished them by the end of May following. They obtained the measure of that degree, whose middle point was in lat. 66° 20′ north, and found it 57,439 toises, when reduced to the level of the sea. About the same time another company of philosophers was sent to South America, viz. messieurs Godin, Bouguer, and Condamine, of France, to whom were joined don Jorge Juan, and don Antonio de Ulloa, of Spain. They left Europe in 1735, and began their operations in the province of Quito, in Peru, about October 1736, and finished them, after many interruptions, about eight years after. The Spanish gentlemen published a separate account, and assigned for the measure of a degree of the meridian at the equator 56,768 toises. M. Bouguer makes it 56,753 toises, when reduced to the level of the sea; and M. Condamine states it at 56,749 toises.

M. La Caille, being at the Cape of Good Hope in 1752, found the length of a degree of the meridian in lat. 33° 18′ 30″ south, to be 57,037 toises. In 1755 father Boscovich found the length of a degree in lat. 43° north to be about 56,972 toises, as measured between Rome and Rimini, in Italy. In the year 1740 messrs. Cassini and La Caille again examined the former measures in France; and after making all the necessary corrections, found the measure of a degree, whose middle point is in lat. 49° 22′ north, to be 57,074 toises; and in the lat. of 45° it was 57,050 toises.

In 1764 F. Beccaria completed the measurement of a portion of the meridian near Turin; from which it is deduced that the length of a degree, whose middle lat. is 44° 44′ north, is 57,024 Paris toises.

At Vienna three degrees of the meridian were measured; and the medium for the latitude of 47° 40′ north may be taken at 57,091 Paris toises. See an account of this measurement in the Phil. Trans. 1768.

Finally, in the same volume is an account of the measurement of a part of the meridian in Maryland and Pennsylvania, North America, 1766, by messieurs Mason and Dixon; from which it follows that the length of a degree whose middle point is 39° 12′ north, was 363,763 English feet, or 56,904½ Paris toises.

Hence from the whole we may collect the following table of the principal measures of a degree in different parts of the earth, as measured by different persons, viz.

Mean Latitude.	Length of a Degree in Paris Toises.	Names of the Measurers.	Years of Measurement.
66° 20′ N	57422	Maupertuis, &c.	1736 and 1737
49 23 N	57074	Maupertuis, &c. and Cassini	1739 and 1740
47 40 N	57091	Liesganig	1766
45 0 N	57028	Cassini	1739 and 1740
44 44 N	57069	Beccaria	1760 to 1764
43 0 N	56979	Boscovich and Le Maire	1752
39 12 N	56888	Mason & Dixon	1764 to 1768
0 0 N	56750	Bouguer and Condamine	1736 to 1744
33 18 S	57037	La Caille	1752

The method of obtaining the length of a degree of the terrestrial meridian, is to measure a certain distance upon it by a series of triangles, whose angles may be found by actual observation, connected with a base whose length may be taken by an actual survey or otherwise; and then to observe the different altitudes of some star at the two extremities of that distance, which gives the difference of latitude between them: then, by proportion, as this difference of latitude is to one degree, so is the measured length to the length of one degree of the meridian sought. This method was first practised by Erastosthenes, in Egypt.

DEGREE *of longitude*, is the space between two meridians that make an angle of 1° with each other at the poles; the quantity or length of which is variable, according to the latitude, being every where as the cosine of the latitude; viz. as the cosine of one lat. is to the cosine of another, so is the length of a degree in the former lat. to that in the latter; and from this theorem is computed the following table of the length of a degree of long. in different latitudes, supposing the earth to be a globe.

Note. This table is computed on the supposition, that the degrees of the equator are equal to those of the meridian at the medium latitude of 45°, which length is $69\frac{1}{15}$ English miles.

The expressions latitude and longitude are borrowed from the antients, who happened to be acquainted with a much larger extent of earth in the direction east and west than in that of north and south; the former of which therefore passed, with them, for the length of the earth, or longitude; and the latter for the breadth, or shorter dimension, viz. the latitude.

Deg. lat.	English miles.	Deg lat.	English miles.	Deg. lat.	English miles.
0	69·07	31	59·13	61	33·45
1	69·06	32	58·51	62	32·40
2	69·03	33	57·87	63	31·33
3	68·97	34	57·20	64	30·24
4	68·90	35	56·51	65	29·15
5	68·81	36	55·81	66	28·06
6	68·62	37	55·10	67	26·96
7	68·48	38	54·37	68	25·85
8	68·31	39	53·62	69	24·73
9	68·15	40	52·85	70	23·60
10	67·95	41	52·07	71	22·47
11	67·73	42	51·27	72	21·32
12	67·48	43	50·46	73	20·17
13	67·21	44	49·63	74	19·02
14	66·95	45	48·78	75	17·86
15	66·65	46	47·93	76	16·70
16	66·31	47	47·06	77	15·52
17	65·98	48	46·16	78	14·35
18	65·62	49	45·26	79	13·17
19	65·24	50	44·35	80	11·98
20	64·84	51	43·42	81	10·79
21	64·42	52	42·48	82	9·59
22	63·97	53	41·53	83	8·41
23	63·51	54	40·56	84	7·21
24	63·03	55	39·58	85	6·00
25	62·53	56	38·58	86	4·81
26	62·02	57	37·58	87	3·61
27	61·48	58	36·57	88	2·41
28	60·93	59	35·54	89	1·21
29	60·35	60	34·50	90	0·00
30	59·75				

Our theory of navigation being founded upon an hypothesis of the degrees of latitude being all equal, must of consequence be very erroneous, wherefore we here insert a table of the degrees in the quadrantal arch of the meridian, both in the sphere and spheroid, with their differences, as calculated by the Rev. Mr. Murdoch.

A TABLE of Arches of the Meridian to the Spheroid and Sphere, in minutes of the Equator.

Degr.	Spheroid.	Sphere.	Diff.
1	58·7	60·0	1·3
2	117·3	120·0	2·7
3	176·0	180·0	4·0
4	234·7	240·0	5·3
5	293·4	300·0	6·6
6	352·1	360·0	7·9
7	410·8	420·0	9·2
8	469·6	480·0	10·4
9	528·3	540·0	11·7
10	587·0	600·0	13·0
11	645·8	660·0	14·2
12	704·5	720·0	15·5
13	763·3	780·0	16·7
14	822·1	840·0	17·9
15	880·9	900·0	19·1
16	939·7	960·0	20·3
17	998·5	1020·0	21·5
18	1057·4	1080·0	22·6
19	1116·3	1140·0	23·7
20	1175·2	1200·0	24·8

A TABLE of Arches of the Meridian to the Spheroid and Sphere, in minutes of the Equator.

Degr.	Spheroid.	Sphere.	Diff.
21	1234·1	1260·0	25·9
22	1293·0	1320·0	27·0
23	1352·0	1380·0	28·0
24	1411·0	1440·0	29·0
25	1470·0	1500·0	30·0
26	1529·0	1560·0	31·0
27	1588·1	1620·0	31·9
28	1647·2	1680·0	32·8
29	1706·3	1740·0	33·7
30	1765·5	1800·0	34·5
31	1824·7	1860·0	35·3
32	1883·9	1920·0	36·1
33	1943·1	1980·0	36·9
34	2002·4	2040·0	37·6
35	2061·7	2100·0	38·3
36	2121·0	2160·0	39·0
37	2180·4	2220·0	39·6
38	2239·8	2280·0	40·2
39	2299·2	2340·0	40·8
40	2358·7	2400·0	41·3
41	2418·2	2460·0	41·8
42	2477·7	2520·0	42·3
43	2537·3	2580·0	42·7
44	2596·8	2640·0	43·2
45	2656·6	2700·0	43·4
46	2716·4	2760·0	43·6
47	2776·2	2820·0	43·8
48	2835·9	2880·0	44·1
49	2895·5	2940·0	44·5
50	2955·3	3000·0	44·7
51	3015·2	3060·0	44·8
52	3075·0	3120·0	44·9
53	3135·0	3180·0	45·0
54	3194·9	3240·0	45·1
55	3254·9	3300·0	45·1
56	3314·9	3360·0	45·1
57	3370·0	3420·0	45·0
58	3435·1	3480·0	44·9
59	3495·2	3540·0	44·8
60	3555·3	3600·0	44·7
61	3615·5	3660·0	44·5
62	3675·7	3720·0	44·3
63	3736·0	3780·0	44·0
64	3796·2	3840·0	43·8
65	3856·5	3900·0	43·5
66	3916·8	3960·0	43·2
67	3977·2	4020·0	42·8
68	4037·5	4080·0	42·5
69	4097·9	4140·0	42·1
70	4158·4	4200·0	41·6
71	4218·8	4260·0	41·2
72	4279·3	4320·0	40·7
73	4339·8	4380·0	40·2
74	4400·3	4440·0	39·7
75	4460·8	4500·0	39·2
76	4521·3	4560·0	38·7
77	4581·9	4620·0	38·1
78	4642·5	4680·0	37·5
79	4703·1	4740·0	36·9
80	4763·7	4800·0	36·3

A TABLE of Arches of the Meridian to the Spheroid and Sphere, in minutes of the Equator.

Degr.	Spheroid.	Sphere.	Diff.
81	4824·3	4860·0	35·7
82	4884·9	4920·0	35·1
83	4945·5	4980·0	34·5
84	5006·2	5040·0	33·8
85	5066·8	5100·0	33·2
86	5127·5	5160·0	32·5
87	5188·2	5220·0	31·8
88	5248·8	5280·0	31·2
89	5309·5	5340·0	30·5
90	5370·2	5400·0	29·8

DEGREE, in the civil and canon law, denotes an interval in kinship by which proximity and remoteness of blood are computed. In computing degrees of consanguinity, the rule of the civil law is universal, either in the direct or collateral, otherwise called the oblique line; for as many generations as there are, so many degrees there are likewise. But in the canon law, the rule is different for the oblique line. And here a distinction is made between the equal and the unequal oblique line. In the first case the rule is, as many degrees as the persons allied are distant from the common stock, so many they are distant from one another. In the other case the rule is, as many degrees as the most remote is distant from the common stock, so many the persons are distant from one another. Hence the sister of a person's grandfather by the civil law is distant from that person in the fourth degree; whereas, by the canon law, she is only in the third degree.

DEGREE, *theoretical*, in music, the difference of position or elevation between any two notes. There are conjunct and disjunct degrees. When two notes are situated so as to form the interval of a second, the degree is said to be conjunct; and when they form a third, or any greater interval, the degree is called disjunct.

DEGREE, in universities, denotes a kind of rank or distinction conferred on the students or members as a testimony of their proficiency in the arts or sciences, and entitling them to certain privileges. The degrees are much the same in all universities, but the laws and the previous discipline or exercise differ. The degrees are bachelor, master, and doctor; instead of which last, in some foreign universities, they have licentiate.

With regard to obtaining degrees at Oxford and Cambridge, matters are nearly on the same footing.

To pass bachelor of divinity, the candidate must have been seven years master of arts: he must have opposed a bachelor of divinity act, and preached before the university once in Latin and once in English.

DELEGATES, court of, is so called, because by stat. 26 H. VIII. c. 19, the judges are delegated by the king's commission under the great seal, to hear and determine appeals in the three following cases: 1. Where a sentence is given in any ecclesiastical cause by the archbishop or his official. 2. When a sentence is given in any

ecclesiastical cause in the places exempt. 3. When a sentence is given in the admiral's court, in suits civil and marine, by order of the civil law. This commission is usually filled with lords spiritual and temporal, judges of the courts at Westminster, and doctors of the civil law. 4 Inst. 339.

DELEGATION, in the civil law, is a kind of nomination, by which a debtor appoints one that is debtor to him, to answer a creditor in his place. This delegation differs from transferring, or translation, in this; that three persons intervene in a delegation, viz. the creditor, the debtor, and a third indebted to the debtor; whereas in a transfer, it is enough that the transferer and transferee be present.

DELF, from to delve, or dig, denotes a quarry or mine, where either stone or coal is dug; but is more particularly used for the veins of coal lying under ground, before it is dug up. A delf, or delve of coals, also denotes a certain quantity when dug.

DELF, in heraldry, is by some supposed to represent a square rod or turf, and to be so called from delving, or digging.

DELFT *ware*, a kind of pottery of baked earth, covered with an enamel or white glazing, which gives it the appearance and neatness of porcelain. Some kinds of this enamelled pottery differ much from others, either in their sustaining sudden heat without breaking, or in the beauty and regularity of their forms, of their enamel, and of the painting with which they are ornamented. In general, the fine and beautiful enamelled ware, which approaches the nearest to porcelain in external appearance, is at the same time that which least resists a brisk fire. Again, those which sustain a sudden heat are coarse, and resemble common pottery.

The basis of this pottery is clay, which is mixed, when too fat, with such a quantity of sand, that the earth shall preserve enough of its ductility to be worked, moulded, and turned easily; and yet that its fatness shall be sufficiently taken from it, that it may not crack or shrink too much in drying or in baking. Vessels formed of this earth must be dried very gently, to avoid cracking. They are then to be placed in a furnace, to receive a slight baking, which is only meant to give them a certain consistence or hardness. And lastly, they are to be covered with an enamel or glazing, which is done by putting upon the vessel thus prepared the enamel, which has been ground very fine, and diluted with water.

As vessels on which the enamel is applied, are but slightly baked, they readily imbibe the water in which the enamel is suspended, and a layer of this enamel adheres to their surface. These vessels may then be painted with colours composed of metallic calces, mixed and ground with a fusible glass. When they are become perfectly dry, they are to be placed in the furnace, included in cases of baked earth called seggars, and exposed to a heat capable of fusing uniformly the enamel which covers them. The heat given to fuse the enamel being much stronger than that which was applied at first to give some consistence to the ware, is also the heat necessary to complete the baking of it. The furnace and colours used for painting this ware, are the same as those employed for porcelain. Delft-ware is not so much used in England as formerly.

DELIAC, or DELIAN PROBLEM, a problem much celebrated in the writings of the antients, concerning the duplication of the cube. See CUBE.

DELIMA, in botany, a genus of plants belonging to the polyandria monogynia class, with an elongated style: it has no flower-petals; the cup consists of five leaves; the fruit is a bivalve capsule, and contains two seeds. There is one species.

DELIRIUM. See MEDICINE.

DELIVERY. See MIDWIFERY.

DELPHINIUM, DOLPHIN-FLOWER, or LARKSPUR, a genus of the trigynia order, in the polyandria class of plants, and in the natural method ranking under the 26th order, multisiliquæ. There is no calyx; the petals are five; the nectarium bifid, and horned behind; the siliquæ three or one. There are 11 species; four are cultivated in gardens. Two of these are annual, and two perennial: they are herbaceous plants of upright growth, rising from 18 inches to four feet in height, garnished with finely divided leaves, and terminated by long spikes of pentapetalous flowers, of blue, red, white, or violet colours. One annual species, the consolida, is found wild in several parts of Britain, and grows in corn-fields. According to Dr. Withering, the expressed juice of the petals, with a little alum, makes a good blue ink. The seeds are acrid and poisonous. When cultivated, the blossoms often become double. Sheep and goats eat this plant; horses are not fond of it; cows and swine refuse it.

DELPHINUS, or DOLPHIN, a genus of fishes belonging to the order of cete. There are three species:

1. The delphinus, delphis, or dolphin. Historians and philosophers seem to have contended who should invent most fables concerning this fish. It was consecrated to the gods, was celebrated in the earliest time for its fondness of the human race, was honoured with the title of the sacred fish, and distinguished by that of philanthropist. At present the appearance of this fish, and the porpesse, are far from being esteemed favourable omens by the seamen; for their boundings, springs, and frolics, in the water, are held to be certain signs of an approaching gale. It is from their leaps out of that element that they assume a temporary form that is not natural to them; but which the old painters and sculptors have almost always given them. A dolphin is scarcely ever exhibited by the antients in a straight shape, but almost always incurvated: such are those on the coin of Alexander the Great, which is preserved by Belon, as well as on several other pieces of antiquity; and the poets describe them much in the same manner. The natural shape of the dolphin, however, is almost straight, the back being very slightly incurvated, and the body slender; the nose is long, narrow, and pointed, not much unlike the beak of some birds, for which reason the French call it l'oie-de-mer. It has in all 40 teeth, 21 in the upper jaw and 19 in the lower; a little above an inch long, conic at their upper end, sharp-pointed, bending a little in. They are placed at small distances from each other; so that when the mouth is shut, the teeth of both jaws lock into one another; the spout-hole is placed in the middle of the head; the tail is semilunar; the skin is smooth, the colour of the back and sides dusky, the belly whitish; it swims with great swiftness, and its prey is fish. It was formerly reckoned a great delicacy. This species of dolphin, however, must not be confounded with that to which seamen give the name; the latter being quite another kind of fish, the coryphæna hippuris of Linnæus, and the dorado of the Portuguese.

2. The phocæna, or porpesse. This species is found in vast multitudes in all parts of the British seas; but in greatest numbers at the time when fish of passage appear, such as mackarel, herrings, and salmon, which they pursue up the bays with the same eagerness as a dog does a hare. In some places they almost darken the sea, as they rise above water to take breath: but porpesses not only seek for prey near the surface, but often descend to the bottom in search of sand-eels and sea-worms, which they root out of the sand with their noses. Their bodies are very thick towards the head, but grow slender towards the tail. The nose projects a little, is much shorter than that of the dolphin, and is furnished with very strong muscles, which enable it the readier to turn up the sand. The colour of the porpesse is generally black, and the belly whitish; but they sometimes vary. In the river St. Lawrence there is a white kind; and Dr. Borlase, in his voyage to the Scilly isles, observed a small species of cetaceous fish, which he calls thornbacks, from their broad and sharp fin on the back. Some of these were brown, some quite white, others spotted: but whether they were only a variety of this fish, or whether they were small grampuses, which are also spotted, we cannot determine. The porpesse is remarkable for the vast quantity of fat that surrounds the body, which yields a great quantity of excellent oil. From this, or from their rooting like swine, they are called in many places seahogs. This was once a royal dish, even so late as the reign of Henry VIII. and from its magnitude must have held a very respectable station at the table; for in a household-book of that prince, extracts of which are published in the third volume of the Archæologia, it is ordered, that if a porpesse should be too big for a horse-load, allowance should be made to the purveyor. This fish continued in vogue even in the reign of Elizabeth.

3. The orca, or grampus, is found from the length of 15 feet to that of 25. It is remarkably thick in proportion to its length; one of 18 feet being in the thickest place 10 feet diameter. With reason then did Pliny call this "an immense heap of flesh armed with dreadful teeth." It is extremely voracious; and will not even spare the porpesse, a congenerous fish. It is said to be a great enemy to the whale, and that it will fasten on it like a dog on a bull, till the animal roars with pain. The nose is flat, and turns up at the end. There are 30 teeth in each jaw; those before are blunt, round, and slender; the farthest sharp and thick: between each is a space adapted to receive the teeth of the opposite jaw when the mouth is closed. The spout-hole is in the top of the neck. The colour of the back is black, but on each shoulder is a large white spot; the sides marbled with black and white; the belly of a snowy whiteness. These fishes sometimes appear on our coasts, but are found in much

greater numbers off the North Cape in Norway, whence they are called the north-capers. These and all other whales are observed to swim against the wind; and to be much disturbed, and tumble about with unusual violence, at the approach of a storm.

4. The leucas, a species called by the Germans and Russians "white fish." The body is oblong, and rather slender, tapering from the back (which is a little elevated) to the tail. It is quite destitute of the dorsal fin. Its length is from 12 to 18 feet. It makes great use of its tail in swimming; for it bends that part under it, as a lobster does its tail, and works it with such force as to dart along with the rapidity of an arrow. It is common in all the Arctic seas, and forms an article of commerce, being taken on account of its blubber. They are numerous in the Gulph of St. Lawrence, and go with the tide as high as Quebec. There are fisheries for them and the common porpesse in that river. A considerable quantity of oil is extracted, and of their skin is made a sort of morocco leather, thin, yet strong enough to resist a musket-ball. They are frequent in the Dwina and the Oby, go in small families from five to ten, and advance pretty far up the rivers in pursuit of fish. They are usually caught in nets, but are sometimes harpooned. They bring only one young at a time, which is dusky; but they grow white as they advance in age, the change first c mmencing on the belly. They are apt to follow boats, as if they were tamed, and appear extremely beautiful by their resplendent whiteness.

DELPHINUS, in astronomy, a constellation of the northern hemisphere, whose stars in Ptolemy's and Tycho's catalogues are ten, and in Mr. Flamsteed's eighteen.

DEMAIN, or DEMESNE, signifies the king's lands appertaining to him in property. No common person has any demains simply understood, for we have no land (that of the crown only excepted) which is not holden of a superior, as all depends either mediately, or immediately, on the crown: thus, when a man in pleading would signify his land to be his own, he says that he is or was seized thereof in his demain as of fee; whereby he means, that although his land is to him and his heirs for ever, yet it is not true demain, but depending upon a superior lord, and holden by service, or rent in lieu of service, or by both service and rent.

DEMAND, calling upon a man for any sum or sums of money, or any other thing due. By the several statutes of limitation, debts, claims, &c. are to be demanded and made in time, or they will be lost in law. There are two manners of demands, the one in deed, the other in law: in deed, as in every precipe there is an express demand; in law, as in every entry in land, distress for rent, taking or seizing of goods, and such like acts, which may be done without any words, are demands in law. Where there is a duty which the law makes payable on demand, no demand need be made; but if there is no duty till demand, in such case there must be a demand to make the duty. 1 Lit. 432. Upon a penalty the party need not make a demand; as if a man be found to pay 20*l.* on such a day, and in default thereof to pay 40*l.* the 40*l.* must be paid without demand. If a person release to another all demands, this is the best release the releasee can have, as he is thereby excluded from all actions, duties, and seizures.

DEMI-CADENCE, in music, a term used in church-music. When the last or final sound of a verse in a chant is on the key-note, it is called a full or complete cadence; but if it fall on any other than the key-note, as the fifth or third, it takes the name of an imperfect or demi-cadence.

DEMI-CULVERIN, a piece of ordnance usually 4½ inches bore, 2700 pound weight, 10 feet long, and carrying point-blank 175 paces.

DEMI-CULVERIN *of the least size*, is 4¼ inches bore, 10 feet long, and 2000 pounds weight. It carries a ball of four inches diameter, and of nine pounds weight, and its level range is 174 paces.

DEMI-CULVERIN *of the largest sort*, is 4¾ inches bore, 10⅓ feet long, and weighs 3000 pounds. It carries a ball 4½ inches diameter, weighing 12 pounds 11 ounces, point-blank 178 paces.

DEMI-DITONE, a minor third.

DEMI-GORGE, in fortification, is that part of the polygon which remains after the flank is raised, and goes from the curtin to the angle of the polygon. It is half of the vacant space or entrance into a bastion.

DEMI-LUNE, *half-moon*, in fortification, an outwork consisting of two faces and two little flanks, frequently built before the angle of a bastion, and sometimes also before the curtin, though now much disused.

DEMI-TONE, an interval of half a tone. See SEMITONE.

DEMISEMIQUAVER, a note of the ninth degree of length, reckoning from the large, or of the sixth degree of length, reckoning from the semibreve, or longest note now in common use, of which it is a thirty-second part.

DEMISE, is applied to an estate in fee simple, fee tail, or for term of life, and so it is commonly taken in many writs, 2 Inst. 483. The king's death is in law termed the demise of the king to his successor.

DEMONSTRATION, in logic, a series of syllogisms, all the premises of which are either definitions, self-evident truths, or propositions already established.

DEMURRAGE, is an allowance made to the master of a ship by the merchants, for being detained in port longer than the time appointed and agreed for his departure. The rate of this allowance is generally settled in the charterparty. It is now firmly established, that the claim of demurrage ceases as soon as the ship is cleared out, and ready for sailing. Jameson *v.* Lawrie, house of lords, Nov. 10, 1796.

DEMURRER, is a kind of pause or stop, put to the proceedings of an action upon a point of difficulty, which must be determined by the court before any farther proceedings can be had therein. He that demurs in law confesses the facts to be true, as stated by the opposite party; but denies that by the law arising upon those facts, any injury is done to the plaintiff, or that the defendant has made out a lawful excuse. As if the matter of the plaintiff's declaration be insufficient in law, then the defendant demurs to the declaration: if, on the other hand, the defendant's excuse or plea be invalid, the plaintiff demurs in law to the plea; and so on in every other part of the proceedings, where either side perceives any material objection in point of law, upon which he may rest his case. 3 Black. 314. General demurrer being entered, it cannot be afterwards waved, without leave of the court; but a special demurrer generally may, unless the plaintiff has lost a term, or the assizes, by the defendant's demurring. Impey, i. K. B. And upon either a general or special demurrer, the opposite party avers it to be sufficient, which is called a rejoinder in demurrer, and then the parties are at issue in point of law; which issue in law, or demurrer, is argued by counsel on both sides; and if the points are difficult, then it is argued openly by the judges of the court, and if they, or the majority of them, concur in opinion, accordingly judgment is given; but in case of great difficulty, they may adjourn into the exchequer-chamber, where it shall be argued by all the judges. 1 Inst. 71.

DEMURRER *to evidence*, is where a question of law arises thereon; and because juries, by direction of the court, usually find a doubtful matter specially, demurrers upon evidence are now seldom used. 5 Rep. 104.

DEMURRER *to indictments*. If a criminal joins issue upon a point of law in an indictment or appeal, allowing the fact to be true as laid therein, this is a demurrer in law, by which he insists that the fact as stated is no felony or treason, or whatever the crime is alleged to be. But demurrer to indictments are seldom used, since the same advantages may be taken upon a plea of not guilty; or afterwards in arrest of judgment, where the verdict has established the fact. 4 Black. 333.

DEN, a syllable which added to the names of places shews them to be situated in valleys, or near woods; as Tenterden, in Kent.

DENARIUS, in Roman antiquity, the chief silver-coin among the Romans, worth in our money about seven-pence three farthings. As a weight, it was the seventh part of a Roman ounce.

DENARIUS *tertius comitatus*, a third part of the profits of county-courts. When these courts had superior jurisdictions, before others were erected, two parts of the profits went to the king, and a third part to the earl of the county.

DENDRITES, or ARBORIZATIONS. This appellation is given to figures of vegetables which are frequently observed in fossil substances. They are of two kinds; the one superficial, the other internal.

The first are chiefly found on the surface of stones, and between the strata and in the fissures of those of a calcareous nature. Stones of a similar kind, when very compact, sometimes also exhibit internal arborizations; such are the marbles of Hesse, of Angersburg in Prussia, and of Baden-Dourlach on the left bank of the Rhine. Several of these dendrites bear a striking resemblance to the poplar; while others exhibit the straight stem, pyramidal form, and pendant branches, of the fir. Some specimens of dendrites found in Switzerland, represent, in a very surprising manner, plantations of willows; and many of them are so beautiful, as really to appear the work of art.

The superficial dendrites are mostly of a brown, changing gradually to a reddish yellow. The internal dendrites are of a deep

black. The most esteemed dendrites are those found in agates; and more particularly in the sardonyx, cornelian, and other precious stones, brought from the East, and which are commonly denominated Moka stones. The Oriental agates display the most varied and beautiful forms. Sometimes they exhibit the appearance of terraces covered with different species of moss, interspersed with plants of the fern-tribe, having large leaves, and the outlines exquisitely finished: the colours are likewise extremely brilliant.

These colours are supposed to be owing to metallic oxides; others are of a different, and perhaps of a bituminous nature. The first are dissolved, and wholly disappear, on immersing the stone in any of the mineral acids; while the others resist their action in a greater or less degree. Some naturalists suppose that dendrites are owing to metallic solutions, or other colouring matters, finding their way through the pores of the stone, and being afterwards forced into the smallest fissures by a mechanism similar to that by which fluids ascend in capillary tubes. But a careful examination of the structure and disposition of dendrites, must evince this opinion to be merely hypothetical; as the principal branches, in diverging from the common stem, observe a great regularity; they are nearly parallel to one another on each side, and always proceed in one direction, like the stems and branches of a real tree; a circumstance inconsistent with the supposition of capillary attraction, which extends equally in all directions.

The same observation is equally applicable to micaceous dendrites, which are frequently found in the granite of the Pyrenees. These dendrites, which greatly resemble bunches of ostrich feathers, are certainly neither the effect of chance, nor of capillary attraction, but of a principle much more active than that by which simple crystallization is produced.

A species of metallic dendrites is sometimes formed by means of fire. For example, some kinds of copper ore, on being subjected to the action of heat, and afterwards withdrawn from the furnace, appear covered with brilliant yellow spots, some inches in diameter, exactly resembling in form lichens growing on rocks. These arborizations, which are of pure copper, are very singular; being composed of vertical threads, of about a line in height, united in fasciculi, like so many small sheaves standing upright by the side of each other. The finest specimens of this kind of metallic dendrites are produced at a foundry on the Oural mountains. The ore with which this foundry is supplied, is brought from the mines of Touria, where the most beautiful native copper in a state of vegetation yet known, is to be found. In whatever manner we may be inclined to account for this wonderful phenomenon, it should seem, from the above fact, that the same cause which produces these arborizations in the mine, must likewise produce the same effect after the ore has been subjected to the action of fire. See Plate Nat. Hist. figs. 160 and 161.

DENEB, an Arabic term, signifying tail, used by astronomers to denote several fixed stars. Thus deneb elecet, signifies the bright star in the lion's tail; deneb adigege, that in the swan's tail; &c.

DENDROMETER, from δενδρον a tree, and μετρεω I measure, an instrument invented by Messrs. Duncombe and Whittel, for which they obtained a patent, so called from its use in measuring trees. It consists of a semicircle A, plate Miscel. fig. 37 and 38, divided into two quadrants, and graduated from the middle; upon the diameter B there hangs a plummet L for fixing the instrument in a vertical position; there are also a chord D parallel to the diameter, and a radius E passing at right angles through the diameter and chord. From a point on the radius hangs an altimeter C, between the chord and diameter, to which are fixed a small semicircle G, and a screw, to confine it in any position. The altimeter, which is contrived to form the same angle with the radius of the instrument as the tree forms with the horizon, is divided from its centre both ways into forty equal parts; and these parts are again divided into halves and quarters. Upon the small semicircle G, on which is accounted the quantity of the angle made by the altimeter and radius, are expressed degrees from 60 to 120, being 30 on each quadrant. The radius is numbered with the same scale of divisions as the altimeter. There is also a nonius to the small semicircle, which shows the quantity of an angle to every five minutes. On the back of the instrument the stock M (fig. 38) of the sliding piece is confined to the axis N, which moves concentrically parallel to the elevation index F on the opposite side, to which it is fixed. This index is numbered by a scale of equal divisions with the altimeter and radius. At the end of the index is a nonius, by which the angles of elevation above, or of depression below, the horizon, measured upon the semicircle of the instrument, are determined to every five minutes. There is also a groove in the radius, that slides across the axis by means of a screw I, working between the chord and semicircle of the instrument; and this screw is turned by the key O. Upon the stock M is a sliding piece P, that always acts at right angles with the altimeter, by means of a groove in the latter. To the shank of the sliding piece is affixed a moveable limb Q, which forms the same angle with the altimeter as the bough forms with the body or trunk of the tree. This limb may be of any convenient length, divided into equal parts of the same scale with all the foregoing divisions. At the extremity of the fixed axis, on a centre, an index R, with telescopic sights, works horizontally upon the moveable limb of the sliding piece. Upon this horizontal index R may be fixed a small quadrant T, described with any convenient radius from the centre on which the index moves, and divided into 90 degrees, beginning at a right line drawn from the centre at right angles with the fiducial edge of the said index; and upon the extremity of the axis is a nonius, whereby to determine the quantity of an angle upon the quadrant every five minutes. There are also two small semicircular arches S, S, serving to keep the sights in a parallel position, each containing an equal number of degrees. Upon these arches is measured the angle subtending a side equal to the difference of the altitudes of the observed objects above the plane of the horizon, and whose base is the nearest distance between the perpendiculars in which these objects are situated. The dendrometer is fitted to a theodolite; and may be used either with or without it, as occcasion requires.

The principal use of this instrument is for measuring the length and diameter of any tree, perpendicular or oblique to an horizontal plane, or in any situation of the plane on which it rests, or of any figure, whether regular or irregular, and also the length and diameter of the boughs, by mere inspection; and the inventors of it have calculated tables, annexed to their account of the instrument itself, by the help of which the quantity of timber in a tree is obtained without calculation, or the use of the sliding rule. The instrument is rectified by setting it in a perpendicular position, by means of the plummet, and screwing it to the staff; then the altimeter is placed in the exact position of the tree, whether perpendicular, reclining, or inclining, and screwed fast. If the tree stands on level ground, the horizontal distance from the tree to the axis of the instrument is measured with a tape-line, and the radius is moved with the key till that distance be cut upon it by the inside of the diameter; but if the ground be slanting, the distance from the tree to the instrument is measured, and the elevation index is moved till the point of the tree from which the distance was measured is seen through the sights, and there screwed fast; and the radius is moved backwards or forwards with the key, till this distance is cut upon the elevation index by the perpendicular line of the altimeter; and the horizontal line will be marked upon the radius by the inside of the diameter. In order to obtain the length of the tree, the elevation index is first moved downwards, till the bottom of the tree cut by the horizontal wires is observed through the sights, and the feet and inches marked by the index upon the altimeter below the point of sight or horizontal line are noted down; then the index is moved upwards till the part to which you would measure, cut by the horizontal wires, is seen, and the feet and inches marked on the altimeter above the point of sight are noted: these two quantities added together give the exact length of the tree, which is inserted in a field-book. For the girth of the tree, the circumference in that part where the horizontal distance was taken, is measured with the tape-line; and a sixth part of this circumference is added to the distance on the radius, which was before cut by the inside of the diameter, because the tape-line, in taking the distance, cannot be applied to the centre of the body of the tree; then the elevation index is lowered to that part of the tree of which the diameter is to be taken, and screwed fast. Set the moveable limb of the sliding piece quite straight, and the edge of the horizontal index upon the first division of it. Turn the whole instrument about to the left hand, till you see through the sights the left side of the tree cut exactly by the perpendicular wires; then, the instrument being fixed, move the sights only upon the sliding piece, till you see the right side of the tree cut also by the perpendicular wires; and you will find the true diameter marked by the horizontal index upon the sliding piece, which is to be entered in a distinct column of the field-book.

For the boughs. Let the distance on the radius be now reduced to its former quantity,

and the elevation index moved upwards till the bough is seen through the sights, and screwed fast. Set the moveable part of the sliding piece in a position parallel to the bough, and the edge of the horizontal index on the first division of it. Turn the whole instrument about till you see through the sights the shoot of the bough close to the trunk cut by the perpendicular wires; then move the sights till you see the other end of the bough cut by the said wires, and note the feet and inches marked by the horizontal index on the moveable limb of the sliding piece, which will give the true length of the bough to be inserted in the field-book. And the girth of the bough may be obtained by directing the sight to that part of it whose girth is desired; then by moving the elevation index downwards till you see the under side of the bough cut by the horizontal wires, and there noting the feet and inches marked by the said index on the altimeter; after which, let the elevation index be moved upwards, till the upper side of the bough cut by the horizontal wires is seen; the feet and inches marked upon the altimeter are to be noted as before. The former quantity subtracted from the latter will give the true diameter of the bough, which is entered in the field-book. The true solidity both of the body of the tree and of the boughs may be found from the diameter and lengths in tables calculated for this purpose.

The dendrometer, fitted to a theodolite, may be applied to measuring the heights and distances of objects, accessible or inaccessible, whether situated in planes parallel or oblique to the plane in which the instrument is placed. It may be also used for taking all angles, whether vertical, horizontal, or oblique, in any position of the planes in which they are formed; and thus for facilitating the practical operations of engineering, land-surveying, levelling, mining, &c. and for performing the various cases of plane trigonometry without calculation, of which the inventors have subjoined to their account of this instrument many examples.

DENIER, a small French copper coin, of which 12 make a sol. There were two kinds of deniers, the one tournois, the other parisis, whereof the latter was worth a fourth part more than the former.

DENIZEN. A denizen is an alien-born, who has obtained letters patent whereby he is constituted an English subject. A denizen is in a middle state, between an alien and a natural-born or naturalized subject, partaking of the nature of both. He may take lands by purchase; or derive a title by descent through his parents or any ancestor, though they be aliens. By stat. 25 Geo. II. c. 39, no natural-born subject shall derive a title through an alien parent or ancestor, unless he be born at the time of the death of the ancestor, who dies seized of the estate which he claims by descent; with this exception, that if a descent shall be cast upon a daughter of an alien, it shall be divested in favour of an after-born son, and in case of an after-born daughter or daughter only, all the sisters shall be coparceners. The children born previous to the denization of their parent cannot inherit by descent, whilst those of a foreigner naturalized are in every respect entitled to the same privileges as British subjects. See ALIEN.

DENOMINATOR, in arithmetic, a term used in speaking of fractions. The denominator of a fraction is the number below the line, shewing into how many parts the integer is supposed to be divided. Thus in the fraction $\frac{3}{4}$, the number 4 shews that the integer is divided into four parts. So in the fraction $\frac{a}{b}$, b is the denominator.

DENOMINATOR *of a ratio*, is the quotient arising from the division of the antecedent by the consequent. Thus 8 is the denominator of the ratio 40 : 5, because 40 divided by 5 gives 8 for a quotient. It is also called the exponent of a ratio.

DENSITY *of bodies*, is that property directly opposite to rarity, whereby they contain such a quantity of matter under such a bulk. Accordingly, a body is said to have double or triple the density of another body, when their bulk being equal, the quantity of matter in the one is double or triple the quantity of matter in the other. See GRAVITY.

DENSITY *of the planets*. In homogeneous, unequal, spherical bodies, the gravities on their surfaces are as their diameters when the densities are equal, or the gravities are as the densities when the bulks are equal; therefore, in spheres of unequal magnitude and density, the gravity is in the compound ratio of the diameters and densities, or the densities are as the gravities divided by the diameters. Knowing therefore the diameters of the planets by observation and comparison, and the gravities at their surface by means of the revolution of the satellites, the relation of their densities becomes known. And as the mean density of the earth is found to be about $4\frac{1}{2}$ times that of water (Philos. Trans. 1778), hence the densities of the planets, with respect to water, become known, and are as below.

	Densities.
Water	1
The Sun	$1\frac{2}{15}$
Mercury	$9\frac{1}{6}$
Venus	$5\frac{11}{15}$
The Earth	$4\frac{1}{2}$
Mars	$3\frac{2}{7}$
The Moon	$3\frac{1}{11}$
Jupiter	$1\frac{1}{24}$
Saturn	$0\frac{13}{32}$
Herschel	$0\frac{99}{100}$.

As it is not likely that any of these bodies are homogeneal, the densities here determined are supposed to be the mean densities.

DENTALIUM, in natural history, a genus of the vermes testacea order. The shell has no hinge, and is formed only of one piece. The figure approaches to cylindric or conic; and is sometimes crooked, sometimes straight, sometimes closed at one end, sometimes open at both; its inhabitant is called nereis. There are eight species. The name dentalium has been given this shell, from the great resemblance it has to the dentes canini of quadrupeds. Several species of it frequent the shores of Italy, Portugal, &c. Among us they are found fossil in clay-pits, some smooth, some striated, but in much greater abundance in the mountains of France and Italy.

DENTARIA, *toothwort* or *tooth-violet*, a genus of the siliquosa order, in the tetradynamia class of plants, and in the natural method ranking under the 39th order, siliquosæ. The siliqua parts with a spring, and the valvules roll spirally backwards; the stigma is emarginated, the calyx closing longitudinally. There are four species, hardy perennials; producing annual stalks 12 or 18 inches high, adorned with many-lobed leaves, and spikes of quadrupetalous cruciform flowers of a red or purple colour. They delight in shady places, and are propagated either by seeds or parting the roots.

DENTELLA, a genus of the monogynia order, in the pentandria class of plants. The calyx is a five-parted perianthium, with small subulated leaves; the stamina five short subulated filaments; the antheræ small; the pericarpium a globular bilocular capsule; the seeds egg-shaped, and very numerous. There is one species, a native of New Caledonia.

DENTILES, or DENTILS. See ARCHITECTURE.

DENTITION, the breeding, or cutting, the teeth in children. Among all the disorders which afflict children, there are none that generate such grievous symptoms as difficult dentition. About five or six months after birth, the teeth generally begin to make their appearance: first, the incisores, or fore-teeth; next, the canini, or dog-teeth; and lastly, the molares, or grinders. About the seventh year there come a new set; and at twenty-one the two inner grinders, called dentes sapientiæ, or teeth of wisdom. See ANATOMY, and MEDICINE.

DENUNCIATION, a solemn publication or promulgation of any thing. All vessels of enemies are lawful prize, after denunciation or proclamation of war. The design of the denunciation of excommunicated persons is, that the sentence may be the more fully executed by the person's being more known.

DEODAND, is where any moveable thing inanimate, or beast animate, moves or causes the death of any reasonable creature, by mischance, without the will or fault of himself, or of any person. 3 Inst. 57. Formerly wherever the thing which was the occasion of a man's death was in motion at the time, not only that part thereof which immediately wounded him, but all things which moved together with it, and helped to make the wound more dangerous, were forfeited also. 1 Haw. 66. But juries have lately determined very differently. As these forfeitures seem to have been originally founded in the superstition of an age of ignorance, they are now discountenanced in Westminster-hall. Fost. 266.

DE ONERANDA PRO RATA PORTIONIS, is a writ that lies where one is distrained for a rent, that ought to be paid by others proportionably with him.

DEPARTURE from a plea or matter, is where a man pleads a plea in bar of an action, which being replied to, he in his rejoinder shews another matter contrary to his first plea: this is called a departure from his bar. It may also be applied to a plaintiff, who in his replication shews new matter from his declaration. Plow. Com. 7, 8. Co. 2. par. fo. 147.

DEPARTURE, in navigation, is the easting or westing of a ship in respect of the meridian it departed or sailed from; or it is the difference of longitude, either east or west, between the present meridian the ship is under, and that where the last reckoning or

observation was made. This departure, any where but under the equator, must be counted according to the number of miles in a degree proper to the parallel the ship is under. The departure, in plane and Mercator's sailing, is always represented by the base of a right-angled plane triangle, where the course is the angle opposite to it, and the distance sailed is the hypothenuse; the perpendicular or other leg being the difference of latitude. And then the theorem for finding it, is always this: as radius, is to the sine of the course, so is the distance sailed, to the departure sought.

DEPORTATION, a sort of banishment used by the Romans, whereby some island or other place was allotted to a criminal for the place of his abode, with a prohibition not to stir out of the same on pain of death.

DEPOSIT, among civilians, something that is committed to the custody of a person, to be kept without any reward, and to be returned again on demand. Deposit is distinguished into simple and judiciary.

DEPOSITION. Proof in the high court of chancery is by the depositions of witnesses; and the copies of such, regularly taken and published, are read as evidence at the hearing. For the purpose of examining witnesses in or near London, there is an examiner's office appointed; but for such as live in the country, a commission to examine witnesses is usually granted to four commissioners, two named on each side, or any three or two of them, to take the depositions there. And if the witnesses reside beyond sea, a commission may be had to examine them there, upon their own oaths; and if foreigners, upon the oaths of two skilful interpreters. The commissioners are sworn to take the examinations truly, and without partiality, and not to divulge them till published in the court of chancery; and their clerks are also sworn to secresy. The witnesses are compellable by process of subpœna, as in the courts of common law, to appear and submit to examination; and when their depositions are taken, they are transmitted to the court with the same care that the answer of a defendant is sent. 3 Black. 445.

DEPOT, any particular place in which military stores are deposited for the use of an army. In a more extensive sense, it means several magazines collected together for that purpose. It also signifies an appropriated fort, or place, for the reception of recruits, or detached parties, belonging to different regiments. The barracks near Maidstone are depots for the British cavalry, and Chatham is allotted to the infantry. During hostilities, the greatest attention should be given to preserve the several depots which belong to the fighting army. Hence the line of operation should be invariably connected with them; or rather no advance should be made upon that line, without the strictest regard being paid to the one of communication.

DEPOT is also used to denote a particular place at the tail of the trenches, out of the reach of the cannon of the place; where the troops generally assemble who are ordered to attack the outworks, or support the troops in the trenches, when there is reason to imagine the besieged intend making a vigorous sally.

DEPOT likewise means a temporary magazine for forage, for fascines, gabions, tools, and every other thing necessary for the support of an army, or for carrying on a siege.

DEPRESSION *of the pole*. When a person sails or travels towards the equator, he is said to depress the pole; because as many degrees as he approaches nearer the equator, so many degrees will the pole be nearer the horizon. This phenomenon arises from the spherical figure of the earth. When a star is under the horizon, it is termed the depression of that star under the horizon. The altitude or depression of any star is an arch of the vertical intercepted between the horizon and that star.

DEPRESSION *of the visible horizon*, or *dip of the horizon*, denotes its sinking or dipping below the true horizontal plane, by the observer's eye being raised above the surface of the sea; in consequence of which the observed altitude of an object is by so much too great.

Thus, the eye being at E, the height AE above the surface of the earth, whose centre is C; then EH is the real horizon, and E*h* the visible one, below the former by the angle HE*h*, by reason of the elevation AE of the eye.

To compute the depression or dip of the horizon.—In the right-angled triangle CE*h* (Pl. Miscel. fig. 39), are given C*h*, the earth's radius = 21000000 feet, and the hypothenuse CE = the radius increased by the height AE of the eye; to find the angle C, which is = the angle HE*h*, or depression sought;

As C*h* : CE : : radius : sec. ∠C,
or As CE : C*h* : : radius : cosin. ∠C.

By either of these theorems are computed the numbers in the following table; which shews the depression or dip of the horizon of the sea for different heights of the eye, from 1 foot to 100 feet.

Height of the eye.	Dip of the horizon.	Height of the eye.	Dip of the horizon.	Height of the eye.	Dip of the horizon.	Height of the eye.	Dip of the horizon.
Feet.	′ ″	Feet.	′ ″	Feet.	′ ″	Feet.	′ ″
1	0 57	13	3 26	26	4 52	60	7 23
2	1 21	14	3 34	28	5 3	70	7 59
3	1 39	15	3 42	30	5 14	80	8 32
4	1 55	16	3 49	35	5 39	90	9 3
5	2 8	17	3 56	40	6 2	100	9 33
6	2 20	18	4 3	45	6 24		
7	2 31	19	4 10	50	6 44		
8	2 42	20	4 16				
9	2 52	21	4 22				
10	3 1	22	4 28				
11	3 10	23	4 34				
12	3 18	24	4 40				

DEPRESSOR. See ANATOMY.

DEPRIVATION, in the canon law, is an ecclesiastical censure, by which a clergyman is deprived of his parsonage, vicarage, or other spiritual promotion of dignity. Degg's Parson's Counsellor, c. 9.

Causes of deprivation. If a clerk obtains preferment in the church by simonical contract; if he is an excommunicate, a drunkard, fornicator, adulterer, infidel, or heretic; or guilty of murder, manslaughter, perjury, forgery, &c.; if a clerk is illiterate, and not able to perform the duty of his church; if he is a scandalous person in life and conversation, or bastardy is objected against him; if he is under age, viz. the age of twenty-three years; is disobedient and incorrigible to his ordinary, or a nonconformist to the canons; if he refuses to use the common-prayer, or preaches in derogation of it; does not administer the sacrament, or read the articles of religion, &c.; if any parson, vicar, &c. has one benefice with cure of souls, and takes plurality without a faculty or dispensation; or if he commits waste in the houses and lands of the church, called dilapidations: all these have been held good causes for deprivation of priests. Deg. Par. Coun. 98, 99.

DEPTH, in geometry, the same with altitude; though, strictly speaking, we only use the term depth to denote how much one body, or part of a body, is below another. See HEIGHT, &c.

DEPTH *of a battalion, squadron, &c.* the number of men in a file, or who stand before each other in a straight line. In the antient armies this was very great.

DEPUTY, is one that exercises an office in another's right; and the forfeiture or misdemeanour of such deputy shall cause the person, whom he represents, to lose his office.

There is a great difference between a deputy and assignee of an office; for an assignee has an interest in the office itself, and does all things in his own name, for which his grantor shall not answer unless in special case; but a deputy has not any interest in the office, but is only the shadow of an officer, in whose name he does all things. 9 Rep. 49.

A superior officer must answer for his deputy in civil actions if he is not sufficient; but in criminal cases it is otherwise, where deputies are to answer for themselves. 2 Inst. 191.

DERMESTES, in zoology, a genus of insects belonging to the order of coleoptera. The antennæ are clavated, with three of the joints thicker than the rest; the breast is convex; and the head is inflected below the breast. There are thirty species, of which the following deserve notice:

1. The lardarius is of an oblong form, and of a dim-black colour, easily distinguishable by a light-brown stripe, that occupies transversely almost the anterior half of the elytra. That colour depends on small grey hairs situated on that part. The stripe is irregular at its edges; and is intersected through the middle by a small transversal streak of black spots, three in number on each of the elytra, the middlemost of which is somewhat lower than the rest, which gives the black streak a serpentine form. Its larva, that is oblong, somewhat hairy, and divided into segments alternately dark and light-coloured, gnaws and destroys preparations of animals preserved in collections, and even feeds upon the insects. See Plate Nat. Hist. fig. 162.

2. The domesticus varies greatly in size and colour; some being found of a dark-brown, others of a much lighter hue. The form of it is oblong, almost cylindrical. The elytra are striated; the thorax is thick, and rather gibbous. This little animal, when touched, draws in its head under its thorax, and its feet beneath its abdomen; remaining so motionless, that one would suppose it

dead. This is the same insect which makes in wooden furniture those little round holes that reduce it to powder.

3. The violaceus is a beautiful little insect; its elytra are of a deep violet-blue. The thorax is covered with greenish hairs; the legs are black. The whole animal being of a glittering brilliancy renders it a pleasing object. The larva, as well as the perfect insect, inhabits the bodies of dead animals.

4. The fumatus is of a light-brown colour, except the eyes, which are black. It is, however, sometimes more or less deep. The thorax is margined, and the insect has the whole carriage of a scarabæus; but its antennæ have the character of those of the dermestæ. This little creature is found in dung. It also frequently finds its way into houses.

5. The ferrugineus is the largest of the genus; its colour is a rusty iron, having many oblong, velvety, black spots upon the elytra, which give the insect a gloomy, yet elegant, appearance. The antennæ differ from the preceding species; the last three articulations being considerably longer, thicker, and not perfoliated.

The twenty-five other species are distinguished by their colour. Many varieties of this genus, as well as the larvæ, are to be met with in dried skins, bark of trees, wood, carcases of dead animals, &c.

DERVIS, a name given to all Mahommedan monks, though of various orders. The most noted among them are the bektashi, the mevelevi, the kadri, and the seyah. The bektashi, who are allowed to marry and live in cities and towns, are obliged, by the rules of their order, to visit remote lands, and to salute every one they meet with gazel, or love-songs; and with esma, or the invocation of the names of God, and humbly to wish him prosperity, which they do by repeating the word eivallah, a solemn exclamation of the wrestlers, by which the conquered yields the palm to the conqueror. The mevelevi, so called from Mevelava their founder, are used to turn round for two or three hours together with such swiftness, that you cannot see their faces; they are great lovers of music: in their monasteries they profess great humility and poverty, and when visited make no distinction of persons; they first bring their guests coffee to drink; and, if the ways have been dirty, they wash their feet and sandals. The kadri, with a peculiar superstition, emaciate their bodies; they go quite naked, except their thighs, and often join hands and dance, sometimes a whole day, repeating, with great vehemence, "Hu! hu! hu!" (one of the names of God) till, like madmen, they fall on the ground, foaming at the mouth, and running down with sweat: the prime vizir Kupruli Achmed Pasha, thinking this sect unbecoming the Mahommedan religion, ordered it to be suppressed; but, after his death, it revived, and is at present more numerous than ever, especially at Constantinople. The seyah are wanderers, and though they have monasteries, yet they often spend their whole life in travelling; when they are sent out, their superiors impose upon them such a quantity of money or provisions, forbidding them to come back till they have procured it, and sent it to the monastery; wherefore when a seyah comes into a town, he cries aloud in the market-place, "Ya allah senden," &c. "O God! give me, I pray, five thousand crowns, or a thousand measures of rice." Many of these dervises travel over the whole Mahommedan world, entertaining the people wherever they come with agreeable relations of all the curiosities they have met with. There are dervises in Egypt, who live with their families, and exercise their trades, of which kind are the dancing dervises at Damascus. They are all distinguished among themselves by the different forms and colours of their habits; those of Persia wear blue; the solitaries and wanderers wear only rags of different colours; others carry on their heads a plume made of the feathers of a cock; and those of Egypt wear an octagonal badge of a greenish-white alabaster at their girdles, and a high stiff cap, without any thing round it.

DESCANT, in the old music, the art of composing in several parts. Descant is threefold, viz. plain, figurative, and double.

DESCENSION, in astronomy, is either right or oblique. Right descension is an arch of the equinoctial, intercepted between the next equinoctial point and the intersection of the meridian, passing through the centre of the object, at its setting, in a right sphere. Oblique descension is an arch of the equinoctial intercepted between the next equinoctial point and the horizon, passing through the centre of the object, at its setting, in an oblique sphere.

DESCENT, in general, is the tendency of a body from a higher to a lower place. Heavy bodies, meeting with no resistance, descend with an uniformly accelerated motion, for the laws of which see MECHANICS.

Laws of descent of bodies. 1st. Heavy bodies, in an unresisting medium, fall with an uniformly accelerated motion. For it is the nature of all constant and uniform forces, such as that of gravity, at the same distance from the centre of the earth, to generate or produce equal additions of velocity in equal times. So that if in one second of time there is produced one degree of velocity, in two seconds there will be two degrees of velocity, in three seconds three degrees, and so on; the degree or quantity of velocity being always proportional to the length of the time.

2d. The space descended by an uniform gravity, in any time, is just the half of the space that might be uniformly described in the same time by the last velocity acquired at the end of that time, if uniformly continued. For as the velocity increases uniformly in an arithmetical progression, the whole space descended by the variable velocity will be equal to the space that would be described with the middle velocity uniformly continued for the same time; and this again will be only the space that would be with the half of the last velocity, also uniformly continued for the same time, because the last velocity is double of the middle velocity, being produced in a double time.

3d. The spaces descended by an uniform gravity, in different times, are proportional to the squares of the times, or to the squares of the velocities. For the whole space descended in any number of particles of time, consists of the sums of all the particular spaces or velocities, which are in arithmetical progression; but the sum of such an arithmetical progression, beginning at 0, and having the last term and the number of terms the same in quantity, is equal to half the square of the last term, or of the number of terms; therefore the whole sums are as the squares of the times, or of the velocities.

This theory of the descents by gravity was first discovered and taught by Galileo, who afterwards confirmed the same by experiments; which have often been repeated in various ways by many other persons since his time, as Grimaldi, Riccioli, Huygens, Newton, and others, all confirming the same laws.

The experiments of Grimaldi and Riccioli were made by dropping a number of balls, of half a pound weight, from the top of several towers, and measuring the times of falling by a pendulum. An abstract of their experiments is exhibited here below:

Vibrations of the pendulum.	The time.		Space at the end of the time.	Space descended each time.
	n	*m*	Rom. feet.	Rom. feet.
5	0	50	10	10
10	1	40	40	30
15	2	30	90	50
20	3	20	160	70
25	4	10	250	90
6	1	0	15	15
12	2	0	60	45
18	3	0	135	75
24	4	0	240	105

The space descended by a heavy body in any given time, being determined by experiment, is sufficient, in connection with the preceding theorems, for determining every inquiry concerning the times, velocities, and spaces descended, depending on an uniform force of gravity. From many accurate experiments made in England, it has been found that a heavy body descends freely through 16 feet 1 inch, or $16\frac{1}{12}$ feet, in the first second of time; and consequently, by theorem 2, the velocity gained at the end of 1 second, is $32\frac{1}{6}$ feet per second. Hence, by the same, and theorem 3, the velocity gained in any other time t is $32\frac{1}{6}t$, and the space descended is $16\frac{1}{12}t^2$. So that, if v denote the velocity, and s the space due to the time t, and there be put $g = 16$; then is

$$v = 2gt = 2\sqrt{gs} = \frac{2s}{t}.$$

$$s = gt^2 = \frac{v^2}{4g} = \tfrac{1}{2}tv.$$

$$t = \frac{v}{2g} = \sqrt{\frac{s}{g}} = \frac{2s}{v}.$$

The experiments with pendulums give also the same space for the descent of a heavy body in a second of time. Thus, in the latitude of London, it is found by experiment, that the length of a pendulum vibrating seconds, is just $39\frac{1}{8}$ inches; and it being known that the circumference of a circle is to its diameter, as the time of one vibration of any pendulum is to the time in which a heavy body will fall through half the length of the pendulum; therefore, as $3.1416 : 1 :: 1 : \frac{1}{3.1416}$, which is the time of descending through $19\frac{9}{16}$ inches, or half the length of the pendulum; then, spaces being as the squares of the times, as $\frac{1}{3.1416^2} : 1^2 :: 19\frac{9}{16} : 193$ inches, or 16 feet 1 inch, which therefore is the space a heavy body will descend through in one second; the very same as before.

4th, For any other constant force, instead of the perpendicular free descent by gravity, find by experiment, or otherwise, the space descend-

ed in one second by that force, and substitute that instead of $16\frac{1}{12}$ for the value of g in these formulæ: or, if the proportion of the force to the force of gravity be known, let the value of g be altered in the same proportion, and the same formulæ will still hold good. So, if the descent be on an inclined plane, making, for instance, an angle of 30° with the horizon; then, the force of descent upon the plane being always as the sine of the angle it makes with the horizon, in the present case it will be as the sine of 30°, that is, as $\frac{1}{2}$ the radius; therefore, in this case, the value of g will be but half the former, $8\frac{1}{24}$, in all the foregoing formulæ.

Or, if one body descending perpendicularly draw another after it, by means of a cord sliding over a pulley; then it will be, as the sum of the two bodies is to the descending body, so is $16\frac{1}{12}$ to the value of g in this case; which value of it being used in the said formulæ, they will still hold good. And in like manner for any other constant forces whatever.

5th, The time of the oblique descent down any chord of a circle, drawn either from the uppermost or lowermost point of the circle, is equal to the perpendicular descent through the diameter of the circle.

6th, The descent, or vibration, through all arcs of the same cycloid, are equal, whether great or small.

7th, But the descent, or vibration, through unequal arcs of a circle, are unequal; the times being greater in the greater arcs, and less in the less.

DESCENT, *line of swiftest*, is that which a body, falling by the action of gravity, describes in the shortest time possible, from one given point to another. And this line, it is proved by philosophers, is the arc of a cycloid, when the one point is not perpendicularly over the other. See CYCLOID.

DESCENT, in law, or hereditary succession, is the title by which a man on the death of his ancestor acquires his estate by right of representation as his heir at law; and an estate so decending to the heir is in law called the inheritance. 2 Black. 201.

Descent is of three kinds; by common law, by custom, or by statute. By common law, as where one has land of inheritance in fee-simple, and dies without disposing of it in his life-time, and the land goes to the eldest son and heir of course, being cast upon him by the law. Descent of fee-simple by custom, is sometimes to all the sons or to all the brothers (where one brother dies without issue), as in gavelkind; sometimes to the youngest son, as in borough-English; and sometimes to the eldest daughter, or the youngest, according to the customs of particular places. Descent by statute is of fee-tail, as directed by the statute of Westminster 2, de donis.

Descent at common law is either lineal or collateral. Lineal consanguinity is that which subsists between persons, of whom one is descended in a direct line from the other, as between a man and his father, grandfather, and great-grandfather, and so upwards in a direct ascending line; or between a man and his son, grandson, great-grandson, and so downwards in the direct descending line. Every generation, in this lineal direct consanguinity, constitutes a different degree, reckoned either upwards or downwards; the father is related in the first degree, and so likewise are the son, grandsire, and grandson, in the second; great-grandsire, and great-grandson, in the third. This is the only natural way of reckoning the degrees in the direct line, and therefore universally obtains, as well in the civil and canon as in the common law. Collateral kindred answers to the same description; collateral relations agreeing with the lineal in this, that they descend from the same stock or ancestor; but differing in this, that they do not descend one from the other. Collateral kinsmen are therefore such as lineally sprung from one and the same ancestor, who is the stirps or root, stipes, trunk or common stock, whence these relations are branched out. As if a man has two sons, who have each a different issue, both these issues are lineally descended from him as their common ancestor; and they are collateral kinsmen to each other, because they are all descended from this common ancestor; and all have a portion of his blood in their veins, which denominates them consanguineors. Inheritances shall lineally descend to the issue of the person last actually seized, in infinitum, but shall never lineally ascend. 3 Black. 208.

The male issue shall be admitted before the female; and where there are two or more males in equal degree, the eldest only shall inherit (except where there are particular local customs to the contrary); but the females shall inherit all together, except in case of succession to the crown, which is indivisible; and of succession to dignities and titles of honour: yet where a man holds an earldom to him and the heirs of his body, and dies, his eldest daughter shall not succeed of course to the title of countess, but the dignity is in suspense or abeyance till the king shall declare which of the daughters shall have that title. 2 Black. 216.

DESCENT OF CROWN LANDS. All the lands whereof the king is seized in jure coronæ, shall attend upon and follow the crown; so that to whomsoever the crown descends, those lands and possessions descend also. Plowd. 247.

DESCENT OF DIGNITIES. The dignity of peerage is personal, annexed to the blood, and so inseparable, that it cannot be transferred to any person, or surrendered even to the crown: it can move neither backward nor forward, but only downward to posterity; and nothing but corruption of blood, as if the ancestor be attainted of treason or felony, can hinder the descent to the right heir. Lex Const. 85.

DESCENT, in heraldry, is used to express the coming down of any thing from above; as, a lion en descent, is a lion with his head towards the base points and his heels towards one of the corners of the chief, as if he were leaping down from some high place.

DESCENTS, in fortification, are the holes, vaults, and hollow places, made by undermining the ground. The descent into the moat or ditch is a deep passage made through the esplanade and covert-way, in form of a trench, whereof the upper part is covered with madriers and clays, to secure the besiegers from the enemy's fire. In wet ditches this trench is on a level with the surface of the water, but in dry ones it is sunk as deep as the bottom of the ditch.

DESCRIPTION, in law. In deeds and grants there must be a certain description of the lands granted, the places where they lie, and the person to whom granted, &c. to make them good. But wills are more favoured than grants as to those descriptions; and a wrong description of the person will not make a devise void, if there be otherwise a sufficient certainty what person was intended by the testator. 1 Nels. Abr. 467.

Where a first description of land, &c. is false, though the second be true, a deed will be void: contra, if the first be true, and the second false. 3 Rep. 2, 3, 8, and 10.

DESERTER, in a military sense, a soldier who, by running away from his regiment or company, abandons the service.

A deserter is, by the articles of war, punishable by death, and, after conviction, is hanged at the head-of the regiment he formerly belonged to, with his crime written on his breast, and suffered to hang till the army leave that camp, for a terror to others.

DESACHE', in heraldry, is where a beast has its limbs separated from its body, so that they still remain on the escutcheon, with only a small separation from their natural places.

DESIGN, in a general sense, the plan, order, representation or construction of a building, book, painting, &c.

In building the term ichnography may be used, when by design is only meant the plan of a building, or a flat figure drawn on paper: when some side or face of the building is raised from the ground, we may use the term orthography; and when both front and sides are seen, in perspective, we may call it scenography.

DESIGN, in manufactories, expresses the figures with which the workman enriches his stuff, or silk, and which he copies after some painter, or eminent draughtsman, as in diaper, damask, flowered silk, tapestry, and the like.

In undertaking of such kinds of figured stuffs, it is necessary, says M. Savary, that before the first stroke of the shuttle, the whole design be represented on the threads of the warp; we do not mean in colours, but with an infinite number of little packthreads, which, being disposed so as to raise the threads of the warp, let the workmen see, from time to time, what kind of silk is to be put in the eye of the shuttle, for woof. This method of preparing the work is called reading the design and reading the figure, which is performed in the following manner: A paper is provided, considerably broader than the stuff, and of a length proportionate to what is intended to be represented on it. This they divide lengthwise, by as many black lines as there are intended threads in the warp; and cross these lines, by others drawn breadthwise, which, with the former, make little equal squares; on the paper thus squared, the draughtsman designs his figures, and heightens them with colours as he sees fit. When the design is finished, a workman reads it, while another lays it on the simblot.

To read the design, is to tell the person who manages the loom, the number of squares, or threads, comprised in any space, intimating at the same time whether it is ground or figure. To put what is read on the simblot, is to fasten little strings to the several packthreads, which are to raise the threads, named; and thus they continue to do till the whole design is read. Every piece being composed of several repe-

titions of the same design, when the whole design is drawn, the drawer, to begin the design afresh, has nothing to do but raise the little strings, with slip-knots, to the top of the simblot, which he had let down to the bottom: this he is to repeat as often as is necessary till the whole is manufactured. The ribbon-weavers have likewise a design, but far more simple than that now described. It is drawn on paper, with lines and squares representing the threads of the warp and woof. But instead of lines of which the figures of the former consist, these are constituted of points only, or dots, placed in certain of the little squares, formed by the intersection of the lines. These points mark the threads of the warp that are to be raised. and the spaces left blank denote the threads that are to keep their situation: the rest is managed as in the former.

DESIGN is also used, in painting, for the first idea of a large work, drawn roughly, and in little, with an intention to be executed and finished in large. The art of painting has been by some of the greatest masters divided into the design or draught, the proportion, the expression, the claro-obscuro, the ordonnance, the colouring, and the perspective.

Design, in painting, is the simple contour or outlines of the figures intended to be represented, or the lines that terminate and circumscribe them: such design is sometimes drawn in crayons, or ink without any shadows at all. Sometimes it is etched; that is, the shadows are expressed by sensible outlines, usually drawn across each other with the pen, crayon, or graver. Sometimes, again, the shadows are done with the crayon rubbed so as that there do not appear any lines: at other times, the grains or strokes of the crayon appear, as not being rubbed: sometimes the design is washed, that is, the shadows are done with a pencil in Indian ink, or some other liquor; and sometimes the design is coloured, that is, colours are laid on much like those intended for the grand work.

The essential requisites of a design are correctness, good taste, elegance, character, diversity, expression, and perspective. Correctness depends on the justness of the proportions, and knowledge of anatomy. Taste is a certain manner of correctness peculiar to the artist, derived either from nature, masters, or studies, or all of them united. Elegance gives a delicacy that not only strikes persons of judgment, but communicates an agreeableness that pleases universally. The character is what is peculiar to each thing, in which there must be diversity, insomuch that every thing has its peculiar character to distinguish it. The expression is the representation of an object, according to the circumstances it is supposed to be in. Perspective is the representation of the parts of a painting, or a figure, according to the situation they are in with regard to the point of sight.

The design or draught, is a part of the greatest import and extent in painting. It is acquired chiefly by genius and application, rules being of less avail here than in any other branches of the art, as colouring, &c. The principal rules that regard design are, that novices accustom themselves to copy good originals at first sight; not to use squares in drawing, lest they stint and confine their judgment; to design well from life, before they practise perspective; to learn to adjust the size of their figures to the visual angle, and the distance of the eye from the model or object; to mark out all the parts of their design before they begin to shade; to make their contours in great pieces, without taking notice of the little muscles, and other breaks; to make themselves masters of the rules of perspective; to observe the perpendicular, parallel, and distance, of every stroke; to compare and oppose the parts that meet and traverse the perpendicular, so as to form a kind of square in the mind, which is the great and almost the only rule of designing justly; to have regard not only to the model, but to the parts already designed, there being no such thing as designing with strict justness, but by comparing and proportioning every part to the first. All the other rules relate to perspective. See PAINTING, and PERSPECTIVE.

DE SON TORT DEMESN, in law, a formula used in action of trespass, by way of reply to the defendant's plea; signifying that the trespass was his own voluntary and free act.

DETACHED PIECES, in fortification, are such outworks as are detached or at a distance from the body of the place; as demilunes, ravelins, bastions, &c. In painting the figures are said to be well detached, when they stand free and disengaged from each other.

DETACHMENT, in military affairs, a certain number of soldiers drawn out from several regiments or companies equally, to be employed as the general thinks proper; whether on an attack, at a siege, or in parties to scour the country. A detachment of two or three thousand men, is a command for a brigadier; eight hundred, for a colonel; four or five hundred, for a lieutenant-colonel. A captain never marches on a detachment with less than fifty men, a lieutenant, an ensign, and two serjeants. A lieutenant is allowed thirty, and a serjeant; and a serjeant ten or twelve men. Detachments are sometimes made of entire squadrons and battalions.

DETENTS, in clock-work, are those stops, which by being lifted up or let down, lock or unlock the clock in striking. See CLOCK-WORK.

DETENT-WHEEL, or *hoop-wheel*, in a clock, that wheel which has a hoop almost round it, in which there is a vacancy at which the clock locks.

DETERGENTS, in pharmacy, such medicines as are not only softening and adhesive, but also, by a peculiar activity, conjoined with a suitable configuration of parts, are apt to abrade, and carry along with them, such particles as they lay hold on in their passage. See PHARMACY.

DETERMINATE PROBLEM, in geometry, that which has but one, or at least, a limited number of answers: as the following problem, which has but one only solution, viz. To describe an isosceles triangle on a given line, whose angles at the base shall be double that at the vertex. But the following has two solutions, viz. To find an isosceles triangle, whose area and perimeter are given.

DETINUE is a writ which lies where any man comes to goods or chattels either by delivery or by finding, and refuses to re-deliver them; and it lies for the detaining, when the detaining was unlawful. 1 Inst. 286.

In this writ the plaintiff shall recover the thing detained; and therefore it must be so certain, as that it may be specifically known. Therefore it cannot be brought for money, corn, or the like, for that cannot be known from other money or corn, unless it is in a bag or sack, for then it may be distinguishably marked. Ibid.

But detinue may be brought for a piece of gold of the price of 21*s*. though not for 21*s*. in money; for there is a demand of a particular piece. Buller, N. P. 50.

In order therefore to ground an action of detinue, which is only for the detaining, these points are necessary: 1. That the defendant came lawfully by the goods, as either by delivery to him, or finding them. 2. That the plaintiff has a property. 3. That the goods themselves are of value. And 4. that they be ascertained in point of identity. Upon this, the jury, if they find for the plaintiff, assess the respective values of the several parcels detained, and also damages for the detention; and the judgment is conditional, that the plaintiff recover the said goods, or (if they cannot be had) their respective values, and also the damages for detaining them. Id.

DETINUE OF CHARTERS. An action of detinue lies for charters which make the title of lands; and the heir may have detinue of charters, although he have not the land. But if they concern the freehold, the action must be in the common-pleas, and no other court.

DETONATION, in chemistry, the noise and explosion which any substance makes upon the application of fire to it. It is also called fulmination; such are the explosions of gunpowder, of fulminating silver, gold, &c.

DETRANCHE', in heraldry a line bendwise, proceeding always from the dexter side but not from the very angle, diagonally athwart the shield.

DEVASTAVIT, or *devastarunt bona testatoris*, in law is a writ which lies against executors, for paying debts for simple contract, before debts on bonds, and specialities, or the like; for in this place the executors are as liable to action, as if they had wasted the goods of the testator riotously, or converted them to their own use; and are compellable to pay such debts by speciality out of their own goods, to the value of what they so paid illegally. Cowel.

By the 30 C. II. c. 7. if an executor de son tort waste the goods and die, his executors shall be liable in the same manner as their testator would have been, if he had been living. And it has since been adjudged, that a rightful executor, who wastes the goods of the testator, is in effect an executor de son tort, for abusing his trust. 5 Mod. 113. And his executor or administrator is made liable to a devastavit by 4 and 5 W. and M. c. 24.

DEVENERUNT, in law, a writ directed to the escheator, when any tenant of the king holding in capite, died: and when his son and heir, within age, and in the king's custody, died; then this writ issued, commanding the escheator, that he, by the oath of good and

lawful men, inquire what lands and tenements, by the death of the tenant, came to the king. Dyer, 360. pl. 4.

DEVESTING, in old law-books, the reverse of investing or investiture. See the article INVESTITURE.

DEVISE, or *device*, in heraldry, painting, and sculpture, any emblem used to represent a certain family, person, action, or quality; with a suitable motto, applied in a figurative sense.

DEVISE, in law, the act whereby a person bequeaths his lands or tenements to another, by his last will and testament. The person who makes this act, is called the devisor, and he in whose favour the act is made, is termed in law the devisee.

DEVOTION, *devotio*, a sincere and ardent worship of the deity.

DEVOURING, in heraldry, is when fishes are borne in an escutcheon in a feeding posture, for they swallow all the meat whole.

DEW, a dense moist vapour, falling on the earth in form of a misling rain. See METEOROLOGY.

DEXTANS, in Roman antiquity, ten ounces, or $\frac{10}{12}$ of their libra.

DEXTER, in heraldry, an appellation given to whatever belongs to the right side of the shield, or coat of arms: thus we say, bend-dexter, dexter point, &c.

DIABETES, in physic, an excessive discharge of urine, which comes away crude, and exceeds the quantity of liquids drunk. See MEDICINE.

DIACAUSTIC CURVE, a species of the caustic curves formed by refraction. Thus if you imagine an infinite number of rays BA, BM, BD, &c. (Pl. Miscel. fig. 40) issuing from the same luminous point B to be refracted to or from the perpendicular MC by the given curve AMD, and so that CE, the sines of the angles of incidence CME, be always to CG, the sines of the refracted angles CMG, in a given ratio; then the curve HFN, which touches all the refracted rays, is called the diacaustic, or caustic refraction. See CAUSTIC CURVE.

DIACHYLON, in pharmacy, an emollient digestive plaster. See PHARMACY.

DIADELPHIA, in the Linnæan system of botany, a class of plants, the seventeenth in order; comprehending all those with papilionaceous and hermaphrodite flowers, and leguminous seed-vessels. See BOTANY.

DIADEM, in antiquity, a head-band, or fillet, worn by kings, as a badge of their royalty. It was made of silk, thread, or wool, and tied round the temples and forehead, the ends being tied behind, and let fall on the neck. It was usually white, and quite plain, though sometimes embroidered with gold, and set with pearls and precious stones. In latter times, it came to be twisted round crowns, laurels, &c. and even appears to have been worn on divers parts of the body.

DIADEM, in heraldry, is applied to certain circles or rims, serving to inclose the crowns of sovereigns and to bear the globe and cross, or the flower-de-luces for their crest

DIÆRESIS, in surgery, an operation serving to divide and separate the part when the continuity is a hindrance to cure. See SURGERY.

DIÆRESIS, in medicine. is the consuming of the vessels of an animal body. See MEDICINE.

DIÆRESIS, in grammar, the division of one syllable into two, which is usually noted by two points over a letter, as aulaï instead of aulæ, dissolüenda for dissolvenda.

DIÆTETÆ, in Grecian antiquity, a kind of judges, of which there were two sorts, the cleroti and diallacterii. The former were public arbitrators, chosen by lot to determine all causes exceeding ten drachms, within their own tribe, and from their sentence an appeal lay to the superior courts.

DIAGNOSTIC, in medicine, a term given to those signs which indicate the present state of a disease, its nature and cause. See MEDICINE.

DIAGONAL, in geometry, a right line drawn across a quadrilateral figure, from one angle to another, by some called the diameter. Thus *ab* in plate Miscel. fig. 41. is called a diagonal. It is demonstrable, 1. that every diagonal divides a parallelogram into two equal parts. 2. That two diagonals drawn in any parallelogram bisect each other. 3. A line *f g*, passing through the middle point of the diagonal of a parallelogram, divides the figure into two equal parts. 4. That the diagonal of a square is incommensurable with one of its sides. 5. That the sum of the squares of the diagonals of every parallelogram is equal to the sum of the squares of the four sides.

DIAGRAM, in geometry, a scheme for explaining and demonstrating the properties of any figure, whether triangle, square, circle, &c.

DIAGRAM, among musicians (from the Greek). The name given by the antients to the table, or model, representing all the sounds of their system.

DIAL, or sun-dial, is a plane, upon which lines are described in such a manner, that the shadow of a wire, or of the upper edge of a plate stile, erected perpendicularly on the plane of the dial, may shew the true time of the day. The edge of the plate by which the time of the day is found, is called the stile of the dial, which must be parallel to the earth's axis; and the line on which the said plate is erected, is called the substile. The angle included between the substile and stile, is called the elevation, or height of the stile.

Those dials whose planes are parallel to the plane of the horizon, are called horizontal dials; and those dials whose planes are perpendicular to the plane of the horizon, are called vertical or erect dials.

Those erect dials, whose planes directly front the north or south, are called direct north or south dials; and all other erect dials are called decliners, because their planes are turned away from the north or south.

Those dials, whose planes are neither parallel nor perpendicular to the plane of their horizon, are called inclining or reclining dials, according as their planes make acute or obtuse angles with the horizon; and if their planes are also turned aside from facing the south or north, they are called declining-inclining or declining-reclining dials.

The intersection of the plane of the dial, with that of the meridian, passing through the stile, is called the meridian of the dial, or the hour-line of XII.

Those meridians, whose planes pass through the stile, and make angles of 15, 30, 45, 60, 75, and 90 degrees with the meridian of the place (which marks the hour-line of 12), are called hour-circles; and their intersections with the plane of the dial, are called hour-lines.

In all declining dials, the substile makes an angle with the hour-line of XII; and this angle is called the distance of the substile from the meridian.

The declining plane's difference of longitude, is the angle formed at the intersection of the stile and plane of the dial, by two meridians; one of which passes through the hour-line of XII, and the other through the substile.

We shall now proceed to explain the different principles of their construction.

The universal principle on which dialing depends.—If the whole earth *a P c p* (Plate fig. 1) were transparent and hollow, like a sphere of glass, and had its equator divided into twenty-four equal parts by so many meridian semicircles, *a, b, c, d, e, f, g*, &c. one of which is the geographical meridian of any given place, as London (which is supposed to be at the point *a*); and if the hours of XII were marked at the equator, both upon that meridian and the opposite one, and all the rest of the hours in order on the rest of the meridians; those meridians would be the hour-circles of London: then, if the sphere had an opake axis, as P E *p*, terminating in the poles P and *p*, the shadow of the axis would fall upon every particular meridian and hour, when the sun came to the plane of the opposite meridian, and would consequently shew the time at London, and at all other places on the meridian of London.

Horizontal dial.—If this sphere was cut through the middle by a solid plane AB C D, in the rational horizon of London, one half of the axis E P would be above the plane, and the other half below it; and if straight lines were drawn from the centre of the plane, to those points where its circumference is cut by the hour-circles of the sphere, those lines would be the hour-lines of a horizontal dial for London: for the shadow of the axis would fall upon each particular hour-line of the dial, when it fell upon the like hour-circle of the sphere.

Vertical dials.—If the plane which cuts the sphere be upright, as A F C G (fig. 2), touching the given place (London) at F, and directly facing the meridian of London, it will then become the plane of an erect direct south dial; and if right lines be drawn from its centre E, to those points of its circumference where the hour-circles of the sphere cut it, these will be the hour-lines of a vertical or direct south dial for London, to which the hours are to be set as in the figure (contrary to those on a horizontal dial); and the lower half E *p* of the axis will cast a shadow on the hour of the day in this dial, at the same time that it would fall upon the like hour-circle of the sphere, if the dial-plane was not in the way.

Inclining and reclining dials.—If the plane (still facing the meridian) be made to incline, or recline, by any given number of degrees, the hour-circles of the sphere will still cut the edge of the plane in those points to which the hour-lines must be drawn straight from the centre; and the axis of the sphere will cast a shadow on these lines at the respective hours. The like will still hold, if the

plane be made to decline by any given number of degrees from the meridian, towards the east or west: provided the declination be less than ninety degrees, or the reclination be less than the co-latitude of the place; and the axis of the sphere will be a gnomon, or stile, for the dial. But it cannot be a gnomon, when the declination is quite 90 degrees, nor when the reclination is equal to the co-latitude; because, in these two cases, the axis has no elevation above the plane of the dial.

And thus it appears, that the plane of every dial represents the plane of some great circle upon the earth; and the gnomon the earth's axis; whether it be a small wire, as in the above figures, or the edge of a thin plate, as in the common horizontal dials.

The whole earth, as to its bulk, is but a point, if compared to its distance from the sun: and therefore, if a small sphere of glass be placed upon any part of the earth's surface, so that its axis be parallel to the axis of the earth; and the sphere have such lines upon it, and such planes within it, as above described; it will shew the hours of the day as truly as if it were placed at the earth's centre, and the shell of the earth were as transparent as glass. See figs. 1 and 2.

But because it is impossible to have a hollow sphere of glass perfectly true, blown round a solid plane; or if it was, we could not get at the plane within the glass to set it in any given position; we make use of a wire sphere to explain the principles of dialing, by joining twenty-four semicircles together at the poles, and putting a thin flat plate of bra-s within it.

Dialing by the common terrestrial globe.—A common globe, of twelve inches diameter, has generally twenty-four meridian semicircles drawn upon it. If such a globe be elevated to the latitude of a given place, and turned about until any one of these meridians cuts the horizon in the north point, where the hour of XII is supposed to be marked; the rest of the meridians will cut the horizon at the respective distances of all the other hours from XII. Then, if these points of distance be marked on the horizon; and the globe be taken out of the horizon, and a flat board or plate be put into its place, even with the surface of the horizon; and if straight lines be drawn from the centre of the board, to those points of distance on the horizon which were cut by the twenty-four meridian semicircles; these lines will be the hour-lines of a horizontal dial for that latitude, the edge of whose gnomon must be in the very same situation that the axis of the globe was, before it was taken out of the horizon: that is, the gnomon must make an angle with the plane of the dial, equal to the latitude of the place for which the dial is made.

If the pole of the globe be elevated to the co-latitude* of the given place, and any meridian be brought to the north point of the horizon, the rest of the meridians will cut the horizon in the respective distances of all the hours from XII, for a direct south dial, whose gnomon must make an angle with the plane of the dial, equal to the co-latitude of the place; and the hours must be set the contrary way on this dial, to what they are on the horizontal.

But if your globe have more than twenty-four meridian semicircles upon it, you must take the following method for making horizontal and south dials by it.

To construct a horizontal dial.—Elevate the pole to the latitude of your place, and turn the globe until any particular meridian (suppose the first) comes to the north point of the horizon, and the opposite meridian will cut the horizon in the south. Then, set the hour-index to the uppermost XII on its circle; which done, turn the globe westward until fifteen degrees of the equator pass under the brasen meridian, and then the hour-index will be at I (for the sun moves fifteen degrees every hour); and the first meridian will cut the horizon in the number of degrees from the north point, that I is distant from XII. Turn on, until fifteen more degrees of the equator pass under the brasen meridian, and the hour-index will be then at II, and the first meridian will cut the horizon in the number of degrees that II is distant from XII: and so, by making fifteen degrees of the equator pass under the brasen meridian for every hour, the first meridian of the globe will cut the horizon in the distances of all the hours from XII to VI, which is just ninety degrees; and then you need go no farther; for the distances of XI, X, IX, VIII, VII, and VI, in the forenoon, are the same from XII, as the distances of I, II, III, IV, V, and VI, in the afternoon: and these hour-lines continued through the centre, will give the opposite hour-lines on the other half of the dial: but no more of these lines need be drawn, than what answer to the sun's continuance above the horizon of your place on the longest day, which may be easily found.

Thus, to make an horizontal dial for the latitude of London, which is about $51\frac{1}{2}$ degrees north, elevate the north pole of the globe $51\frac{1}{2}$ degrees above the north point of the horizon, and then turn the globe, until the first meridian (which is that of London on the English terrestrial globe) cuts the north point of the horizon, and set the hour-index to XII at noon.

Then, turning the globe westward until the index points successively to I, II, III, IV, V, and VI, in the afternoon; or until 15, 30, 45, 60, 75, and 90 degrees of the equator pass under the brasen meridian, you will find that the first meridian of the globe cuts the horizon in the following numbers of degrees from the north towards the east, viz. $11\frac{2}{3}$, $24\frac{1}{4}$, $38\frac{1}{12}$ $53\frac{1}{2}$, $71\frac{1}{15}$, and 90; which are the respective distances of the above hours from XII upon the plane of the horizon.

To transfer these, and the rest of the hours, to a horizontal plane, draw the parallel right lines $a\,c$ and $b\,d$ (fig. 3) upon that plane, as far from each other as is equal to the intended thickness of the gnomon or stile of the dial, and the space included between them will be the meridian or twelve-o'clock line on the dial. Cross this meridian at right angles with the six-o'clock line $g\,h$, and setting one foot of your compasses in the intersection a, as a centre, describe the quadrant $g\,e$ with any convenient radius or opening of the compasses; then setting one foot in the intersection b as a centre, with the same radius describe the quadrant $f\,h$, and divide each quadrant into ninety equal parts or degrees, as in the figure.

Because the hour-lines are less distant from each other about noon, than in any other part of the dial, it is best to have the centres of these quadrants at a little distance from the centre of the dial-plane, on the side opposite to XII, in order to enlarge the hour-distances thereabout under the same angles on the plane. Thus, the centre of the plane is at C, but the centres of the quadrants at a and b.

Lay a ruler over the point b; and keeping it there for the centre of all the afternoon hours in the quadrant $f\,h$; draw the hour-line of I, through $11\frac{2}{3}$ degrees in the quadrant; the hour-line of II, through $24\frac{1}{4}$ degrees; of III, through $38\frac{1}{12}$ degrees; IV through $53\frac{1}{2}$, and V through $71\frac{1}{15}$: and because the sun rises about four in the morning on the longest days at London, continue the hour-lines of IV and V, in the afternoon, through the centre b to the opposite side of the dial. This done, lay the ruler to the centre a of the quadrant $e\,g$, and through the like divisions or degrees of that quadrant, viz. $11\frac{2}{3}$, $24\frac{1}{4}$, $38\frac{1}{12}$, $53\frac{1}{2}$, and $71\frac{1}{15}$, draw the forenoon hour-lines of XI, X, IX, VIII, and VII; and because the sun sets not before eight in the evening on the longest days, continue the hour-lines of VII and VIII in the forenoon, through the centre a, to VII and VIII in the afternoon; and all the hour-lines will be finished on this dial; to which the hours may be set, as in the figure.

Lastly, through $51\frac{1}{2}$ degrees of either quadrant, and from its centre, draw the right line $a\,g$ for the hypothenuse or axis of the gnomon $a\,g\,i$; and from g, let fall the perpendicular $g\,i$, upon the meridian line $a\,i$, and there will be a triangle made, whose sides are $a\,g$, $g\,i$, and $i\,a$. If a plate similar to this triangle be made as thick as the distance between the lines $a\,c$ and $b\,d$, and set upright between them, touching at a and b; its hypothenuse $a\,g$ will be parallel to the axis of the world, when the dial is truly set, and will cast a shadow on the hour of the day.

The trouble of dividing the two quadrants may be saved, by means of a scale with a line of chords upon it: for if we extend the compasses from 0 to 60 degrees of the line of chords; and with that extent, as a radius, describe the two quadrants upon their respective centres, the above distances may be taken with the compasses upon the line, and set off upon the quadrants. See INSTRUMENTS MATHEMATICAL.

To make an erect direct south dial.—Elevate the pole to the co-latitude of your place, and proceed in all respects as above taught for the horizontal dial, from VI in the morning to VI in the afternoon; only the hours must be reversed, as in figure 4, and the hypothenuse $a\,g$, of the gnomon $a\,g\,f$, must make an angle with the dial-plane equal to the co-latitude of the place. As the sun can shine no longer on this dial, than from six in the morning until six in the evening, there is no occasion for having any more than twelve hours upon it.

To make an erect dial, declining from the

* If the latitude be subtracted from 90 degrees, the remainder is called the co-latitude, or complement of the latitude. See GEOGRAPHY.

south towards the east or west.—Elevate the pole to the latitude of your place, and screw the quadrant of altitude to the zenith. Then if the dial declines towards the east (which we will suppose it to do at present), count in the horizon the degrees of declination, from the east point towards the north, and bring the lower end of the quadrant to that degree of declination at which the reckoning ends. This done, bring any particular meridian of your globe (as suppose the first meridian) directly under the graduated edge of the upper part of the brasen meridian, and set the hour-index to XII at noon. Then, keeping the quadrant of altitude at the degree of declination in the horizon, turn the globe eastward on its axis, and observe the degrees cut by the first meridian in the quadrant of altitude (counted from the zenith) as the hour-index comes to XI, X, IX, &c. in the forenoon, or as 15, 30, 45, &c. degrees of the equator pass under the brasen meridian at these hours respectively; and the degrees then cut in the quadrant by the first meridian, are the respective distances of the forenoon hours from XII on the plane of the dial. For the afternoon hours, turn the quadrant of altitude round the zenith until it comes to the degree in the horizon opposite to that where it was placed before; namely, as far from the west point of the horizon towards the south, as it was set at first from the east point towards the north; and turn the globe westward on its axis, until the first meridian comes to the brasen meridian again, and the hour-index to XII: then, continue to turn the globe westward, and as the index points to the afternoon hours I, II, III, &c. or as 15, 30, 45, &c. degrees of the equator pass under the brasen meridian, the first meridian will cut the quadrant of altitude in the respective number of degrees from the zenith, that each of these hours is from XII on the dial. And note, that when the first meridian goes off the quadrant at the horizon, in the forenoon, the hour-index shews the time when the sun will come upon this dial: and when it goes off the quadrant in the afternoon, the index will point to the time when the sun goes off the dial.

Having thus found all the hour-distances from XII, lay them down upon your dial-plate, either by dividing a semicircle into two quadrants of 90 degrees each beginning at the hour-line of XII, or by the line of chords.

In all declining dials, the line on which the stile or gnomon stands, commonly called the substile-line, makes an angle with the twelve-o'clock line, and falls among the forenoon hour-lines, if the dial declines toward the east; and among the afternoon hour-lines, when the dial declines towards the west; that is, to the left hand from the 12-o'clock line in the former case, and to the right hand from it in the latter.

To find the distance of the substile from the twelve-o'clock line.—If your dial declines from the south towards the east, count the degrees of that declination in the horizon from the east point toward the north, and bring the lower end of the quadrant of altitude to that degree of declination where the reckoning ends: then, turn the globe until the first meridian cuts the horizon in the like number of degrees, counted from the south point toward the east; and the quadrant and first meridian will then cross one another at right angles; and the number of degrees of the quadrant which are intercepted between the first meridian and the zenith, is equal to the distance of the substile line from the twelve-o'clock line; and the number of degrees of the first meridian, which are intercepted between the quadrant and the north pole, is equal to the elevation of the stile above the plane of the dial.

If the dial declines westward from the south, count that declination from the east point of the horizon towards the south, and bring the quadrant of altitude to the degree in the horizon at which the reckoning ends; both for finding the forenoon hours, and the distance of the substile from the meridian; and for the afternoon hours, bring the quadrant to the opposite degree in the horizon, namely, as far from the west towards the north, and then proceed in all respects as above.

Thus we have finished our declining dial: and in so doing, we made four dials, viz.

1. A north dial, declining eastward by the same number of degrees; 2. A north dial, declining the same number west; 3. a south dial, declining east; and, 4. a south dial, declining west: only, placing the proper number of hours, and the stile or gnomon respectively, upon each plane. For, in the south-west plane, the substilar line falls among the afternoon hours: and in the south-east of the same declination, among the forenoon hours, at equal distances from XII. And so all the morning hours on the west decliner will be like the afternoon hours on the east decliner: the south-east decliner will produce the north-west decliner; and the south-west decliner, the north-east decliner; by only extending the hour-lines, stile, and substile, quite through the centre: the axis of the stile, or edge that casts the shadow on the hour of the day, being in all dials whatever parallel to the axis of the world, and consequently pointing towards the north pole of the heavens in north latitudes, and towards the south pole in south latitudes.

An easy method for constructing of dials.—But because every one who would like to make a dial, may perhaps not be provided with a globe to assist him, and may probably not understand the method of doing it by logarithmic calculation; we shall shew how to perform it by the plain dialing-lines, or scale of latitudes and hours (see fig. 5). Scales of this kind are sold by all mathematical instrument-makers.

This is the easiest of all mechanical methods, and by much the best, when the lines are truly divided: not only the half hours and quarters may be laid down by all of them, but every fifth minute by most, and every single minute by those where the line of hours is a foot in length.

Having drawn a double meridian line *a b*, *c d* (fig. 6), on the plane intended for an horizontal dial, and crossed it at right angles by the six-o'clock line *f e* (as in fig. 3), take the latitude of your place with the compasses, in the scale of latitudes, and set that extent from *c* to *e*, and from *a* to *f*, on the six-o'clock line; then, taking the whole six hours between the points of the compasses in the scale of hours, with that extent set one foot in the point *e*, and let the other foot fall where it will upon the meridian line *c d*, as at *d*. Do the same from *f* to *b*, and draw the right lines *e d* and *f b*, each of which will be equal in length to the whole scale of hours. This done, setting one foot of the compasses in the beginning of the scale at XII, and extending the other to each hour on the scale, lay off these extents from *d* to *e* for the afternoon hours, and from *b* to *f* for those of the forenoon; this will divide the lines *d e* and *b f* in the same manner as the hour-scale is divided, at 1, 2, 3, 4, 5, and 6; on which the quarters may also be laid down, if required. Then laying a ruler on the point *c*, draw the first five hours in the afternoon, from that point, through the dots at the numeral figures 1, 2, 3, 4, 5, on the line *d e*; and continue the lines of IV and V through the centre *c* to the other side of the dial, for the like hours of the morning; which done, lay the ruler on the point *a*, and draw the last five hours in the forenoon through the dots 5, 4, 3, 2, 1, on the line *f b*: continuing the hour-lines of VII and VIII through the centre *a* to the other side of the dial, for the like hours of the evening; and set the hours to their respective lines as in the figure. Lastly, make the gnomon the same way as taught above for the horizontal dial, and the whole will be finished.

To make an erect south dial.—Take the co-latitude of the place from the scale of latitudes, and then proceed in all respects for the hour-lines as in the horizontal dial; only reversing the hours, as in fig. 2; and making the angle of the stile's height equal to the co-latitude.

The dialing-lines (fig. 5) are large enough for making a dial of nine inches or more in diameter, and they are drawn sufficiently exact for common practice, to every quarter of an hour. This scale may be cut off from the plate, and pasted upon wood or pasteboard, which will render it somewhat more exact than it is on the plate; for being rightly divided upon the copper-plate, and printed off on wet paper, it shrinks as the paper dries; but when it is wetted again, it stretches to the same size as when newly printed; and if pasted on while wet, it will remain of that size afterwards.

We shall now shew how to make a dial without these helps. Divide a quadrant into 90 equal parts or degrees for taking the proper angle of the stile's elevation, which is easily done.

To describe an horizontal dial.—With any opening of the compasses, as Z L (fig. 7), describe the two semicircles L F *k* and L Q *k*, upon the centres Z and *z*, where the six-o'clock line crosses the double meridian line, and divide each semicircle into twelve equal parts, beginning at L; then connect the divisions which are equidistant from L, by the parallel lines K M, I N, H O, G P, and F Q. Draw V Z for the hypothenuse of the stile, making the angle V Z E equal to the latitude of your place; and continue the line V Z to R. Draw the line R *r* parallel to the six-o'clock line, and set off the distance *a* K from Z to Y, the distance *b* I from Z to X, *c* H from Z to W, *d g* from Z to T, and *e* F from Z to S. Then draw the lines S *s*, T *t*, W *w*, X *x*, and Y *y*, each parallel to R *r*. Set off the distance Y *y* from *a* to 11, and from *f* to 1; the distance *x* X from *b* to 10, and from *g* to 2; *w* W from *c* to 9, and from *h* to 3; *t* T from *d* to

8, and from *i* to 4; *s* S from *e* to 7, and from *n* to 5. Then laying a ruler to the centre Z, draw the forenoon hour-lines through the points 11, 10, 9, 8, 7; and laying it to the centre *z*, draw the afternoon lines through the points 1, 2, 3, 4, 5; continuing the forenoon lines of VII and VIII through the centre Z, to the opposite side of the dial, for the like afternoon hours; and the afternoon lines IV and V through the centre *z*, to the opposite side, for the like morning hours. Set the hours to these lines as in the figure, and then erect the stile or gnomon; and the horizontal dial will be finished.

To construct a south dial, draw the line V Z, making an angle with the meridian Z L equal to the co-latitude of your place; and proceed in all respects as in the above horizontal dial for the same latitude, reversing the hours, and making the elevation of the gnomon equal to the co-latitude.

We shall now, to render this article complete, explain the method of constructing the dialing-lines, and some others.

With any opening of the compasses, as E A (fig. 8), according to the intended length of the scale, describe the circle A D C B, and cross it at right angles by the diameters C E A and D E B. Divide the quadrant A B first iuto nine equal parts, and then each part into ten; so shall the quadrant be divided into ninety equal parts or degrees. Draw the right line A F B for the chord of this quadrant, and setting one foot of the compasses in the point A, extend the other to the several divisions of the quadrant, and transfer these divisions to the line A F B by the arcs 10 10, 20 20, &c. and this will be a line of chords, divided into 90 unequal parts; which, if transferred from the line back again to the quadrant, will divide it equally. It is plain by the figure, that the distance from A to 60 in the line of chords, is just equal to A E, the radius of the circle from which that line is made; for if the arc 60 60 be continued, of which A is the centre, it goes exactly through the centre E of the arc A B.

And therefore, in laying down any number of degrees on a circle by the line of chords, you must first open the compasses, so as to take in just 60 degrees upon that line, as from A to 60: and then, with that extent as a radius, describe a circle which will be exactly of the same size with that from which the line was divided: which done, set one foot of the compasses in the beginning of the chord line, as at A, and extend the other to the number of degrees you want upon the line, which extent, applied to the circle, will include the like number of degrees upon it.

Divide the quadrant C D into 90 equal parts, and from each point of division draw right lines as *i*, *k*, *l*, &c. to the line C E; all perpendicular to that line, and parallel to D E, which will divide E C into a line of sines; and although these are seldom put among the dialing-lines on a scale, yet they assist in drawing the line of latitudes. For, if a ruler be laid upon the point D, and over each division in the line of sines, it will divide the quadrant C B into 90 unequal parts, as B *a*, *a b*, &c. shewn by the right lines 10 *a*, 20 *b*, 30 *c*, &c. drawn along the edge of the ruler. If the right line B C be drawn, subtending this quadrant, and the nearest distances B *a*, B *b*, B *c*, &c. be taken in the compasses from B, and set upon this line in the same manner as directed for the line of chords, it will make a line of latitudes B C, equal in length to the line of chords A B, and of an equal number of divisions, but very unequal as to their lengths.

Draw the right line D G A, subtending the quadrant D A; and parallel to it, draw the right line *r s*, touching the quadrant D A at the numeral figure 3. Divide this quadrant into six equal parts, as 1, 2, 3, &c. and through these points of division draw right lines from the centre E to the line *r s*, which will divide it at the points where the six hours are to be placed, as in the figure. If every sixth part of the quadrant be subdivided into four equal parts; right lines drawn from the centre through these points of division, and continued to the line *r s*, will divide each hour upon it into quarters.

A dial on a card.—In fig. 9, we have the representation of a portable dial, which may be easily drawn on a card, and carried in a pocket-book. The lines *a d*, *a b*, and *b c*, of the gnomon, must be cut quite through the card; and as the end *a b* of the gnomon is raised occasionally above the plane of the dial, it turns upon the uncut line *c d* as on a hinge. The dotted line A B must be slit quite through the card; and the thread must be put through the slit, and have a knot tied behind, to keep it from being easily drawn out. On the other end of this thread is a small plummet D, and on the middle of it a small bead for shewing the time of the day.

To rectify this dial, set the thread in the slit right against the day of the month, and stretch the thread from the day of the month over the angular point where the curve-lines meet at XII; then shift the bead to that point on the thread, and the dial will be rectified.

To find the hour of the day, raise the gnomon (no matter how much or how little), and hold the edge of the dial next the gnomon towards the sun, so that the uppermost edge of the shadow of the gnomon may just cover the shadow-line; and the bead then playing freely on the face of the dial, by the weight of the plummet, will shew the time of the day among the hour-lines, as it is forenoon or afternoon.

To find the time of sun-rising and setting, move the thread among the hour-lines, until it either covers some one of them, or lies parallel betwixt any two; and then it will cut the time of sun-rising among the forenoon hours, and of sun-setting among the afternoon hours, on that day of the year for which the thread is set in the scale of months.

To find the sun's declination, stretch the thread from the day of the month over the angular point at XII, and it will cut the sun's declination, as it is north or south, for that day, in the arched scale of north and south declination.

To find on what days the sun enters the signs; when the bead, as above rectified, moves along any of the curve lines which have the signs of the zodiac marked upon them, the sun enters those signs on the days pointed out by the thread in the scale of months.

The construction of this dial is very easy, especially if the reader compares it all along with fig. 10, as he reads the following explanation of that figure.

Draw the occult line A B (fig. 10), parallel to the top of the card, and cross it at right angles with the six-o'clock line E C D; then upon C, as a centre, with the radius C A, describe the semicircle A E L, and divide it into twelve equal parts (beginning at A), as A *r*, A *s*, &c. and from these points of division, draw the hour-lines *r*, *s*, *t*, *u*, *v*, E, *w*, and *x*, all parallel to the six-o'clock line E C. If each part of the semicircle be subdivided into four equal parts, they will give the half-hour lines and quarters, as in fig. 9. Draw the right line A S D *o*, making the angle S A B equal to the latitude of your place. Upon the centre A describe the arch R S T, and set off upon it the arcs S R and S T, each equal to 23½ degrees, for the sun's greatest declination; and divide them into 23½ equal parts, as in fig. 9. Through the intersection D of the lines E C D and A D *o*, draw the right line F D G at right angles to A D *o*. Lay a ruler to the points A and R, and draw the line A R F through 23½ degrees of south declination in the arc S R; and then laying the ruler to the points A and T, draw the line A T G through 23½ degrees of north declination in the arc S T: so shall the lines A R F and A T G cut the line F D G in the proper length for the scale of months. Upon the centre D, with the radius D F, describe the semicircle F *o* G; and divide it into six equal parts, F *m*, *m n*, *n o*, &c. and from these points of division draw the right lines *m h*, *n i*, *p k*, and *q l*, each parallel to *o* D. Then setting one foot of the compasses in the point F, extend the other to A, and describe the arc A *z* H for the tropic of ♑; with the same extent, setting one foot in G, describe the arc A E O for the tropic of ♋. Next setting one foot in the point *h*, and extending the other to A, describe the arc A C I for the beginnings of the signs ♒ and ♐; and with the same extent, setting one foot in the point *l*, describe the arc A N for the beginnings of the signs ♊ and ♌. Set one foot in the point *i*, and having extended the other to A, describe the arc A K for the beginnings of the signs ♓ and ♏; and with the same extent, set one foot in *k*, and describe the arc A M for the beginnings of the signs ♉ and ♍. Then, setting one foot in the point D, and extending the other to A, describe the curve A L for the beginnings of ♈ and ♎; and the signs will be finished. This done, lay a ruler from the point A over the sun's declination in the arch R S T (found by the following table) for every fifth day of the year; and where the ruler cuts the line F D G, make marks; and place the days of the months right against these marks, in the manner shewn by fig. 9. Lastly, draw the shadow-line P Q, parallel to the occult line A B; make the gnomon, and set the hours to their respective lines, as in fig. 9, and the dial will be finished.

The following table shews the sun's place and declination, in degrees and minutes, at the noon of every day of the second year after leap-year; which is a mean between those of leap-year itself, and the first and third years after. It is useful for inscribing the months and their days on sun-dials, and also for finding the latitudes of places.

A TABLE, Shewing the Sun's Place and Declination.

Days.	JANUARY. Sun's Pl. D.	M.	Sun's De. D.	M.	Days.	FEBRUARY. Sun's Pl. D.	M.	Sun's De. D.	M.
1	11	5	23 S	1	1	12♒	38	17 S	2
2	12	6	22	55	2	13	39	16	45
3	13	8	22	49	3	14	40	16	27
4	14	9	22	43	4	15	41	16	10
5	15	10	22	37	5	16	41	15	51
6	16	11	22	29	6	17	42	15	33
7	17	12	22	22	7	18	43	15	14
8	18	13	22	14	8	19	43	14	55
9	19	14	22	5	9	20	44	14	36
10	20	16	21	56	10	21	45	14	17
11	21	17	21	47	11	22	45	13	57
12	22	18	21	37	12	23	46	13	37
13	23	19	21	27	13	24	46	13	17
14	24	20	21	17	14	25	47	12	57
15	25	21	21	6	15	26	47	12	36
16	26	22	20	54	16	27	48	12	15
17	27	24	20	43	17	28	48	11	54
18	28	25	20	30	18	29	48	11	33
19	29	26	20	18	19	0♓	49	11	12
20	0♒	27	20	5	20	1	49	10	50
21	1	28	19	52	21	2	50	10	29
22	2	29	19	38	22	3	50	10	7
23	3	30	19	24	23	4	50	9	45
24	4	31	19	10	24	5	51	9	23
25	5	32	18	55	25	6	51	9	0
26	6	33	18	40	26	7	51	8	38
27	7	34	18	24	27	8	51	8	16
28	8	35	18	9	28	9	51	7	53
29	9	35	17	53					
30	10	36	17	36					
31	11	37	17	19					

In these tables N signifies north declination, and S south.

A TABLE, Shewing the Sun's Place and Declination.

Days.	MAY. Sun's Pl. D.	M.	Sun's De. D.	M.	Days.	JUNE. Sun's Pl. D.	M.	Sun's De. D.	M.
1	10♉	55	15 N	7	1	10♊	44	22 N	5
2	11	53	15	25	2	11	41	22	13
3	12	51	15	43	3	12	39	22	21
4	13	49	16	0	4	13	36	22	28
5	14	47	16	18	5	14	34	22	35
6	15	45	16	35	6	15	31	22	41
7	16	43	16	51	7	16	28	22	47
8	17	41	17	8	8	17	26	22	53
9	18	39	17	24	9	18	23	22	58
10	19	36	17	40	10	19	20	23	3
11	20	34	17	55	11	20	18	23	7
12	21	32	18	10	12	21	15	23	11
13	22	30	18	25	13	22	12	23	15
14	23	28	18	40	14	23	9	23	18
15	24	25	18	54	15	24	7	23	20
16	25	23	19	8	16	25	4	23	22
17	26	21	19	22	17	26	1	23	24
18	27	19	19	35	18	26	58	23	26
19	28	16	19	48	19	27	56	23	27
20	29	14	20	1	20	28	53	23	28
21	0♊	11	20	13	21	29	50	23	28
22	1	9	20	25	22	0♋	47	23	28
23	2	7	20	37	23	1	45	23	28
24	3	4	20	48	24	2	42	23	27
25	4	2	20	59	25	3	39	23	26
26	4	59	21	10	26	4	36	23	24
27	5	57	21	20	27	5	33	23	21
28	6	54	21	30	28	6	31	23	19
29	7	52	21	39	29	7	28	23	16
30	8	49	21	49	30	8	25	23	12
31	9	47	21	57					

A TABLE, Shewing the Sun's Place and Declination.

Days.	SEPTEMBER. Sun's Pl. D.	M.	Sun's De. D.	M.	Days.	OCTOBER. Sun's Pl. D.	M.	Sun's De. D.	M.
1	8♍	49	8 N	16	1	8♎	8	3 S	14
2	9	47	7	55	2	9	7	3	37
3	10	46	7	33	3	10	7	4	1
4	11	44	7	10	4	11	6	4	24
5	12	42	8	48	5	12	5	4	47
6	13	40	6	26	6	13	4	5	10
7	14	39	6	3	7	14	4	5	33
8	15	37	5	41	8	15	3	5	56
9	16	35	5	18	9	16	3	6	19
10	17	34	4	55	10	17	2	6	42
11	18	32	4	32	11	18	1	7	5
12	19	31	4	9	12	19	1	7	27
13	20	29	3	46	13	20	0	7	50
14	21	28	3	23	14	21	0	8	12
15	22	26	3	0	15	22	0	8	35
16	23	25	2	37	16	23	0	8	57
17	24	24	2	14	17	23	59	9	19
18	25	22	1	50	18	24	59	9	41
19	26	21	1	27	19	25	58	10	3
20	27	20	1	4	20	26	58	10	24
21	28	19	0	40	21	27	58	10	42
22	29	17	0	17	22	28	58	11	7
23	0♎	16	0 S	6	23	29	58	11	28
24	1	15	0	30	24	0♏	58	11	49
25	2	14	0	53	25	1	58	12	10
26	3	13	1	17	26	2	58	12	31
27	4	12	1	40	27	3	58	12	51
28	5	11	2	4	28	4	58	13	12
29	6	19	2	27	29	5	58	13	32
30	7	9	2	50	30	6	58	13	51
					31	7	58	14	11

A TABLE, Shewing the Sun's Place and Declination.

Days.	MARCH. Sun's Pl. D.	M.	Sun's De. D.	M.	Days.	APRIL. Sun's Pl. D.	M.	Sun's De. D.	M.
1	10♓	52	7 S	30	1	11♈	38	4 N	36
2	11	52	7	7	2	12	37	4	59
3	12	52	6	44	3	13	36	5	22
4	13	52	6	21	4	14	35	5	45
5	14	52	5	58	5	15	34	6	8
6	15	52	5	35	6	16	33	6	31
7	16	51	5	12	7	17	31	6	53
8	17	51	4	48	8	18	30	7	16
9	18	51	4	25	9	19	29	7	38
10	19	51	4	2	10	20	28	8	0
11	20	51	3	38	11	21	27	8	22
12	21	50	3	14	12	22	25	8	44
13	22	50	2	51	13	23	24	9	6
14	23	50	2	27	14	24	23	9	28
15	24	49	2	4	15	25	21	9	49
16	25	49	1	40	16	26	20	10	11
17	26	48	1	16	17	27	18	10	32
18	27	48	0	53	18	28	17	10	53
19	28	48	0	29	19	29	15	11	14
20	29	47	0	5	20	0♉	14	11	34
21	0♈	47	0 N	19	21	1	12	11	55
22	1	46	0	42	22	2	11	12	15
23	2	45	1	6	23	3	9	12	35
24	3	45	1	29	24	4	7	12	55
25	4	44	1	53	25	5	6	13	14
26	5	43	2	17	26	6	4	13	34
27	6	42	2	40	27	7	2	13	53
28	7	42	3	3	28	8	0	14	12
29	8	41	3	27	29	8	59	14	30
30	9	40	3	50	30	9	57	14	49
31	10	39	4	13					

A TABLE, Shewing the Sun's Place and Declination.

Days.	JULY. Sun's Pl. D.	M.	Sun's De. D.	M.	Days.	AUGUST. Sun's Pl. D.	M.	Sun's De. D.	M.
1	9♋	22	23 N	8	1	8♌	58	18 N	2
2	10	19	23	4	2	9	55	17	47
3	11	16	23	0	3	10	53	17	32
4	12	14	22	55	4	11	50	17	16
5	13	11	22	49	5	12	48	17	0
6	14	8	22	43	6	13	45	16	43
7	15	5	22	37	7	14	43	16	26
8	16	0	22	30	8	15	41	16	9
9	17	2	22	23	9	16	38	15	52
10	17	57	22	16	10	17	36	15	25
11	18	54	22	8	11	18	33	15	17
12	19	51	22	0	12	19	31	14	59
13	20	49	21	52	13	20	29	14	41
14	21	46	21	43	14	21	26	14	23
15	22	41	21	33	15	22	24	14	4
16	23	40	21	22	16	23	22	13	45
17	24	38	21	14	17	24	20	13	26
18	25	35	21	3	18	25	17	13	7
19	26	32	20	52	19	26	15	12	47
20	27	29	20	41	20	27	13	12	27
21	28	27	20	30	21	28	11	12	7
22	29	24	20	18	22	29	9	11	47
23	0♌	21	20	6	23	0♍	7	11	27
24	1	19	19	54	24	1	5	11	6
25	2	16	19	41	25	2	3	10	46
26	3	13	19	28	26	3	1	10	25
27	4	11	19	14	27	3	59	10	4
28	5	8	19	1	28	4	57	9	43
29	6	6	18	46	29	5	55	9	21
30	7	3	18	32	30	6	53	9	0
31	8	0	18	17	31	7	51	8	38

A TABLE, Shewing the Sun's Place and Declination.

Days.	NOVEMBER. Sun's Pl. D.	M.	Sun's De. D.	M.	Days.	DECEMBER. Sun's Pl. D.	M.	Sun's De. D.	M.
1	8♍	58	14 S	30	1	9♐	16	21 S	52
2	9	58	14	50	2	10	17	22	1
3	10	59	15	8	3	11	18	22	10
4	11	59	15	27	4	12	19	22	18
5	12	59	15	45	5	13	20	22	26
6	13	59	16	3	6	14	21	22	33
7	15	0	16	21	7	15	22	22	40
8	16	0	16	39	8	16	23	22	46
9	17	0	16	56	9	17	24	22	52
10	18	1	17	13	10	18	25	22	58
11	19	1	17	30	11	19	26	23	3
12	20	2	17	46	12	20	27	23	8
13	21	2	18	2	13	21	28	23	12
14	22	3	18	18	14	22	29	23	15
15	23	4	18	34	15	23	30	23	18
16	24	4	18	49	16	24	31	23	21
17	25	5	19	4	17	25	33	23	24
18	26	5	19	18	18	26	34	23	26
19	27	6	19	32	19	27	35	23	27
20	28	7	19	46	20	28	36	23	28
21	29	7	19	59	21	29	37	23	23
22	0♐	8	20	12	22	0♑	38	23	28
23	1	9	20	25	23	1	40	23	28
24	2	10	20	37	24	2	41	23	27
25	3	11	20	49	25	3	42	23	25
26	4	11	21	1	26	4	43	23	23
27	5	12	21	12	27	5	44	23	21
28	6	13	21	23	28	6	46	23	18
29	7	14	21	33	29	7	47	23	15
30	8	15	21	43	30	8	48	23	11
					31	9	49	23	6

To find the altitude of any place by observation.—The latitude of any place is equal to the elevation of the pole above the horizon of that place. Therefore it is plain, that if a star was fixed in the pole, there would be required to find the latitude, but to take the altitude of that star with a good instrument. But although there is no star in the pole, yet the latitude may be found by taking the greatest and least altitude of any star that never sets: for if half the difference between these altitudes be added to the least altitude, or subtracted from the greatest, the sum or remainder will be equal to the altitude of the pole at the place of observation.

But because the length of the night must be more than 12 hours, in order to have two such observations; the sun's meridian altitude and declination are generally made use of for finding the latitude, by means of its complement, which is equal to the elevation of the equinoctial above the horizon; and if this complement be subtracted from 90 degrees, the remainder will be the latitude, concerning which the following rules seem to take in all the various cases.

1. If the sun has north declination, and is on the meridian, and to the south of your place, subtract the declination from the meridian altitude (taken by a good quadrant), and the remainder will be the height of the equinoctial or complement of the latitude north.

EXAMPLE.

Suppose the sun's meridian altitude	42°	20′	south
And his declination, subt.	10	15	north
Remains the complement of the latitude	32	5	
Which subtract from	90	0	
And the rem. is the latitude	57	55	north.

2. If the sun has south declination, and is southward of your place at noon, add the declination to the meridian altitude; the sum, if less than 90 degrees, is the complement of the latitude north; but if the sum exceeds 90 degrees, the latitude is south; and if 90 be taken from that sum, the remainder will be the latitude.

EXAMPLES.

The sun's meridian altitude	65°	10′	south
The sun's declination, add	15	30	south
Complement of the latitude	80	40	
Subtract from	90	0	
Remains the latitude	9	20	north.
The sun's meridian altitude	80°	40′	south
The sun's declination, add	20	10	south
The sum is —	100	50	
From which subtract	90	0	
Remains the latitude	10	50	south.

3. If the sun has north declination, and is on the meridian north of your place, add the declination to the north meridian altitude; the sum, if less than 93 degrees, is the complement of the latitude south: but if the sum is more than 90 degrees, subtract 90 from it, and the remainder is the latitude north.

EXAMPLES.

Sun's meridian altitude	60°	30′	north
Sun's declination, add	20	10	north
Complement of the latitude	80	40	
Subtract from —	90	0	
Remains the latitude	9	20	south.
Sun's meridian altitude	70°	20′	north
Sun's declination, add —	23	20	north
The sum is —	93	40	
From which subtract	90	0	
Remains the latitude	3	40	north.

4. If the sun has south declination, and is north of your place at noon, subtract the declination from the north meridian altitude, and the remainder is the complement of the latitude south.

EXAMPLE.

Sun's meridian altitude	50°	30′	north
Sun's declination, subtract	20	10	south
Complement of the latitude	32	20	
Subtract this from	90	0	
And the rem. is the latitude	57	40	south.

5. If the sun has no declination, and is south of your place at noon, the meridian altitude is the complement of the latitude north: but if the sun be then north of your place, his meridian altitude is the complement of the latitude south.

EXAMPLES.

Sun's meridian altitude	38°	30′	south
Subtract from	90	0	
Remains the latitude	51	30	north.
Sun's meridian altitude	38°	30′	north
Subtract from	90	0	
Remains the latitude	51	30	south.

6. If you observe the sun beneath the pole, subtract his declination from 90 degrees, and add the remainder to his altitude; the sum is the latitude.

EXAMPLE.

Sun's declination —	20°	30′	
Subtract from —	90	0	
Remains — —	69	30	} add
Sun's altitude below the pole	10	20	}
The sum is the latitude	79	50.	

Which is north or south, according as the sun's declination is north or south: for when the sun has south declination, he is never seen below the north pole; nor is he ever seen below the south pole, when his declination is north.

7. If the sun be in the zenith at noon, and at the same time has no declination, you are then under the equinoctial, and so have no latitude.

8. If the sun be in the zenith at noon, and has declination, the declination is equal to the latitude, north or south. These two cases are so plain, that they require no examples.

DIALECTICS, dialectica, in the literary history of the antients, that branch of logic which taught the rules and modes of reasoning.

DIALLAGE, in mineralogy, called also resplendent hornblende. This stone was called *smaragdite* by Saussure, from the resemblance it has to emerald. It is never crystallized. Its texture is foliated, and it is easily divided into plates. The laminæ are inflexible, and the specific gravity is 3. The colour in some cases is fine green; in others it has the grey colour, and metallic lustre, of mica: it assumes all the shades of colour between these two extremes. According to Vauquelin, it is composed of

50.0	silica
13.0	lime
11.0	alumina
7.5	oxide of chromium
6.0	magnesia
5.5	oxide of iron
1.6	oxide of copper.
94.2	

DIALLING, the art of constructing all manner of dials. See DIAL.

Having described the most useful dials under the word DIAL, we now proceed to explain the philosophical principles of the art of dialling. In order to this, therefore, we are to consider, that as the time which passes between any meridian's leaving the sun, and returning to it again, is divided into 24 hours, so if we conceive a sphere to be constructed with twenty-four of these meridians, the sun will orderly come upon one of them at the beginning of every hour. Such a sphere may be represented by the figure P D S B (fig. 11), where the several meridians are represented by P 1 S, P 2 S, P 3 S, and so on to twenty-four in all; since these meridians divide the equinoctial into twenty-four equal parts, each part will contain just 15°, because 15×24=360, the whole circle; and since all the meridians pass through the poles of the world, the planes of those meridians all intersect each other in one common line P S, which is the axis of the sphere, therefore the said axis P S is in the plane of each of the twelve meridians. Suppose Z to be the zenith of any place, and D W B E the plane of the horizon fixed within the sphere, constructed with the twelve meridians, 1, 1; 2, 2; 3, 3; 4, 4; &c. then will the axis of the sphere P S pass through the centre of the plane at N; so that one half N P will be above the plane, and the other half N S below it. Suppose now this dialling-sphere to be suspended by the point Z, and moved about so as to have the points D and B exactly in the south and north points of the horizon, and E and W in the east and west points, then will the sphere have a situation every way similar to that of the earth and heavens with respect to the given place, and the axis of the sphere to that of the earth. The sun, therefore, shining on such a sphere, will be attended with all the same incidents, and produce all the same effects, as would happen if the said sphere were at the centre of the earth, or the centre N of the sphere coincided with the centre of the earth, because the distance between the surface and centre of the earth is insensible at the distance of the sun. Now it is evident, as the sun revolves about such a sphere, it will every hour be upon one half or other of the twelve hour-circles, viz. from midnight to noon, it will be on those parts of the circles which are in the eastern hemisphere; and

from noon to midnight, it will pass over all those in the western. It is also farther evident, that while the sun is in the eastern hemisphere, it will be first below and then above the plane of the horizon, and *vice versa* on the other side. Again, when the sun is upon any of these hour-circles, by shining upon the axis it causes it to cast a shadow on the contrary side, on the plane of the horizon, on the lower or upper surface, as it is below or above the said plane. This shadow of the axis will be precisely in the line in which the plane of the hour-circle would intersect the plane of the horizon: if, therefore, lines were drawn through the centre N, joining the points on each side the plane where the hour-circles touch it, as 4N4, 5N5, 6N6, &c. the shadow of the axis would fall on those lines at the beginning of each respective hour, and thereby indicate the hour-circle the sun is in for every hour of the day. These lines are properly called hour-lines, and among the rest that which represents the hour of 12 at noon is NB, half the meridian line DB; whence it appears that the hour-lines N1, N2, N3, &c. which serve for the afternoon, lie on the east side of the plane, and are numbered from the north to the east; and on the contrary.

It also appears, that as the sun's altitude above the plane is greater or less, the number of hour-circles the sun will possess above the horizontal plane will be also greater or less. Thus when the sun is at S in the equinoctial, its diurnal path for that day being the equinoctial circle itself ÆEQW, it is plain, since the arch ÆE = EQ, the sun will apply to six hour-circles below the horizon, and to six above it, in each half of the day; and consequently that on this day the shadow will occupy but 12 of the hour-lines on each surface of the plane, beginning and ending at six. But when the sun is in the tropic of Cancer, its diurnal path for that day being the tropic itself, TCRF, it is manifest the sun in the forenoon ascends above the plane in passing between the hour-circles of 3 and 4 in the morning, and descends below it in the afternoon between the hours of 8 and 9: therefore on the summer tropic the shadow will pass over 16 of those hour-lines. On the contrary, when the sun is in the winter tropic at O, its path being then OGIH, it rises above the plane between 8 and 9, and leaves it between 3 and 4.

From what has been said it is evident, that if the circles be supposed removed, and only the horizontal plane remains, with the half of the axis above it in the same position as before, then should we have constituted a horizontal dial, every way the same with those in common use, with only the addition of a substile to render the stile very firm. Hence appears the reason why the gnomon or stile in those dials in our latitude is always directed to the north pole, and always contains such an angle PNB, with the hour of 12 line NB, as is equal to the latitude of the place. Lastly, the reason appears why the number of hour-lines on these dials exceeds not 16, and they are all drawn from 6 to 12 and 6 again on the northern part, the rest on the southern; and why the hour-line of 6 lies directly east and west, as that of 12 does north and south.

DIALLING-GLOBE, an instrument of brass or wood, with a plane fitted to the horizon, and an index, so contrived as to give a clear illustration of the principles on which dials are made.

DIALLING-LINES or SCALES, are graduated lines placed on rulers or the edges of quadrants and other instruments, to expedite the construction of dials. These are, 1. A scale of six hours, which is only a double tangent, or two lines of tangents, each of 45°, set together in the middle, and equal to the whole line of sines, with the declination set against the meridian altitudes in the latitude of the place. 2. A line of latitudes, which is fitted to the hour-scale, and is made by this canon; As the radius : to the chord of 90° :: so are the tangents of each respective degree of the line of latitudes : to the tangents of other arcs. And then the natural sines of these arches are the numbers, which taken from a diagonal scale of equal parts, shall graduate the divisions of the line of latitudes to any radius. The lines of hours and latitudes are general, for pricking down all dials with centres.

The other scales are particular, and give the several requisites for all upright declining dials by inspection. They are, 1. A line of chords. 2. A line for the substile's distance from the meridian. 3. A line for the stile's height. 4. A line of the angle of 12 and 6. 5. A line of inclination of meridians. See DIAL.

DIALLING-SPHERE, an instrument made of brass, with several semicircles sliding over each other upon a moveable horizon, serving to demonstrate the nature of spherical triangles, as well as to give the true idea of drawing dials on all sorts of planes.

DIALIUM, a genus of the monogynia order, in the diandria class of plants. The corolla is pentapetalous; no calyx; the stamina at the upper side of the receptacle. There is one species, a tree of the East Indies.

DIALOGISM, in rhetoric, is used for the soliloquy of persons deliberating with themselves, as the following of Juno, in the first Æneid of Virgil:

Mene incepto desistere victam,
Nec posse Italia Teucrorum avertere regem,
Quippe vetor fatis? &c.

In this sense it is distinguished from dialogue.

DIAMETER, in geometry, a right line passing through the centre of a circle, and terminated at each side by the circumference thereof. The chief property of the diameter is, that it divides the circumference of a circle into two equal parts: hence we have a method of describing a semicircle upon any line, assuming its middle point for the centre. The diameter is the greatest of all chords. For finding the ratio of the diameter to the circumference, see CIRCLE.

How to find the diameter of shot or shells.—For an iron ball, whose diameter is given, supposing a nine-pounder, which is nearly four inches, say the cube root 2.08 (of nine pounds), is to four inches, as the cube root of the given weight, is to the diameter sought. Or, if 4 be divided by 2.08, the cube root of 9, the quotient 1.923 will be the diameter of a one-pound shot; which being continually multiplied by the cube root of the given weight, gives the diameter required. Or by logarithms much shorter, thus: If the logarithm of 1.923, which is .283979, be constantly added to the third part of the logarithm of the weight, the sum will be the logarithm of the diameter. Suppose a shot to weight 24 pounds: add the given logarithm .283979 to .460070 the third part of the logarithm 1.3802112 of 24, the sum .7440494 will be the logarithm of the diameter of a shot weighing 24 pounds, which is 5.5468 inches.

If the weight should be expressed by a fraction, the rule is still the same: for instance, the diameter of a $1\frac{1}{2}$ pound ball, or $\frac{3}{2}$, is found by adding the logarithm .2839793 found above, to .0586971 one-third of the logarithm of $\frac{2}{3}$; the sum .3426764 will be the logarithm of the diameter required, *i. e.* 2.2013 inches.

As the diameter of the bore, or the caliber of the piece, is made 1-20th part larger than that of the shot, according to the present practice, the following table is computed.

Diameters of the shots and calibers of English guns.

lb.	0	1	2	3	4	5	6	7	8	9	
0	0	1.923	2.423	2.775	3.053	3.288	3.498	3.679	3.846	4.000	Diam.
	0	2.019	2.544	2.913	3.204	3.568	3.668	3.861	4.038	4.200	Calib.
1	4.143	4.277	4.403	4.522	4.635	4.743	4.846	4.945	5.040	5.131	Diam.
	4.349	4.490	4.623	4.748	4.866	4.981	5.088	5.192	5.292	5.368	Calib.
2	5.220	5.305	5.388	5.409	5.547	5.623	5.697	5.769	5.839	5.908	Diam.
	5.480	5.570	5.661	5.742	5.824	5.893	5.982	6.057	6.129	6.203	Calib.
3	5.975	6.041	6.105	6.168	6.230	6.290	6.350	6.408	6.465	6.521	Diam.
	6.273	6.343	6.410	6.475	6.541	6.604	6.666	6.707	6.788	6.846	Calib.
4	6.576	6.631	6.684	6.737	6.789	6.640	6.890	6.940	6.989	7.037	Diam.
	6.904	6.962	7.018	7.076	7.128	7.182	7.234	7.287	7.338	7.383	Calib.

DIALLING.

Horizontal Dial.

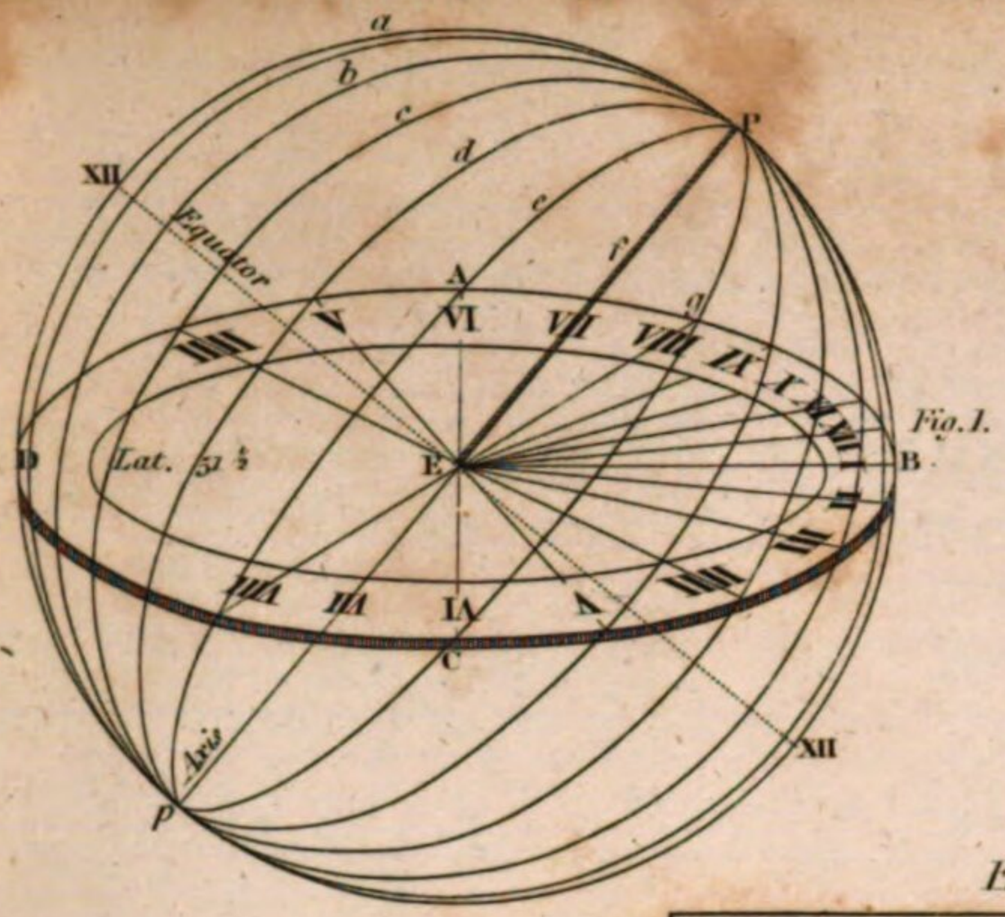


Fig. 1.

Vertical Dial.

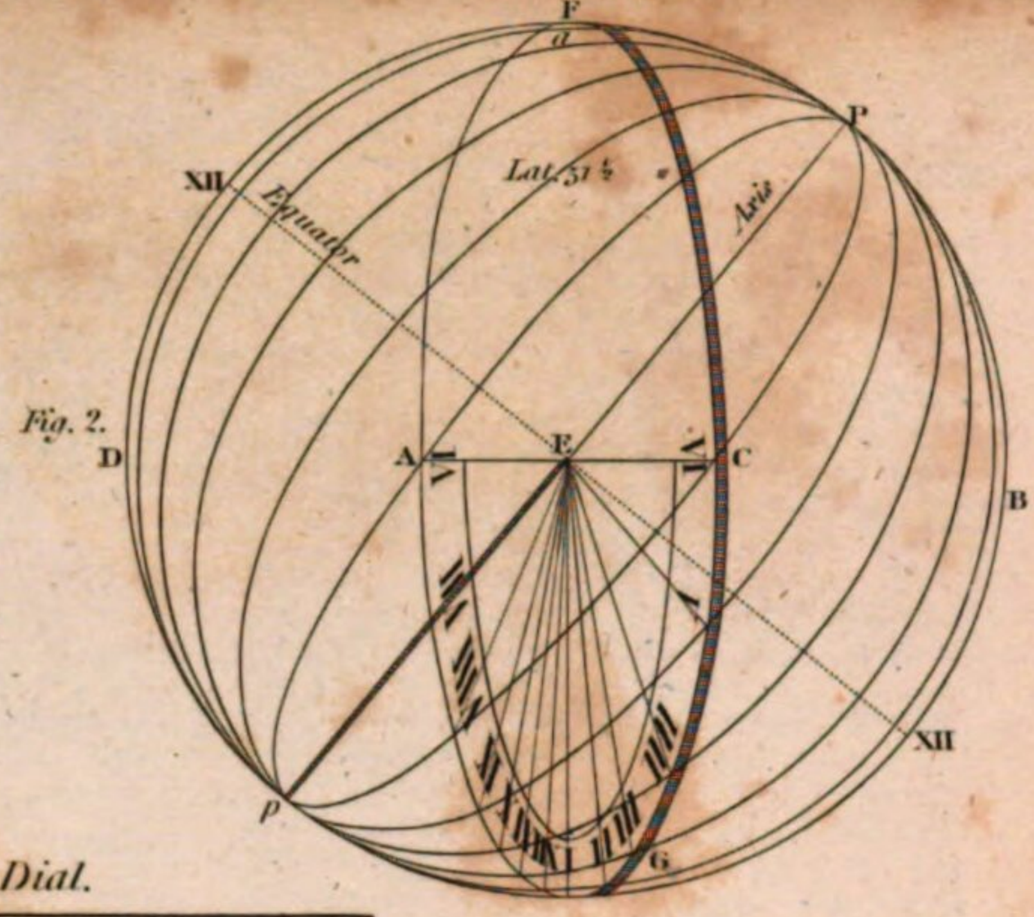


Fig. 2.

Erect South Dial.

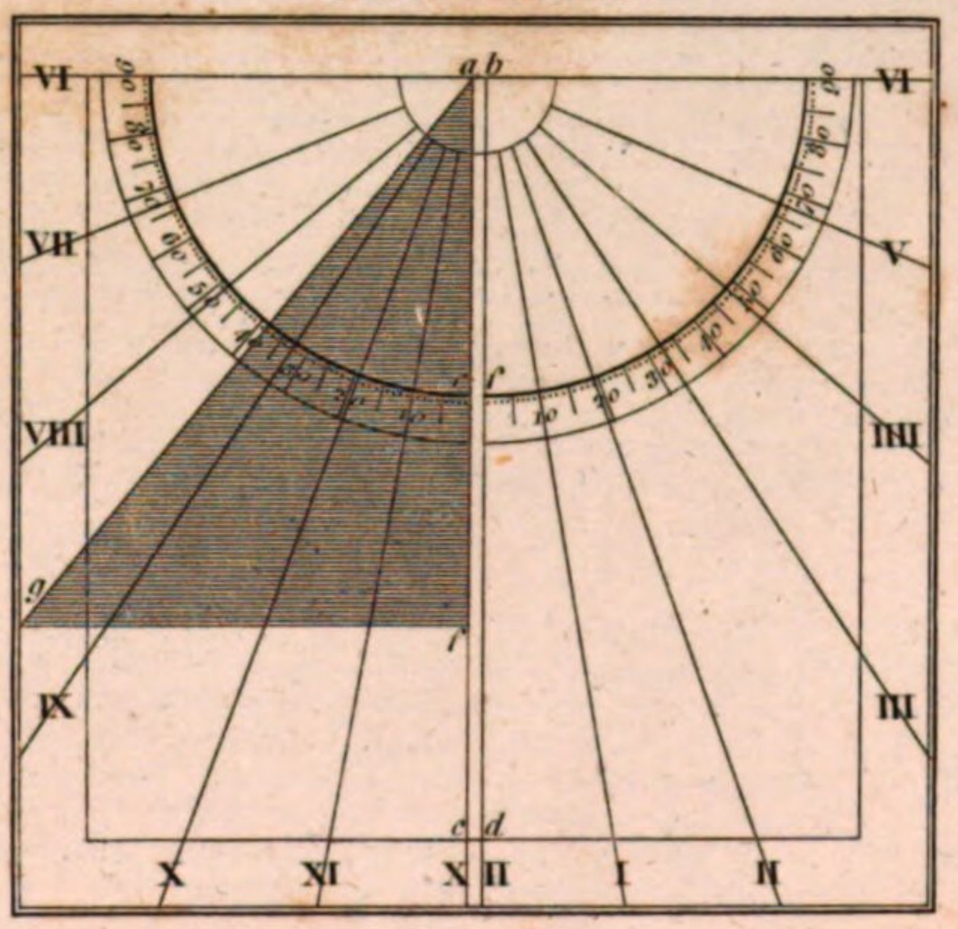


Fig. 4.

Horizontal Dial.

Fig. 3.

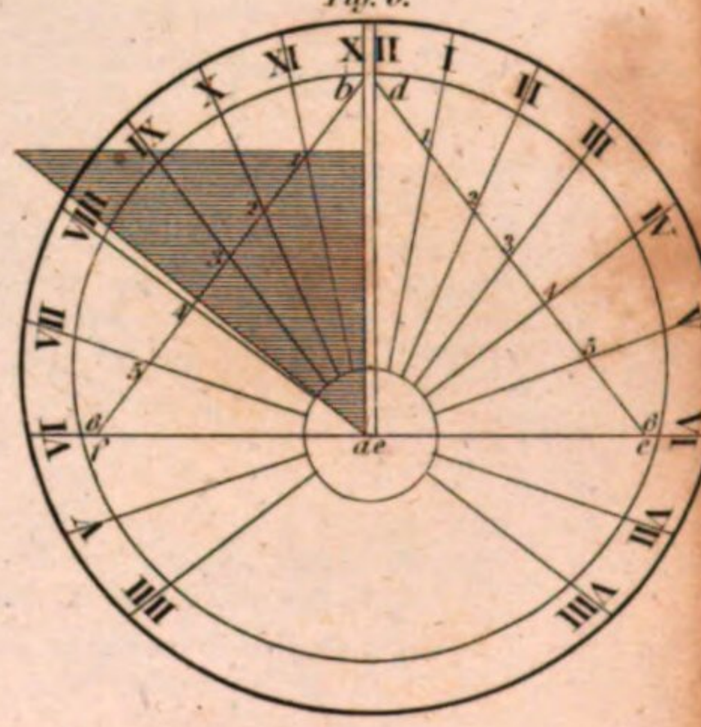


Fig. 6.

Dialling Lines.

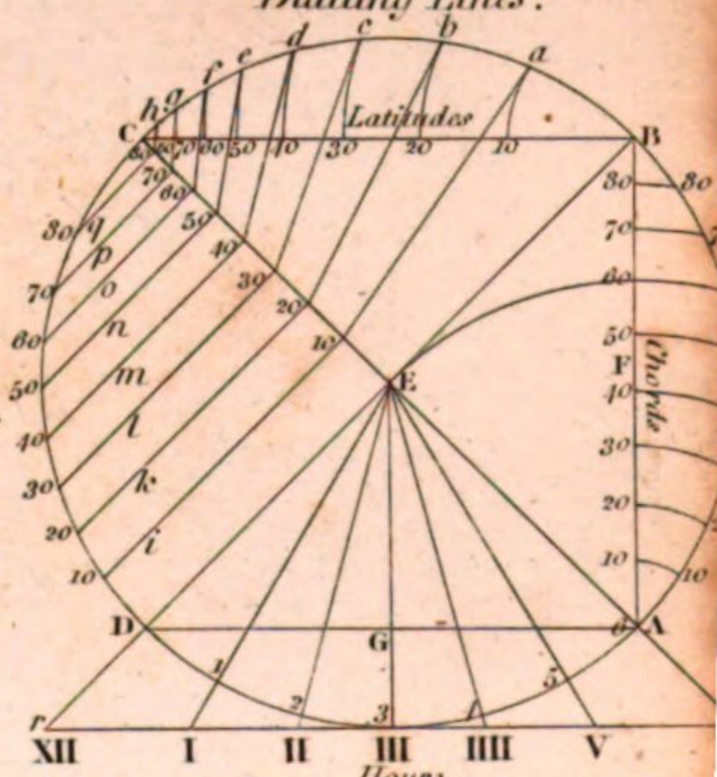
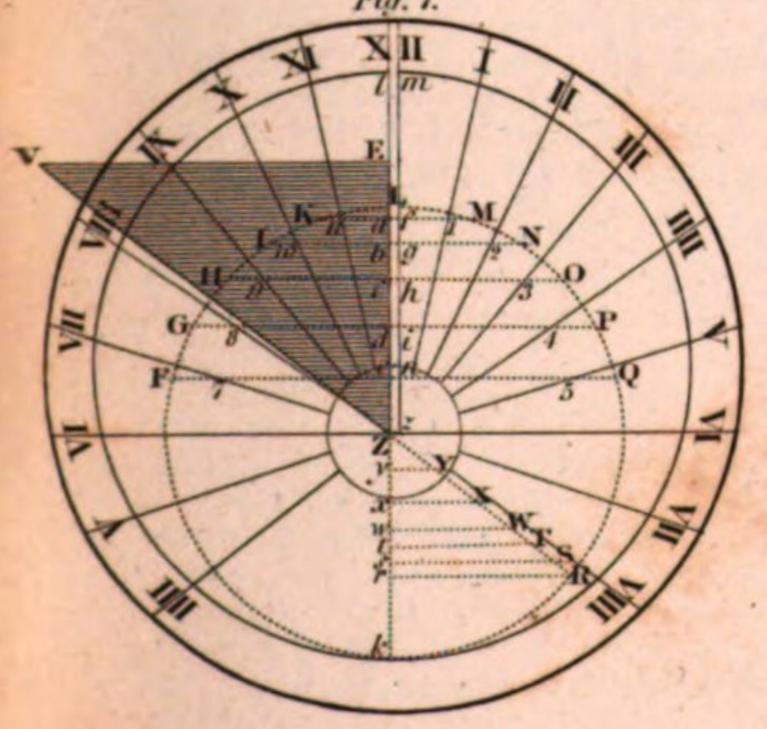


Fig. 8.

Fig. 7.



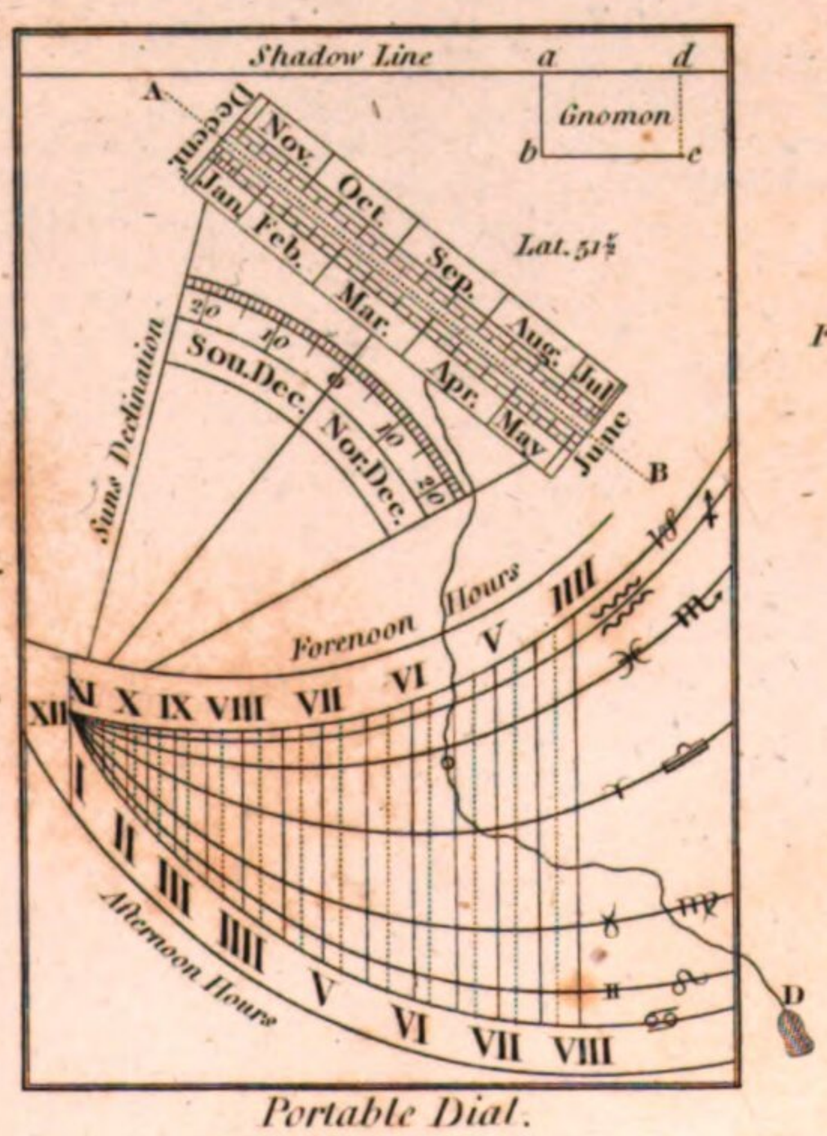


Fig. 9.

Portable Dial.

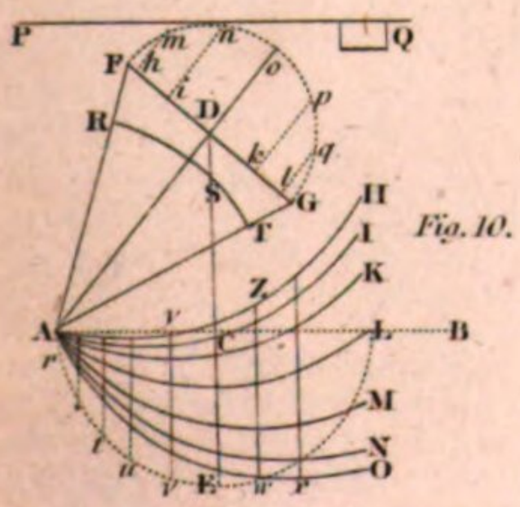


Fig. 10.

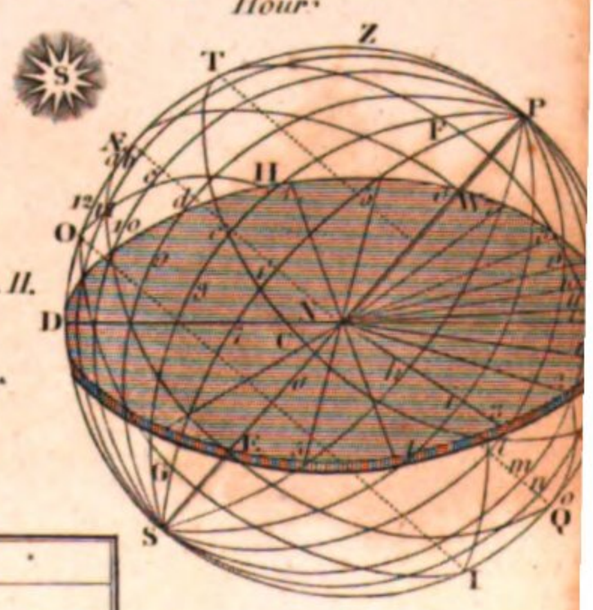


Fig. 11.

Dialling Scale.

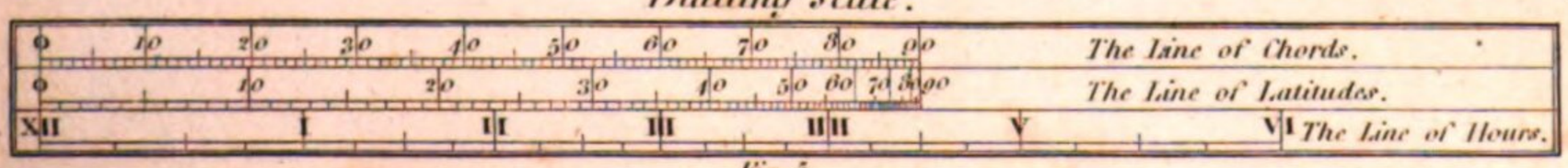


Fig. 5.

Explanation.

The numbers in the first horizontal line are units, and those in the first vertical column tens; the other numbers, under the one, and opposite to the others, are the respective diameters of shot and calibers. Thus, to find the diameter of the shot, and the caliber of a 24-pounder, look for the number 2 on the left-hand side, and for 4 at top; then the number 5.547, under 4, and opposite 2, will be the diameter of the shot in inches and decimals, and the number 5824, under the first, the caliber of a 24-pounder, &c.

Diameters of leaden bullets from 1 to 29 in the pound.

	0	1	2	3	4	5	6	7	8	9
0	0	1.671	1.326	1.158	1.05	.977	.919	.873	.835	.803
1	.715	.51	.730	.711	.693	.677	.663	.650	.637	.626
2	.615	.605	.596	.587	.579	.571	.564	.557	.550	.544
3	.538	.536	.526	.521	.517	.511	.506	.501	.497	.493

The diameter of musket-bores differs about 1-50th part from that of the bullet. The government allows 11 bullets in the pound for the proof of muskets, and 14 in the pound, or 29 in two pounds, for service; 17 for the proof of carbines, and 20 for service; 28 in the pound for proof of pistols, and 34 for service.

DIAMETER *of a curve*, is a right line AC (Plate Miscel. fig. 42.) bisecting the right lines DE, DE, drawn parallel to one another; and either of a finite or infinite length. Though a right line, bisecting all parallel lines drawn from one point of a curve to another, is taken in a strict sense only for the diameter of a curve line, yet it may not be amiss more generally to define a diameter in saying that it is that line, whether right or curve, which bisects all parallels drawn from one point of a curve to another, so that, according to this, every curve will have a diameter: and thence sir Isaac Newton's curves of the second order have all either a right-lined diameter, or else the curves of some one of the conic sections for diameters; and many geometrical curves of the higher orders may also have for diameters curves of more inferior ones, and that *ad infinitum*. See CURVE.

DIAMETER *of a sphere*, is the diameter of the semicircle, by whose rotation the sphere is generated; in which sense it is the same with axis. See AXIS.

DIAMETER *of gravity*, in any surface or solid, is that line in which the centre of gravity is placed. See CENTER OF GRAVITY.

DIAMETER, in astronomy. The diameters of the planets are either apparent or real: the apparent diameters are such as they appear to the eye; and being measured by a micrometer, are found different in different circumstances and parts of their orbit. See ASTRONOMY.

The mean apparent diameters of the planets, as seen from the sun, are as follow:

Merc.	Ven.	Ear.	Moon	Mars	Jup.	Sat.	Her.
20″	30″	17″	6″	11″	37″	16″	4″

DIAMOND, is a precious stone, which has been known from the remotest ages. When pure, it is perfectly transparent like crystal, but much more brilliant. Its figure varies considerably; but most commonly it is crystallized in the form of a six-sided prism, terminated by a six-sided pyramid. It is the hardest of all bodies; the best-tempered steel makes no impression on it. Diamond-powder can only be obtained by grinding one diamond against another. Its specific gravity is rather more than 3.5. It is a non-conductor of electricity.

As the diamond is not affected by a considerable heat, it was for many ages considered as incombustible. Sir Isaac Newton, observing that combustibles refract light more powerfully than other bodies, and that the diamond possesses this property in great perfection, suspected it, from that circumstance, to be capable of combustion. This singular conjecture was verified in 1694 by the Florentine academicians, in the presence of Cosmo III. grand duke of Tuscany. By means of a burning-glass, they consumed several diamonds. Francis I. emperor of Germany, afterwards witnessed the destruction of several more in the heat of a furnace. These experiments were repeated by Rouelle, Macquer, and Darcet; who proved that the diamond was not merely evaporated, but actually burnt; and that if air was excluded, it underwent no change.

No attempt, however, was made to ascertain the product till 1772. Lavoisier, in a Memoir published that year, shewed that when the diamond is burnt, carbonic acid gas is obtained, and that there is a striking analogy between it and charcoal. In 1785, Guyton-Morveau found that the diamond is combustible when dropped into melted nitre; that it burns without leaving any residuum, and in a manner analogous to charcoal. This experiment was repeated with more precision by Mr. Tennant in 1797. The conclusion which he drew from it was, that when a diamond is burnt the whole of the product is carbonic acid gas; that a given weight of diamond yields just as much carbonic acid gas as the same weight of charcoal; and that diamond and charcoal are both composed of the very same substance. The conclusion that diamond is nothing else than charcoal, was directly contrary to what one would have expected from comparing the two substances together. Their colour, hardness, specific gravity, and electrical properties, are exceedingly different; nor do they resemble each other more nearly in their combustibility. Charcoal takes fire at a red heat; and when once kindled in oxygen gas continues to burn till it is wholly consumed. According to Morveau, the diamond, before it can be burnt, must be exposed to the sun's rays in the focus of a large burning glass, or to a heat not under 5000°. But sir George M'Kenzie found that diamonds will burn in a muffle, when heated no higher than 14° or 15° Wedgewood; which must be considerably lower than 5000° Fahrenheit. Its surface assumes a black colour like charcoal: this crust is soon wasted, and another is formed in its place. It was in this manner that a diamond weighing 3.089 grains troy, gradually wasted away completely when exposed by Morveau for one hour and 40 minutes in the focus of the celebrated burning glass of Tschirnhausen, while a thermometer exposed to the sun stood at 104°.

Morveau found that one part of diamond during its combustion combines with 4.592 parts of oxygen, and the carbonic acid gas formed amounts to 5.592 parts: consequently, carbonic acid gas is composed of one part of diamond and 4.592 of oxygen; or, which is the same thing, 100 parts of carbonic acid gas are composed of

17.88 diamond
82.12 oxygen

100.00

But Lavoisier ascertained that one part of charcoal, when burnt, combines with 2.5714 parts of oxygen, and forms 3.5714 parts of carbonic acid gas: consequently, 100 parts of carbonic acid gas are composed of

28 charcoal,
72 oxygen.

100.

But 100 parts of carbonic acid gas are also composed of 17.88 diamond, and 82.12 oxygen. We have therefore this equation:

Diamond. Oxygen. Char. Oxygen.
17.88 + 82.12 = 28 + 72.

Consequently, subtracting 72 parts of oxygen from both sides of the equation, we have

Diamond. Oxygen.
17.88 + 10.12 = 28 charcoal.

That is to say, 28 parts of charcoal are composed of 17.88 diamond and 10.12 oxygen. Of course, 100 parts of charcoal are composed of

63.85 diamond,
36.15 oxygen.

100.00

Thus we see why diamond and charcoal possess different properties: the one is a simple substance; the other is a compound of the diamond and oxygen, or it is what the French chemists call an oxide of diamond. The diamond, then, is that substance in a state of purity to which Lavoisier and his associates gave the name of carbon; charcoal is not carbon, as they supposed, but the oxide of carbon.

Diamond-mines are found only in the East Indies, and in Brazil in South America; in the kingdoms of Golconda, Visapour, Bengal, and the island of Borneo. There are four mines, or rather two mines and two rivers, whence diamonds are drawn. 1. The mine of Raolconda, in the province of Carnatica, five days journey from Golconda, and eight from Visapour, which has been discovered about 200 years. 2. That of Gani, or Coolour, seven days journey from Golconda eastwardly. It was discovered 140 years ago by a peasant, who, digging in the

ground, found a natural fragment of twenty-five carats. 3. That of Soumelpour, a large town in the kingdom of Bengal, near the diamond-mine. This is the most antient of all, and should rather be called that of Goual, which is the name of the river, in the sand whereof these stones are found. Lastly, the fourth mine, or rather the second river, is that of Succudan, in the island of Borneo.

The diamond, we have already observed, is the hardest of all precious stones. It can only be cut and ground by itself and its own substance. To bring it to that perfection which augments its price so considerably, they begin by rubbing several against each other while rough, after having first glued them to the ends of two wooden blocks, thick enough to be held in the hand. It is this powder thus rubbed off the stones, and received in a little box for the purpose, that serves to grind and polish the stones. Diamonds are cut and polished by means of a mill, which turns a wheel of soft iron sprinkled over with diamond-dust mixed with oil of olives. The same dust well ground and diluted with water and vinegar, is used in the sawing of diamonds; which is performed with an iron or brass wire, as fine as a hair. Sometimes, in lieu of sawing the diamonds, they cleave them, especially if there are any large shivers in them. But the Europeans are not usually daring or expert enough to run the risk of cleaving, for fear of breaking.

The first water in diamonds, means the greatest purity and perfection of their complexion, which ought to be that of the purest water. When diamonds fall short of this perfection, they are said to be of the second or third water, &c. till the stone may be properly called a coloured one: for it would be an impropriety to speak of an imperfectly coloured diamond, or one that has other defects, as a stone of a bad water only.

Mr. Boyle has observed, from a person much conversant in diamonds, that some of these gems, in their rough state, were much heavier than others of the same size, especially if they were cloudy or foul. With regard to their specific gravities, Mr. Ellicot, who made many experiments, has drawn out a table of their several differences with great care and accuracy. This, taking in all the common varieties in diamonds, may indeed serve as a general rule for their mean gravity and differences. From this the mean specific gravity of the Brasil diamonds appears to be 3513; of East India diamonds, 3519; the mean of both, 3517. Therefore, if any thing is to be concluded as to the specific gravity of the diamond, it is, that it is to water as 3517 to 1000.

For the valuation of diamonds of all weights Mr. Jefferies lays down the following rule. He first supposes the value of a rough diamond to be settled at 2*l.* per carat at a medium; then to find the value of diamonds of greater weights, multiply the square of their weight by 2, and the product is the value required: *e. g.* To find the value of a rough diamond of two carats: $2 \times 2 = 4$, the square of the weight; which, multiplied by 2, gives 8*l.* the true value of a rough diamond of two carats. For finding the value of manufactured diamonds, he supposes half their weight to be lost in manufacturing them; and therefore, to find their value, we must multiply the square of double their weight by 2, which will give their true value in pounds. Thus, to find the value of a wrought diamond weighing two carats; we first find the square of double the weight, viz. $4 \times 4 = 16$; then $16 \times 2 = 32$. So that the true value of a wrought diamond of two carats is 32*l.* On these principles Mr. Jefferies has constructed tables of the price of diamonds from 1 to 100 carats.

The largest diamond ever known in the world is one belonging to the king of Portugal, which was found in Brasil. It is still uncut: and Mr. Magellan informs us, that it was of a larger size; but a piece was cleaved or broken off by the ignorant countryman who chanced to find this great gem, and tried its hardness by the stroke of a large hammer upon the anvil. This prodigious diamond weighs 1680 carats; and though uncut, Mr. Romé de l'Isle says that it is valued at 224 millions sterling; which gives the estimation of 79,36 or about 80 pounds sterling for each carat, viz. for the multiplicand of the square of its whole weight. The famous diamond in the sceptre of the emperor of Russia, weighs 779 carats, and is worth at least 4,854,728 pounds sterling, although it hardly cost 135,417 guineas. This diamond originally was one of the eyes of a Malabarian idol named Scheringham; and a French grenadier, who had deserted from the Indian service, contrived to become one of the priests of that idol, and by that means to steal it. After passing through several hands, the late prince Orloff purchased it at Amsterdam in 1766, for his sovereign the empress of Russia. The diamond of the great Mogul is cut in rose, weighs $279\frac{9}{16}$ carats, and is worth 380,000 guineas, though it has a small flaw near the bottom; and Tavernier, who fully examined it, valued the carat at 150 French livres. Another diamond belonging to the king of Portugal weighs 215 carats, is extremely fine, and is worth at least 369,800 guineas. The diamond of the emperor of Germany weighs $139\frac{1}{2}$ carats, and is worth at least 109,520 guineas. It is said this diamond has a little hue of a citron colour. The diamond once the property of the late unfortunate king of France, called the *Pitt* or *Regent*, weighs $136\frac{3}{4}$ carats: this gem is worth at least 208,333 guineas, although it did not cost above half that sum. Another diamond of the same monarch, called the *Sancy*, weighs 55 carats, cost 25,000 guineas, and is said to be worth much more.

Diamond, *brilliant*, is that which is cut in faces both at top and bottom; and whose table, or principal face at top, is flat. To make a complete square brilliant, if the rough diamond is not found of a square figure, it must be made so; and if the work is perfectly executed, the length of the axis will be equal to the side of the square base of the pyramid. Jewellers then form the table and collet by dividing the block or length of the axis into 18 parts. To render a brilliant perfect, each corner of the table-diamond must be shortened by 1-20th of its original. The corner ribs of the upper sides must be flattened or run towards the centre of the table 1-6th less than the sides; the lower part, which terminates in the girdle, must be 1-8th of one side of the girdle; and each corner rib of the under side must be flattened at the top to answer the above flattening at the girdle, and at bottom must be 1-4th of each side of the collet. The parts of the small work which completes the brilliant or the star and skill facets, are of a triangular figure. Both of these partake equally of the depth of the upper sides from the table to the girdle, and meet in the middle of each side of the table and girdle, as also at the corners. Thus they produce regular lozenges on the four upper sides and corners of the stone. The triangular facets, on the under sides, joining to the girdle, must be half as deep again as the above facets, to answer to the collet part. The stone here described is said to be a full-substanced brilliant. If the stone is thicker than in the proportion here mentioned, it is said to be an over-weighted brilliant. If the thickness is less than in this proportion, it is called a spread brilliant. The beauty of brilliants is diminished from their being either over-weighted or spread. The true proportion of the axis or depth of the stone to its side is as 2 to 3. Brilliants are distinguished into square, round, oval, and drops, from the figure of their respective girdles.

Diamond, *Cornish*, a name given by many people to the crystals found in digging the mines of tin in Cornwall. These crystals are of the nature of the Kerry-stone of Ireland, but somewhat inferior to it. They are usually bright and clear, except towards the root, where they are coarse and foul, or whitish. They are usually found in the common form of an hexangular column, terminated at each end by an hexangular pyramid.

Diamond, *rose*, is one that is quite flat underneath, with its upper part cut in many little faces, usually triangles, the uppermost of which terminate in a point. In rose-diamonds the depth of the stone from the base to the point must be half the breadth of the diameter of the base of the stone. The diameter of the crown must be two-thirds of the diameter of the base. The perpendicular, from the base to the crown, must be three-fifths of the diameter of the stone. The lozenges which appear in all circular rose-diamonds, will be equally divided by the ribs that form the crown; and the upper angles or facets will terminate in the extreme point of the stone, and the lower in the base or girdle.

Diamond, *rough*, is the stone as nature produces it from the mine. It should be chosen uniform, of a good shape, transparent, not quite white, and free from flaws and shivers. Black, rugged, dirty, flawy, veiny stones, and all such as are not fit for cutting, are pounded in a steel mortar made for that purpose; and when pulverised, the dust serves to saw, cut, and polish the rest. Shivers are occasioned by the miners attempting to get them more easily out of the vein, which winds between two rocks, by breaking the rocks with huge iron levers, which shake, and thus fill the stone with cracks and shivers. The antients had two mistaken notions with regard to the diamond: the first, that it became soft by steeping it in hot goat's blood; and the second, that it is malleable, and bears the hammer.

Diamonds and precious stones may be imported duty-free, saving the duty granted to the East India company on diamonds imported from any place within the limits of their charter. 6 Geo. II. c. 7. s. 1. 2.

Diamond, in the glass trade, an instrument used for squaring the large plates or pieces; and, among glaziers, for cutting their glass.

These diamonds are differently managed. That used for large pieces, as looking-glasses, is set in an iron ferule, about two inches long, and a quarter of an inch in diameter; the cavity of the ferule being filled up with lead, to keep the diamond firm: there is al o a handle of box or ebony fitted to the ferule, and by which it is held.

DIAMOND, in heraldry, a term used for expressing the black colour in the achievements of peerage. Guillim does not approve of blazoning the coats of peers by precious stones instead of metals and colours; but the English practice allows it. Morgan says the diamond is an emblem of fortitude.

DIANÆ ARBOR or ARBOR LUNÆ, in chemistry, the beautiful crystallizations of silver dissolved in aqua-fortis, to which some quicksilver is added; and so called from their resembling the trunk, branches, leaves, &c. of a tree. See ARGENTUM ARBORESCENS.

DIANDRIA, the name of the second class in Linnæus's sexual system, consisting of hermaphrodite plants, which, as the name imports, have flowers with two stamina or male organs. The orders in this class are three, derived from the number of styles or female parts. Most plants with two stamina have one style; as jessamine, lilac, privet, veronica, and bastard alaternus: vernal grass has two styles; pepper, three.

DIANTHERA, in botany, a genus of the monogynia order, in the diandria class of plants, and in the natural method ranking under the 40th order, personatæ. The corolla is ringent; the capsule bilocular, parting with a spring at the heel; the stamina each furnished with two antheræ, placed alternately. There are 12 species.

DIANTHUS, clove-gilliflower, carnation, pink, sweet-william, &c. a genus of the digynia order, in the decandria class of plants, and in the natural method ranking under the 22d order, caryophyllei. The calyx is cylindrical and monophyllous, with four scales at the base. There are five petals, with narrow heels; the capsule is cylindrical and unilocular. There are 30 species; but not more than four that have any considerable beauty as garden-flowers, each of which furnishes some beautiful varieties.

1. The caryophyllus, or clove-gilliflower, including all the varieties of carnation. It rises with many short trailing shoots from the root, with long, very narrow, evergreen leaves; and amidst them upright slender flower-stalks, from one to three feet high, emitting many side-shoots; all of which, as well as the main stalk, are terminated by large solitary flowers, having short oval scales to the calyx, and crenated petals. The varieties of this are very numerous, and unlimited in the diversity of flowers.

2. The deltoides, or common pink, rises with numerous short leafy shoots crowning the root, in a tufted head close to the ground, with small narrow leaves; and from the ends of the shoots many erect flower-stalks, from about 6 to 15 inches high, terminated by solitary flowers of different colours, single and double, and sometimes finely variegated. This species is perennial, as all the varieties of it commonly cultivated also are.

3. The chinensis, Chinese, or Indian pink, is an annual plant, with upright firm flower-stalks, branching erect on every side, a foot or 15 inches high, having all the branches terminated by solitary flowers of different colours and variegations, appearing from July to November.

4. The barbatus, or bearded dianthus, commonly called sweet-william. This rises with many thick leafy shoots, crowning the root in a cluster close to the ground, with spear-shaped evergreen leaves, from half an inch to two inches broad. The stems are upright and firm, branching erect two or three feet high, having all the branches and main-stem crowned by numerous flowers in aggregate clusters of different colours and variegations. The culture of these is very generally known.

DIAPASON, in music. By this term the antient Greeks expressed the interval of the octave: and certain musical instrument-makers have a kind of rule or scale, called the diapason, by which they determine the measures of the pipes, or other parts of their instruments. There is a diapason for trumpets and serpents: bell-founders have also a diapason for the regulation of the size, thickness, weight, &c. of their bells. Diapason is likewise the appellation given to certain stops in an organ. See STOP.

DIAPASON DIAPENTE (from the Greek), the interval compounded of an octave and a fifth conjoined; a twelfth.

DIAPASON DIATESSARON (from the Greek), the interval compounded of an octave and a fourth conjoined; an eleventh.

DIAPENSIA, in botany, a genus of the pentandria-monogynia class of plants, the flower of which consists of one saucer-like petal, the tube being cylindrical, and the limb divided into five obtuse and plane segments; the fruit is a trilocular roundish capsule, containing a great many roundish seeds. There is one species.

DIAPENTE, in the antient music, an interval marking the second of the concords; and, with the diatessaron, an octave. This is what in the modern music is called a fifth.

DIAPERED, or DIAPRE', in heraldry, the dividing of a field in planes, like fret-work, and filling the same with variety of figures.

DIAPHRAGM, in anatomy, a large, robust, musculous membrane or skin, placed transversely in the trunk, and dividing the thorax from the abdomen, whence the Latin writers call it septum transversum. See ANATOMY.

DIARRHŒA. See MEDICINE.

DIARTHROSIS. See ANATOMY.

DIASCORDIUM, in pharmacy, a celebrated composition so called from scordium, one of its ingredients. It is otherwise termed *confectio fracastorii*. See PHARMACY.

DIASTOLE, among physicians, signifies the dilatation of the heart, auricles, and arteries; and stands opposed to the systole, or contraction of the same parts. See PHYSIOLOGY.

DIASTOLE, in grammar, a figure of prosody, whereby a syllable naturally short is made long: such is the first syllable of Priamides, in the following verse of Virgil:

Atque hic Priamides: nihil ô tibi, amice, relictum.

DIASTYLE. See ARCHITECTURE.

DIATESSARON in music (from the Gr.), a term applied by the antient Greeks to that interval which we call a fourth; consisting of a greater tone, a lesser tone, and one greater semitone. The word is now used for the four gospels, arranged after the manner of a harmony.

DIATESSARON, in pharmacy, the name of a composition so called from the four ingredients it comprehends. See PHARMACY.

DIATONIC (from the Greek), a term applied by the antient Greeks to that of their three genera, which consisted, like the modern system of intervals, of major-tones and semitones. The diatonic genus has long since been considered as more natural than either the chromatic or enharmonic. Aristoxenus asserts it to have been the first, and informs us that the other two were formed from the division of its intervals.

DIATONUM INTENSUM, or sharp diatonic, the name given by musical theorists to those famous proportions of the intervals proposed by Ptolemy, in his system of that name; a system which, long after the time of this antient speculative musician, was received in our counterpoint, and is pronounced by Dr. Wallis, Dr. Smith, and the most learned writers on harmonics, to be the best division of the scale.

DIAZEUXIS (Greek), division, separation; the name given by the antients to the tone which separated two disjunct tetrachords. The diazeuxis was placed between the mesis and paramesis, *i. e.* between the highest note of the second tetrachord, and the lowest of the third; or between the note synnemenon, and the paramesis hyperboleon.

DICE, among gamesters, cubical pieces of bone or ivory, marked with dots on each of their faces, from one to six, according to the number of faces. Sharpers have several ways of falsifying dice: 1. By sticking a hog's bristle in them so as to make them run high or low as they please. 2. By drilling and loading them with quicksilver; which cheat is found out by holding them gently by two diagonal corners; for if false, the heavy sides will turn always down. 3. By filing and rounding them. But all these ways fall far short of the art of the dice-makers; some of whom are so dextrous this way, that sharpers will repay them with any money.

DICERA, a genus of the polyandria monogynia class and order. The petals are four, ovate and trifid; nectarium four or five emarginate corpuscules; anthers two horned. There are two species, trees of New Zealand.

DICHONDRIA, a genus of the class and order pentandria digynia. The calyx is five-leaved; corolla rotate, inferior; capsule dicoccous. There is one species, an herb of New Zealand.

DICHORD (from the Greek), the name given to the two-stringed lyre, said to have been invented by the Egyptian Mercury. Apollodorus accounts for its invention in the following manner: "Mercury," says he, "walking on the banks of the river Nile, happened to strike his foot against the shell of a tortoise, the flesh of which had been dried away by the heat of the sun, and nothing left of its contents but the nerves and cartilages; he was so pleased with the sound it produced, that he thence conceived the idea of a lyre, which he afterwards constructed in the form of a tortoise, and strung it with the dried sinews of animals."

DICHOTOMY, a term used by astrono-

mers for that phasis or appearance of the moon, wherein she is bisected, or shews just half her disk. In this situation the moon is said to be in a quadrate aspect, or to be in her quadrature.

DICHOTOMY. See BOTANY.

DICKSONIA, a genus of the class and order cryptogamia filices. There are two species, one of which is supposed to be the same with the baromets or Scythian lamb.

DICTAMNUS, white dittany, or fraxinella, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 26th order, multisiliquæ. The calyx is pentaphyllous; the petals are five and patulous; the filaments sprinkled with glandulous points; the capsules five, coalited. There are two species.

The dalbus, or fraxinella, has thick, penetrating, perennial roots, collected into a head at top, sending up erect stalks annually, two or three feet high, garnished with pinnated alternate leaves, of three or four pair of oblong stiff lobes, terminated by an odd one; and the stalks crowned by long, pyramidal, loose spikes of flowers, of white, red, and purple colours. They are very ornamental plants, and succeed in any of the common borders.

DICTATOR, in the policy of the antient Romans, a magistrate invested with sovereign and even arbitrary power. He had power of life and death; also to raise or disband troops, make war or peace, and that without the consent either of the senate or people, or being accountable for his proceedings. He was elected by one of the consuls in the night-time on the frontiers of the commonwealth, and no where else; and the ordinary duration of his office was only for six months, during which time all other magistracies ceased, the tribuneship excepted. Whenever he appeared in public, he was attended by 24 lictors, or double the number allowed a consul. However, notwithstanding all this power, he could not go out of Italy, nor even ride on horseback during a march, without leave from the people. This office was accounted the safeguard of the commonwealth for 400 years together, till Sylla and Cæsar, by assuming the title of perpetual dictators, converted it into tyranny, and rendered the very name odious.

DIDELPHIS, *opossum*, a genus of quadrupeds of the order of feræ. The generic character is: front teeth small, rounded; superior ten, the two middle ones longer; inferior eight, the two middle ones broader and very short; canine teeth long; grinders denticulated; tongue ciliated with papillæ; abdominal pouch, in most species, containing the teats.

The animals of this highly singular genus first became known to naturalists on the discovery of the western continent, and most justly excited the admiration of the philosophic world, by the strange, and, till then, unheard-of, contrivance of nature for the protection and preservation of the young; which, instead of being exposed, like other animals, during their state of helpless imbecility, to the casualties incident to that period, were securely concealed in a pouch or receptacle situated under the body of the parent.

The opossums were long supposed to be peculiar to America; but later discoveries have evinced that several species, unknown to America, exist in other parts of the globe. The following are the most remarkable species:

1. Didelphis Virginiana, or Virginian opossum. This, which seems to have been the species first discovered in America, is not much inferior in size to a cat, but is of a thicker form, owing to the length and upright growth of the fur. The general measure seems to be about one foot four inches from the nose to the tail, which is commonly about a foot or thirteen inches long. It is an animal of an inelegant aspect; having a long sharpened face, and very wide mouth, armed with very numerous sharp teeth: the tail is blackish at its origin, and covered with longish hair; but from that part to the end is naked, and covered with a scaly skin, the divisions of which are marked in such a manner as to give the tail very much the appearance of a whitish snake: it is strongly prehensile, or possessed of the power of coiling, like those of several monkeys, round any object from which the animal pleases to suspend itself. Its general colour is a dingy yellowish white; the legs blackish; the belly is white, and its lower part, in the female, is furnished with a large cavity or receptacle, which can be opened and closed at pleasure: in this are situated the teats; and in it the young, immediately after birth, are either placed by the parent animal, or introduce themselves; for this is one of those particulars in natural history which hitherto seem to have eluded investigation: it is, however, more than probable that the parent herself places them there; since, even long after their residence in it, they are void of hair, and resemble fœtuses or embryos, strongly adhering to the teats. When they have attained sufficient growth and strength, they emerge, after which they occasionally take refuge in the same receptacle on the appearance of any danger, and are carried about by the parent. This is the practice with most of the opossum tribe; but there are two species which have no ventral pouch for the reception of their young, but a kind of depression or furrow in its stead.

When imported into Britain, the opossums have never been known to breed; the late Mr. John Hunter having frequently procured several for this purpose, but could by no means succeed in his endeavours to ascertain the particulars of their history in this respect. The kangaroo however, which is an example of a similar contrivance of nature, has afforded opportunities of illustrating the subject more satisfactorily.

The Virginian opossum, like all the other American species, is a carnivorous animal, and preys on poultry, small birds, &c. in the manner of the European polecat: it is also frugivorous, eating several kinds of roots, fruits, &c. It is of a gentle disposition, and may easily be tamed; but, like some other species, it has a disagreeable smell: its voice is a sort of grunting squeak; its pace in running is not swift, but it is very expert in climbing trees, and readily passes, by means of its clinging tail, from bough to bough, in the manner of a monkey. The female produces four or five at a birth, and has the power of closing the pouch so strongly as to make it extremely difficult to open it by the hand; nor will any torture compel the animal to loosen it. This power of strongly closing the pouch is performed by certain bones and muscles which nature has provided for that purpose. These were observed and described by the celebrated Cowper, in the last century, as also by Dr. Tyson. The female, when ready to produce her young, is said to make herself a nest of dry grass, in some bush, near the root of a tree. See Plate Nat. Hist. fig. 165.

2. Didelphis marsupialis, or Molucca opossum. This, which is a larger species than the former, is of a thinner or more slender habit than the Virginian opossum, with the snout longer, and the mouth wider in proportion. The count de Buffon, however, considers it as the same species, and accuses Seba of negligence or ignorance in representing it as a native of the East Indies, contending that all the animals of this genus are natives of the New World. Subsequent discoveries, however, have amply justified Seba's account of its residence, specimens having been frequently imported from the Indian islands, &c. Its colour is a moderately deep brown, paler beneath; the ears are moderately large, and somewhat longer in proportion than in the Virginian opossum, or not of so rounded a form; the tail nearly similar to that of the Virginian; but the superior size and thinner form both of body and limbs, together with its much darker colour, sufficiently distinguish it, even at first sight, from the former species. It is reckoned a delicate food, and is said to be often seen at the tables of the great in India, where it is reared with rabbits.

3. Didelphis brachyura, or short-tailed opossum. This is one of the smaller species, and is said seldom to exceed the length of five inches from nose to tail, and in general to be somewhat smaller than this; and the tail scarcely ever exceeds the length of two inches. Its colour is a reddish-brown on the upper parts, and whitish beneath; it is destitute of an abdominal pouch, the young fastening themselves to the teats. The fur of this animal is very soft and elegant; the tail is very thick at the base, and gradually tapers to the end. It is a native of S. America.

4. Didelphis orientalis, or phalanger. The phalanger is of the size of a very large rat, measuring about nine inches from nose to tail, and the tail measures ten inches. It is a native of the Molucca islands, and is supposed to be unknown in America, though the count de Buffon informs us that the specimens which he examined were transmitted to him under the name of rats of Surinam. The colour of the phalanger is rufous grey on the upper part, and yellowish white beneath, and along the top of the head and the back runs a blackish line: the tail is hairy for about two inches and a half from the base, and the remainder is naked. Its voice is said to resemble that of a squirrel, and it often assumes the attitude of a squirrel when feeding. The muzzle is rather thick; the ears short and covered with hair: in the upper jaw are eight cutting teeth, and two in the lower.

5. Didelphis philander. The philander is about the size of a large rat; the head is large, the snout thick, and the ears rounded and upright; the tail is longer than the body, and is hairy for some little distance from the base, the remainder being naked, and towards the end prehensile. The length of the body is

nine inches, and of the tail thirteen. The philander is of a reddish brown above, and whitish beneath; the eyes are surrounded with a brownish border; the mouth on each side is beset with very long vibrissæ or whiskers; down the forehead runs a brownish stripe; the thumbs on the hind feet are rounded, as in most others of this genus. It has ten upper fore teeth, of which the middle ones are rather longer than the rest; and eight lower fore teeth, the middle ones rather longest, and standing distant. It is a native of Surinam, and, in all probability, of several other parts of South America.

6. Didelphis dorsigera, or Merian opossum. This species is so named from the celebrated madame Merian, who has introduced a figure of it into her splendid work on the insects of Surinam. Madame Merian's own account of the animal is as follows: "By way of filling up a plate, I have represented a kind of wood-rat, which always carries her young ones (of which there are commonly five or six) upon her back: she is of a yellowish brown colour, and white beneath. When these rats come out of their hole, either to play or to seek their food, they run about with their mother; but when they are satisfied with food, or are apprehensive of danger, they climb up again on the back of their mother, and twist their tails round that of the parent, who runs with them into her hole again."

7. Didelphis lemurina, or lemurine opossum. This is a large species, being equal in size to a cat, but longer-bodied in proportion. Its colour is a fine brownish or iron-grey above, and pale yellowish-brown beneath, in some specimens nearly white: the sides of the neck and the feet have also a tinge of this colour; the fur on the whole animal is extremely thick, rich, and soft, scarcely yielding in elegance to that of the petaurus or great flying opossum: the muzzle is short and roundish; the whiskers large and black; the ears upright, large, and a little inclining to a pointed form at the tips; the eyes bright and reddish; the hind feet furnished with a rounded interior toe; the tail, which is thick, long, and very furry, is prehensile, and is of the same colour with the body for about a fourth of its length, the remainder being black; it is naked beneath to a great distance from the tip. The general length of the body is about 18 inches, of the tail about 12.

8. Murina. In this species the tail is hairy at the base, and a fold includes the teats. It inhabits South America, and eats fruit, grain, fish, &c. It is slow and stupid. See Plate Nat. Hist. fig. 164.

9. Didelphis viverrina, or viverrine opossum. This animal is remarkable for its slender form; and this, together with its sharpened visage and long brushy tail, gives it, at first view, the appearance of one of the weesel tribe rather than that of an opossum. Its general size seems to be that of a stoat, measuring about ten inches from nose to tail, and the tail itself about eight inches. It is impossible to say critically what the various forms of the teeth are adapted for from the general principles of teeth. In the front we have what may divide and tear off; behind those there are holders or destroyers; behind the latter such as will assist in mashing, as the grinders of the lion and other carnivorous animals; and, last of all, grinders to divide parts into smaller portions, as in the graminivorous tribe: the articulation of the jaw in some degree admits of all those motions.

10. Didelphis petaurus, or petaurine opossum. The size, colour, and form, of the petaurine or great flying opossum of New Holland, conspire to render it one of the most beautiful of quadrupeds. It measures about 22 inches from the tip of the nose to the beginning of the tail, which is 20 inches in length. The body is about the size of a half-grown cat or a small rabbit, and the general appearance of the animal is similar to that of a flying squirrel; an expansile membrane, covered with fur, stretching from the fore legs to the hind on each side of the body, and thus enabling the animal to spring to a considerable distance at pleasure.

The general colour of this species is a very fine sable, or deep grey-brown above, varied with a cast of ferruginous: beneath it is nearly white; a stripe of darker or blacker brown than the rest runs along the back from head to tail; the fur near the edge of the flying membrane on its upper part has also a darker tinge than on the other parts, while the edge itself is white, thus forming a beautiful contrast of colour round the whole border of the membrane; a darker or blacker shade than on the rest of the fur prevails on the upper parts of the shoulders, extending over each side of the neck. The tail is at least equal to the whole length of the head and body, and is extremely full of long, soft fur, of a blacker cast than the rest, particularly towards the end, where it is longer or more floccy than towards the base: the whole is of a roundish or subcylindric form, but from the disposition of the long fur, has a slightly flattened appearance towards the extremity.

11. Didelphis sciurea, or squirrel opossum. This is perhaps the most beautiful quadruped, if we except the petaurus or great flying opossum, of all the Australasian species yet discovered. In its general aspect it has so much the appearance of a squirrel, that, on a cursory view, it might readily pass for such. A more exact inspection into its characters will, however, evince it to be a genuine opossum. Its size is nearly that of a common squirrel; but from the fulness and particular growth of the fur, which, like that of the lemur, grows in a suberect manner, it appears somewhat larger. Its general colour is exactly like that of the sciurus cinereus, or American grey squirrel. A black stripe passes over each eye along the top of the head: under each ear is a black patch surrounded with white, the hair on the white part having a more soft or flocculent appearance than the black. The tail, which is prehensile, is of the same colour with the body for about half its length, the remainder being black. It is very full of hair, and tapers a little towards the extremity, but without any acute termination. The eyes are black, rounded, and full: the ears round, shortish, and very thin; the whole under side of the animal is milk-white; the upper parts of the feet are also white, and the edge of the lateral or flying membrane, which extends from the fore feet to the hind, is edged with a blackish border, as in the flying squirrels. The abdominal pouch is of considerable size, and is situated, as in other opossums, on the lower part of the abdomen: the hind feet are furnished with a rounded, unarmed, or mutic thumb. Nothing can exceed the softness and delicacy of this animal's fur, which is, if possible, still finer than that of the petaurus, to which indeed, though very greatly inferior in size, as well as widely different in colour, it yet bears a striking affinity. It is a nocturnal animal, and continues torpid the greatest part of the day, but during the night is full of activity. In this, as well as in other Australian opossums, the two toes on the hind feet nearest the thumb or rounded one, are connate, or both conjoined under one common skin.

12. Didelphis pygmæa, or pygmy opossum. This is by far the most minute of all the opossums, and, from its diminutive size, not exceeding that of a common mouse, has been named the pygmy opossum. It is furnished on each side the body with an expansile membrane, exactly in the manner of the flying squirrel, by the assistance of which it is enabled to spring to a considerable distance. The fur on the whole animal is extremely fine; the colour is a soft or palish brown above, and almost white beneath; the edges of the flying membrane are also white; the nose, feet, and ears, internally are of a light pink or flesh-colour; the tail is of a flattened form, and is beautifully edged on each side with soft silky hairs. The opening of the abdominal pouch in this species is of a semilunar form: on opening this receptacle in the specimen described in the New Holland Zoology, was discovered on each side a young one, large in proportion to the parent animal, and totally destitute of hair: they had, therefore, not approached to the period of their second birth. In such specimens as were not in a pregnant state, the mammæ or teats were extremely small, and only four in number. The tongue in this animal is remarkably large and long, and of a flattened form; the hind feet have rounded and unarmed thumbs, and the two interior toes are united under a common skin.

13. Macrotarsus: tail slender, naked, hairy at the tip, heels of the hind-feet long, naked, thumb-nail flat. See Plate Nat. Hist. fig. 166, and also the article KANGAROO.

DIDELTA, a genus of the class and order syngenesia polygamia frustranea. The lyx is expanding; receptacle honey-combed into parts, which retain the seeds; down chaffy, many-leaved. There are two species, annuals of the Cape.

DIDUS, or DODO, in ornithology, a genus belonging to the order of gallinæ. The bill is contracted in the middle by two transverse rugæ; each mandible is inflected at the point; and the face is bare behind the eyes. Only one species, the ineptus, is mentioned by Linnæus. Other naturalists have added two more.

1. The dronte, or hooded dodo (ineptus, Lin.), is somewhat larger than a swan, and near three feet in length. The bill is strong, large, and hooked at the end; the gape stretches beyond the eyes: the colour is a very pale blue, except the end of the upper mandible, which is yellowish, and has a red spot on the bend of it; the end of the lower is blackish; the irides are white. The general colour of the plumage is cinereous: it is soft to the touch; the belly and thighs are whitish. The head is large, and seems covered with a black hood or cowl. The wings are very short, and of a yellowish ash-

colour; the tail feathers are curled, stand up on the rump, and incline to yellow. The legs have four toes, three before and one behind; are very stout, short, and yellowish; the claws are black. It inhabits the islands of Mauritius and Bourbon in the Indian Ocean. See Plate Nat. Hist. fig. 169.

2. The solitaire, or solitary dodo, is a large bird, and the male is said to weigh sometimes 45 pounds. The neck is of a proportionable length, and the eye black and lively; the head is not crested, and the general colour of the plumage is grey and brown mixed: it has scarcely any tail, and the bastard wing swells out into a round knob; the wings are too short for flight; and the hind parts are rounded like a horse's rump, being clothed with feathers, which may be termed coverts. The females are covered with sometimes brown and sometimes light-yellow feathers, and appear very beautiful. The feathers on each side of the breast enlarge into two white tufts, somewhat resembling the bosom of a woman. Those of the thighs are rounded at the end like shells; and, according to Leguat, the bird has altogether a noble and elegant gait. This is an inhabitant of the isle of Rodrigue, where it is not uncommon; but not met with in flocks, scarcely more than two being found together. It makes its nest in by-places, of leaves of the palm, a foot and a half in thickness, and lays one egg, bigger than that of a goose. The male sits in his turn, and does not suffer any bird to approach within 200 yards of the spot while the hen is sitting, which is seven weeks. The young is some months before it can shift for itself; the old ones, in the mean time, are affectionate to it, and faithful to each other afterwards, though they occasionally may mix with others of their kind. The young birds, though timid, are stupid enough to suffer the approach of any one; but when grown up, are more shy, and will not be tamed. They are chased in the winter season, viz. from March to September, being then fat, and the young birds are much esteemed for the table.

3. The Nazarene dodo is larger than a swan. The bill is a little bent downwards, and large; instead of feathers, the whole is covered over with a black down; but the wings are feathered, and it has some frizzled ones upon the rump, which serve instead of a tail; the legs are long and scaly, and there are three toes on each foot. This was met with in the Isle of France, and described as above by Fr. Cauche; who adds, that the female lays only one egg, which is white, and as big as a penny-loaf, and that there is always found with it a white stone of the size of a hen's egg; that it makes a nest of leaves and dry herbs in the forests on the ground; and that there is likewise found a grey stone in the gizzard of the young bird.

DIDYNAMIA, the name of the 14th class in Linnæus's sexual method, consisting of plants with hermaphrodite flowers, which have four stamina or male organs, two of which are long and two short. See Botany.

DIES, in common law, are of two kinds, dies juridici, and non juridici. Dies juridici, or fasti, are all days wherein justice is administered in court. Dies non juridici, or nefasti, are all Sundays in the year: and, in Easter term, the feast of ascension of our Lord; in Trinity term, the nativity of St. John the Baptist; in Michaelmas term, the feasts of all saints and all souls; and in Hilary term, the purification of the Blessed Virgin.

Dies datus, is a day, or time of respite, given by the court to the defendant in a cause.

DIESIS. (From the Greek.) The name given to the smallest interval used in the music of the ancient Greeks. In harmonic calculations, those are called diesis which are greater than a comma, and less than a semi-tone. Diesis, in modern music, is the name given to the elevation of a note above its natural pitch. This raising of the sound is, however, only a kind of insensible gliding through the interval of a semi-tone, and does not produce any change in the denomination of the note upon which it operates. With some authors, diesis is only another name for the quarter of a tone.

DIET. See Materia Medica.

Diet, or Dyet, in matters of policy, is used for the general assembly of the states or circles of the empire of Germany, and formerly of Poland, to deliberate and concert measures proper to be taken for the good of the public. The general diet of the empire is usually held at Ratisbon: it consists of the emperor, the ten electors, and the ecclesiastical princes; viz. the archbishops, bishops, abbots, and abbesses; the secular princes, who are dukes, marquises, counts, viscounts, or barons; and the representatives of the imperial cities. It meets on the emperor's summons, and any of the princes may send their deputies thither in their stead. The diet makes laws, raises taxes, determines differences between the several princes and states, and can relieve the subjects from the oppressions of their sovereigns.

Dieu et mon droit, *God and my right*, the motto of the royal arms of England, first assumed by king Richard I. to intimate that he did not hold his empire in vassalage of any mortal authority. It was afterwards taken by Edward the Third, and was continued without interruption to the time of king William III. who used the motto *je maintiendray*, though the former was still retained upon the great seal. After him, queen Anne used the motto *semper eadem*, which had been before used by queen Elizabeth; but ever since queen Anne, *dieu et mon droit* continues to be the royal motto.

Dieu son act, words anciently often used in our law; and to this day, it is a maxim in law, that the act of God shall prejudice no man: therefore, if a house is blown or beaten down by a tempest, thunder, or lightning, the lessee, or tenant for life or years, shall be quit of an action of waste; and, by the law, he has likewise a special interest or liberty allowed to take timber, to rebuild the house for his habitation.

DIFFERENCES, in heraldry, certain additaments to coat armour, whereby something is added or altered to distinguish younger families from the elder.

DIFFERENTIAL calculus. See Calculus differentialis.

DIFFERENTIO, differentialis calculus, is a method of differencing differential quantities.

We have observed, under the word Calculus, that the differential of a quantity is expressed by the letter *d* prefixed to it, as the differential of x is called dx; we are to remark, therefore, in this place, that the differential of dx, is ddx; and the differential of ddx, is $dddx$; or, as sir Isaac Newton would express it, $\dot{x}$, &c. These differentials may be expressed more compendiously thus, d^1x, d^2x, &c. whence we have powers or degrees of differentials. The differential of an ordinary quantity, is called a differential of the first degree, as dx. The differential of the second degree, is an infinitesimal of a differential quantity of the first degree, as ddx, $dxdx$, or dx^2, $dxdy$, &c. The differential of the third degree, is an infinitesimal of a differential quantity of the second degree, as $dddx$, dx^3, $dxdydz$, and so on.

The powers of differentials are differenced after the same manner as the powers of ordinary quantities: and as compound differentials either multiply or divide each other, or are perfect or imperfect powers of differentials of the first degree, the differentio-differentialis calculus is in effect the same with the differential calculus. See Calculus differentialis.

DIGASTRICUS, in anatomy, a muscle of the lower jaw, called also biventer.

DIGESTION, in medicine, is the dissolution of the aliments into such minute parts as are fit to enter the lacteal vessels, and circulate with the mass of blood.

There is a very great difference in the quantity of aliment which animals require, and in the time which they can pass without it. In general, those animals which are most active require most, and those which are most indolent require least food. The cause of this is obvious: the bodies of animals do not remain stationary, they are constantly wasting; and the waste is proportional to the activity of the animal. Hence the body must receive, from time to time, new supplies, in place of what has been carried off. The use of food answers this purpose.

We are much better acquainted with the food of animals than of vegetables. It consists of an infinite variety of animal and vegetable substances: for there are but very few of either which some animal or other does not use as food. Man uses as food chiefly the muscles of animals, the seed of certain grasses, and a variety of vegetable fruits. Almost all the inferior animals have particular substances on which they feed exclusively. Some of them feed on animals, others on vegetables. Man has a greater range; he can feed on a very great number of substances. To enumerate these substances would be useless, as we are not able to point out with accuracy what it is which renders one substance more nourishing than another.

Many substances do not serve as nourishment at all; and some, instead of nourishing, destroy life. These last are called poisons. Some poisons act chemically, by decomposing the animal body. The action of others is not so well understood.

The food is introduced into the body by the mouth, and almost all animals reduce it to a kind of pulpy consistence. In man and many other animals this is done in the mouth by means of teeth, and the saliva with which it is there mixed; but many other animals grind their food in a different manner. After the food has been thus ground, it is introduced into the stomach, where it is subjected to

new changes. The stomach is a strong soft bag, of different forms in different animals: in man it has some resemblance to the bag of a bagpipe. In this organ the food is converted into a soft pap, which has no resemblance to the food when first introduced. This pap has been called chyme.

Since chyme possesses new properties, it is evident that the food has undergone some changes in the stomach, and that the ingredients of which it was composed have entered into new combinations.

The formation of chyme, in fact, is owing to the stomach; and it has been concluded, from the experiments of Stevens, Reaumur, Spallanzani, Scopoli, Brugnatelli, Carimini, &c. that its formation is brought about by the action of a particular liquid secreted by the stomach, and for that reason called gastric juice.

That it is owing to the action of a liquid is evident; because, if pieces of food are inclosed in close tubes, they pass through the stomach without any farther alteration than would have taken place at the same temperature out of the body; but if the tubes are perforated with small holes, the food is converted into chyme.

This liquid does not act indiscriminately upon all substances: for if grains of corn are put into a perforated tube, and a granivorous bird is made to swallow it, the corn will remain the usual time in the stomach without alteration; whereas, if the husk of the grain is previously taken off, the whole of it will be converted into chyme. It is well known, too, that many substances pass unaltered through the intestines of animals, and consequently are not acted upon by the gastric juice. This is the case frequently with grains of oats when they have been swallowed by horses entire with their husks on. This is the case also with the seeds of apples, &c. when swallowed entire by man; yet these very substances, if they have been previously ground sufficiently by the teeth, are digested. It appears, therefore, that it is chiefly the husk or outside of these substances which resists the action of the gastric juice. We see also, that trituration greatly facilitates the conversion of food into chyme.

The gastric juice is not the same in all animals; for many animals cannot digest the food on which others live. The conium maculatum (hemlock), for instance, is a poison to man instead of food, yet the goat often feeds upon it. Many animals, as sheep, live wholly upon vegetables; and if they are made to feed on animals, their stomachs will not digest them: others again, as the eagle, feed wholly on animal substances, and cannot digest vegetables.

The gastric juice does not continue always of the same nature, even in the same animal: it changes gradually according to circumstances. Graminivorous animals may be brought to live on animal food; and after they have been accustomed to this for some time, their stomachs become incapable of digesting vegetables. On the other hand, those animals which naturally digest nothing but animal food may be brought to digest vegetables.

What is the nature of the gastric juice, which possesses these singular properties? It is evidently different in different animals; but it is a very difficult task, if not an impossible one, to obtain it in a state of purity. Various attempts have indeed been made by very ingenious philosophers to procure it; but their analysis of it is sufficient to shew us, that they have never obtained it in a state of purity.

The methods which have been used to procure gastric juice are, first, to kill the animal whose gastric juice is to be examined, after it has fasted for some time. By this method Spallanzani collected 37 spoonfuls from the two first stomachs of a sheep. It was of a green colour, undoubtedly owing to the grass which the animal had eaten. He found also half a spoonful in the stomach of some young crows which he killed before they had left their nest.

Small tubes of metal pierced with holes, and containing a dry sponge, have been swallowed by animals; and when vomited up, the liquid imbibed by the sponge is squeezed out. By this method, Spallanzani collected 481 grains of gastric juice from the stomachs of five crows.

A third method consists in exciting vomiting in the morning, when the stomach is without food. Spallanzani tried this method twice upon himself, and collected one of the times, 1 oz. 32 gr. of liquid; but the pain was so great, that he did not think proper to try the experiment a third time. Mr. Gosse, however, who could excite vomiting whenever he thought proper, by swallowing air, has employed that method to collect gastric juice.

Spallanzani has observed that eagles throw up every morning a quantity of liquid, which he considers as gastric juice; and he has availed himself of this to collect it in considerable quantities.

It is almost unnecessary to remark how imperfect these different methods are, and how far every conclusion drawn from the examination of such juices must deviate from the truth. It is impossible that the gastric juice, obtained by any one of these processes, can be pure; because in the stomach it must be constantly mixed with large quantities of saliva, mucus, bile, food, &c. It may be questioned, indeed, whether any gastric juice at all can be obtained by these methods; for as the intention of the gastric juice is to convert the food into chyme, in all probability it is only secreted, or at least thrown into the stomach, when food is present.

We need not be surprised, then, at the contradictory accounts concerning its nature, given us by those philosophers who have attempted to examine it; as these relate not so much to the gastric juice, as to the different substances found in the stomach. The idea that the gastric juice can be obtained by vomiting, or that it is thrown up spontaneously by some animals, is, to say the least of it, very far from being probable.

According to Brugnatelli, the gastric juice of carnivorous animals, as hawks, kites, &c. has an acid and resinous odour, is very bitter, and not at all watery; and is composed of an uncombined acid, a resin, an animal substance, and a small quantity of muriat of soda. The gastric juice of herbivorous animals, on the contrary, as goats, sheep, &c. is very watery, a little muddy, has a bitter saltish taste, and contains ammonia, an animal extract, and a pretty large quantity of muriat of soda. Mr. Carminati found the same ingredients; but he supposes that the ammonia had been formed by the putrefaction of a part of their food, and that in reality the gastric juice of these animals is of an acid nature.

The accounts which have been given of the gastric juice of man are so various, that it is not worth while to transcribe them. Sometimes it has been found of an acid nature, at other times not. The experiments of Spallanzani are sufficient to shew, that this acidity is not owing to the gastric juice, but to the food. He never found any acidity in the gastric juice of birds of prey, nor of serpents, frogs, and fishes. Crows gave an acidulous gastric juice only when fed on grain; and he found that the same observation holds with respect to dogs, herbivorous animals, and domestic fowls. Carnivorous birds threw up pieces of shells and coral without alteration; but these substances were sensibly diminished in the stomachs of hens, even when inclosed in perforated tubes. Spallanzani himself swallowed calcareous substances inclosed in tubes; and when he fed on vegetables and fruits, they were sometimes altered and a little diminished in weight, just as if they had been put into weak vinegar; but when he used only animal food, they came out untouched. According to this philosopher, whose experiments have been by far the most numerous, the gastric juice is naturally neither acid nor alkaline. When poured on the carbonat of potass, it causes no effervescence.

Such are the results of the experiments on the juices taken from the stomach of animals. No conclusion can be drawn from them respecting the nature of the gastric juice. But from the experiments which have been made on the digestion of the stomach, especially by Spallanzani, the following facts are established.

The gastric juice attacks the surface of bodies, unites to the particles of them, which it carries off, and cannot be separated from them by filtration. It operates with more energy and rapidity the more the food is divided, and its action is increased by a warm temperature. The food is not merely reduced to very minute parts; its taste and smell are quite changed; its sensible properties are destroyed, and it acquires new and very different ones. This juice does not act as a ferment; so far from it that it is a powerful antiseptic, and even restores flesh already putrefied. There is not the smallest appearance of such a process; indeed, when the juice is renewed frequently, as in the stomach, substances dissolve in it with a rapidity which excludes all idea of fermentation. Only a few air-bubbles make their escape, which adhere to the alimentary matter, and buoy it up to the top, and which are probably extricated by the heat of the solution.

With respect to the substances contained in the stomach, only two facts have been perfectly ascertained. The first is, that the juice contained in the stomachs of oxen, calves, and sheep, invariably contains uncombined phosphoric acid, as Macquart and Vanquelin have demonstrated: the second, that the juice contained in the stomach, and even the inner coat of the stomach itself, has the property of coagulating milk and the serum of blood. Dr. Young found, that seven grains of the inner coat of a calf's stomach, infused in water, gave a liquid which coagulated more than 100 ounces of milk; that is, more than

6857 times its own weight; and yet, in all probability, its weight was not much diminished.

What the substance is which possesses this coagulating property, has not yet been ascertained; but it is evidently not very soluble in water: for the inside of a calf's stomach, after being steeped in water for six hours, and then well washed with water, still furnishes a liquor on infusion which coagulates milk: and Dr. Young found that a piece of the inner coat of the stomach, after being previously washed with water, and then with a diluted solution of carbonat of potass, still afforded a liquid which coagulated milk and serum.

It is evident, from these facts, that this coagulating substance, whatever it is, acts very powerfully; and that it is scarcely possible to separate it completely from the stomach. But we know at present too little of the nature of coagulation to be able to draw any inference from these facts. An almost imperceptible quantity of some substances seems to be sufficient to coagulate milk: for Mr. Vaillant mentions in his Travels in Africa, that a porcelain dish which he procured, and which had lain for some years at the bottom of the sea, possessed, in consequence, the property of coagulating milk when put into it; yet it communicated no taste to the milk, and did not differ in appearance from other cups.

It is probable that the saliva is of service in the conversion of food into chyme as well as the gastric juice. It evidently serves to dilute the food; and probably it may be serviceable also by communicating oxygen. The chyme, thus formed, passes from the stomach into the intestines, where it is subjected to new changes, and at last converted into two very different substances, chyle and excrementitious matter.

The chyle is a white-coloured liquid, very much resembling milk. It is exceedingly difficult to collect it in any considerable quantity, and for that reason it has never been accurately analysed. We know only in general that it resembles milk; containing, like it, an albuminous part capable of being coagulated, a serum, and globules which have a resemblance to cream. It contains also different salts; and, according to some, a substance scarcely differing from the sugar of milk.

Concerning the process by which chyle is formed from chyme, scarcely any thing is known. It does not appear that the chyle is precisely the same in all animals; for those which are herbivorous have a greater length of intestine than those which are carnivorous. It is certain that the formation of the chyle is effected by a chemical change, although we cannot say precisely what that change is, or what the agents are by which it is produced. But that the change is chemical, is evident, because the chyle is entirely different, both in its properties and appearance, from the chyme. The chyme, by the action of the intestines, is separated into two parts, chyle and excrement: the first of which is absorbed by a number of small vessels called lacteals; the second is pushed along the intestinal canal and at last thrown out of the body altogether.

After the chyme has been converted into chyle and excrement, although these two substances remain mixed together, it does not appear that they are able to decompose each other; for persons have been known seldom or never to emit any excrementitious matter per anum for years. In these, not only the chyle, but the excrementitious matter also, was absorbed by the lacteals; and the excrement was afterwards thrown out of the body by other outlets, particularly by the skin: in consequence of which, those persons have constantly that particular odour about them which distinguishes excrement. Now in these persons it is evident that the chyle and excrement, though mixed together, and even absorbed together, did not act on each other; because these persons have been known to enjoy good health for years, which could not have been the case had the chyle been destroyed.

It has been supposed by some that the decomposition of the chyme, and the formation of chyle, are produced by the agency of the bile, which is poured out abundantly, and mixed with the chyme, soon after its entrance into the intestines. If this theory was true, no chyle could be formed whenever any accident prevented the bile from passing into the intestinal canal: but this is obviously not the case; for frequent instances have occurred of persons labouring under jaundice from the bile-ducts being stopped, either by gall-stones or some other cause, so completely, that no bile could pass into the intestines; yet these persons have lived for a considerable time in that state. Consequently digestion, and therefore the formation of chyle, must be possible, independant of bile.

The principal use of the bile seems to be to separate the excrement from the chyle, after both have been formed, and to produce the evacuation of the excrement out of the body. It is probable that these substances would remain mixed together, and that they would perhaps even be partly absorbed together, was it not for the bile, which seems to combine with the excrement, and by this combination to facilitate its separation from the chyle, and thus to prevent its absorption. Fourcroy supposes that the bile, as soon as it is mixed with the contents of the intestinal canal, suffers a decomposition; that its alkali and saline ingredients combine with the chyle, and render it more liquid, while its albumen and resin combine with the excrementitious matter, and gradually render them less and less fluid; and this theory is certainly very probable. The bile also stimulates the intestinal canal, and causes it to evacuate its contents sooner than it otherwise would do; for when there is a deficiency of bile, the body is constantly costive.

The excrementitious matter, then, which is evacuated per anum, consists of all that part of the food and chyme which was not converted into chyle; entirely altered, however, from its original state, partly by the decomposition which it underwent in the stomach and intestines, and partly by its combination with the resin and albumen of the bile. Accordingly we find in it many substances which did not exist at all in the food. Thus in the dung of cows and horses there is found a very considerable quantity of benzoic acid. The excrements of animals have not yet been subjected to an accurate analysis, though such an analysis would throw much light upon the nature of digestion: for if we knew accurately the substances which were taken into the body as food, and all the new substances which were formed by digestion; that is to say, the component parts of chyle and of excrement, and the variation which different kinds of food produce in the excrement; it would be a very considerable step towards ascertaining precisely the changes produced on food by digestion.

Vauquelin has ascertained that the fæces are constantly acid, always reddening vegetable blues. They run very quickly into fermentation, becoming at first more acid, but very soon begin to exhale ammonia. Pigeon-dung contains an acid of a peculiar nature, which increases when the matter is diluted with water; but gradually gives place to ammonia, which is at last exhaled in abundance.

To the same excellent chemist we are indebted for an analysis of the fixed parts of the excrements of fowls, and a comparison of them with the fixed parts of the food; from which some very curious cousequences may be deduced.

He found that a hen devoured in ten days 11111.843 grains troy of oats. These contained

136.509 gr. of phosphat of lime
219.548 silica.

356.057

During these ten days she laid four eggs; the shells of which contained 98.776 gr. phosphat of lime, and 453.417 gr. carbonat of lime. The excrements emitted during these ten days contained 175.529 gr. phosphat of lime, 58.494 gr. of carbonat of lime, and 185.266 gr. of silica. Consequently the fixed parts thrown out of the system during these ten days amounted to

274.305 gr. phosphat of lime
511.911 carbonat of lime
185.266 silica.

Given out	971.482
Taken in	356.057
Surplus	654.125

Consequently the quantity of fixed matter given out of the system in ten days exceeded the quantity taken in by 615.425 grains.

The silica taken in amounted to 219.548 gr.
That given out was - 185.266 gr.

Remains 34.282

Consequently there disappeared 34.282 grains of silica.

The phosphat of lime taken in was 136.509 gr.
That given out was - 274.305 gr.

137.796

Consequently there must have been formed, by digestion in this fowl, no less than 137.796 grains of phosphat of lime, besides 511.911 grains of carbonat. Consequently lime (and perhaps also phosphorus) is not a simple substance, but a compound, and formed of ingredients which exist in oat-seed, water, or air, the only substances to which the fowl had access. Silica may enter into its composition, as a part of the silica had disappeared; but if so, it must be combined

with a great quantity of some other substance.

These consequences are too important to be admitted without a very rigorous examination. The experiment must be repeated frequently, and we must be absolutely certain that the hen has no access to any calcareous earth, and that she has not diminished in weight; because in that case some of the calcareous earth, of which part of her body is composed, may have been employed. This rigour is the more necessary, as it seems pretty evident, from experiments made long ago, that some birds at least cannot produce eggs, unless they have access to calcareous earth. Dr. Fordyce found, that if the canary-bird was not supplied with lime at the time of her laying, she frequently died, from her eggs not coming forward properly. He divided a number of these birds at the time of their laying eggs into two parties: to the one he gave a piece of old mortar, which the little animals swallowed greedily; they laid their eggs as usual, and all of them lived; whereas many of the other party, which were supplied with no lime, died.

The chyle, after it has been absorbed by the lacteals, is carried by them into a pretty large vessel, known by the name of thoracic duct. Into the same vessel likewise is discharged a transparent fluid, conveyed by a set of vessels which arise from all the cavities of the body. These vessels are called lymphatics, and the fluid which they convey is called lymph. In the thoracic duct, then, the chyle and the lymph are mixed together.

Very little is known concerning the nature of the lymph, as it is scarcely possible to collect it in any quantity. It is colourless, has some viscidity, and is said to be specifically heavier than water. It is said to be coagulable by heat; if so, it contains albumen; and from its appearance it probably contains gelatine. Its quantity is certainly considerable, for the lymphatics are very numerous.

The chyle and lymph being thus mixed together, are conveyed directly into the blood-vessels. The effect produced by their union in the thoracic duct is not known, but neither the colour nor external properties of the chyle are altered. In man, and many other animals, the thoracic duct enters at the junction of the left subclavian and carotid veins, and the chyle is conveyed directly to the heart, mixed with the blood, which already exists in the blood-vessels. From the heart, the blood and chyle thus mixed together are propelled into the lungs, where in their united state they undergo farther changes.

Such are the phenomena of digestion, as far as they have been traced. The food is first conveyed to the stomach, where by means of the gastric juice it is converted into chyme. The chyme passes into the intestinal canal, where it is subjected to a new process, being gradually decomposed and converted into chyle and excrementitious matter, which by means of the bile are separated from each other. The excrementitious matter is evacuated, but the chyle is absorbed by the lacteals, and conveyed to the blood-vessels by the lungs.

DIGESTOR, in chemistry, a strong vessel, made of copper or iron, and fitted with a close cover and screws; so as to remain perfectly tight in a considerable degree of heat, whilst water, common air, and the subject of the operation, are contained in it. The cover of the digestor should always be provided with a valve to let out a part of the steam, otherwise the vessel will certainly burst, by which it may prove fatal to the by-standers. Of all chemical vessels hitherto invented, the digestor seems best calculated for increasing the action of the menstruums. Water, confined in a digestor, is susceptible of so much heat as to melt lead; and it is frequently found to melt the solder of lead and tin, with which the copper vessel was held together: hence appears the necessity of using hard solder, made of spelter, or silver and brass, for this purpose; otherwise, the digestor cannot contain the water, when much heated, without melting in the joints. In this vessel, fresh ox-bone will be so digested in the space of a quarter of an hour, as to become soft and tender, and capable of being cut with a knife; and the water, in which it was boiled, turned into a hard jelly, and a large cake of fat on its surface, when all is properly cooled.

DIGGING, among miners, is appropriated to the operation of freeing any kind of ore from the bed or stratum in which it lies, where every stroke of their tools turns to account: in contradistinction to the openings made in search of such ore, which are called hatches or essay-hatches, and the operation itself, tracing of mines, or hatching. When a bed of ore is discovered, the beele-men, so called from the instrument they use, which is a kind of pick-ax, free the ore from the fossils around it, and the shovel-men throw it up from one shamble to another, till it reaches the mouth of the hatch. In some mines, to save the expence as well as well as fatigue of the shovel-men, they raise the ore by means of a winder, and two buckets, one of which goes up as the other comes down.

DIGIT, DIGITUS, in astronomy, the 12th part of the diameter of the sun or moon, is used to express the quantity of an eclipse. Thus an eclipse is said to be of six digits, when six of these parts are hidden.

DIGITS, or MONADES, in arithmetic, signify any integer under 10, as 1. 2. 3. 4. 5. 6. 7. 8. 9.

DIGIT is also a measure taken from the breadth of the finger. It is properly 3-4ths of an inch, and contains the measure of four barleycorns laid breadthwise.

DIGITALIS, FOX-GLOVE, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 28th order, luridæ. The calyx is quinquepartite; the corolla campanulated, quinquefid, and ventricose; the capsule ovate and bilocular. There are 12 species; 5 of which are hardy, herbaceous, biennial, and perennial plants. The herbaceous species rise two or three feet high, crowned with spikes of yellow iron-coloured or purple flowers. The canariensis or shrubby sort rises five or six feet high, having spear-shaped rough leaves, four or five inches long, and half as broad; the branches being all terminated with flowers growing in loose spikes. All the species are easily raised by seeds. An ointment made of the flowers of purple fox-glove and fresh butter, is much commended by some surgeons for scrophulous ulcers which run much and are ill-conditioned. Taken internally, this plant is a violent purgative and emetic; and is therefore only to be administered to robust constitutions. An infusion of two drams of the leaf in a pint of water, given in half-ounce doses every two hours, till it begins to vomit or purge, is recommended in dropsy, particularly that of the breast. It is said to have produced an evacuation of water so copious and sudden, in ascites, by stool and urine, that the compression of bandages was found necessary. The use of this remedy, however, is thought dangerous by many physicians, yet the Edinburgh pharmacopœia has retained it.

DIGITATED, among botanists, an appellation given to compound leaves, each of which is composed of a number of simple foliola, placed regularly on a common petiole; though strictly speaking, there must be more than 4 foliola to make a digitated leaf.

DIGNITY ECCLESIASTICAL: ecclesiastical dignities are those of archbishop, bishop, dean, archdeacon, and prebendary, and the possessors of these dignities are called dignitaries. Of dignities and prebends, Camden reckons 544 in England.

DIGYNIA, from δις twice, and γυνη a woman, the name of an order or secondary division, in each of the first 13 classes except the 9th, in Linnæus's sexual method; consisting of plants, which to the classic character, whatever it is, add the circumstance of having two styles or female organs.

DILAPIDATION, is where an incumbent of a church-living suffers the parsonage house or out-houses to fall down, or be in decay, for want of necessary reparations; or it is the pulling down or destroying any of the houses or buildings belonging to a spiritual living, or destroying of the woods, trees, &c. appertaining to the same; for it is said to extend to committing or suffering any wilful waste, in or upon the inheritance of the church Deg. Pars. Couns. 89. By 13 Eliz. c. 10. if any ecclesiastical persons, who are bound to repair the buildings whereof they are seised in right of their place or function, suffer them to fall into decay for want of repair, and make fraudulent gifts of their personal estate, with intent to hinder their successors from recovering dilapidations against their executors or administrators, in such case the successor shall have like remedy in the ecclesiastical court, against the grantee of such personal estate, as he might have against the executor or administrator of the predecessor. By 14 Eliz. c. 11. all moneys recovered by dilapidations, shall within two years be employed upon the buildings for which they were paid, on pain of forfeiting double so much as shall not be so employed, to the queen.

DILATATORES, see ANATOMY.

DILATORY PLEAS, are such as are put in merely for delay, and are of three kinds: 1. To the jurisdiction of the court, alleging, that it ought not to hold plea of the matter in hand, as belonging to some other court. 2. To the disability of the plaintiff, by reason whereof he is unable to commence or continue the suit, as that he is outlawed, attainted, an infant, or the like. 3. In abatement;

as for some defect in the writ, as a misnomer of the defendant, or other want of form in any material respect. These pleas were formerly used as merely dilatory, without any foundation of truth, and calculated only for delay; but now by stat. 4 and 5 Anne, c. 16. no dilatory plea shall be admitted, without affidavit made of the truth thereof, or some probable matter shewn to the court to induce them to believe it true. 3 Black. 301.

DILATRIS, in botany, a genus of the monogynia order, belonging to the triandria class of plants. There is no calyx; the corolla has six petals, and is shaggy; the stigma is simple. Three species, herbaceous plants of the Cape.

DILEMMA, in logic, an argument consisting of two or more propositions, which divides the whole into all its parts, or members, by a disjunctive proposition, and then infers something concerning each part, which is finally referred to concerning the whole.

DILLENIA, in botany, a genus of the polyandria-polygynia class of plants; the corolla of which consists of five coriaceous, large, roundish, and hollow petals: the fruit is roundish, and externally covered with a number of capsules, which are oblong, and divided by a furrow; within, there is a large column or pulpous receptacle: the seeds are numerous, and very small; and nidulated underneath the capsules. There are seven species, beautiful trees of the East Indies.

DIMENSION, in geometry, is either length, breadth, or thickness; hence a line has one dimension, viz. length; a superficies two, viz. length and breadth; and a body or solid has three, viz. length, breadth, and thickness.

DIMENSION is used with regard to the power of the roots of an equation, which are called the dimensions of that root. Thus in a simple equation $x = a + b$, the unknown quantity is only of one dimension: in a quadratic equation $x^2 = a^2 + b^2$, it is of two dimensions: in a cubic $x^3 = a^3 + b^3$ it is of three dimensions; and so on.

DIMINUTION, in architecture, a contraction of the upper part of a column, by which its diameter is made less than that of the lower part.

DIMINUTION, in law, is where the plaintiff or defendant in a writ of error, alleges on an appeal to a superior court, that part of the record is omitted, and remains in the inferior court not certified; whereon he prays that it may be certified by certiorari. Co. Ent. 222. 242.

DIMINUTION, in music, is when there are several words which are to make tones, and several quick motions in a cadence, several quavers, semiquavers, &c. corresponding to a crochet or minim, as when a semibreve is divided into two minims, four crotchets, &c.

DIMINUTION, in rhetoric, the exaggerating what you have to say by an expression that seems to diminish it.

DIMINUTIVE, in grammar, a word formed from some other, to soften or diminish the force of it, or to signify a thing is little in its kind. Thus cellule is a diminutive of cell, globule of globe, hillock of hill.

DIMISSORY LETTERS, are such as are used where a candidate for holy orders has a title in one diocese, and is to be ordained in another; the proper diocesan sends his letters dimissory, directed to some other ordaining bishop, giving leave that the bearer may be ordained, and have such a cure within his diocese.

DIOCESE, the circuit of every bishop's jurisdiction: for this realm has two sorts of divisions; one into shires or counties, in respect of the temporal state; and another into provinces, in regard to the ecclesiastical state; which provinces are divided into dioceses. The provinces are two, Canterbury and York; whereof Canterbury includes twenty-one dioceses, or sees of suffragan bishops; and York three, besides the bishopric of the Isle of Man, which was annexed to the province of York by king Henry the VIII.

DIODIA, in botany, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 47th order, stellatæ. The corolla is monopetalous and funnel-shaped; the capsule bilocular and dispermous. There are six species.

DIODON, or SUN-FISH, a genus of fishes belonging to the order of amphibia nantes.

There are three species. 1. The atinga, grows to a great bulk; one examined by Sylvianus was above 100 pounds in weight; and Dr. Borlase mentions another taken at Plymouth, in 1734, that weighed 500 pounds. In form it resembles a bream or some deep fish cut off in the middle. The mouth is very small, and contains in each jaw two broad teeth with sharp edges. The eyes are little; before each is a small semilunar aperture; the pectoral fins are very small, and placed behind them. The colour of the back is dusky and dappled; the belly silvery: between the eyes and the pectoral fins are certain streaks pointing downwards. The skin is free from scales. When boiled, it has been observed to turn into a glutinous jelly, resembling boiled starch when cold, and serving the purposes of glue on being tried on paper and leather. The meat of this fish is uncommonly rank: it feeds on shell-fish. Care must be taken not to confound it with the sun-fish of the Irish, which differs in all respects from this. 2. The mola, or short sun-fish, differs from the former, in being much shorter and deeper. The back and the anal fins are higher, and the aperture to the gills not semilunar, but oval. The situation of the fins is the same in both; and both are taken on the western coasts of this kingdom, but in much greater numbers in the warmer parts of Europe. 3. The hystrix, or globe, is common to Europe and South Carolina. As yet only a single specimen has been discovered in our seas, taken at Penzance in Cornwall. The length was one foot seven; the length of the belly, when distended, one foot; the whole circumference in that situation two feet six. The form of the body is usually oblong; but when alarmed, it has the power of inflating its belly to a globular shape of great size. This seems designed as a means of defence against fish of prey; as they have less means of laying hold of it; and are besides terrified by the number of spines with which that part is armed, and which are capable of being erected on every part. The mouth is small: the irides white, tinged with red: the back from head to tail almost straight, or at least very slightly elevated; of a rich deep-blue colour. It has the pectoral, but wants the ventral fins: the tail is almost even, divided by an angular projection in the middle; tail and fins brown. The belly and sides are white, shagreened or wrinkled: and beset with innumerable sharp spines, adhering to the skin by four processes. See Plate Nat. Hist. figs. 167 and 168.

DIŒCIA, from δὶς twice, and οἶκος a house or habitation, two houses. The name of the 22d class in Linnæus's sexual method; consisting of plants which, having no hermaphrodite flowers, produce male and female flowers on separate roots. These latter only ripen seeds; but require for that purpose, according to the sexualists, the vicinity of a male plant; or the aspersion, that is, sprinkling, of the male dust. From the seeds of the female flowers are raised both male and female plants. The plants then in the class diœcia are all male and female; not hermaphrodite, as in the greater number of classes; nor with male and female flowers upon one root, as in the class monœcia of the same author. See BOTANY.

DIOMEDIA, in ornithology, the albatross, a genus belonging to the order of anseres. The bill is straight; the superior mandible is crooked at the point, and the lower one is truncated; the nostrils are oval, open, a little prominent, and placed on the sides. There are two species, viz. 1. The exulans, has pinnated wings, and three toes on each foot. It is the albatross of Edwards; and is about the size of a pelican. These birds are found in the ocean betwixt the tropics and at the Cape of Good Hope. They are also often seen in vast flocks in Kamtschatka, and the adjacent islands, about the end of June, where they are called great gulls; but it is chiefly in the bay of Penschinensi, the whole inner sea of Kamtschatka, the Kurile isles, and that of Bering; for on the eastern coasts of the first, they are scarce, a single straggler only appearing now and then. Their chief motive for frequenting these places seems to be plenty of food; and their arrival is a sure presage of shoals of fish following. At their first coming they are very lean, but soon grow immensely fat. They are voracious birds, and will often swallow a salmon of four or five pounds weight; but as they cannot take the whole of it into the stomach at once, part of the tail-end will often remain out of the mouth; and the natives, finding the bird in this situation, make no difficult matter of knocking it on the head on the spot. Before the middle of August they migrate elsewhere. They are often taken by means of a hook baited with a fish; but it is not for the sake of their flesh that they are valued, it being hard and unsavoury; but on account of their intestines, a particular part of which they blow up as a bladder, to serve as floats to buoy up their nets in fishing. Of the bones they make tobacco-pipes, needle-cases, and other useful things. When caught, they defend themselves stoutly with their bills. Their cry is harsh and disagreeable, not unlike the braying of an ass. The breeding-places of the albatross, if at all in the northern hemisphere, have not yet been pointed out; but we are certain of their multiplying in the southern, viz. at Patagonia and Falkland-islands; to this last place they come about the end of September or beginning of Octo-

NATURAL HISTORY.

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Dendrites

161

Dendrites

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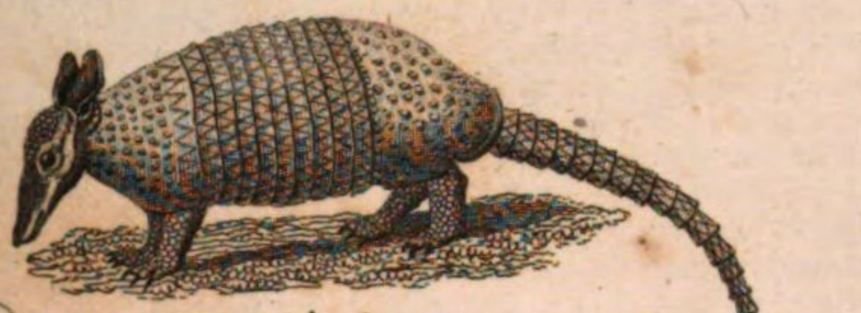

Dasypus novemcinctus
Nine banded Armadillo

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Dermestes lardarius

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Didelphis marina

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Didelphis gigantea

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Didelphis Opossum

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Didelphis macrotarsus

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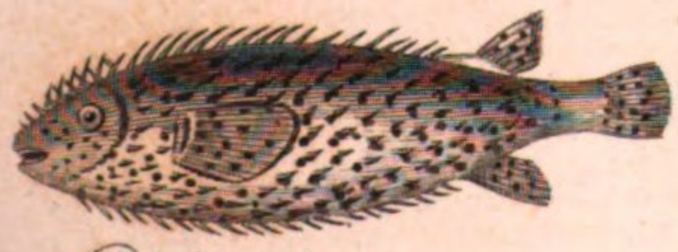

Diodon alinga

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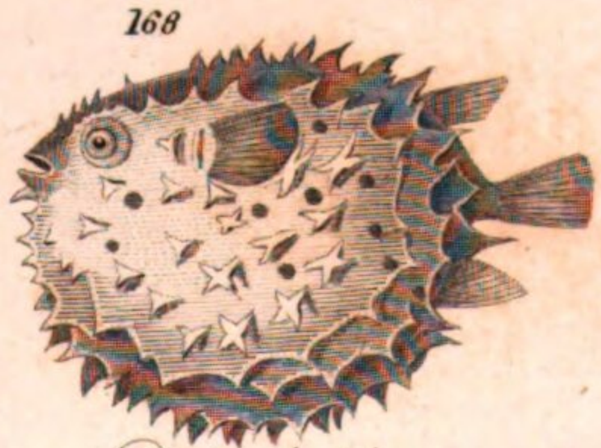

Diodon hystrix

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ber, among other birds, in great abundance. Their nests are made on the ground with earth, are round in shape, a foot in height, and indented at top. The egg is larger than that of a goose, four inches and a half long, white, marked with dull spots at the large end; and is thought to be good food, the white never growing hard with boiling. While the female is sitting, the male is constantly on the wing and supplies her with food: during this time they are so tame as to suffer themselves to be pushed off the nest while their eggs are taken from them; but their chief destruction arises from the hawk, which, the moment the female gets off the nest, darts on it, and flies away with the egg. The albatross itself likewise has its enemy, being greatly persecuted, while on the wing, by the dark grey gull called skua. 2. The demersa, has no quill-feathers on the wings; and the feet have four toes, connected together by a membrane. It is the black penguin of Edwards, about the size of a goose, and is found at the Cape of Good Hope. It is an excellent swimmer and diver; but hops and flutters in a strange awkward manner on the land, and, if hurried, stumbles perpetually, and frequently runs for some distance like a quadruped, making use of the wings instead of legs, till it recovers its upright posture; crying out at the same time like a goose, but in a much hoarser voice. It is said to climb some way up the rocks in order to make its nest; in doing which, it has been observed to assist with its bill. The eggs are two in number, white, as large as those of a duck, and reckoned delicious eating; at least they are thought so at the Cape, where they are brought in great numbers for that purpose. At this place the birds are often kept tame; but in general they do not survive the confinement many months.

DIONÆA MUSCIPULA, or Venus's fly-trap, in botany, a newly discovered sensitive plant, in the construction of which nature seems to have had some view towards its nourishment, in forming the upper joint of its leaf like a machine to catch food; and placing upon the middle of it the bait for the unhappy insect that becomes its prey. Many minute red glands that cover its inner surface, and which perhaps discharge some sweet liquor, tempt the poor insect to taste them; and the instant these tender parts are irritated by its feet, the two lobes rise up, grasp it fast, lock the two rows of spines together, and squeeze it to death. And further, lest the strong efforts for life, in the creature thus taken, should serve to disengage it, three small erect spines are fixed near the middle of each lobe among the glands, that effectually put an end to all its struggles. Nor do the lobes ever open again, while the dead animal continues there. But it is nevertheless certain, that the plant cannot distinguish an animal from any other substance; for if we put a straw or a pin between the lobes, it will grasp it full as fast as if it was an insect. The plant is one of the monogynia order, in the decandria class. It grows in America, about 35 deg. N. lat. in wet shady places, and flowers in July and August. The largest leaves are about three inches long, and an inch and a half across the lobes: the glands of those exposed to the sun are of a beautiful red colour; but those in the shade are pale and inclining to green. The roots are squamous, sending forth but few fibres, and are perennial. The leaves are numerous, inclining to bend downwards, and are placed in a circular order; they are jointed and succulent; the lower joint, which is a kind of stalk, is flat, longish, two-edged, and inclining to heart-shaped. In some varieties they are serrated on the edges near the top. The upper joint consists of two lobes; each lobe is of a semi-oval form, with the margins furnished with stiff hairs like eyebrows, which embrace or lock in each other when they close: this they do when they are inwardly irritated. The upper surfaces of these lobes are covered with small red glands; each of which appears, when highly magnified, like a compressed arbutus-berry. Among the glands, about the middle of each lobe, are three very small erect spines. When the lobes inclose any substance, they never open again while it continues there. If it can be pushed out so as not to strain the lobes, they expand again; but if force is used to open them, so strong has nature formed the spring of their fibres that one of the lobes will generally snap off rather than yield. The stalk is about six inches high, round, smooth, and without leaves; ending in a spike of flowers. The flowers are milk-white, and stand on foot-stalks, at the bottom of which is a little painted bractea or flower-leaf. The soil in which it grows, as appears from what comes about the roots of the plants when they are brought over, is a black light mould, intermixed with white sand, such as is usually found in our moorish heaths. Being a swamp plant, a north-east aspect will be properest for it at first, to keep it from the direct rays of the sun; and in winter, till we are acquainted with what cold weather it can endure, it will be necessary to shelter it with a bell-glass, such as is used for melons. This should be covered with straw or a mat in hard frosts. By this means several of these plants have been preserved through the winter in a very vigorous state. Its sensitive quality will be found in proportion to the heat of the weather, as well as the vigour of the plant. Our summers are not warm enough to ripen the seed; or possibly we are not sufficiently acquainted with the culture of it. See Plate Nat. Hist. fig. 170.

DIOPHANTINE PROBLEMS, in mathematics, certain questions relating to square and cube numbers, and right-angled triangles, &c. the nature of which was determined by Diophantus, a mathematician of Alexandria, who is believed to have lived about the third century. In these questions it is endeavoured to find commensurable numbers to answer indeterminate problems; which bring out an infinite number of incommensurable quantities. For example, it is proposed to find a right-angled triangle, whose sides x, y, z, are expressed by commensurable numbers; it is known that $x^2+y^2=z$, z being the supposed hypothenuse. But it is possible to assume x and y so, that z will be incommensurable; for if $x=1$, and $y=2$, $z=\sqrt{5}$. The art of resolving such problems consists in managing the unknown quantity or quantities in such a manner, that the square or higher power may vanish out of the equation, and then by means of the unknown quantity in its first dimension, the equation may be resolved without having recourse to incommensurables.

For example, in the equation above, $x^2+y^2=z^2$, suppose $z=x+u$, then is $x^2+y^2=x^2+2xu+u^2$, out of which equation x^2 vanishes, and then it is $y^2=2xu+u^2$, which gives $x=\frac{y^2-u^2}{2u}$. Hence, assuming y and u equal to any numbers at pleasure, the three sides of the triangle will be y, $\frac{y^2-u^2}{2u}$, and $\frac{y^2+u^2}{2u}$, which are all rational whenever y and u are rational. For example, if $y=3$, and $u=1$, then $\frac{y^2-u^2}{2u}=4$, and $x+u$, or $\frac{y^2+u^2}{2u}=5$. It is evident that this problem admits of infinite numbers of solutions (see Sanderson's Algebra), as y or u may be assumed infinitely various.

DIOPSIS, a genus of the vermes class and of the diptera order. Head with two inarticulate filiform horns much longer than the head, at the tip of which are placed the eyes. It inhabits South America and Guinea, and resembles the ichneumon. There is but a single species.

DIOPTRICS, the science of refractive vision; or that part of optics which considers the different refractions of light in its passing through different mediums, as air, water, glass, &c. and especially lenses. See OPTICS.

DIOSCOREA, in botany, a genus of the hexandria order, in the diœcia class of plants; and in the natural method ranking under the 11th order, sarmentaceæ. The male calyx is sexpartite, there is no corolla: the female calyx is sexpartite; no corolla; three styles; the capsule trilocular and compressed; and there are two membranaceous seeds. There are 15 species, of which the only remarkable one is the sativa or yam. This has slender stalks, which trail upon the ground and extend a great way: these frequently put out roots from their joints as they lie upon the ground, by which the plants are multiplied. The roots are eaten by the inhabitants of both the Indies; and are particularly serviceable in the West India islands, where they make the greatest part of the negroes' food. The plant is supposed to have been brought from the East to the West Indies; for it has never been observed to grow wild in any part of America; but in the island of Ceylon, and on the coast of Malabar, it grows in the woods, and there are in those places a great variety of sorts. It is propagated by cutting the root in pieces, observing to preserve an eye in each, as is practised in planting potatoes. One plant will produce three or four large roots. The skin of these roots is pretty thick, rough, unequal, covered with many stringy fibres or filaments, and of a violet colour approaching to black. The inside is white, and of the consistence of red beet. It resembles the potatoe in its mealiness, but is of a closer texture. When raw, the yams are viscous and clammy: when roasted or boiled, they afford very nourishing food; and are often preferred to bread by the inhabitants of the West Indies, on account of their lightness and facility of digestion. When first dug out of the ground, the roots are placed in the sun to dry: after which, they are either put into sand, dry garrets, or casks; where if kept from moisture, they may be preserved for years, without being spoiled or diminished in their goodness. The

root commonly weighs two or three pounds, though some yams have weighed upwards of twenty pounds. With us it must be kept in the stove.

DIOSCURIA, in Grecian antiquity, a festival kept in honour of the Dioscuri, or Castor and Pollux, wherein the assistants shared plentifully of the gifts of Bacchus.

DIOSMA, AFRICAN SPIRÆA, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking with those of which the order is doubtful. The corolla is pentapetalous, the nectarium crown-shaped above the germen: there are five capsules coalited; the seeds hooded. There are 19 species; of which the most remarkable are the hirsuta, with narrow hairy leaves; and the oppositifolia, with leaves placed in the form of a cross. The first is a very handsome shrub, growing to the height of five or six feet: the stalks are of a fine coral colour: the leaves come out alternately on every side of the branches, and are narrow-pointed and hairy: the flowers are produced in small clusters at the end of the shoots, and are of a white colour. They are succeeded by starry seed-vessels having five corners; in each of which corners is a cell, containing one smooth, shining, oblong, black seed: these seed-vessels abound with a resin which emits a grateful scent, as does also the whole plant. The second species rises to the height of three or four feet: the branches are slender, and produced from the stem very irregularly; the leaves are placed crosswise; the flowers are produced at the ends of the branches, between the leaves: the plants continue a long time in flower, and make a fine appearance when they are intermixed with other exotics in the open air. Both species are propagated by cuttings; which may be planted during any of the summer months in pots, and plunged into a moderate hotbed, where they should be shaded from the sun, and frequently watered. In about two months they will have taken root; when each should be transplanted into a small pot where they are to remain; but during winter, like most other exotic plants, they must be preserved in a greenhouse.

DIOSPYROS, the INDIAN DATE-PLUM; a genus of the diœcia order, in the polygamia class of plants; and in the natural method ranking under the 18th order, bicornes. The calyx is hermaphrodite and quadrifid; the corolla urceolated and quadrifid; there are eight stamina; the style quadrifid; the berry octospermous: the male calyx, corolla, and stamina, as in the former. There are 9 species; the most remarkable are: 1. The lotus, which is supposed to be a native of Africa, whence it was transplanted into several parts of Italy, and also into the south of France. The fruit of this tree is supposed to be the lotus with which Ulysses and his companions were enchanted, and which made those who ate of it forget their country and relations. In the warm parts of Europe, this tree grows to the height of 30 feet. In the botanic garden at Padua, there is one very old tree which has been described by some of the former botanists under the title of guaiacum patavinum. This tree produces plenty of fruit every year; from the seeds of which many plants have been raised. 2. The Virginiana, pinshamin, persimon, or pitchumon plum, is a native of America, but particularly of Virginia and Carolina. The seeds of this sort have been frequently imported into Britain, and the trees are common in many nurseries about London. It rises to the height of 12 or 14 feet; but generally divides into many irregular trunks near the ground, so that it is very rare to see a handsome tree of this sort. Though plenty of fruit is produced on these trees, it never comes to perfection in this country. In America the inhabitants preserve the fruit till it is rotten, as is practised with medlars in England; when it is esteemed very pleasant. Both species are propagated by seeds; and the plants require to be treated tenderly while young; but when they are grown up, they resist the greatest cold of this country. See Plate Nat. Hist. fig. 171.

DIPHTHONG, in grammar, a double vowel, or the mixture of 2 vowels pronounced together, so as to make one syllable.

DIPHYSA, a genus of the class and order diadelphia decandria. The cal. is half five-cleft; legume with a bladder on each side; seeds hooked. There is one species, a small tree of New Spain.

DIPSACUS, TEAZEL, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 48th order, aggregatæ. The common calyx is polyphyllous, proper above; the receptacle paleaceous. There are four species; the most remarkable of which is the dipsacus fullonum, which grows wild in many parts of England. It is of singular use in raising the nap upon woollen cloth. For this purpose, the heads are fixed round the circumference of a large broad wheel, which is made to turn round and the cloth is held against them. In the west of England, great quantities of this plant are cultivated for the use just-mentioned. It is propagated by sowing the seeds in March, upon a soil that is well prepared. About one peck of seed is sufficient for an acre, as the plants must have room to grow; otherwise the heads will not be large enough, nor in great quantity. When the plants come up, they must be hoed in the same manner as is practised for turnips, cutting down all the weeds, and thinning the plants to about eight inches distance: and as the plants advance, and the weeds begin to grow again, they must be hoed a second time, cutting out the plants to a wider distance, so that they may finally stand a foot distant from each other. The second year they will shoot up heads, which may be cut about the beginning of August. They are then to be tied up in bunches, and set in the sun if the weather is fair; if not, in rooms to dry them. The common produce is about 160 bundles or sheaves upon an acre, which are sold for one shilling each.

DIPTERYX, a genus of the diadelphia decandria class and order. The cal. has the two upper segments winged; legume ovate, compressed, one-seeded. There are two species, tall trees of Guiana.

DIPLOMA, an instrument of licence given by colleges, societies, &c. to a clergyman to exercise the ministerial function, or to a physician to practise the profession, &c. after passing examination or admitting him to a degree.

DIPPING, among miners, signifies the interruption, or breaking off, of the veins of ore; an accident that gives them a great deal of trouble before they can discover the ore again.

DIPPING NEEDLE. See MAGNETISM, and NAVIGATION.

DIPTERE, or DIPTERON, in the antient architecture, signified a temple surrounded with two rows of columns, which formed a sort of porticoes, called wings or isles. Pseudodiptere is the same, except that instead of the double row of columns, this was only encompassed with a row of single ones.

DIPTYCHS, in antiquity, a public register, in which were written the names of the consuls and other magistrates among the heathens; and among the Christians, they were a sort of tablets, on one of which were written the names of the deceased, and on the other those of the living patriarchs, bishops, &c. or those who had done any service to the church, for whom prayers were offered, the deacon reading the names at mass.

DIPUS, JERBOA, a genus of quadrupeds of the glires order. The generic character is, front-teeth two above and below: forelegs very short; hind-legs very long: clavicles in the skeleton.

1. Dipus sagitta, or common jerboa. This is the species which seems to have been known to the ancients under the name of μυς διπους, or two-footed mouse, and which is represented, though with no great degree of exactness, on some coins of Cyrene, where it was antiently found in great abundance, and where it still continues. It is supposed to be the saphan of the scriptures. It is about the size of a rat, and is of a very pale tawny-brown above, and white beneath; and across the upper part of the rump runs an obscure dusky band, which is probably not a permanent character, since it appears to be more or less distinct in different individuals. The head is short; the ears thin, broad, upright, and rounded: the eyes large, round, and dark-coloured: the fore legs about an inch long, with five toes to each foot: the hind legs are extremely long, thin, sparingly covered with short hair, and very much resemble those of a bird: the hind feet have three toes each, the middle of which is somewhat longer than the rest, and all are furnished with sharp and strong claws: there is also a very small spur or back toe, with its corresponding claw.

The usual length of the common jerboa, from nose to tail, is about seven inches and a quarter: the tail is about ten inches long, of a form rather inclining to square than cylindric, and of the same colour with the body, but terminated by an elegant, flattish, oval tuft of black hair, with a white tip. On each side the nose are situated several very long hairs or whiskers, as is usual in most animals of this tribe: the cutting-teeth are sharp and strong, and resemble those of a rat. In its attitudes and manner of progression this animal resembles a bird; generally standing, like the kangaroo, on its hind feet, and leaping with much celerity, and to a great distance: but sometimes it sets its fore feet to the ground for a moment or two, and then recovers its former attitude. It principally uses the fore legs in feeding; pulling to its mouth the ears of corn, and various other vegetable substances on which it feeds. It inhabits subterraneous holes, which it either prepares itself, or finds ready exca-

vated, in the dry, stony, and sandy deserts in which it resides. During the day it commonly remains in its hole; coming out at night for food and exercise. On the approach of cold it is said to grow torpid for some time, reviving on the change of weather.

This animal has frequently been brought into Europe, and in a state of confinement has been known to burrow almost through a brick wall.

Sonnini, in his Egyptian Travels, assures us, that he never was able to find any difference either in the form or colour of the Egyptian jerboa. Sonnini considers the jerboa as constituting a link between quadrupeds and birds. In this idea he is by no means singular; the same sentiment naturally suggesting itself to the mind of every philosophical observer. Mons. Sonnini adds, that though the transition from quadrupeds to birds has not yet been investigated, we have nevertheless reason to consider the connection as existing. We have the beginning of it in the jerboa, and the last link of it in the bat. We have every reason to believe, that the series of gradations will develope itself in proportion as good observers shall carry their researches into countries the natural history of which is still unexplored.

"The jerboa appears, says Sonnini, to be a prolific animal; for it is exceedingly numerous in Arabia, Nubia, Egypt, and Barbary. During my stay or rather during my excursions in Egypt, I opened several jerboas. My principal aim was to ascertain that they had only one stomach, and consequently could not possess the power of ruminating. This was in answer to one of the questions that Michaelis, professor at Gottingen, had addressed to the travellers sent to the East by the king of Denmark, viz. Whether the jerboa was a ruminating animal; a question arising from the same mistake which had occasioned the confounding the jerboa with the daman Israel, or saphan of the Hebrews.

"The sand and ruins that surround modern Alexandria are much frequented by the jerboas. They live in society, and in burrows, which they dig with their teeth and nails. I have even been told, that they sometimes make their way through the soft stone which is under the stratum of sand. Though not absolutely wild, they are very shy, and upon the least noise, or the sight of any object, retire precipitately to their holes. They can only be killed by surprise. The Arabs contrive to take them alive, by stopping up all the avenues to their burrows except one, by which they force them to come out. I never ate any: their flesh indeed is said to be not very palatable, though it is not despised by the Egyptians. Their skin, covered with soft and shining hair, is used as a common fur.

"In Egypt, I kept six of these animals for some time in a large cage: the very first night they entirely gnawed through the upright and cross pieces of wood, and I was obliged to have the inside of the cage lined with tin. They ate rice, walnuts, and all kinds of fruit. They delighted in being in the sun; and when taken into the shade, huddled together, and seemed to suffer from the privation of heat. It has been said that the erboas sleep by day, and never in the night but, for my part, I observed quite the contrary. In a state of liberty they are found round their subterraneous habitations in open day, and those which I kept were never more lively nor awake than in the heat of the sun. Although they have a great deal of agility in their motions, they seem to be of a mild and tranquil disposition. Mine suffered themselves to be touched without difficulty; and there was neither noise nor quarrel among them, even when taking their food. At the same time they testified neither joy, fear, nor gratitude: their gentleness was neither amiable nor interesting: it appeared to be the effect of cold and complete indifference, bordering on stupidity. Three of these animals died successively, before my departure from Alexandria. I lost two others during a somewhat stormy passage to the isle of Rhodes, when the last, owing to the negligence of the person to whose care it was committed, got out of its cage and disappeared. I had a strict search made for it, when the vessel was unloaded, but without effect: it had no doubt been killed by the cats."

2. Dipus jaculus, or alagtaga, in its general appearance perfectly resembles the common or Egyptian jerboa, but is considerably larger, though there appear to be permanent varieties or races which are, on the contrary, much smaller than the common species. It is principally distinguished by the remarkable character of the hind feet, each of which has a pair of very conspicuous spurs, or additional toes, situated at some distance above the front toes, and furnished with sharp claws.

Of this species there are two supposed varieties, agreeing in form with the above-mentioned, but differing in size, and in some degree in colour; but the differences are not such as to justify our considering them as specifically distinct. The first of these varieties is the Middle Siberian jerboa, which is of the size of a rat, and has the thighs crossed by a white line; and a whitish zone or circle surrounds the nose. It is found in the eastern deserts of Siberia and Tartary, beyond the lake Baikal. It also occurs in Barbary and Syria, and extends, according to Dr. Pallas, even as far as India. The other variety is called by Mr. Pennant, the pygmy Siberian jerboa. It agrees in form with the other, but has no white circle round the nose, and has a smaller tuft to the tail, the end of which is just tipped with white. In size it is far inferior to the middle variety. It is said to inhabit the same places with the large or first-described kind. All these agree in their manners, burrowing in hard clayey ground, not only in high and dry spots, but even in low and salt places; digging their holes with great celerity with their fore feet and teeth; thus forming oblique and winding burrows, of some yards in length, and ending in a large hole or receptacle by way of nest, in which are deposited the herbs, &c. on which they feed. They are said to wander about chiefly by night. They sleep rolled up, with the head between the thighs: they are extremely nimble, and on the approach of danger spring forward so swiftly, that a man well mounted can scarcely overtake them. They are said to be particularly fond of the roots of tulips, and some other bulbous-rooted plants. They are supposed to sleep during the winter in the manner of dormice.

Mr. Bruce tells us, that there is little variety in the animal, either in size or colour; but that towards Aleppo they have broader noses than the African; that their bodies are thicker, and their colour lighter.

"The Arabs of the kingdom of Tripoli (says Mr. Bruce), make very good diversion with the jerboa, in training their greyhounds, which they employ to hunt the gazel or antelope, after instructing him to turn himself by hunting this animal. The prince of Tunis, son of Sidi Younis, and grandson of Ali Bey, who had been strangled by the Algerines when that capital was taken, being then an exile at Algiers, made me a present of a small greyhound, which often gave us excellent sport. It may perhaps be imagined that a chace between these two creatures could not be long: yet I have often seen, in a large inclosure, or court-yard, the greyhound employ a quarter of an hour before he could master his nimble adversary: the small size of the creature assisted him much; and had not the greyhound been a practised one, and made use of his feet as well as his teeth, he might have killed two antelopes in the time he could have killed one jerboa."

3. Dipus cafer, or cape jerboa, is by far the largest of all the jerboas, and is a native of the mountainous country to the north of the Cape of Good Hope. Its length from nose to tail is one foot two inches; of the tail near 15 inches. It is an animal of great strength and activity, and will spring to the distance of 20 or 30 feet at once. When eating, it sits upright in the manner of a squirrel. It burrows in the ground, like the smaller kind of jerboas, with great ease and expedition, having very strong and long claws, five in number, on the fore feet: those on the hind feet are rather short, and are four in number.

4. Dipus meridianus, or torrid jerboa, according to Dr. Pallas, was first figured by Seba, whose specimen appears to have been not fully grown. Specimens were brought to Dr. Pallas in the year 1770, which were taken on the borders of the sandy desert of Naryn, in 46½ north latitude. The burrows or passages which they had formed in the dry soil, had a triple entrance, and were about an ell deep in the ground. The size of this species is between that of a rat and a field-mouse; and notwithstanding the great length of the hind legs, it does not leap, like the rest of the jerboas, but runs in the manner of the rat tribe; and it seems to be on this account that Mr. Pennant has ranked it under his division of jerboid rats, rather than among the true jerboas.

5. Dipus canadensis, or Canadian jerboa. This minute species is thus described by general Davies, who had an opportunity of examining it during his residence at Quebec.

"As I conceive there are very few persons, however conversant with natural history, who may have seen or known that there was an animal existing in the coldest parts of Canada, of the same genus with the jerboa, hitherto confined to the warmer climates of Africa, I take the liberty of stating the following particulars. With respect to the food, or mode of feeding, of this animal, I have it not in my power to speak with any degree of certainty, as I could by no means

procure any kind of sustenance that could induce it to eat; therefore, when caught, it lived only a day and a half. The first I was so fortunate as to catch, was taken in a large field near the falls of Montmorenci, and by its having strayed too far from the skirts of the wood, allowed myself, assisted by three other gentlemen, to surround it, and after an hour's hard chase, to get it unhurt, though not before it was thoroughly fatigued, which might in a great measure accelerate its death. During the time the animal remained in its usual vigour, its agility was incredible for so small a creature. It always took progressive leaps of from three to four, and sometimes of five yards, although seldom above 12 or 14 inches from the surface of the grass; but I have frequently observed others in shrubby places, and in the woods, among plants, where they chiefly reside, leap considerably higher. When found in such places, it is impossible to take them, from their wonderful agility, and their evading all pursuit, by bounding into the thickest part of the covert they can find. With respect to the figure given of it in its dormant state, I have to observe, that the specimen was found by some workmen, in digging the foundation for a summer-house in a gentleman's garden, about two miles from Quebec, in the latter end of May, 1787. It was discovered enclosed in a ball of clay, about the size of a cricket-ball, nearly an inch in thickness, perfectly smooth within, and about 20 inches under ground. The man who first discovered it, not knowing what it was, struck the ball with his spade, by which means it was broken to pieces, or the ball would have been presented to me. How long it had been under ground it is impossible to say; but as I could never observe these animals in any parts of the country after the beginning of September, I conceive they lay themselves up some time in that month, or beginning of October, when the frost becomes sharp. Nor did I ever see them again before the last week in May or beginning of June. From their being enveloped in balls of clay, without any appearance of food, I conceive they sleep during the winter, and remain for that term without sustenance. As soon as I conveyed this specimen to my house, I deposited it, as it was, in a small chip box, in some cotton, waiting with great anxiety for its waking, but that not taking place at the season they generally appear, I kept it until I found it begin to smell; I then stuffed it, and preserved it in its torpid position. I am led to believe its not recovering from that state arose from the heat of my room during the time it was in the box, a fire having been constantly burning in the stove, and which in all probability was too great for its respiration."

DIRCA, a genus of the monogynia order, in the octandria class of plants, and in the natural method ranking under the 1st order, vepreculæ. There is no calyx; the corolla is tubular, with the limb indistinct; the stamina are longer than the tube; the berry is monospermous. There is one species, a small shrub of North America.

DIRECT, in astronomy. A planet is said to be direct when it appears to an observer on the earth to go forward in the zodiac, or according to the succession of the signs. See ASTRONOMY.

DIRECT, in matters of genealogy, is understood of the principal line, or the line of ascendants and descendants, in contradistinction to the collateral line. The heirs in the direct lines always precede those in the collateral lines.

DIRECT RAY, in optics, is a ray flowing from a point of a visible object directly to the eye, through one and the same medium.

DIRECT *east and west dials*, dials drawn upon planes that directly face the east and west points of the horizon, or parallel to the meridian. See DIAL.

DIRECT *south and north dials*, are those which face directly the north and south points of the horizon, or parallel to the prime vertical circle. See DIAL.

DIRECTION, in mechanics, signifies the line or path of a body's motion, along which it endeavours to proceed, according to the force impressed upon it. See MECHANICS.

DIRECTOR, in surgery, a grooved probe to direct the edge of the knife or scissars, in opening sinuses, or fistulæ, that by this means the subadjacent vessels, nerves, and tendons, may remain unhurt. See SURGERY.

DIRIGENT, or DIRECTRIX, a term in geometry, signifying the line of motion along which the describent line or surface is carried in the genesis of any plane or solid figure: thus, if the line AB (plate Miscel. fig. 43) move along the line AC, so that the point A always keeps in the line AC, a parallelogram, as ABCD, will be formed, of which the side AB is the describent, and the line AC the dirigent; so also, if the surface ABCD be supposed to be carried along CE, in a position always parallel to itself in its first situation, the solid ADFH will be formed, where the surface AD is the describent, and the line CE the dirigent.

DISA, a genus of the gynandria diandria class and order. The spathe is one-valved; petals three, the third less, two-parted, gibbous at the base. There are four species, herbaceous plants of the Cape, with beautiful blue flowers.

DISABILITY, in law, an incapacity in a man to inherit or take a benefit which otherwise he might have done, which may happen four ways; by the act of the ancestor, by the act of the party, by the act of law, and by the act of God. 1. Disability by the act of the ancestor; as if a man be attainted of treason or felony; by this attainder his blood is corrupt, and himself and his children disabled to inherit. 2. Disability by the act of the party himself; as if one make a feoffment to another who then is sole, upon condition, that he shall enfeoff a third before marriage, and before the feoffment made, the feoffee takes a wife; he has by that disabled himself from performing the condition according to the trust reposed in him, and therefore the feoffer may enter, and oust him. Lit. 357. 3. Disability by act of law, is when a man by the sole act of the law is disabled, as an alien-born, &c. 4. Disability by the act of God, is where a person is of non-sane memory, and in cases of idiocy, &c. But it is a maxim in our law, that a man of full age shall never be received to disable his own person. Co. lib. 4. 123, 124. See also ALIENS, DISSENTERS, IDIOCY, and INFAMY.

DISAGREEMENT, will make a nullity of a thing that had effect before: and disagreement may be to certain acts to make them void, &c. Co. Lit. 380.

DISANDRA, a genus of the monogynia order, in the heptandria class of plants. The calyx has seven leaves; the corolla is parted into seven, and flat; the capsule two-celled. There are two species, pretty trailing plants, natives of Madeira.

DISARMING, in law, the prohibiting people to wear arms. It is an offence by the common law of England for persons to go or ride armed with dangerous and uncommon weapons: though gentlemen may wear common armour, according to their quality. It is also ordained by statute, that no persons shall come before the king's justices with force of arms, on pain of imprisonment, &c.

DISC, *discus*, in antiquity, a quoit made of stone, iron, or copper, five or six fingers broad, and more than a foot long, inclining to an oval figure, which was hurled in the manner of a bowl, to a vast distance, by the help of a leathern thong tied round the person's hand who threw it, and put through a hole in the middle.

DISC, in astronomy, the body and face of the sun and moon, such as it appears to us on the earth; or the body or face of the earth, such as it appears to a spectator in the moon. The disc in eclipses is supposed to be divided into 12 equal parts, called digits; in a total eclipse of the luminaries, the whole disc is obscured; in a partial eclipse, only a part of it. See ASTRONOMY.

DISC, in botany, is an aggregate of florets forming, as it were, a plane surface.

DISC, in optics, is the width of the aperture of telescopic glasses, whatever their form be, whether plane, convex, concave, &c.

DISCHARGE, is where a man confined by some legal process, performs that which the law requires, and is released from the matter for which he is confined. If an obligee discharge one obligor where several are jointly bound, it discharges the others. See ARREST, BOND, PAYMENT.

DISCLAIMER, is a plea containing an express denial, renouncing or disclaiming; as if the tenant sues a replevin upon a distress taken by the lord, and the lord avows, saying that he holds of him as his lord, and that he distrained for rent not paid, or service not performed; then the tenant denying to hold of such lord, is said to disclaim; and the lord proving the tenant to hold of him, the tenant loses his land. Co. on Lit. 102.

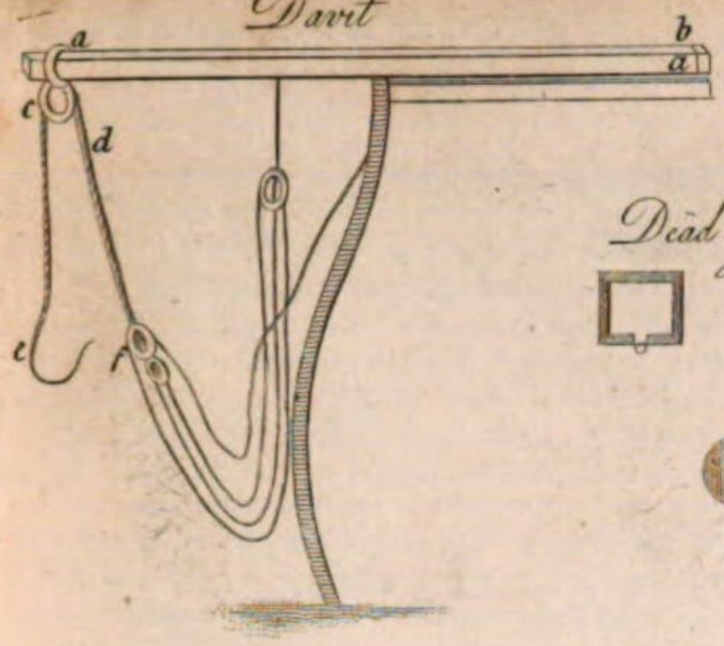
DISCONTINUANCE OF POSSESSION. A man may not enter upon his own lands or tenements alienated (such alienation being a discontinuance of possession), whatsoever his right be to them, of his own self or by his own authority, but must bring his writ, and seek to recover possession by law. Co. Rep. lib. 3. 85.

DISCONTINUANCE OF PROCESS, is where the plaintiff leaves a chasm in the proceedings of his cause, whereby the opportunity of prosecution is lost for that time, in which case he must begin again, and usually pays costs to the defendant, or the plaintiff is dismissed the court, &c. Every suit, whether civil or criminal, and every process therein, ought to be properly continued from day to day, &c. from its commencement to its conclusion; and the suffering any default or gap herein, is called a discontinuance. 2 Haw. 298.

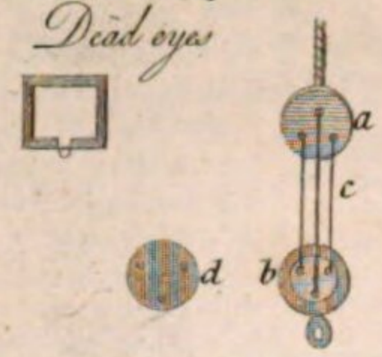
DISCONTINUANCE OF PLEA: if where divers things should be pleaded to, then some

MISCELLANIES.

31
Davit



32
Dead eyes



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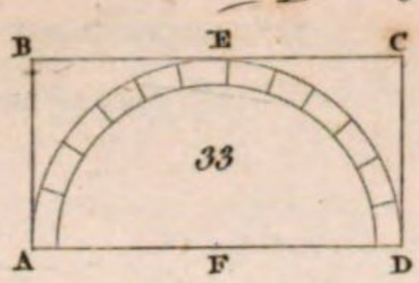

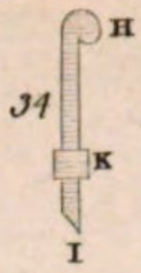

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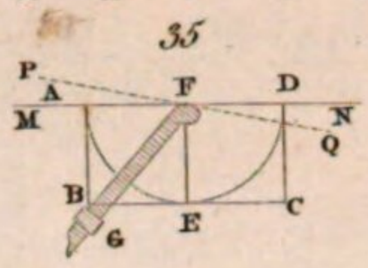

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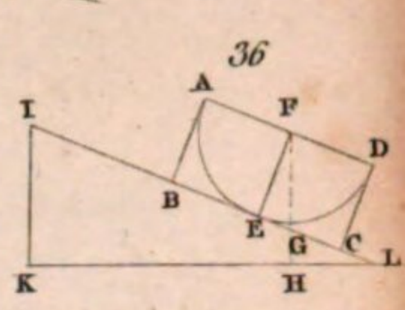
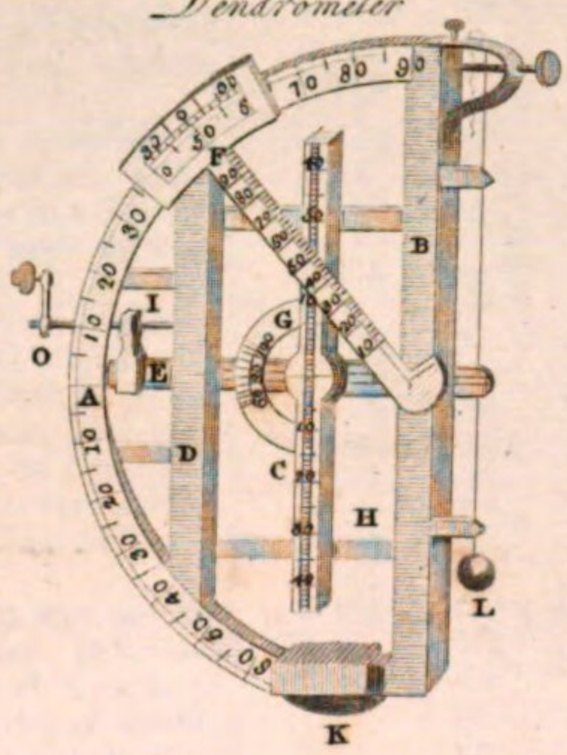
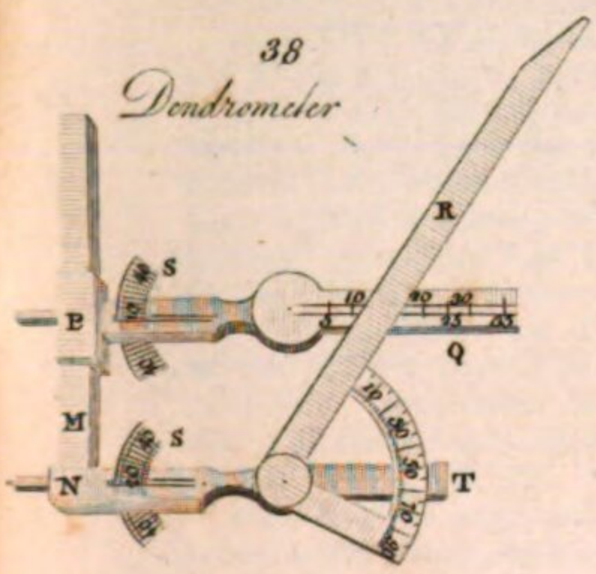


37
Dendrometer



38
Dendrometer



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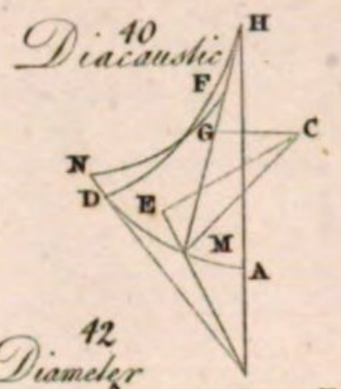
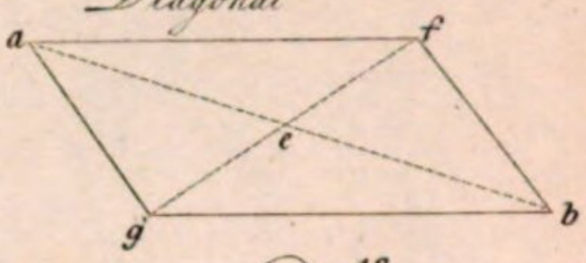
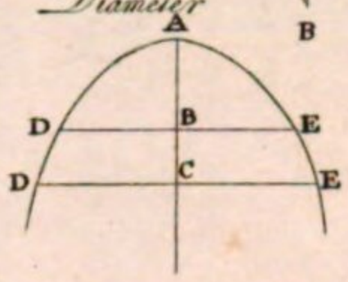
Diacaustic



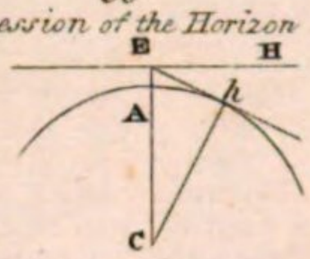
41
Diagonal



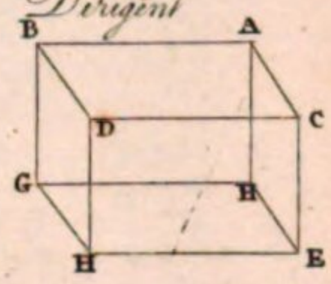
42
Diameter



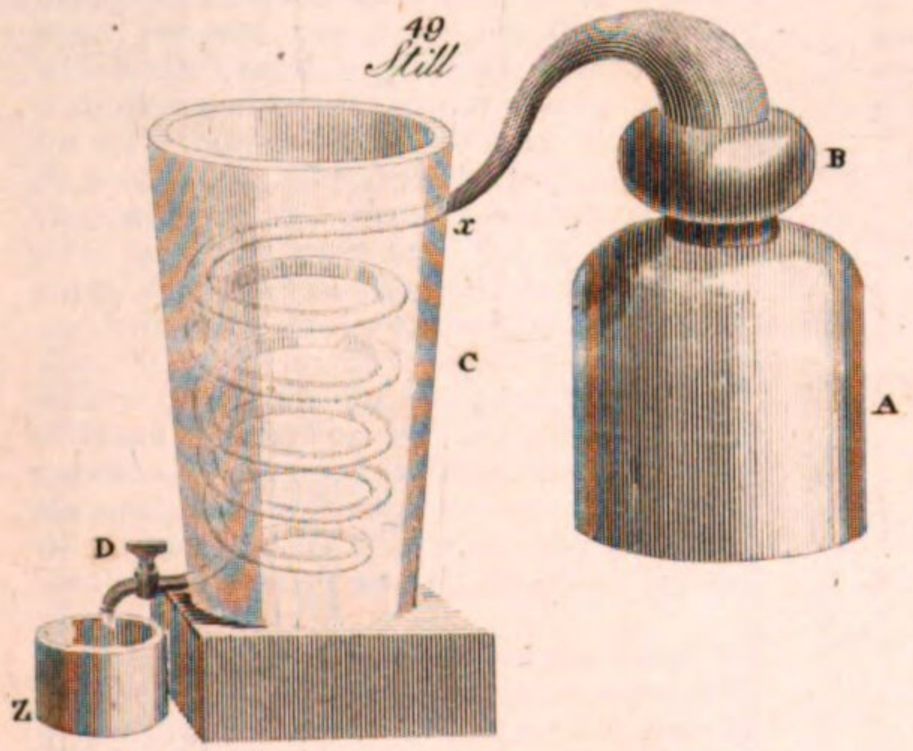
39
Depression of the Horizon



43
Dirigent



49
Still

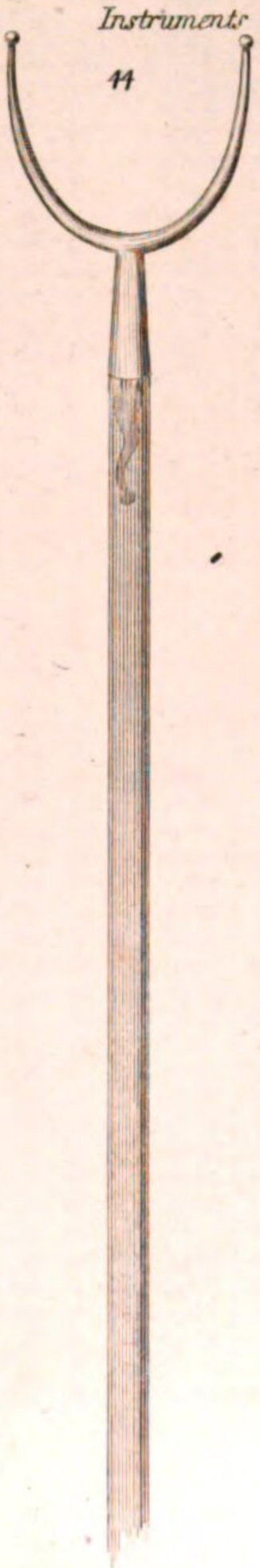


47
Implements of restoration from Drowning

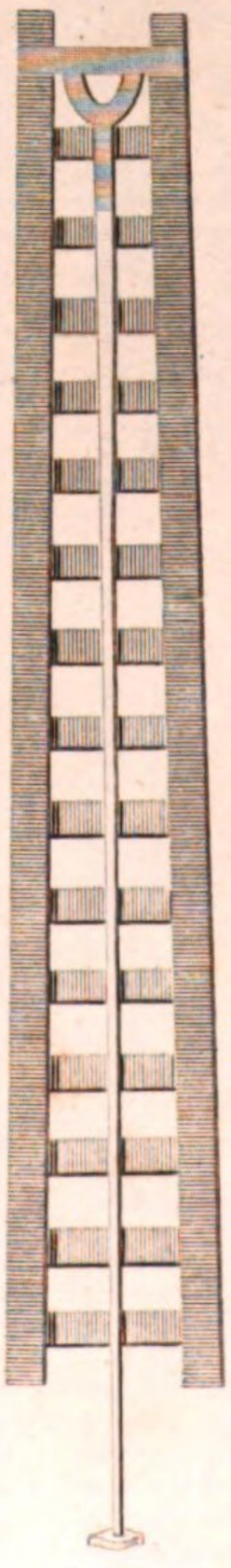
48

Instruments for recovering the bodies of Drowned Persons

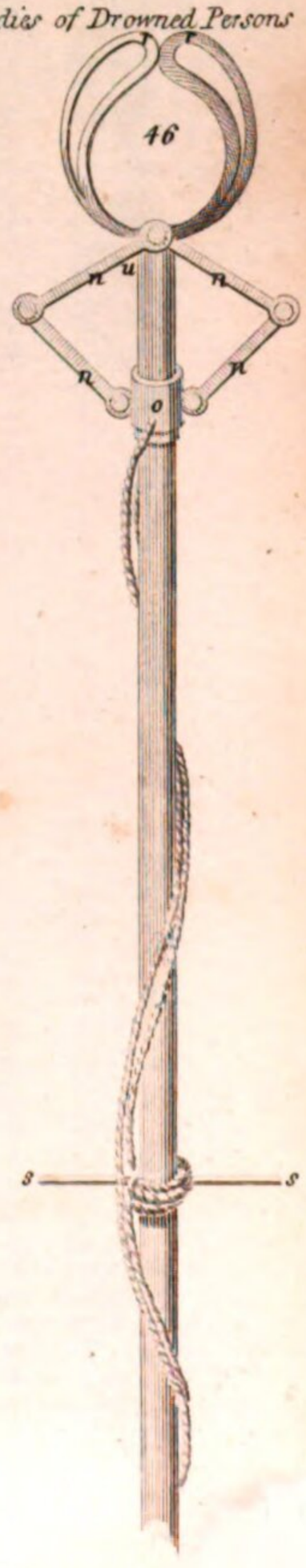
44



45



46



are omitted, this is a discontinuance. 1 Nels. Abr. 660, 661.

DISCORD, in music, is a dissonant or inharmonious combination of sounds, so called in opposition to the concord, the effects of which the discord is calculated to relieve and sweeten. Among various other discords are those formed by the union of the fifth with the sixth, the fourth with the fifth, the seventh with the eighth, and the third with the ninth and seventh, all which require to be introduced by certain preparatives, and to be succeeded by concords to which they have some relation.

DISCORDANT, an epithet applied to all dissonant and inharmonious sounds, whether successive or simultaneous.

DISCOVERY, the act of revealing or disclosing any matter by a defendant, in his answer to a bill filed against him in a court of equity. A bill for a discovery must shew an interest in the plaintiff in the subject, to which the required discovery relates; and such an interest as entitles him to call on the defendant for the discovery. Finch, Rep. 36, 44. 1 Vern. 399. It is a general rule, that no one is bound to answer so as to subject himself to punishment, in whatever manner that punishment may arise. 2 Vez. 245, 451. 1 Atk. 450. 2 Atk. 393.

DISCOUNT, in commerce, a term among traders, merchants, and bankers. It is used by the two former on occasion of their buying commodities on the usual time of credit, with a condition that the seller shall allow the buyer a certain discount at the rate of so much per cent. per annum, for the time for which the credit is generally given, upon condition that the buyer pays ready money for such commodities, instead of taking the time of credit. Traders and merchants also frequently taking promissory notes for money due, payable to them or order at a certain time, and sometimes having occasion for money before the time is elapsed, they procure these notes to be discounted by bankers or others before the time of payment; which discount is more or less, according to the credit and reputation of the person who drew the note, and the indorser or indorsers. Bills of exchange are also discounted by bankers, and in this consists one article of the profits of banking. See Bank.

The best tables of discount are those of Mr. Smart, founded upon the true principles of decimal arithmetic. By these it appears, that he who allows 5*l.* for the discount of 100*l.* for one year at 5 per cent. wrongs himself; for he ought to receive so much money as at 5 per cent. interest will amount to 100*l.* in one year, and the sum is 95*l.* 4*s.* 9$\frac{1}{4}$*d.* The rule for finding the true discount is this:

As the amount of 100*l.* for the given rate and time:
Is to the given sum::
So is the interest of 100*l.* for the given rate and time:
To the discount of the debt.

Thus, if p be the principal, r the rate of interest, and t the time, then say, as $100 + rt : p :: rt : \frac{prt}{100+rt}$, which is the true discount.

Hence $p - \frac{prt}{100+rt} = \frac{100p}{100+rt}$ is the present worth, or sum to be received.

Ex. Suppose it be required to find the discount of 250*l.* for five months, at the rate of 5*l.* per cent. per annum interest. Here $p = 250$, $r = 5$, and $t = \frac{5}{12}$; therefore $\frac{prt}{100+rt} = \left| \begin{array}{l} \frac{250 \times 5 \times \frac{5}{12}}{100 + 5 \times \frac{5}{12}} = \frac{250 \times 25}{1200 + 25} = \frac{250}{49} = \\ \text{£.5 2s. } \frac{2}{49}\text{d.} \end{array} \right.$

The following Table is an enlargement of one invented by Mr. D. Baird and will be found exceedingly Useful for all practical purposes in Trade and Commerce.

TABLE FOR CALCULUTION OF DISCOUNTS.

FROM $\frac{1}{2}$*d.* TO £.1,000.

s.	d.		s.	d.		s.	d.		s.	d.		£.	s.	
0	0½	15	5	0	1825	12	9	4653	30	6	11,132	3	13	26,645
0	1	30	5	1	1855	13	0	4745	30	9	11,223	3	14	27,010
0	1½	45	5	2	1885	13	3	4836	31	0	11,315	3	15	27,375
0	2	60	5	3	1916	13	6	4927	31	3	11,406	3	16	27,740
0	2½	76	5	4	1946	13	9	5018	31	6	11,497	3	17	28,105
0	3	91	5	5	1977	14	0	5110	31	9	11,588	3	18	28,470
0	3½	106	5	6	2007	14	3	5201	32	0	11,680	3	19	28,835
0	4	122	5	7	2037	14	6	5292	32	3	11,771	4	0	29,200
0	4½	137	5	8	2068	14	9	5383	32	6	11,862	4	1	29,565
0	5	152	5	9	2098	15	0	5475	32	9	11,953	4	2	29,930
0	5½	167	5	10	2129	15	3	5566	33	0	12,045	4	3	30,295
0	6	182	5	11	2159	15	6	5657	33	3	12,136	4	4	30,660
0	6½	197	6	0	2190	15	9	5748	33	6	12,227	4	5	31,025
0	7	213	6	1	2220	16	0	5840	33	9	12,318	4	6	31,390
0	7½	228	6	2	2250	16	3	5931	34	0	12,410	4	7	31,755
0	8	243	6	3	2281	16	6	6022	34	3	12,501	4	8	32,120
0	8½	258	6	4	2311	16	9	6113	34	6	12,592	4	9	32,485
0	9	274	6	5	2342	17	0	6205	34	9	12,683	4	10	32,850
0	9½	289	6	6	2372	17	3	6296	35	0	12,775	4	11	33,215
0	10	304	6	7	2402	17	6	6387	35	3	12.866	4	12	33,580
0	10½	319	6	8	2433	17	9	6478	35	6	12,957	4	13	33,945
0	11	334	6	9	2463	18	0	6570	35	9	13,048	4	14	34,310
0	11½	350	6	10	2494	18	3	6661	36	0	13,140	4	15	34,675
1	0	365	6	11	2524	18	6	6752	36	3	13,231	4	16	35,040
1	1	395	7	0	2555	18	9	6843	36	6	13,322	4	17	35,405
1	2	426	7	1	2585	19	0	6935	36	9	13,413	4	18	35,770
1	3	456	7	2	2615	19	3	7026	37	0	13,505	4	19	36,135
1	4	487	7	3	2646	19	6	7117	37	3	13,596	5	0	36,500
1	5	517	7	4	2676	19	9	7208	37	6	13,687	5	5	38,325
1	6	547	7	5	2707	20	0	7300	37	9	13,778	5	10	40,150
1	7	578	7	6	2737	20	3	7391	38	0	13,870	5	15	41,975
1	8	608	7	7	2767	20	6	7482	38	3	13,961	6	0	43,800
1	9	638	7	8	2798	20	9	7573	38	6	14,052	6	5	45,625
1	10	669	7	9	2828	21	0	7665	38	9	14,143	6	10	47,450
1	11	699	7	10	2859	21	3	7756	39	0	14,235	6	15	49,275
2	0	730	7	11	2889	21	6	7847	39	3	14,826	7	0	51,100
2	1	760	8	0	2920	21	9	7938	39	6	14,417	7	5	52,925
2	2	791	8	1	2950	22	0	8030	39	9	14,508	7	10	54,750
2	3	821	8	2	2980	22	3	8121	40	0	14,600	7	15	56,575
2	4	852	8	3	3011	22	6	8212	41	0	14,965	8	0	58,400
2	5	882	8	4	3041	22	9	8303	42	0	15,330	8	5	60,225
2	6	912	8	5	3072	23	0	8395	43	0	15,695	8	10	62,050
2	7	943	8	6	3102	23	3	8486	44	0	16,060	8	15	63,875
2	8	973	8	7	3132	23	6	8577	45	0	16,425	9	0	65,700
2	9	1004	8	8	3163	23	9	8668	46	0	16,790	9	5	67,525
2	10	1034	8	9	3193	24	0	8760	47	0	17,155	9	10	69,350
2	11	1064	8	10	3224	24	3	8851	48	0	17,520	9	15	71,175
3	0	1095	8	11	3254	24	6	8942	49	0	17,885	10	0	73,000
3	1	1125	9	0	3285	24	9	9033	50	0	18,250	10	5	74,825
3	2	1156	9	1	3315	25	0	9125	51	0	18,615	10	10	76,650
3	3	1186	9	2	3345	25	3	9216	52	0	18,980	10	15	78,475
3	4	1217	9	3	3376	25	6	9307	53	0	19,345	11	0	80,300
3	5	1247	9	4	3406	25	9	9398	54	0	19,710	11	5	82,125
3	6	1277	9	5	3437	26	0	9490	55	0	20,075	11	10	83,950
3	7	1308	9	6	3467	26	3	9581	56	0	20,440	11	15	85,775
3	8	1338	9	7	3497	26	6	9672	57	0	20,805	12	0	87,600
3	9	1369	9	8	3528	26	9	9763	58	0	21,170	12	5	89,425
3	10	1399	9	9	3558	27	0	9855	59	0	21,535	12	10	91,250
3	11	1429	9	10	3589	27	3	9946	60	0	21,900	12	15	93,075
4	0	1460	9	11	3619	27	6	10,037	61	0	22,265	13	0	94,900
4	1	1490	10	0	3650	27	9	10,128	62	0	22,630	13	5	96,725
4	2	1521	10	3	3741	28	0	10,220	63	0	22,995	13	10	98,550
4	3	1551	10	6	3832	28	3	10,311	64	0	23,360	13	15	100,375
4	4	1582	10	9	3923	28	6	10,402	65	0	23,725	14	0	102,200
4	5	1612	11	0	4015	28	9	10,493	66	0	24,090	14	5	104,025
4	6	1642	11	3	4106	29	0	10,585	67	0	24,445	14	10	105,850
4	7	1673	11	6	4197	29	3	10,676	68	0	24,820	14	15	107,675
4	8	1703	11	9	4288	29	6	10,767	69	0	25,185	15	0	109,500
4	9	1734	12	0	4380	29	9	10,858	70	0	25,550	15	5	111,325
4	10	1764	12	3	4471	30	0	10,950	71	0	25,915	15	10	113,150
4	11	1794	12	6	4562	30	3	11,041	72	0	26,280	15	15	114,975

TABLE OF DISCOUNTS (*Continued.*)

£.	s.		£.	s.	
16	0	116,800	43	10	317,550
16	5	118,625	44	0	321,200
16	10	120,450	44	10	324,850
16	15	122,275	45	0	328,500
17	0	124,100	45	10	332,150
17	5	125,925	46	0	335,800
17	10	127,750	46	10	339,450
17	15	129,575	47	0	343,100
18	0	131,400	47	10	346,750
18	5	133,225	48	0	350,400
18	10	135,050	48	10	354,050
18	15	136,875	49	0	357,700
19	0	138,700	49	10	361,350
19	5	140,525	50	0	365,000
19	10	142,350	51	0	372,300
19	15	144,175	52	0	379,600
20	0	146,000	53	0	386,900
20	5	147,825	54	0	394,200
20	10	149,650	55	0	401,500
20	15	151,475	56	0	408,800
21	0	153,300	57	0	416,000
21	5	155,125	58	0	423,400
21	10	156,950	59	0	430,700
21	15	158,775	60	0	438,000
22	0	160,600	61	0	445,300
22	5	162,425	62	0	452,600
22	10	164,250	63	0	459,900
22	15	166,075	64	0	467,200
23	0	167,900	65	0	474,500
23	5	169,725	66	0	481,800
23	10	171,550	67	0	489,100
23	15	173,375	68	0	496,400
24	0	175,200	69	0	503,700
24	10	178,850	70	0	511,000
25	0	182,500	71	0	518,300
25	10	186,150	72	0	525,600
26	0	189,800	73	0	532,900
26	10	193,450	74	0	540,200
27	0	197,100	75	0	547,500
27	10	200,750	76	0	554,800
28	0	204,400	77	0	562,100
28	10	208,050	78	0	569,400
29	0	211,700	79	0	576,700
29	10	215,350	80	0	584,000
30	0	219,000	81	0	591,300
30	10	222,650	82	0	598,600
31	0	226,300	83	0	605,900
31	10	229,950	84	0	613,200
32	0	233,600	85	0	620,500
32	10	237,250	86	0	627,800
33	0	240,900	87	0	635,100
33	10	244,550	88	0	642,400
34	0	248,200	89	0	649,700
34	10	251,850	90	0	657,000
35	0	255,500	91	0	664,300
35	10	259,150	92	0	671,600
36	0	262,800	93	0	678,900
36	10	266,450	94	0	686,200
37	0	270,100	95	0	693,500
37	10	273,750	96	0	700,800
38	0	277,400	97	0	708,100
38	10	281,050	98	0	715,400
39	0	284,700	99	0	722,700
39	10	288,350	100	0	730,000
40	0	292,000	150	0	1,095,000
40	10	295,650	200	0	1,460,000
41	0	299,300	300	0	2,190,000
41	10	302,950	400	0	2,920,000
42	0	306,600	500	0	3,650,000
42	10	310,250	1000	0	7,300,000.
43	0	313,900			

Method of Calculation by the above Table.—To find the interest of any sum of money for any given number of days, multiply the sum by the number of days, and the table will shew the product.

If the interest on any number of sums be required, multiply the number of pounds by the days, as above, on each sum, and add the product into one sum; the value of which, (if less than 1000*l.*) will be immediately shewn by the table: and thus by the union of the respective sums, the loss or gain of fractions falls only on the gross sum, instead of each component part.

Example. On the 1st of May I want to discount a bill for 100*l.*, due the 25th of June following:

100*l.* × 40 days = 4000; by referring to the table, I find the nearest number less than 4000 is 3923 = 10*s.* 9*d.*;

which, being deducted, leaves 77

76 = 2½*d.*

10*s.* 11½*d.* $\frac{1}{7\frac{1}{2}}$. Or (which is easier), finding that 4015 is, by the table, equal to 11 shillings; and that 15 is equal to ½*d.*, I find the answer to be 10*s.* 11½*d.*

Ex. The interest is required on the following sums:

	100*l.*	for	75 days,
	245		42
	987		86
	92		140
100*l.*	× 75 days	=	7,500
245*l.*	× 42 days	=	10,290
987*l.*	× 86 days	=	84,882
92*l.*	×140 days	=	12,880

115,552, the nearest No. less than this in the table, is - - 114,975 = 15*l.* 15*s.*, which being subtracted, leaves 577. I find, by the table, 578 amount to 1*s.* 7*d.*; and as the unit which forms the difference is only $\frac{1}{7\frac{1}{2}}$ of a farthing, I call the answer 15*l.* 16*s.* 7*d.*;

strictly 15*l.* 16*s.* 6$\frac{5}{4}$*d.* $\frac{6\frac{1}{2}}{7\frac{1}{2}}$.

The interest on any sum may be found without the assistance of the table, by multiplying the number of pounds by the days, as above, and dividing by 7,300 to give the product in Pounds

by 365 - - - Shillings

by $30\frac{5}{12}$ - - - Pence.

The units in this table being less than $\frac{1}{7}$ of a farthing each, the fractions of these units are omitted.

DISCRETE or DISJUNCT PROPORTION, is when the ratio of two or more pairs of numbers or quantities is the same, but there is not the same proportion between all the four numbers. Thus if the numbers 3 : 6 : : 8 : 16 be considered, the ratio between 3 : 6, is the same as that between 8 : 16, and therefore the numbers are proportional; but it is only discretely or disjunctly, for 3 is not to 6 as 6 to 8; that is, the proportion is broken off between 8 and 3, and is not continued as in the following continual proportionals; 3 : 6 : : 12 : 24.

DISCRETE QUANTITY, such as is not continuous and joined together. Such is a number whose parts being distinct units, cannot be united into one continuum; for in a continuum, there are no actual determinate parts before division, but they are potentially infinite.

DISCRETION, is to discern between right and wrong; and therefore whoever has power to act at discretion, is bound by the rule of reason and law. 2 Inst. 56. 298. And the court of king's-bench has a power to redress things that are otherwise done, notwithstanding they are left to the discretion of those that do them. 1 Lill. Abr. 477.

DISDIAPASON, or BISDIAPASON, in music, a compound concord, described by F. Parron, in the quadruple ratio of 4 : 1, or 8 : 2. The disdiapason is produced when the voice grows diatonically from its first to its fifteenth sound, and may be called a fifteenth. The voice ordinarily does not go farther than from its first sound to the disdiapason, that is, it does not go beyond the compound, or double octave; for the disdiapason is an octave doubled. The voice sometimes rises several degrees above the disdiapason, but the effort or struggle disfigures it, and makes it false. In reality, the antient scale or diagram extended only to a disdiapason.

DISEASE, in medicine, that state of a living body, wherein it is deprived of the exercise of any of its functions, whether vital, natural, or animal. See MEDICINE.

DISEMBOGUE, in the sea-language, is said of a ship that passes out of a gulph or bay into the open sea. A river is also said to disembogue or discharge itself into the sea.

DISFRANCHISING, among civilians, signifies the depriving a person of the rights and privileges of a free citizen or subject.

DISFRANCHISEMENT, is the taking away a man's freedom or privilege. Corporations generally have power by their charter or prescription, to disfranchise a member for doing any thing against the duty of his office as citizen or burgess, and to the prejudice of the public weal of the city or borough, and against his oath, which he took when he was sworn a freeman. But the matter which shall be the cause of his disfranchisement, ought to be an act or deed, and not an endeavour or enterprize whereof he may repent before the execution thereof, and of which no prejudice ensues. 11 Co. 98.

DISGUISED PERSONS, not to hunt in a park or warren, under severe penalties; prosecutions against them must be within three years, and the trial may be in any county. 9 Geo. I. c. 22. See BLACK ACT.

DISH, among miners, denotes a wooden measure, wherein they are obliged to measure their ore; it is kept by the bar-master, and contains about 672 solid inches.

DISJUNCTIVE PROPOSITION, in logic, is that where of several predicates we affirm one necessarily to belong to the subject to the exclusion of all the rest, but leave that particular one undetermined. Such is the major of the following disjunctive syllogism.

The world is either self-existent, or the work of some finite, or of some infinite being:
But it is not self-existent, nor the work of a finite being;
Therefore it is the work of an infinite being.

DISLOCATION, the putting a bone out of joint by violence. See SURGERY.

DISMEMBERED, in heraldry, is applied to birds that have neither feet nor legs, and also to lions and other animals whose members are separated.

DISPARAGEMENT, in our law, is properly used for the matching an heir in marriage under his degree, or against decency.

DISPART, in gunnery, is the setting a mark upon the muzzle-ring, or thereabouts, of a piece of ordnance, so that a sight-line taken upon the top of the base-ring against the touch-hole, by the mark set on or near the muzzle, may be parallel to the axis of the concave cylinder. The common way of doing this, is to take the two diameters of the base-ring, and of the place where the dis-

part is to stand, and divide the difference between them into two equal parts, one of which will be the length of the dispart; which is set on the gun with wax or pitch, or fastened there with a piece of twine or marlin. By means of an instrument it may be done with all possible nicety.

DISPAUPER: when any person, on account of poverty, attested by his own oath of not being worth 5*l.* his debts being paid, is admitted to sue in forma pauperis, if afterwards, before the suit is ended, he has any lands, or personal estate fallen to him; or that the court where the suit depends, thinks fit for that or any other reason, to take away that privilege from him; then he is said to be dispaupered, and can no longer sue in forma pauperis.

DISPENSARY, or DISPENSATORY, denotes a book containing the method of preparing the various kinds of medicines used in pharmacy. The apothecaries in and about London are obliged to make up their compound medicines according to the formulas prescribed in the college dispensary, and are enjoined to keep always ready in their shops all the medicines there enumerated.

It is also a kind of charitable institution of late years very prevalent in England, particularly in the metropolis, where they are distinguished by different titles, as the general dispensary, the royal universal dispensary, &c. They are supported by voluntary subscriptions; have each one or more physicians and surgeons, whose business it is to attend at stated times, in order to prescribe for the poor; and, if necessary, to visit them at their own habitations. It is in this latter respect, that the patients of a dispensary differ from those called out-patients at an hospital. The poor are supplied gratis with their medicines; and many of these institutions also afford gratuitous assistance to lying-in women. Formerly there were three dispensaries established in London for selling medicines to the poor at prime cost, under the direction of the college of physicians.

DISPENSATION, in law, the granting a licence of doing some certain action that otherwise is not permitted. The greatest dealer in dispensations is the pope, who claims the office jure divino, and extends it to every thing. The more moderate of the Romanists themselves deny that he can give a dispensation for any thing contrary to the divine law, or the law of nature; and confine him to what is contrary to positive laws, or to things relating to fasts, marriages, holding several benefices, &c. and they limit him even in these things.

The archbishop of Canterbury has a power, by statute, of dispensing in any cause wherein dispensations were formerly granted by the see of Rome, and as well to the king as his subjects; and during the vacancy of the archbishop's see, the guardian of the spiritualities may grant dispensations. Every bishop of common right has the power of instituting to benefices, and of dispensing in common cases, &c. A dispensation of the king makes a thing prohibited lawful to be done by the person that has it, though a thing evil in itself will not admit of a dispensation. And where the subject has an immediate interest in an act of parliament, the king cannot dispense with it; but may, if the suit be the king's own, only for the breach of a penal law that is not to the damage of a third person.

There is a dispensation by non obstante, which is where a statute tends to restrain some prerogative incident to the person of the king, as the right of pardoning, or commanding the service of the subjects for the benefit of the public, &c. each of which prerogatives is inseparable from the king, and therefore, by a clause non obstante, such a statute may be dispensed with.

DISPERSION. See SURGERY.

DISPLAYED, in heraldry, is understood of the position of an eagle, or any other bird, when it is erect, with its wings expanded or spread forth.

DISPONDEE, in the Greek and Latin poetry, a double spondee or foot, consisting of four long syllables.

DISPOSITION, in rhetoric, the placing of words in such an order as contributes most to the beauty, and sometimes even to the strength of a discourse.

DISSECTION. See ANATOMY. Le Gendre observes, that the dissection of a human body, even dead, was held a sacrilege till the time of Francis I. and the same author assures us he has seen a consultation held by the divines of Salamanca, at the request of Charles V. to settle the question whether or not it was lawful in point of conscience to dissect a human body, in order to learn the structure thereof.

It is easily perceived that surgery and physic must improve in a country, according to the opportunities of enquiring into the structure of the animal economy; for which reason we could wish that students in anatomy were furnished with subjects for dissection in this country, in as great abundance, and with as little inconvenience, as in France.

DISSEISIN, in law, is a wrongful putting out of him that is seized of the freehold, which may be effected either in corporeal inheritances, or incorporeal. Disseisin of things corporeal, as of houses and lands, must be by entry and actual dispossession of the freehold. Disseisin of incorporeal hereditaments, cannot be an actual dispossession, for the subject itself is neither capable of actual bodily possession nor dispossession, but is only at the election and choice of the party injured, if, for the sake of more easily trying the right, he is pleased to suppose himself disseised. And so also even in corporeal hereditament, a man may frequently suppose himself to be disseised, when he is not so in fact, for the sake of entitling himself to the more easy and commodious remedy of an assise of novel disseisin, instead of being driven to the more tedious process of a writ of entry. 3 Black. 169.

DISSENTERS. Before the Revolution many statutes were in force against dissenters, but by 1 W. stat. 1. c. 18, commonly called the toleration act, it is enacted, that none of the acts made against persons dissenting from the church of England, (except the test acts 25 C. II. c. 2. and 30 C. II. st. 2. c. 1.) shall extend to any teacher or preacher dissenting from the church of England, who shall at the general sessions of the peace, to be held for the county or place where such person shall live, take the oaths of allegiance and supremacy, and subscribe the declaration against popery, of which the court shall keep a register; and no officer shall take more than 6*d.* for registering the same, and 6*d.* for a certificate thereof signed by such officer. Provided that the place of meeting be certified to the bishop of the diocese, or to the archdeacon of the archdeaconry, or to the justices of the peace at the general or quarter sessions; and the register or clerk of the peace shall register on record the same, and give certificate thereof to any one who shall demand the same, for which no greater fee than 6*d.* shall be taken; and provided that during the time of meeting, the doors shall not be locked, barred, or bolted. See CONVENTICLE. Dissenters chosen to any parochial or ward offices, and scrupling to take the oaths, may execute the office by deputy, who shall comply with the law in this behalf. 1 W. c. 18. But it seems they are not subject to fine, on refusing to serve corporation offices; for they may object to the validity of their election, on the ground of their own nonconformity. 3 Bro. P. C. 465.

DISSIDENTS, a denomination applied in Poland to persons of the Lutheran, Calvinistic, and Greek profession.

DISSIPATION, *circle of*, in optics, is used for that circular space upon the retina, which is taken up by one of the extreme pencils or rays issuing from an object. To understand this, it is to be observed, that when the distance of an object from the eye is too small or too great for perfect or distinct vision, the rays of each pencil, issuing from the object, cannot be united at a point on the retina, but beyond it, or before they arrive at the retina; consequently, the rays of each pencil will occupy a circular space upon the retina, and this circle is called the circle of dissipation, because the rays of a pencil, instead of being collected into a central point, are dissipated all over this circle. See OPTICS.

DISSOLVENT, in general, whatever dissolves or reduces a solid body into such minute parts as to be sustained in a fluid.

DISSOLUTION, in music, is when a sound in the enharmonic genus is lowered three dieses; for thereby that genus is dissolved, and the music, or that interval at least, is chromatic.

DISTAFF, an instrument about which flax is tied in order to be spun.

DISTANCE, in general, an interval between two things, either with regard to time or place. See GEOMETRY and MENSURATION.

DISTANCE, in navigation, the number of minutes or leagues a ship has sailed from any given place or point. See NAVIGATION.

DISTANCE, in astronomy. The distance of the sun, planets, and comets, is only found from their parallax, as it cannot be found either by eclipses or their different phases: for from the theory of the motions of the earth and planets we know, at any time, the proportion of the distances of the sun and planets from us; and the horizontal parallaxes are in a reciprocal proportion to these distances. See ASTRONOMY.

DISTANCE, *curtate*, the distance of the planet's place, reduced to the ecliptic, from the sun.

DISTANCE *of the eye*, in perspective, is a line drawn from the eye to the principal point. See PERSPECTIVE.

DISTANCE *of the bastions*, in fortification, is the side of the exterior polygon.

DISTEMPER, in painting, a term used for the working up of colours with something besides water or oil. If the colours are prepared with water, that kind of painting is called limning; and if with oil, it is called painting in oil, and simply painting. If the colours are mixed with size, white of eggs, or any such proper glutinous or unctuous matter, and not with oil, then they say it is done in distemper. In this manner the admirable cartoons at Hampton-court are painted. The greatest disadvantage of distemper is, that it has no glittering, and all its colours look dead, by which means they appear alike in all sorts of lights, which oil colours, or even colours in distemper when varnished, do not.

DISTICH, a couplet of verses making a complete sense. Thus hexameter and pentameter verses are disposed in distichs.

DISTICHIASIS, in surgery, a disease of the eye-lids, when under the ordinary eye-lashes there grows another extraordinary row of hair, which frequently eradicates the former, and pricking the membrane of the eye, excites pain, and brings on a defluxion.

DISTILLATION. The objects of distillation, considered as a trade distinct from the other branches of chemistry, are chiefly spirituous liquors, and those waters impregnated with the essential oils of plants, commonly called simple distilled waters. The distilling of compound spirits and waters is reckoned a different branch of business, and those who deal in that way are commonly called rectifiers. This difference, however, though it exists among commercial people, is not at all founded in the nature of the thing; compound spirits being made, and simple spirits being rectified, by the very same operations by which they are first distilled, or at least with very trifling alterations. See CHEMISTRY.

The great object with every distiller ought to be, to procure a spirit perfectly flavourless, or at least as well freed from any particular flavour as may be; and in this country the procuring of such a spirit is no easy matter. The only materials for distillation that have been used in large quantity, are malt, and melasses or treacle. Both of these, especially the first, abound with an oily matter, which, rising along with the spirit, communicates a disagreeable flavour to it, and from which it can scarcely be freed afterwards by any means whatever.

Previous to the operation of distilling, those of brewing and fermentation are necessary. See BREWING. The fermentation ought always to be carried on as slowly as possible, and performed in vessels closely stopped, only having at the bung a valve pressed down by a spring, which will yield with less force than is sufficient to burst the vessel. It should even be suffered to remain till it has become perfectly fine and transparent; as by this means the spirit will not only be superior in quantity, but also in fragrance, pungency, and vinosity, to that otherwise produced.

With regard to performing the operation of distilling, there is only one general rule that can be given, namely, to let the heat in all cases be as gentle as possible. A water-bath, if sufficiently large, is preferable to any other mode, and will perform the operation with all the dispatch requisite for the most extensive business. As the end of rectification is to make the spirit clean as well as strong, or to deprive it of the essential oil as well as the aqueous part, it will be proper to have regard to this even in the first distillation. For this purpose, the spirit, as it first comes over, should be received into a quantity of cold water; as by this means the connection between it and the oily matter will be considerably lessened. For the same reason, after it has been once rectified in the water-bath, it should be again mixed with an equal quantity of water, and distilled a second time. Thus the spirit will be freed from most of the oily matter, even though it has been very much impregnated with it at first. After the spirit has been distilled once or twice in this manner from water, it may be distilled in a water-bath without any addition; and this last rectification will free it from most of the water it contains.

For the distillation of compound spirits, the following practical rules will amply suffice, and will at the same time afford a competent view of the general process.

In rectifying and distilling compound goods, a smaller still is known to make a cleaner and better commodity than one that is larger: and one that is half a hogshead gage, over and above your hand-breadth depth from the edge or top of your still, is accounted the fittest size for a moderate trade; both as it may be managed without fatigue, and as it produces encouraging profit much superior to the fund it requires. When you erect and place your still, and other utensils, let it be if possible in a building, out-house, or shed, separate from, but nearly adjoining to, your dwelling-house or shop, to prevent any hazard which may arise by fire, to which all spirituous goods are liable; and no otherwise to be extinguished but with a woollen blanket or rug, drenched in water, and cast upon the flame, which extinguishes it by excluding the air. Let the work-house be large enough, not only in regard to your still, worm-tub, and pump, which must be all placed in a row, or ranged together, to contribute to your working with ease and pleasure, but because your spirits which are for distilling must lie in some proper place or part of your work-house, to be near at hand to charge your still with, and at some reasonable distance from the fire: and also that you may have room enough for placing all your empty vessels, tubs, cans, and other utensils properly belonging to the distilling-trade, to have them near at hand on all occasions; and let your still-house floor be paved with broad stones or flags, having a descent to carry off all the wash from your still, your hot liquor from the worm-tub, and other occasional slops, which will be made by washing your casks, &c. by which your still-house floor will always be kept clean. They are usually kept in a cistern underneath, and pumped up as wanted. It is absolutely necessary, that there be sufficiency of water where your pump is to be sunk, both to keep your worm-tub continually cool, to make up all your goods to their proper strength, and to serve all other occasions whatsoever; it matters not whether your water be soft or hard, if you have plenty of it.

Your still must be placed upon brick-work, having an ash-hole of 24 inches long, nine inches broad; and to the iron bars, where your fire is to be under your still, 21 or 22 inches high; made somewhat sloping, the better to command the ashes. When the brick-work is made about the height last-mentioned, you must place your grate-door (both of strong iron) before, or in the front of the stove, or place, where your fire is to be made under your still. The iron door and frame must be about ten inches long, and eight inches broad; close behind the door and frame must be placed two cross iron bars, about two inches and a half broad, half an inch thick, and 15 or 16 inches long; both ends of which bars must be laid about three inches into the brick-work, for fixing them the better; and the upper part of it must be about half an inch lower than the upper edge of the door-frames. Just behind the said two iron bars must be placed another flat iron bar, about an inch and a half broad, half an inch thick, and sixteen inches long, fastened in the brick-work as the former, and near an inch lower: upon which fast-mentioned flat iron bar, your iron grate must rest at the higher end; and the other ends of your iron grate must rest upon another flat iron bar of the same dimension, fastened at the furthest end, or most distant part of your still-bottom. The iron grate must consist of about eight bars of inch-square iron, but exactly of one length, made broad, or flatted diagonally, at each end, to rest on the two cross iron bars, so that the upper part of the square bars must be even with the higher part of the flat iron bars on which they rest, that the fire-shovel, or coal-rake, may run smoothly along them. The square iron bars must be about eighteen inches long, and laid loose within an inch breadth of each other upon the two broad iron bars, as firm as you can, yet so that they may be put in, or taken out, as occasion requires; then raise your brick-work, so that your still-bottom, when fixed or rested upon it, may be about 10 or 12 inches above the iron grate, that the fire may have room to play; and the part of the brick-work under the still, where the fire is placed, and as far as it extends within the stove, must be inlaid with hearth inch-tiles, or fire-brick, well fastened with such mortar as will abide the fire much longer than common bricks. Let not the fireplace be too broad, wherein your workman's judgment will have regard to the sides not being of the same thickness with the bottom of your still. There must be left a sloping place, or hole, proper for conveying the smoke into the flue and round the still into the chimney; which flue must be carried up a convenient height, to draw the smoke, and carry it off. Let your still-cock come so far through the brick-work, that your wash may run out either into cans, or otherwise, as you have conveniency for conveying it away. The brick-work about your still must be exactly round, as high as the upper nails of your still, sloping from the flame lest any liquor boil over, and very well mortared, and covered all round with coarse canvas or hop-sack, to keep the fire closer in, the wall from cracking, and your clothes from being injured, and the flue must be plaistered well within.

Your worm-tub must be placed very near your still, upon a strong wooden frame according to the size of your tub, which must be six or eight times the capacity of your still, so that every stave of the tub may rest firmly upon

the frame, the better to support the great weight of such a quantity of water as is necessary to keep the worm constantly cold, or cool enough. Your worm-tub frame must be so high, that when the tub is placed upon it, the low end of your worm which comes through the worm-tub, will admit of your cans being readily placed under, and taken away when they are full. The upper end of your worm must be placed so, that the arm of your still-head may go into it without any difficulty, and shut in so close as to be easily luted; and your worm-tub must stand so upright, that no liquor may hang in the worm; which you may know, by putting a pint or quart of water into the worm, which will run out at the lower end of it. In the middle of your worm-tub you may place a wooden gutter three or four inches square within, to reach from the top of the worm-tub to the bottom of the same, having about three or four inches on the opposite sides at the bottom end of it left open, that the fluid that is pumped into the gutter, which descends, may flow out at the two breaches to the lower part of the worm-tub; which forces all the hot water to ascend upwards, and runs either over the worm-tub, or rather through a leaden pipe of a moderate size, which is called a waste pipe, being put through and soldered in your worm-tub, and extended down your tub-sides to what further length you please, to convey the warm water from your tub, till the liquor in your worm-tub is perfectly cold; which by the continuance of your still working will grow hot again and again, and must be still cooled after the same manner. The water conveyed in by a lead pipe at the bottom is still better. Your pump must be placed next your worm-tub, and of such a height that you may have a spout or cock put into that part of your pump which is next your worm-tub, under which you may fix a good gutter, to reach to, and be led into, the gutter that is fixed in the middle of your worm-tub, that the liquor may be more easily, and with less waste, conveyed into your worm-tub, in order to cool it. You must have also another spout or cock in the fore-part of your pump, much lower than the other, for drawing water for all common uses; the higher spout being closed, and only appropriated for cooling the liquor when hot in the worm-tub. For the still, worm, &c. see Plate.

It will be necessary also to have a large back, set upon a strong frame, to command the worm-tub, and to contain a large quantity of water, having a large brass cock communicating with the still, &c. to draw off what water you may stand in need of suddenly; which may be of very great service to you upon any emergency; and may be drawn off in much less time, and with less trouble, than by pumping; for the still may accidentally be sometimes dry, and prove of dangerous consequence, if you had not a quantity of water ready on all occasions in your back to repair to. Your water-tub must be open at the upper end, that you may dip or drench your cans into it, or lay any small rundlets in it to steep and become tight; and that your tub may be more easily filled with water.

You will find your interest in keeping a good middle-sized press, placed in a corner of your still-house, and fixed so steadily as not to be moved when you use it; having a very strong bed or place, in which the goods to be pressed are put, and five or six haircloths, somewhat broader than your press, to be put betwixt every layer of elder-berries, cherries, raspberries, or any other things which are to be pressed; all which are to be laid as thin as possible, and your press-screw to be drawn pretty much, till the liquor run by a spout made of sheet-lead, nailed to the fore-part of the bottom of your press, into one of your cans, which must be placed under it, to receive the juice from the press, and draw out your iron-pin, to give time to the press to empty itself of what juice lies in the bed; then draw the screw a little closer, and allow time for the juice to run out, and so more and more, till all the juice is wholly drawn or pressed out of the goods. See Plate.

You must have also, at least, three or four iron-bound open-headed tubs, wide at the top, and narrower taper-wise down to the bottom, (one of these tubs is to contain two puncheons or pipes of goods, another to contain one pipe, and another a hogshead) which must be placed orderly in your still-house, and now and then filled with hot liquor out of your still; and the iron hoops driven, or fastened, to keep them firm, and in fit condition to hold the goods that are to be put or made up in them. Likewise three or four iron-bound cans, either with iron round hands or bales; one to hold five, another to contain four, another three, and, if you please, another two gallons; not by bare measure to the top, but let your goods reach no higher than a brass mark placed therein, determining the measure to which the liquor must rise. Another necessary utensil is an iron-bound wood funnel, which by computation would hold three or four gallons, with a strong iron nosel or pipe to put into the bungs of the casks which the goods are to be put in, which must be ranged or placed upon a shelf along with the iron-bound cans pretty near your still.

In some convenient part of your still-house, where room may be most spared, must be placed a pretty large vessel, either covered or open, with a cock in it, in which you must put all your feints or after-runnings, until you have a quantity worth your distilling over; into which vessel or cask you may put the washings out of your casks, the drippings of your cocks, any goods accidently spoiled, either by wrong mixture, spilling on the ground, or otherwise, or any thing else that has a spirituous matter or substance in it. Another piece of necessary furniture for your still-house, and which cannot be dispensed with, is a good strong copper or tin pump, of about five feet long, and six inches in circumference, its nosel about six inches from the top of the pump, and the nosel about fourteen inches long from the body of the pump; besides a little angular nosel about four inches, to be put on upon the other, or taken off as your occasions require. The use of this pump, with its appurtenances, is to draw off your spirits out of the pieces into your cans to charge your still with; and for many other similar purposes in which it will be serviceable.

A pewter-crane or siphon is also absolutely necessary, made somewhat semilunar, or like a half-moon or angle, about six feet and a half from one end to another, and four inches round about on the outside, to draw goods out of any vessel where the pump cannot play. A pewter valencia is likewise useful, being about two feet long, tapering at the end, which you put into the piece, or any other vessel, to draw out any small quantity, by putting or moving your finger on the upper side of the valencia, whereby the liquor enters, for your tasting or trying its proof; which, with the crane, may be hung against the wall.

Hipocrates's bag, or flannel-sleeve, is another thing very necessary for the distiller, whereby all bottoms of casks, though ever so thick and feculent, by putting into this bag or sleeve to filtre, become presently clear, the porous parts of the bag being soon filled with the grosser matter; and the thin or liquid element running clear from the bag, and as good as any of the rest: also any foul goods or liquor may presently be made clear and fine, by putting some powdered alabaster into the goods or liquor, or sprinkling the same on the bag to stop up its pores, by which they presently become or run clear, leaving nothing but the sediment or gross matter in the bag; nor do the goods or liquor contract the least ill flavour from the alabaster powder. This bag or sleeve is made of a yard or ell of flannel, not over-fine or close-wrought, laid sloping, so as to have the bottom of it very narrow, and the top as broad as the cloth will allow, well sewed up the side, and the upper part of the bag folded about a broad wooden hoop, and well fastened to it; then boring the hoop in three or four places, it may be suspended by a cord.

You must have for your still-fire a large poker, fire-shovel, and coal-rake, with other necessary utensils for your still-house; a cooper's hand-saw, adze, gimlet, a striking gimlet, a hammer, a pair of scratching-irons, a pair of tarriers, a bung-borer, a box-foreset, and a box of bungs.

When you are to distil, you are to make ready, against your still is charged, a paste of the size of a turkey-egg, made half of Spanish wheat, and the other half of rye-meal, bean-meal, or wheat-flour, well mixed together, and made into a paste with water, of the consistence of an ordinary paste for baking; and having put on your still-head, with its nose in the upper end of the worm, then take your paste, working and making it pliable with the heat and operation of your hands, and spread it upon the junctures of the body and head of your still, and that part of the arm of your still-head which goes into the end of the worm, to keep in the goods from boiling over: make the paste very smooth, by wetting your hand (with which you lay on the paste) in water, to cause it to lie the closer, and secure the goods from all mischances; and reserve a piece of paste, about the size of a small apple, lest the luting should crack or break out, which is very dangerous, and must therefore be carefully attended to and examined, and in case of any defect, mended with the paste reserved for that purpose.

When you set up a new still, which has not been used, let it be filled, within your hand-breadth of the brim, with water, and put to it a peck of wheat-bran; and put the head upon the still, and fix it firmly on with a wooden bar, about the thickness of your wrist, upon the loop, a little below the neck of your

still, and the upper end of the wooden bar must be fastened under some beam or lentel perpendicularly, to prevent the still-head from moving by the force of distillation; then lute your still as directed in the foregoing paragraph; and having made a fire under it proper for that purpose, draw off two, three, or four gallon-cans by distillation, by which all the joints and nails of your still will be cemented, and made fit for distilling your strongest-proof goods; then damp or extinguish your fire with some wet ashes; wash your still-head and worm; afterwards you may charge and work your still with what goods you please.

All your spirits to be distilled should be proof goods, which you may try by having a small quantity put into a glass phial, and shaking it with your hand; if the blebs or proof of it continues a pretty while upon the top or surface of the goods, it is then what is called proof goods; and when it is distilled, it will yield about, or very near, two-third parts, or every thirty gallons will distil to nearly, and sometimes full, twenty gallons, according as the spirits are higher or lower proof; which you may make proof, or to what strength and weakness you please, by adding what proportion or quantity either of spring or river water is necessary; as for example, take and observe this general rule in distilling, that all double goods coming from the still, clear proof and without feints, must be made up with liquor, to that quantity you charged your still with at first; as if with thirty gallons of proof spirits, it will yield about twenty gallons of high-proof goods, the deficiency of ten gallons must be made up with water, till the whole amounts to thirty gallons, your first charge; and in single goods you add one and a half part more of water (viz. fifteen gallons) to what is ordered in double goods, whereby you will have in all forty-five gallons of single goods; but if your spirits are below proof, upon shaking the phial, or glass, the goods will fall flat, or the blebs or proof will not continue on the surface of it; and according to the degree of its being reduced more or less below proof, the goods will flatten accordingly; and when such goods are distilled, they will fall short in quantity; and upon making them proof, and no otherwise, will you know what body they were of, and how far they were reduced, except by the hydrometer.

When your still is charged with goods for distilling, and luted, then make your fire under the still, which, if possible, must be of coals, because their heat is most constant and durable, and wood fires are very subject to both extremes, of too much or too little heat, which are prejudicial, and sometimes hazardous. Let the fire at first be moderate, and then by degrees increased, and now and then stirred up with your poker, as is usual in common fires; and by laying your hand upon the body of your still, as the fire gains strength in the stove or furnace under the still, you will by moderate degrees ascend up your still-head, occasioned by the goods in the still boiling higher and higher. When your still-head becomes warm or hot, then prepare a damp (which is to check or lessen the violence of the fire); which damp is made of about half a bushel of ashes, taken from under the stove or furnace, and two or three gallons of water cast upon and well mixed with them, upon the ground or hearth, before or under your kiln-door, to be ready to cast upon the fire when there is occasion; and move your hand upon the still, higher and higher, as you find the heat grow hotter, and ascend to the neck of your still-head, which, when it comes with any vehemence more than a common warmth, to turn downwards towards the worm-end, in which the arm of the still is luted, cast three or four fire-shovels of wet ashes upon the hottest part of the fire, which must be done very smartly and critically, at the very turning of the highest part of the swan-like neck of your still towards the still, by which the violence of the fire is abated, which would otherwise bring down the goods through the worm very foul in a rushing stream, which is dangerous, and by all means to be prevented; whereas your damping the fire seasonably, brings down the liquid like a small twine thread.

You must take especial care not to touch or meddle with your fire while your still is near coming to work, because of increasing or heightening the heat, which would unavoidably make your still run foul; but when your fire is damped and come to work, you may let your kiln-door be shut close, and continue so, as long as the worm runs as small as a moderate-large turkey quill. But as the kiln-door being long shut will overcome the damp, and bring the fire to its former violence, so when you are apprehensive of it, you may throw open the kiln-door, which abates the heat immediately, and lessens the stream flowing from your worm; and you must cautiously meddle with your still-fire until more than one or two cans be come off from your still, which is about double the strength of the first goods, and then there is less danger, and you may more safely stir up or mend your fire, or shut your kiln-door, to make your goods come down with a little larger stream, until the goods be wholly come off from the still.

When you perceive near two-third parts of the first quantity which you put into your still to be run from thence, then be often tasting the goods, which must run as long as any strength remains; when all the goods are come off, the former clear colour of them will turn to a blue, and sometimes, according to the nature of the goods, a whitish colour, which are phlegmatic and foul, and if they were suffered to run amongst the spirit, would make it taste disagreeably, but by being kept by themselves, the goods are clean and well tasted; and the feints, or after runnings, being put and kept in a vessel until you have a quantity together, you may then distil them. When the strength of the spirit is gone, or run off, take away your can of goods, and let the feints run into another can, as long as the feints will burn on the still-head, being cast thereon, and a candle or lighted paper put to it to try the experiment.

When your feints are drawn into spirits, which must be made proof, that you may make a better judgment how to convert them to other goods, you must always make them into such goods as carry a very predominant or prevailing gust or taste, above other ingredients; and therefore the common and usual method taken with them is, to convert them into aniseed or wormwood cordials, putting a little more than the receipt of ingredients, which is made use of, the same goods being drawn from clean malt spirits, and also dulcifying a little higher than otherwise, purposely to cleanse or carry off any ill relish contracted from the multiplicity of mixtures in the feints.

You must always keep the water in the worm-tub very cool, that the goods coming off the still may be perfectly so, which will contribute to bettering the spirits, and making them settle sooner; whereas the goods coming off warm or hot from the still, they lose considerably of their strength, which is extracted by the hot liquor, become more palatable, and not without much time and difficulty are made fine.

When you distil any goods which are not above one-third or one-half of the quantity your still will work, be sure you add one, two, or three cans of water to the goods you charge your still with, both for better preserving the still from damage, and because the goods will cleanse and fine themselves, by having a quantity of water with them wrought together, and will run considerably more from the still than when it is charged with full-proof goods; not that they can possibly be more in strength or substance, but by their being weakened with water put to them, are drawn lower, and require less fluid to make them proof.

When you draw off your still more than once a day, if your second distillation is of the same goods with the first, and the quantity of each the same, then when your goods and feints are drawn off, damp your fire very well under your still, draw the wash quite out, and, without cleaning out the ingredients, you may charge it a second time with the spirits and ingredients, and draw off your goods as at other times; but if you charge your still a second time with the same goods, and no greater quantity than what the goods run from what your still was first charged with, then, when your goods are come off and without suffering the feints to run, damp your fire, strike off your still-head, and charge your still accordingly with your ingredients, and draw them off as you do at other times; but if you charge your still a second time the same day with goods different from, and of another sort than, what your still was first charged with, then clean it of all the wash and ingredients, scrape off all the luting on the still-head and upper part of the body of your still, which remained or was left on the still-head; wash down the worm with about a gallon of liquor, to prevent all obstructions; and draw off your goods of the second charging or distillation, as you do at other times, the process not differing either in drawing off or making up the goods from what you do when your still is charged with no other goods, or only one distillation made at that time.

Be sure that betwixt every new charging of your still you scrape off all the paste or luting which cleaves or is burned to the still-head, or the brim of your still, which might endanger your new luting to crack or break, was it put upon the old paste or luting; and also let your worm be constantly washed down with a gallon of water, lest any thing be accidentally got into the worm, which might prove of the worst consequence, and must therefore be prevented or guarded

against by the greatest caution you can possibly take.

It conduces to melio.ate compound spirits, when the ingredients of which they are made are infused in spirit over-night, before they are distilled; which spirit must cover the ingredients, and being measured, you must allow what they measured out of the quantity you put into your still, so that both the spirits in which the ingredients are infused, and the other which you measure into your still, must together make up the intended quantity; and let all your ingredients, according to their several kinds, be bruised, sliced, or otherwise separated, before their infusion, if you have time and opportunity.

Take particular care that no manner of grease, tallow, soap, or any other unctuous matter, get or fall into your pieces, tubs, rundlets, or cans; because they injure the proof of the goods, and although their strength should be very high, yet they will apparently fall as flat as water, and then their strength can only be ascertained by the hydrometer. Above all things, beware of lighted candles, torches, papers, or other combustible matter, being brought too near your still, or any vessel where your goods are contained, which are subject to take fire upon very slight occasions. You must take care to have your stove-chimney and flue often swept or cleaned; both to prevent the danger of its taking fire, and to make your flue, or kiln-chimney, draw the better, whereby your stove-fire will be first lighted, and afterwards continued, with less trouble.

It is best for preserving the strength and flavour of your goods, that as they come off your still into your cans, exactly filled up to the mark of a four or five gallon measure, they be emptied into the casks they are to be kept in; always noting, or keeping an account of, the several cans or quantity of goods to be put by; which must be made up to their several proportions, according to the quality or kind of goods so to be made up; which is, or must be, by adding so much liquor or pump-water, as completes the same. And in dulcifying your goods, first weigh the sugar you intend to put in; then dissolve it in one or more cans of the water, with which you make up your goods; bruising all the lumps of the sugar, and stirring it very well with a rummager in your cans, till all is dissolved: and then emptying it into your other goods; and mixing all well together, by drawing off several cans of the goods at the cocks, and putting them in again at the bungs; and then rummage all well together, till they are perfectly well mixed and compounded.

When you have made up your goods to the quantity and quality you intend, that they may become fine and clear; all your goods which are made proof will without any art or composition settle, and become fine and clear, within one or two days at most; but goods that are reduced below proof, the weaker they are made in strength, the longer they are in becoming fine or saleable. To every hogshead of Geneva, or strong waters, put five or six ounces of alum powdered so as to go through a coarse hair-sieve, and mixed in three or four gallons of the goods, well stirred or dissolved in your cans; and then put to your whole quantity, rummaged and very well stirred together, some cans of goods being drawn off, and put to the goods again, to mix them the better; and the Geneva will be clear in one day, and the other in two or three days.

When your distilled goods are finished, being set upon a stillyon or pair of guntrees, in order to their being drawn off, you must let the bungs of the casks continue open, till they become fine and fit for use: then you may put the bungs in, but not too hard, and set a foreset or a plughole, and a foreset or plug put slightly, in a proper place of your casks, to take out or loosen, to give vent when you draw off any goods: it is a vulgar error to suppose that goods are materially injured or weakened by the bungs being left open; for where there is any quantity of goods of any tolerable body or strength, they receive no manner of injury from it, but mellow and clear more and more by having good vent either by bung or foreset.

You may make any goods deeper or lighter coloured, by dulcifying with browner or finer sugar. And as all common goods bear a low price, they are always sweetened with the cheapest brown sugars, which commonly make them of a deep amber colour; which by long custom and usage has so prevailed with the populace, that goods of a lighter colour, occasioned by being dulcified with better sugar, are less accounted of; whereas fine goods, which are generally drunk by persons of judgment and distinguishing palates, must be made up with fine sugars; and the clearer and lighter colour they are, the more acceptable and valuable to those who know what they buy; and some persons are so nice this way, as to dulcify with loaf-sugar, but the sugars in your receipts specified are what will give a general satisfaction to all your customers.

When you first draw off any goods lately distilled, that which lies next the cork will not be clear, or left fine, according as the goods have been a longer or shorter time distilled; and must be set aside till you have drawn off what fine goods you have present occasion for; and then you may put what you first drew in at the bung, and it will settle in a very little time; and when any of your standard or other casks are near out, or to be emptied or drawn off, let all the bottoms be drawn into one of your cans, and first put one, two, or three gallons of water according to the size of your cask, to wash out the cask; and let your first water with which the cask is washed be put among your feints; and what water you wash clean out with must be cast away; then take your can of bottoms, and first hanging up your flannel sleeve in some convenient place, put your bottoms into it all at once, if your bag will hold it. The first runnings of the bag will be foul, till all the porous parts of the bag are filled up with the sediment that is amongst the bottoms of the casks; and when they run fine, you may take away the foul goods, and put a clean vessel to receive the fine spirits; and when the bag is run nearly out, you may put in it what goods first run foul when the bottoms were put into the bag, and let the bag hang till all the goods be quite run off from the sediment, which must then be cast away, but the fine goods, so filtred through the flannel sleeve, will be as good and wholesome as any of the rest; and the bottoms of fine goods, which are much more valuable, must be filtred, or put through blotting-paper, folded in four parts, one part or leaf to be opened funnelwise, and made capable to receive what it will hold of the bottoms being put into the upper part of a large tin funnel: which will filtre off all the goods from the sediment.

When you are to buy any brandies or spirits, do not consent to take them by measure; but having tasted and tried them in a phial, insist upon having them by weight, at seven pounds three quarters to each gallon, and the stronger spirits will be lighter than what is reduced.

It may not be here improper to insert some certain rules observed by distillers in drawing off and making up their distilled goods: viz. when you perceive about two-third parts of the first quantity you put into your still is come off, then be often trying your goods in a glass or phial; and when you see that the bell, or proof, immediately falls down and does not continue a good while on the surface, then take away the can of goods, and substitute another vessel to receive the feints; which, if suffered to run among the goods, would cause a disagreeable relish, and be longer in fining down: whereas the feints being kept separate, the goods will be clean and well-tasted, when made up with liquor to their due quantity.

It will much improve your goods, to throw into your still along with your goods, when first charged, about six ounces of bay salt to every ten gallons of spirit; and so proportionably, more or less, to a greater or less quantity of spirits; by this means the goods will better cleanse themselves and separate from their phlegmatic parts, and the spirits so dephlegmated will ascend and come over much cleaner and finer in distillation.

One very great desideratum among distillers of this country is, a method of imitating the foreign spirits, brandy, rum, gin, &c. to a tolerable degree of perfection; and notwithstanding the many attempts that are daily made for this purpose, the success in general has been but very indifferent. The general method of distilling brandies in France differs in nothing from that practised here in working from malt-wash or molasses; nor are they in the least more cleanly or exact in the operation. They only observe more particularly to throw a little of the natural ley into the still along with the wine, as finding this gives their spirit the flavour for which it is generally admired abroad. But though brandy is extracted from wine, experience tells us, that there is a great difference in the grapes from which the wine is made. Every soil, every climate, every kind of grapes, varies with regard to the quantity and quality of the spirit extracted from them. A large quantity of brandy is distilled in France during the time of the vintage; for all those poor grapes that prove unfit for wine, are usually first gathered, pressed, their juice fermented, and directly distilled. This rids them of their poor wines at once, and leaves their casks empty for the reception of better. It is a general rule with them not to distil wine that will fetch any price as wine; for in this state the profits obtained are vastly greater than when reduced to brandies. The large stock of small wines, with which they are almost over-run in France, sufficiently accounts

for their making such vast quantities of brandy in that country more than in others which lie in warmer climates, and are much better adapted to the production of grapes. Nor is this the only source of their brandies; for all the wine that turns eager, is also condemned to the still: and, in short, all that they can neither export nor consume at home, which amounts to a large quantity; since much of the wine laid in for their family provision is so poor as not to keep during the time of drawing from the cask. Hence our English spirits, with proper management, are convertible into brandies that shall hardly be distinguished from the foreign in many respects, provided the operation is neatly performed.

The best, and indeed the only method of imitating French brandies to perfection, is by an essential oil of wine; this being the very thing that gives the French brandies their flavour. It must, however, be remembered, that in order to use even this ingredient to advantage, a pure tasteless spirit must first be procured; for it is ridiculous to expect that this essential oil should be able to give the agreeable flavour of French brandies to our malt spirit, already loaded with its own oil, or strongly impregnated with a lixivious taste from the alkaline salts used in rectification.

To prepare the oil of wine, take some cakes of dry wine-lees, such as are used by our hatters, dissolve them in 6 or 8 times their weight of water, distil the liquor with a slow fire, and separate the oil with a separating glass, reserving for only the nicest uses that which comes over first, the succeeding oil being coarser and more resinous. Having procured this fine oil of wine, it may be dissolved in alcohol; by which means it may be preserved a long time fully possessed of all its flavour, but otherwise it will soon grow rancid.

With a fine essential oil of wine thus procured, and a pure and insipid spirit, French brandies may be imitated to perfection. The essential oil, however, must be drawn from the same kind of lees as the brandy to be imitated was procured from; *e. g.* in order to imitate Coniac brandy, it will be necessary to distil the essential oil from Coniac lees; and the same for any other kind of brandy. For as different brandies have different flavours, and as these flavours are entirely owing to the essential oil of the grape, it would be preposterous to endeavour to imitate the flavour of Coniac brandy with an essential oil procured from the lees of Bourdeaux wine. When the flavour of the brandy is well imitated by a proper dose of the essential oil, and the whole reduced into one simple and homogeneous fluid, other difficulties are still behind: the flavour, though the essential part, is not, however, the only one; the colour, the proof, and the softness, must also be regarded, before a spirit that perfectly resembles brandy can be procured. With regard to the proof, it may be easily accomplished, by using a spirit rectified above proof; which, after being intimately mixed with the essential oil of wine, may be let down to a proper standard with fair water: and the softness may, in a great measure, be obtained by distilling and rectifying the spirit with a gentle fire; and what is wanting of this criterion in the liquor when first made, will be supplied by time: for it must be remembered, that it is time alone that gives this property to French brandies, they being at first acrid, foul, and fiery. But with regard to the colour, a particular method is required to imitate it to perfection, which may be effected by means of treacle or burnt sugar. The treacle gives the spirit a fine colour, nearly resembling that of French brandy; but as its colour is dilute, a large quantity must be used. This is not, however, attended with any bad consequences; for notwithstanding the spirit is really weakened by this addition, yet the bubble-proof, the general criterion of spirits, is greatly mended by the tenacity imparted to the liquor by the treacle. The spirit also acquires from the mixture a sweetish or luscious taste, and a fulness in the mouth; both which properties render it very agreeable to some palates. A much smaller quantity of burnt sugar than of treacle will be sufficient for colouring the same quantity of spirits: the taste is also very different; for, instead of the sweetness imparted by the treacle, the spirit acquires from the burnt sugar an agreeable bitterness, and by that means recommends itself to many who are offended with a luscious spirit. The burnt sugar is prepared by dissolving a proper quantity of sugar in a little water, and scorching it over the fire till it acquires a black colour. Either treacle or burnt sugar will nearly imitate the genuine colour of old French brandy; but neither of them will succeed when put to the test of the vitriolic solution.

The spirit distilled from melasses or treacle is very pure. It is made from common treacle dissolved in water, and fermented in the same manner as the wash for the common malt spirit. But if some particular art is not used in distilling this spirit, it will not prove so vinous as malt spirit, but more flat and less pungent and acid, though otherwise much cleaner-tasted, as its essential oil is of a much less offensive flavour. Therefore, if good fresh wine-lees, abounding in tartar, are well fermented with melasses, the spirit will acquire a much greater vinosity and briskness, and approach much nearer to the nature of foreign spirits. Where the melasses spirit is brought to the common proof-strength, if it is found not to have a sufficient vinosity, it will be very proper to add some dulcified spirit of nitre; and if the spirit is clean worked, it may, by this addition only, be made to pass on ordinary judges for French brandy. Great quantities of this spirit are used in adulterating foreign brandy, rum, and arrack. Much of it is also used alone in making cherry-brandy and other cordials by infusion; in all which, many, and perhaps with justice, prefer it to foreign brandies. Melasses, like all other spirits, is entirely colourless when first extracted; but distillers always give it as nearly as possible the colour of foreign spirits.

If these principles hold good, the imitation of foreign spirits of all kinds must be practicable; if we only procure some of those substances from which the spirit is drawn, and distil it with water, the essential oil will always give the flavour desired. Thus to imitate Jamaica rum, it will only be necessary to procure some of the tops, or other useless parts, of the sugar-canes, from which an essential oil being drawn, and mixed with clean melasses spirit, will give it the true flavour. The principal difficulty must lie in procuring a spirit totally, or nearly, free from all flavour of its own. The spirit drawn from the refuse of a sugar-house has been commended as superior to that drawn from melasses; though it is very probable, that to procure an absolutely flavourless spirit is impossible. The only method, therefore, of imitating foreign spirits is, by choosing such materials as will yield a spirit flavoured as much like them as possible; and the materials most recommended, and probably the best that can be used, are raisins.

We shall subjoin the genuine process of preparing Holland gin, agreeably to the practice of the best Dutch distillers. Their grist is composed of ten quarters of malt, ground considerably finer than our malt-distillers' barley grist, and three quarters of rye-meal; or, more frequently, of ten quarters of rye and three quarters of malt-meal. The ten quarters are first mashed with the least quantity of cold water it is possible to blend it up with; when uniformly incorporated, as much boiling water is added as forms it into a thin batter; it is then put into one, two, or more casks, or gyle-tuns, with a much less quantity of yeast than is usually employed by our distillers. Generally on the third day they add the malt or rye meal, previously made into a kind of lob, prepared in a similar manner, except in not being so diluted; but not before it comes to the temperature of the fermenting wash; at the same time adding full as much yeast as when at first setting the backs.

The principal secret in the management of the mashing part of the business is, in first thoroughly mixing the malt with the cold water, and in subsequently adding the due proportion of boiling water, that it may still remain sufficiently diluted after the addition of the fine meal, under the form of lob, and in well rousing all together in the back, that the wash may yet be dilute enough for distilling, without endangering its burning to the bottom of the still. Thus they commodiously reduce the business of brewing and fermenting to one operation. By using cold water to uniformly wet the malt, all danger of clogging the spending of the tap would be necessarily avoided; but here is no occasion to do any thing more, than sufficiently dilute the wash, consisting of the whole of the grain, thin enough to be fermented and distilled together, by which means the spirit of the bran and husky part, as well as of the flour of the grain, are completely extracted, yet their wash, compared with ours, is about three-eighths thinner. For these reasons, they obtain more spirit from their grain than we do, and of a better quality, with not half the trouble taken by our distillers. The gravity of the distillers' wash at Weesoppe, in the neighbourhood of Amsterdam, in 1774, was but eighteen pounds per barrel, very little more than half the gravity of ours. Their stills are usually from three to five hundred gallons each; they constantly draw off three cans of phlegm, after the runnings cease to burn on the head of the still, when distilling wash; and five cans when distilling low wines, a practice we are unacquainted with; as we usually draw our fire as soon as the runnings from the still burn languidly on the still-head. This, and the great quantity of rye they use, cause their spirit to be so much more acid;

and the diluteness of their wash is a very good reason for the greater purity of their spirit; though most writers mistakingly say, our spirit is much cleaner.

Rectification into Holland gin. To every twenty gallons of spirit of the second extraction, about the strength of proof spirit, take three pounds of juniper-berries, and two ounces of oil of juniper, and distil with a slow fire until the feints begin to rise, then change the receiving can; this produces the best Rotterdam gin. An inferior kind is made with a still less proportion of berries, sweet fennel-seeds, and Strasburgh turpentine, without a drop of juniper-oil. It, and a better sort, but inferior to the Rotterdam gin, are made at Weesoppe. The distillers' wash at Scheedam and Rotterdam is stlll lighter than at Weesoppe, where there were about three hundred distillers formerly in 1774. In Plate Miscel. fig. 49, is the representation of a common still. It is a large copper vessel, A, into which the materials are put. The still is built up in brickwork: the fire is applied underneath, and runs round it in a spiral manner. B is the head of the still, which is connected with the worm at *x*. The worm C is a spiral tube, immersed in a vessel of cold water, called the refrigeratory. The liquor being condensed in its passage through the worm, runs out at the cock D into the vessel Z, placed there to receive it.

DISTILLER, he who makes distillations, and commonly a tradesman who makes spirits from malt, &c. By stat. 3 Geo. III. c. 5, s. 12, persons who sell liquors chargeable with duty, and distil spirits, are deemed common distillers, and are liable to surveys, penalties, &c. See Excise.

DISTINCTION, in logic, is an assemblage of two or more words, whereby disparate things, or their conceptions, are denoted.

There are three kinds of distinctions, taken from the three different modes of existence, real, modal, and rational. The first is that between two substances, or the modes of two substances. The second, or modal distinction, is that between several things, one whereof may exist without the other, but not vice versa, the other without that. The third, or rational distinction, is that between several things which are really one and the same, and whereof one cannot exist without the other; nor vice versa, the other without this: such is that between a thing and its essence, between the essences and properties, &c. Of this distinction some authors admit two kinds: the one barbarously called rationis ratiocinatæ, having some foundation in things, as when we distinguish the justice of God from his mercy; the other called rationis raticionantis, which has no foundation at all, and therefore is by many rejected. Chauvin.

DISTORTION, in medicine, a contraction of one side of the mouth, occasioned by a convulsion of the muscles of one side of the face: and it is likewise used to denote any part of an animal body when it is ill placed.

DISTRESS, in law, the taking of a personal chattel, out of the possession of the wrong-doer, into the custody of the person who is injured, to procure a satisfaction for the wrong committed. It is of two kinds; cattle for trespassing, for doing damage; or for nonpayment of rent or other duties. But the most usual injury for which a distress may be taken is that of nonpayment of rent.

A distress may now be taken for any kind of rent in arrear, the detaining of which beyond the day of payment, is an injury to him that is entitled to receive it. 4 G. II. c. 28. This is the most common and best remedy for the recovery of rent in arrear; and the effect of it is to compel the party to replevy the distress, and contest the taking in an action against the distrainer; or, which is more usual, to compound or pay the debt or duty for which he was distrained. 3 Black. 6.

Distress infinite, is a process commanding the sheriff to distrain a person from time to time, and continually afterwards, by taking his goods, by way of pledge, to enforce the performance of something due from the party distrained upon. Generally, it is provided that distress shall be reasonable and moderate; but in case of distress for suit of court, or for defect of appearance, in several cases where this is the only method of enforcing compliance, no distress can be immoderate; because, be it of what value it will, it cannot be sold, but shall be immediately restored on satisfaction made. 3 Black. 251.

Who may distrain for rent. By the common law, and the various statutes in favour of this species of remedy for recovery of rent, all persons having the reversion or remainder of lands, &c. after the determination of the particular estate, or existing term therein, may of common right distrain for rent in arrear, without any clause for that purpose contained in the lease. Co. Lit. 142.

What may or may not be distrained. Every thing upon the premises is liable to the landlord's distress for rent, whether they are the effects of a tenant or a stranger, because of the lien the landlord has on them in respect of the place where the goods are found, and not in respect of the person to whom they belong. Co. Lit. 47. 3 Bur. 1502. 3 Durnf. and East, 601.

Things not distrainable are, tools of a man's trade, corn sent to a mill, a horse sent to a smith's shop or in a common inn, cloth at a taylor's, goods in the hands of a carrier. 1 Salk. 249. 1 Esp. Rep. 206. 4 T. R. 569. Dogs, rabbits, beasts of the plough, milk, fruit, and things fixed to the freehold. 3 Black. 8 and 9. 4 T. R. 569. But beasts of the plough, and working-tools, not actually in use at the time, may be distrained, if there is not sufficient without them. 4 T. R. 569. So may wearing apparel not actually in use. 1 Esp. Rep. 206. Money in a bag sealed may be distrained.

Horses and carriages sent to stand at livery are distrainable by the landlord. 3 Bur. 1498.

Of the time, &c. and manner of taking the distress. Distress for rent must be in the day-time, for if made at night it will be bad. Co. Lit. 142.

Strictly, the rent is demandable, and payable, before the time of sunset of the day when it is reserved. Yet the rent is not due till the last minute of the natural day. 2 Black. 42.

Distress cannot be made therefore till the day after that on which the rent is reserved in the lease; for though payable, it is not strictly due till midnight of the day upon which it is reserved.

Distress cannot be made after the rent has been tendered: if the landlord comes to distrain, the tenant may, before the distress made, tender the arrears: and if the distress is afterwards taken it is illegal; and so if after the distress, and before it is impounded, the tenant tenders payment, the landlord will deliver up the distress; and if he do not, the detainer is unlawful. 2 Inst. 107.

Parole authority to distrain is sufficient, or any authority that can be proved.

By 2 G. II. c. 19, landlords may, by the assistance of a peace-officer of the parish, break open in the day-time any place where goods are fraudulently removed and locked up to prevent a distress, oath being first made, in case it be a dwelling-house, of a reasonable ground to suspect that such goods are concealed therein.

By stat. 8 Anne, c. 14, rent accruing due under a lease must be distrained for within six months after its determination.

If a tenant fraudulently remove goods off the premises, the landlord may seize them within thirty days. But such seizure can only be made where the rent was actually due before the removal.

If a landlord seize only a part of the goods, &c. of his tenant for rent, in the name of them all, it will be a good seizure of the whole. 6 Mod. 215.

Distresses ought not to be excessive, but in proportion to the duty distrained for. 2 Inst. 106.

The remedy for excessive distress is by a special action on the stat. of Mulbridge; for an action is not maintainable upon this account, this being no injury at common law. 1 Vent. 104 Fitzgib. 85. 4 Bur. 590.

Where any distress shall be made for rent justly due, and any irregularity or unlawful act shall be afterwards committed by the party distraining, or his agents, the distress itself shall not on that account be deemed unlawful, nor the party a trespasser from the first; but the person aggrieved shall recover full satisfaction for the special damage sustained by such irregularity, and no more, with full costs of suit. 11 G. II. c. 19.

How a distress is to be disposed of. Persons distraining for rent may impound the distress upon any convenient part of the land, chargeable with the distress; otherwise the goods must be removed to a pound covert, and notice given where they are, unless the tenant consent to a person remaining in possession on the premises. Wood's Inst. 191.

All living chattels distrained are regularly not to be put in the pound covert, because the owner at his peril is to sustain them; and therefore they ought to be put in such an open place as that he may have resort to them for that purpose. Co. Lit. 47. b.

Household goods, and such other things as would be damaged by the weather, must be impounded in the pound covert; otherwise if they are damaged the distrainer will be answerable for the loss. 1 Inst. 47.

If the distress for rent dies or is damaged in the pound, without any default of the dis-

trainer, he may make a fresh distress. 1 Salk. 348.

By 2 W. and M. it is provided, that where any goods or chattels shall be distrained for rent due on any demise, lease, or contract whatsoever, and the owner shall not, within five days next after such distress taken, and notice thereof, and of the cause of the taking left at the dwelling-house, or other most notorious place on the premises charged with the rent, replevy the same, that then, at the expiration of the said five days, the distrainer may, with the assistance of the sheriff, under-sheriff, or constable, cause the goods and chattels so distrained to be appraised by two sworn appraisers, and sold for the best price that can be got for the same, towards satisfaction of the rent for which the said goods and chattels have been distrained, and the costs and charges of such distress, appraisement, and sale; leaving the overplus (if any) in the hands of the said sheriff, or constable, for the use of the owner.

By stat. 2 W. c. 5, on any pound-breach or rescous of goods distrained for rent, the persons grieved thereby shall, in a special action on the case, recover treble damages and costs against the offender, or against the owner of the goods, if they are afterwards found to have come to his use or possession.

DISTRESS FOR PENALTIES. By 27 G. II. c. 20. s. 1, in all cases where any justice of the peace shall be required or empowered by any act of parliament to issue a warrant of distress for the levying any penalty inflicted, or any sum of money directed to be paid by such act, it shall be lawful for the justice granting such warrant, therein to order and direct the goods and chattels so to be distrained, to be sold and disposed of within a certain time to be limited in such warrant; so as such time be not less than four days, nor more than eight days; unless the penalty, or sum of money for which the distress shall be made, together with the reasonable charges of taking and keeping such distress, shall be sooner paid.

DISTRESS OF THE KING. By the common law no subject can distrain out of his fee or seigniory, unless cattle are driven to a place out of the fee, to hinder the lord's distress, &c. But the king may distrain for rent-service, or fee-farm in all the lands of the tenant, wheresoever they be; not only on lands held of himself, but others, where his tenant is in actual possession, and the land manured with his own beasts. 2 Inst. 132.

DISTRIBUTION OF INTESTATE'S EFFECTS, after payment of the debts of the deceased, is to be made according to the stat. 22 and 23 G. II. c. 10, in manner following. One-third shall go to the widow of the intestate, and the residue in equal proportions to his children; or if dead to their representatives, that is, their lineal descendants: if there are no children or legal representatives, then a moiety shall go to the widow, and a moiety to the next kindred in equal degree, or their representatives; if no widow, the whole shall go to the children; if neither widow nor child, the whole shall be distributed amongst the next kindred in equal degree, and their representatives: but no representatives are admitted among collaterals, farther than the children of the intestate's brothers and sisters. The father succeeds to the whole personal effects of his children, if they die intestate, and without issue; but if the father be dead, and the mother survive, she shall only come in for a share equally with each of the remaining children.

DISTRIBUTION, in logic, is a kind of division which distinguishes an universal whole into its several kinds or species; as division is to distinguish an integral whole into its several parts.

DISTRIBUTION, in printing, the taking a form asunder, separating the letters, and disposing them in the cases again, each in its proper box.

DISTRICT, in geography, a part of a province, distinguished by peculiar magistrates, or certain privileges: in which sense it is synonymous with hundred.

DISTRINGAS, in law, a writ commanding the sheriff, or other officer, that he distrain a person for debt to the king, &c. or for his appearance at a certain day. There is a great diversity of this writ.

DISTRINGAS JURATORES, a writ directed to the sheriff, whereby he is commanded to distrain upon a jury to appear, and to return issues on their lands, &c. for non-appearance. This writ of distringas juratores issues for the sheriff to have their bodies in court, &c. at the return of the writ.

DITCH, in fortification, the same with moat. See FORTIFICATION.

DITHYRAMBUS, in antient poetry, a hymn in honour of Bacchus, full of transport and poetical rage. This poetry owes its birth to Greece, and to the transports of wine; and yet art is not quite exploded, but delicately applied to guide and restrain the dithyrambic impetuosity, which is indulged only in pleasing flights. Horace and Aristotle tell us, that the antients gave the name of dithyrambus to those verses in which none of the common rules or measures were observed. As we have now no remains of the dithyrambus of the antients, we cannot say exactly what their measure was.

DITONE, in music, an interval comprehending two tones. The proportion of the sounds that form the ditone is 4 : 5, and that of the semiditone is 5 : 6. F. Parran makes the ditone the fourth kind of simple concord, as comprehending two tones, according to Aristotle, a greater and a less. Others make it the first discord, dividing the ditone into eighteen equal parts, or commas; the nine on the acute side making the greater tone, as asserted by Salmon de Caux.

DIVAN, a council-chamber, or court of justice, among the eastern nations, particularly the Turks. The word is Arabic, and signifies the same with sopha in the Turkish dialect. There are two sorts of divans; that of the grand-signior, called the council of state, which consists of seven of the principal officers of the empire; and that of the grand-vizir, composed of six other vizirs and counsellors of state, the chancellors, and secretaries of state, for the distribution of justice. The word is also used for a hall in the private houses of the orientals. The custom of China does not allow the receiving of visits in the inner parts of the house, but only at the entry, in a divan contrived on purpose for ceremonies. Travellers relate wonders of the silence and energy of the divans of the East.

DIVAN-BEGHI, the superintendant of justice in Persia, whose place is the last of the six ministers of the second rank, who are all under the athemadauler, or first minister. To this tribunal of the divan-beghi he appeals from sentences passed by the governors: he has a fixed stipend of 50,000 crowns for administering justice: all the serjeants, ushers, &c. of the court are in his service: he takes cognizance of the criminal causes of the chams, governors, and other great lords of Persia, when accused of any fault. There are divan-beghis not only at court, and in the capital, but also in the provinces, and other cities of the empire. The alcoran is the sole rule of his administration of justice, which also he interprets at pleasure. He takes no cognizance of civil causes; but all differences arising between the officers of the king's household, and between foreign ministers, are determined by him.

DIVER, in ornithology. See COLYMBUS.

DIVERGENT or *diverging lines*, in geometry, are those which constantly recede from each other.

DIVERGENT RAYS, in optics, are those which going from a point of the visible object, are dispersed, and continually depart one from another, in proportion as they are removed from the object: in which sense it is opposed to convergent. See OPTICS.

DIVERSION, in military affairs, is when an enemy is attacked in one place where they are weak and unprovided, in order to draw off their forces from another place, where they have made, or intend to make, an irruption. Thus the Romans had no other way in their power of driving Hannibal out of Italy, than by making a diversion in attacking Carthage.

DIVERSITY, in logic, stands in opposition to identity. See IDENTITY.

DIVERSITY, in painting, consists in giving every part or figure in a piece its proper air and attitude. See PAINTING.

DIVESTING, or *divestiture*, in law, is used for the act of surrendering one's effects. By a contract of donation, or sale, the donor, or seller, is said to be disseised and divested of his property in such a commodity. In this sense it stands contradistinguished from investiture, where the donee or purchaser becomes invested with the property of the donor or seller.

DIVIDEND, in arithmetic, the number proposed to be divided into equal parts. It must always be greater than the divisor. See ARITHMETIC.

DIVIDEND, in the Exchequer, is one part of an indenture.

DIVIDEND *of stocks*, is a share or proportion of the interest of stocks erected on public funds, as the South Sea, &c. divided among, and paid to, the proprietors half-yearly. See STOCKS.

DIVIDEND, in the university, signifies that part or share which the fellows equally divide among themselves of their yearly stipend.

DIVING, the art or act of descending under water to considerable depths, and abiding there a competent time. The uses of diving are very considerable, particularly in

the fishing for pearls, corals, sponges, &c. See PEARL-FISHING, &c.

Various methods have been proposed, and engines contrived, to render the business of diving more safe and easy. The great point in all these is to furnish the diver with fresh air, without which he must either make but a short stay, or perish.

Those who dive for sponges in the Mediterranean, help themselves by carrying down sponges dipt in oil in their mouths. But considering the small quantity of air that can be contained in the pores of a sponge, and how much that little will be contracted by the pressure of the incumbent water, such a supply cannot long subsist the diver. For it is found by experiment that a gallon of air included in a bladder, and by a pipe reciprocally inspired and expired by the lungs, becomes unfit for respiration in little more than one minute of time. For though its elasticity is but little altered in passing the lungs, yet it loses its oxygen, and is rendered effete. In effect, a naked diver, Dr. Halley assures us, without a sponge, cannot remain above two minutes inclosed in water; nor much longer with one without suffocating; nor without long practice near so long, ordinary persons beginning to be suffocated in about half a minute. Besides, if the depth is considerable, the pressure of the water on the vessels makes the eyes blood-shotten, and frequently occasions a spitting of blood. Hence where there has been occasion to continue long at the bottom, some have contrived double flexible pipes, to circulate air down into a cavity inclosing the diver, as with armour, both to furnish air, and to bear off the pressure of the water, and give leave to his breast to dilate upon inspiration: the fresh air being forced down one of the pipes with bellows, and returning by the other, not unlike to an artery and vein.

But this method is impracticable when the depth surpasses three fathoms; the water embracing the bare limbs so closely as to obstruct the circulation of the blood in them; and also pressing so strongly on all the junctures where the armour is made tight with leather, that, if there is the least defect in any of them, the water rushes in, and instantly fills the whole engine, to the great danger of the diver's life.

It is said to be a fact, that people, by being accustomed to the water from their infancy, will at length be enabled, not only to stay much longer under water than could be supposed, but put on a kind of amphibious nature, so that they seem to have the use of all their faculties as well when their bodies are immersed in water as when they are on dry land. Most savage nations are remarkable for this. According to the accounts of our late voyagers, the inhabitants of the South Sea islands are such expert divers, that when a nail or any piece of iron was thrown overboard, they would instantly jump into the sea after it, and never fail to recover it, notwithstanding the quick descent of the metal. Even among civilized nations many persons have been found capable of continuing an incredible length of time under water. The most remarkable instance of this kind is the famous Sicilian diver, Nicolo Pesce, who, according to the marvellous and indeed incredible account given by Kircher, had from his infancy been so used to the sea, that at last it became almost his natural element. It is said he was frequently known to spend five days in the waves without any other provisions than the fish which he caught there, and ate raw. He often swam over from Sicily into Calabria, a tempestuous and dangerous passage, carrying letters from the king; and as frequently swam among the gulphs of the Lipari islands, no way apprehensive of danger. "In order," says Kircher, "to aid these powers of enduring in the deep, nature seemed to have assisted him in a very extraordinary manner: for the spaces between his fingers and toes were webbed, as in a goose; and his chest became so very capacious, that he could take in, at one inspiration, as much breath as would serve him for a *whole day*." At length, however, we are told, this extraordinary person met his fate in exploring the depths of Charybdis, at the instance of the king; who, after he had once succeeded in bringing up a golden cup that had been thrown in, ordered him to repeat the experiment.

To obviate the inconveniences of diving to those who have not the extraordinary powers attributed to Nicholas Pesce, different instruments have been contrived. The chief of these is the diving-bell; which is most conveniently made in form of a truncated cone, the smaller base being closed, and the larger open. It is to be poised with lead; and so suspended, that the vessel may sink full of air, with its open basis downward, and as nearly as may be in a situation parallel to the horizon, so as to close with the surface of the water all at once. The diver sitting under this, sinks down with the included air to the depth desired; and if the cavity of the vessel can contain a tun of water, a single man may remain a full hour, without much inconvenience, at five or six fathoms deep. But the lower he goes, the included air contracts itself according to the weight of the water which compresses it; so that at thirty-three feet deep the bell becomes half full of water, the pressure of the incumbent water being then equal to that of the atmosphere; and at all other depths the space occupied by the compressed air in the upper part of the bell will be to the under part of its capacity filled with water, as thirty-three feet, to the surface of the water in the bell below the common surface. And this condensed air being taken in with the breath soon accommodates itself to the existing circumstances so as to have no ill effect, provided the bell is permitted to descend slowly. But the greatest inconvenience of this engine is, that the water entering it contracts the bulk of air into so small a compass, that it soon heats, and becomes unfit for respiration: so that there is a necessity for its being drawn up to recruit it; besides the uncomfortable situation of the diver, who must be almost covered with water.

To obviate these difficulties of the diving-bell, Dr. Halley, to whom we owe the preceding account, contrived a farther apparatus, whereby not only to recruit the air from time to time, but also to keep the water wholly out of the machine at any depth. This bell was made of wood, containing about sixty cubic feet in its concavity; and was of the form of a truncated cone, whose diameter at the top was three feet, and at the bottom five. It was so loaded with lead, that it would go down in a perpendicular direction, and no other. In the top was a window to let in light, and likewise a cock to let out the hot air that had been breathed; and below, about a yard under the bell, was a stage, suspended by three ropes, each of which was charged with about one hundredweight to keep it steady. To supply air the bell had a couple of barrels, so cased with lead as to sink when empty; each having a bunghole in its lowest part to let in the water, as the air in them condensed on their descent, and to let it out again when they were drawn up full from below. To a hole in the uppermost part of these was fixed a leathern trunk or hose, long enough to fall below the bunghole, and kept down by a weight in such a way that the air in the upper part of the barrels could not escape, unless the lower ends of these hose were first lifted up. These air-barrels were made to rise and fall like two buckets in a well. By means of these barrels fresh air was continually supplied from above; and it was done with so much ease, that two men, with less than half their strength, could perform all the labour required. By an additional contrivance it was found practicable for a diver to go out of the engine to some distance from it, the air being conveyed to him in a continued stream by small flexible pipes. Some idea of Dr. Halley's machine may be formed from the inspection of Plate Miscel. fig. 50 where the divers are seen at work. B, L, K, R, I, M, P, represent the body of the bell. B, the glass which serves as a window. H, the cock for letting out the air which has been breathed. L, M, the seats. C, one of the air-barrels. P, Q, two of the divers. F, another diver at a distance from the bell, and breathing through the flexible tube K. This diver is supposed to have a head-piece of lead, made to sit quite close about his shoulders: this head-piece is capable of containing as much air as will supply him for a minute or two. When he had occasion for more air he turned a cock at F, by which means a communication was opened with the air in the bell, and thus he could receive a new supply at pleasure.

Since the invention of the diving-bell there has been one contrived by Mr. Triewald, military architect to the king of Sweden, which, for a single person, is in some respects thought to be more eligible than Dr. Halley's, and is constructed as follows; AB, Plate Miscel. fig. 51, is the bell, which is sunk by leaden weights D D, hung to its bottom. This bell is of copper, and tinned all over on the inside, which is illuminated by strong convex lenses, G, G, G, with copper lids H, H, H, to defend them. The iron ring or plate, E, serves the diver to stand on when he is at work; and is suspended at such a distance from the bottom of the bell by the chains F, F, F, that when the diver stands upright his head is just above the water in the bell, where the air is much better than higher up, because it is colder, and consequently more fit for respiration. But as the diver must always be within the bell, and his head of course in the upper part, the inventor has contrived that, even there, when he has breathed the hot air as well as he can, he may, by means of a spiral copper tube *b* C, placed close to the inside of the bell, draw the cooler and fresher air

from the lowermost parts: for which purpose a flexible leather tube, about two feet long, is fixed to the upper end of the copper tube at *b*; and to the other end of this tube is fixed an ivory mouth-piece, by which the diver draws in the air.

A great improvement in the diving-bell was made by the late Mr. Spalding, of Edinburgh. This construction seems designed to remedy some inconveniences of Dr. Halley's, which are very evident, and of a very dangerous tendency. These are, 1. By Dr. Halley's construction the sinking or raising of the bell depends entirely on the people who are at the surface of the water; and as the bell even when in the water has a very considerable weight, the raising it not only requires a great deal of labour, but there is a possibility of the rope breaking by which it is raised, and thus every person in the bell would inevitably perish. 2. As there are, in many parts of the sea, rocks which lie at a considerable depth, the figure of which cannot possibly be perceived from above, there is danger that some of their ragged prominences may catch hold of one of the edges of the bell in its descent, and thus overset it before any signal can be given to those above, which would infallibly be attended with the destruction of the people in the bell; and as it must always be unknown, before trial, what kind of a bottom the sea has in any place, it is plain, that without some contrivance to obviate this last danger, the descent in Dr. Halley's diving-bell is not at all eligible.

How these inconveniences are remedied by Mr. Spalding's new contrivance, will be easily understood from the following description. A B C D, fig. 52, represents a section of the bell, which is made of wood; *e*, *e*, are iron hooks, by means of which it is suspended by ropes Q B F *e*, and Q A E *e*, and Q S, as expressed in the figure: *c*, *c*, are iron hooks, to which are appended leaden weights, that keep the mouth of the bell always parallel to the surface of the water, whether the machine taken altogether is lighter or heavier than an equal bulk of water. By these weights alone, however, the bell would not sink: another is therefore added, represented at L, and which can be raised or lowered at pleasure, by means of a rope passing over the pulley *a*, and fastened to one of the sides of the bell at M. As the bell descends, this weight, called by Mr. Spalding the balance-weight, hangs down a considerable way below the mouth of the bell. In case the edge of the bell is caught by any obstacle, the balance-weight is immediately lowered down so that it may rest upon the bottom. By this means the bell is lightened, so that all danger of oversetting is removed; for being lighter, without the balance-weight, than an equal bulk of water, it is evident that the bell will rise, as far as the length of the rope affixed to the balance-weight will allow it. This weight, therefore, will serve as a kind of anchor to keep the bell at any particular depth which the divers may think necessary; or by pulling it quite up the descent may be continued to the very bottom.

By another very ingenious contrivance Mr. Spalding rendered it possible for the divers to raise the bell, with all the weights appended to it, even to the surface, or to stop at any particular depth, as they think proper; and thus they could still be safe, even though the rope designed for pulling up the bell was broken. For this purpose the bell is divided into two cavities, both of which are made as tight as possible. Just above the second bottom E F, are small slits in the sides of the bell, through which the water, entering as the bell descends, displaces the air originally contained in its cavity, which flies out at the upper orifice of the cock G H. When this is done, the divers turn the handle G, which stops the cock; so that if any more air was to get into the cavity A E F B, it could no longer be discharged through the orifice H as before. When this cavity is full of water the bell sinks; but when a considerable quantity of air is admitted it rises. If therefore the divers have a mind to raise themselves, they turn the small cock G, by which a communition is made between the upper and under cavities of the bell. The consequence of this is, that a quantity of air immediately enters the upper cavity, forces out a quantity of the water contained it, and thus renders the bell lighter by the whole weight of the water which is displaced. Thus if a certain quantity of air is admitted into the upper cavity the bell will descend very slowly; if a greater quantity, it will neither ascend nor descend, but remain stationary; and if a larger quantity of air be still admitted it will rise to the top. It is to be observed, however, that the air which is thus let out into the upper cavity must be immediately replaced from the air-barrel; and the air is to be let out very slowly, or the bell will rise to the top with so great velocity that the divers will be in danger of being shaken out of their seats. But by following these directions every possible accident may be prevented, and people may descend to very great depths without the least apprehension of danger. The bell also becomes so easily manageable in the water, that it may be conducted from one place to another by a small boat with the greatest ease, and with perfect safety to those who are in it.

Instead of wooden seats used by Dr. Halley, Mr. Spalding made use of ropes suspended by hooks *bbb*; and on these ropes the divers may sit without any inconvenience. There are two windows made of thick strong glass, for admitting light to the divers. N represents an air-cask with its tackle, and O C P the flexible pipe through which the air is admitted to the bell. In the ascent and descent of this cask the pipe is kept down by a small appended weight, as in Dr. Halley's machine. R is a small cock by which the hot air is discharged as often as it becomes troublesome. Annexed is a representation of the whole diving apparatus, which, no doubt, will be readily understood without any further explanation. Two air-barrels are represented in this figure; but Mr. Spalding was of opinion that one, capable of containing thirty gallons, is sufficient for an ordinary machine. See fig. 53.

Mr. Adam Walker recommends, for the purposes of diving, a conical tub of wood three feet diameter at the bottom, two and a half feet at the top, and three feet high, so loaded with lead at the bottom as just to sink itself, with a small seat for the diver. See Plate, fig. 54. A bent metal tube is attached to the outside of the bell, as *abc*, with a stop-cock *a*, and a flexible leathern tube to the other end at *c*; this tube terminates in a forcing air-pump fastened to the side of a ship; *d* is a solid piston acted upon by a lever *e*; upon the piston being drawn up the air rushes in at the valve *g*, and fills the space *n*; in its descent the valve *g* shuts, and the conical valve *o* opens, and thus the air is forced down the hose into the bell. The pump is kept working, while the diver, by opening and shutting the stop-cock, is abundantly supplied with fresh air, and that which is vitiated is forced out at the bottom of the bell. By a machine of this kind the greatest part of the wreck was saved from the rich ship Belgiosa.

Mr. Smeaton's diving-bell was a square chest of cast-iron, four and a half feet in height, four and a half feet in length, and three feet wide, and afforded room for two men to work in it. It was supplied with fresh air by a forcing-pump. This was used with great success at Ramsgate. Other contrivances as intimated before have been used for diving to small depths; such as strong cases for the body, to keep off the pressure of the water, which were supplied with fresh air by pipes from the surface.

The most effectual of this kind is a method put in practice by a gentleman of Devonshire. He has contrived a large case of strong leather, perfectly water-proof, which may hold about half a hogshead of air. This is so adapted, that, when he shuts himself up in this case, he may walk at the bottom of the sea, and go into any part of a wrecked vessel, and deliver out the goods. This method, we are told, he has practised for many years, and has thus acquired a large fortune. It would be a considerable improvement of this machine to condense the air in it as much as possible before the diver descended, as he would thus be furnished with an atmosphere endued with an elasticity sufficient to resist the weight of water, which otherwise would squeeze his case into much less room than it originally took up. The condensed air would serve for respiration a much longer time than that which is in its ordinary state.

DIVING-BLADDER, a machine invented by Borelli, and by him preferred, though without any good reason, to the diving-bell. It is a globular vessel of brass or copper, about two feet in diameter, formed to contain the diver's head. It is fixed to a goat's-skin habit, exactly fitted to his person. Within the vessel are pipes, by means of which a circulation of air is contrived; and the person carries an air-pump by his side, by which he can make himself heavier or lighter, as fishes do by contracting or dilating their air-bladders. By this means he thought all the objections to which other diving-machines are liable were entirely obviated, and particularly that of want of air; the air which had been breathed being, as he imagined, deprived of its noxious qualities by circulating through the pipes. These advantages, however, it is evident, are only imaginary. The diver's limbs being defended from the pressure of the water only by a goat's skin, would infallibly be crushed if he descended to any considerable depth; and from the discoveries made by Dr. Priestley and others, it is abundantly evident that air which is once rendered foul by breathing, cannot in any degree be restored by circulation through

pipes. Concerning the use of copper machines in general Mr. Spalding has remarked, that when a person has breathed in them a few minutes, he feels in his mouth a very disagreeable brassy taste, which continues all the time he remains in the vessel; so that, on this account, copper seems by no means an eligible material.

DIVING, submarine vessel for. The following description of a diving-machine, invented by Mr. Bushnell, of Connecticut, is given in the Transactions of the American Philosophical Society.

The external shape of the submarine vessel bore some resemblance to two upper tortoise-shells of equal size, joined together; the place of entrance into the vessel being represented by the opening made by the swell of the shells, at the head of the animal. The inside was capable of containing the operator, and air sufficient to support him thirty minutes without receiving fresh air. At the bottom, opposite to the entrance, was fixed a quantity of lead for ballast. At one edge, which was directly before the operator, who sat upright, was an oar for rowing forward or backward. At the other edge was a rudder for steering. An aperture, at the bottom, with its valve, was designed to admit water, for the purpose of descending; and two brass forcing-pumps served to eject the water within, when necessary for ascending. At the top there was likewise an oar for ascending or descending, or continuing at any particular depth. A water-gauge, or barometer, determined the depth of descent, a compass directed the course, and a ventilator within supplied the vessel with fresh air, when on the surface.

The entrance into the vessel was elliptical, and so small as barely to admit a person. This entrance was surrounded with a broad elliptical iron band, the lower edge of which was let into the wood of which the body of the vessel was made, in such a manner as to give its utmost support to the body of the vessel against the pressure of the water. Above the upper edge of this iron band there was a brass crown, or cover, resembling a hat with its crown and brim, which shut water-tight upon the iron band: the crown was hung to the iron band with hinges, so as to turn over sideways when opened. To make it perfectly secure when shut, it might be screwed down upon the band by the operator, or by a person without.

There were in the brass crown three round doors, one directly in front, and one on each side, large enough to put the hand through. When open they admitted fresh air; their shutters were ground perfectly tight into their places with emery, hung with hinges, and secured in their places when shut. There were likewise several small glass windows in the crown for looking through, and for admitting light in the day-time, with covers to secure them. There were two air-pipes in the crown. A ventilator within drew fresh air through one of the air-pipes, and discharged it into the lower part of the vessel; the fresh air introduced by the ventilator expelled the impure light air through the other air-pipe. Both air-pipes were so constructed, that they shut themselves whenever the water rose near their tops, so that no water could enter through them, and opened themselves immediately after they rose above the water.

The vessel was chiefly filled with lead fixed to its bottom; when this was sufficient, a quantity was placed within, more or less, according to the weight of the operator; its ballast made it so stiff, that there was no danger of oversetting. The vessel with all its appendages, and the operator, was sufficient to settle it very low in the water. About two hundred pounds of the lead, at the bottom for ballast, would be let down forty or fifty feet below the vessel; this enabled the operator to rise instantly to the surface of the water, in case of accident.

When the operator would descend, he placed his foot on the top of a brass valve, depressing it, by which he opened a large aperture in the bottom of the vessel, through which the water entered at his pleasure; when he had admitted a sufficient quantity, he ascended very gradually; if he admitted too much, he ejected as much as was necessary to obtain an equilibrium by the two brass forcing-pumps placed at each hand. Whenever the vessel leaked, or he would ascend to the surface, he also made use of these forcing-pumps. When the skilful operator had obtained an equilibrium, he could row upward or downward, or continue at any particular depth, with an oar placed near the top of the vessel, formed upon the principle of the screw, the axis of the oar entering the vessel; by turning the oar one way he raised the vessel, by turning it the other way he depressed it.

A glass tube eighteen inches long, and one inch in diameter, standing upright, its upper end closed, and its lower end which was open, screwed into a brass pipe, through which the external water had a passage into the glass tube, served as a water-gauge or barometer. There was a piece of cork, with phosphorus on it, put into the water-gauge. When the vessel descended the water rose in the water-gauge, condensing the air within, and bearing the cork, with its phosphorus, on its surface. By the light of the phosphorus the ascent of the water in the gauge was rendered visible, and the depth of the vessel under water ascertained by a graduated line.

An oar, formed upon the principle of the screw, was fixed in the fore part of the vessel; its axis entered the vessel, and being turned one way, rowed the vessel forward, but being turned the other way rowed it backward; it was made to be turned by the hand or foot.

A rudder, hung to the hinder part of the vessel, commanded it with the greatest ease. The rudder was made very elastic, and might be used for rowing forward. Its tiller was within the vessel, at the operator's right-hand, fixed at a right-angle, on an iron rod which passed through the side of the vessel; the rod had a crank on its outside end, which commanded the rudder, by means of a rod extending from the end of the crank to a kind of tiller, fixed upon the left-hand of the rudder. Raising and depressing the first-mentioned tiller, turned the rudder as the case required.

A compass marked with phosphorus directed the course, above and under the water; and a line and lead sounded the depth when necessary.

The internal shape of the vessel, in every possible section of it, verged towards an ellipsis, as near as the design would allow; but every horizontal section, although elliptical, yet was as near to a circle as could be admitted. The body of the vessel was made exceedingly strong; and to strengthen it as much as possible a firm piece of wood was framed, parallel to the conjugate diameter, to prevent the sides from yielding to the great pressure of the incumbent water in a deep immersion. This piece of wood was also a seat for the operator.

Every opening was well secured. The pumps had two sets of valves. The aperture at the bottom, for admitting water, was covered with a plate, perforated full of holes to receive the water, and prevent any thing from choking the passage, or stopping the valve from shutting. The brass valve might likewise be forced into its place with a screw, if necessary. The air-pipes had a kind of hollow sphere, fixed round the top of each, to secure the air-pipe valves from injury: these hollow spheres were perforated full of holes, for the passage of the air through the pipes: within the air-pipes were shutters to secure them, should any accident happen to the pipes or the valves on their tops.

Wherever the external apparatus passed through the body of the vessel, the joints were round, and formed by brass pipes, which were driven into the wood of the vessel; the holes through the pipes were exactly made, and the iron rods, which passed through them, were turned in a lathe to fit them; the joints were also kept full of oil, to prevent rust and leaking. Particular attention was given to bring every part, necessary for performing the operations, both within and without the vessel, before the operator, and as conveniently as could be devised; so that every thing might be found in the dark, except the water-gauge and the compass, which were visible by the light of the phosphorus; and nothing required the operator to turn to the right hand, or to the left, to perform any thing necessary.

The inventor next pursues the subject under the following heads:

1. Description of a magazine, and its appendages, designed to be conveyed by the submarine vessel to the bottom of a ship. In the fore part of the brim of the crown of the submarine vessel were a socket, and an iron tube passing through the socket: the iron tube stood upright, and could slide up and down in the socket six inches: at the top of the tube was a wood screw, fixed by means of a rod, which passed through the tube, and screwed the wood screw fast upon the top of the tube: by pushing the wood screw up against the bottom of a ship, and turning it at the same time, it would enter the planks; driving would also answer the same purpose: when the wood screw was firmly fixed it could be cast off by unscrewing the rod, which fastened it upon the top of the tube.

Behind the submarine vessel was a place, above the rudder, for carrying a large powder-magazine; this was made of two pieces of oak timber, large enough, when hollowed out, to contain 150 pounds of powder, with the apparatus used in firing it, and was secured in its place by a screw, turned by the operator. A strong piece of rope extended from the magazine to the wood screw above-men-

tioned, and was fastened to both. When the wood screw was fixed, and to be cast off from its tube, the magazine was to be cast off likewise by unscrewing it, leaving it hanging to the wood screw; it was lighter than the water, that it might rise up against the object to which the wood screw and itself were fastened.

Within the magazine was an apparatus, constructed to run any proposed length of time: it unpinioned a strong lock resembling a gun-lock, which gave fire to the powder. This apparatus was so pinioned that it could not possibly move till, by casting off the magazine from the vessel, it was set in motion.

The skilful operator could swim so low on the surface of the water as to approach very near a ship in the night, without fear of being discovered; and might, if he chose, approach the stem or stern above water with very little danger. He could sink very quickly, and keep at any depth he pleased, and row a great distance in any direction he desired, without coming to the surface; and when he rose to the surface, he could soon obtain a fresh supply of air, when, if necessary, he might descend again, and pursue his course.

2. Experiments made to prove the nature and use of a submarine vessel. The first experiment made was with about two ounces of gunpowder, which were exploded four feet under water, to prove to some of the first personages in Connecticut, that powder would take fire under water.

The second experiment was made with two pounds of powder, inclosed in a wooden bottle, and fixed under a hogshead, with a two-inch oak plank between the hogshead and the powder; the hogshead was loaded with stones as deep as it could swim; a wooden pipe descending through the lower head of the hogshead, and through the plank, into the powder contained in the bottle, was primed with powder. A match put to the priming, exploded the powder; which produced a very great effect, rending the plank into pieces, demolishing the hogshead, and casting the stones and the ruins of the hogshead, with a body of water, many feet into the air, to the astonishment of the spectators. This experiment was likewise made for the satisfaction of the gentlemen abovementioned.

There were afterwards made many experiments of a similar nature, some of them with large quantities of powder; they all produced very violent explosions, much more than sufficient for any purpose had in view.

In the first essays with the submarine vessel, the inventor took care to prove its strength to sustain the great pressure of the incumbent water, when sunk deep, before he trusted any person to descend below the surface; and he never suffered any person to go under water without having a strong piece of rigging made fast to it, until he found him well acquainted with the operations necessary for his safety. After this he made him descend, and continue at particular depths without rising or sinking, row by the compass, approach a vessel, go under her, and fix the wood screw into her bottom, &c. until he thought him sufficiently expert to put any design into execution.

It required many trials to make a person of common ingenuity a skilful operator: the first employed was very ingenious, and made himself master of the business, but was taken sick in the campaign of 1776, at New York, before he had an opportunity to make use of his skill, and never recovered his health sufficiently afterwards.

3. Experiments made with a submarine vessel. After various attempts to find an operator to his wish, Mr. Bushnell sent one, who appeared more expert than the rest, from New York to a fifty-gun ship, lying not far from Governor's-island. He went under the ship, and attempted to fix the wood screw into her bottom; but struck, as he supposes, a bar of iron, which passes from the rudder-hinge, and is spiked under the ship's quarter. Had he moved a few inches, which he might have done without rowing, he would probably have found wood where he might have fixed the screw; or, if the ship were sheathed with copper, he might easily have pierced it: but not being well skilled in the management of the vessel, in attempting to move to another place, he lost the ship; after seeking her in vain, for some time, he rowed some distance, and rose to the surface of the water, but found day-light had advanced so far, that he durst not renew the attempt. The adventurer said that he could easily have fastened the magazine under the stem of the ship, above water, as he rowed up to the stern, and touched it before he descended. Had he fastened it there, the explosion of 150 pounds of powder (the quantity contained in the magazine), must have been fatal to the ship. In his return from the ship to New York he passed near Governor's-island, and thought he was discovered by the enemy on the island; being in haste to avoid the danger he feared, he cast off the magazine, as he imagined it retarded him in the swell, which was very considerable. After the magazine had been cast off one hour, the time the internal apparatus was set to run, it blew up with great violence.

Afterwards there were two attempts made in Hudson's river, above the city, but they effected nothing. One of them was by the afore-mentioned person. In going towards the ship, he lost sight of her, and went a great distance beyond her: when he at length found her, the tide ran so strong, that as he descended under water for the ship's bottom, it swept him away. Soon after this the enemy went up the river, and pursued the boat which had the submarine vessel on board, and sunk it with their shot. "Though," says Mr. Bushnell, "I afterwards recovered the vessel, I found it impossible, at that time, to prosecute the design any further. I had been in a bad state of health from the beginning of my undertaking, and was now very unwell; the situation of public affairs was such that I despaired of obtaining the public attention, and the assistance necessary. I was unable to support myself, and the persons I must have employed, had I proceeded. Besides, I found it absolutely necessary that the operators should acquire more skill in the management of the vessel before I could expect success, which would have taken up some time, and made no small additional expence. I therefore gave over the pursuit for that time, and waited for a more favourable opportunity, which never arrived."

4. Other experiments made with a design to fire shipping. In the year 1777 Mr. Bushnell made an attempt from a whale-boat against the Cerberus frigate, then lying at anchor between Connecticut river and New London, by drawing a machine against her side, by means of a line. The machine was loaded with powder, to be exploded by a gun-lock, which was to be unpinioned by an apparatus, to be turned by being brought alongside of the frigate. This machine fell in with a schooner at anchor, astern of the frigate, and concealed from his sight. By some means or other it was fired, and demolished the schooner and three men; and blew the only one left alive overboard, who was taken up very much hurt.

After this he fixed several kegs under water, charged with powder, to explode, upon touching any thing, as they floated along with the tide; he set them afloat in the Delaware, above the English shipping at Philadelphia, in December 1777. "I was unacquainted," says he, "with the river, and obliged to depend upon a gentleman very imperfectly acquainted with that part of it, as I afterwards found. We went as near the shipping as we durst venture; I believe the darkness of the night deceived him, as it did me. We set them adrift to fall with the ebb upon the shipping. Had we been within 60 rods, I believe they must have fallen in with them immediately as I designed; but as I afterwards found, they were set adrift much too far distant, and did not arrive until after being detained some time by frost: they advanced in the day-time in a dispersed situation, and under great disadvantages. One of them blew up a boat with several persons in it, who imprudently handled it too freely, and thus gave the British that alarm which brought on the battle of the Kegs.

DIVISIBILITY, that property by which the particles of matter in all bodies are capable of a separation, or disunion from each other.

Some philosophical writers have considered this as a distinct property of matter itself, but it may with more propriety be considered as a property of extension; for we can easily conceive that a given extension may be divided into any number of parts, let it be ever so great; but it is by no means known whether matter is or is not capable of being divided ad infinitum, that is, without any limit.

That a certain extension, as an inch, or any other length, be it ever so small, is capable of infinite division, may be rendered evident by means of arithmetic or of geometry. We may take, for instance, the halves of the proposed extension, then the halves of those parts, and so on without end; for if you proceed in this manner ever so far, there will after all still remain the halves of the last parts, which may be also divided into other halves, &c. Again, suppose the line AB, Plate Miscel. fig. 55, to be the proposed extension. Through the extreme points of this line draw two indefinite lines EF and CD, parallel to each other. In one of those lines, as EF, take a point I, and from this point draw straight lines to any parts of the line D, every one of which

lines will evidently cut the proposed extension AB in a different point. Now as the line BD may be produced towards D without limitation, and straight lines may be drawn from L to an infinite number of points in the extended line BD; therefore the extension AB may be divided without end, or beyond any assignable number of parts.

Or thus: suppose a line, AD, Plate Miscel. fig. 56, perpendicular to BF; with the centres C, C, C, &c. and distances CA, CA, &c. describe circles cutting the line GH in the points *e*, *e*, &c. Now the greater the radius AC is, the less is the part *e* G; but the radius may be augmented in infinitum, and therefore the part *e* G may be diminished in the same manner; and yet it can never be reduced to nothing, because the circles can never coincide with the right line BF. Consequently the parts of any magnitude may be diminished in infinitum.

Thus far we have shewn that extension may be divided into an unlimited number of parts; but with respect to the limits of the divisibility of matter itself we are perfectly in the dark. We can indeed divide certain bodies into surprisingly fine and numerous particles, and the works of nature offer many fluids and solids of wonderful tenuity; but both our efforts, and those naturally small objects, advance a very short way towards infinity. Ignorant of the intimate nature of matter, we cannot assert whether it may be capable of infinite division, or whether it ultimately consists of particles of a certain size, and of perfect hardness. We shall now add some instances of the wonderful tenuity of certain bodies, which have been produced either by art, or discovered by means of microscopical observations amongst the stupendous works of nature.

The spinning of wool, silk, cotton, and such-like substances, affords no bad specimens of this sort; since the thread which has been produced by this means has often been so very fine as almost to exceed the bounds of credibility, had it not been sufficiently well authenticated. Mr. Boyle mentions that two grains and a half of silk was spun into a thread 300 yards long. A few years ago a lady of Lincolnshire spun a single pound of woollen yarn into a thread of 168,000 yards long, which is equal to 95 English miles. Also a single pound-weight of fine cotton-yarn was lately spun, in the neighbourhood of Manchester, into a thread 134,400 yards long.

The ductility of gold likewise furnishes a striking example of the great tenuity of matter amongst the productions of human ingenuity. A single grain-weight of gold has been often extended into a surface equal to 50 square inches. If every square inch of it is divided into square particles of the hundredth part of an inch, which will be plainly visible to the naked eye, the number of those particles in one inch square will be 10,000; and multiplying this number by the 50 inches, the product is 500,000; that is, the grain of gold may be actually divided into at least half a million of particles, each of which is perfectly apparent to the naked eye. Yet if those particles are viewed in a good microscope, they will appear like a large surface, the ten-thousandth part of which might by this means be easily discerned.

An ingenious artist in London has been able to draw parallel lines upon a glass plate, as also upon silver, so near one another, that 10,000 of them occupy the space of one inch. Those lines can be seen only by the assistance of a very good microscope. Another workman has drawn a silver wire, the diameter of which does not exceed the 750th part of an inch. But those prodigies of human ingenuity will appear extremely gross and rude, if they are compared with the immense subtilty of matter which may every where be observed amongst the works of nature. The animal, the vegetable, and even the mineral kingdom, furnish numerous examples of this sort.

What must be the tenuity of the odoriferous parts of musk, when we find that a piece of it will scent a whole room in a short time, and yet it will hardly lose any sensible part of its weight! But supposing it to have lost one-hundredth part of a grain weight, when this small quantity is divided and dispersed through the whole room, it must so expand itself as not to leave an inch square of space where the sense of smell may not be affected by some of its particles. How small must then be the weight and size of one of those particles!

The human eye, unassisted by glasses, can frequently perceive insects so small as to be barely discernible. The least reflection must shew that the limbs, the vessels, and other parts of such animals, must infinitely exceed in fineness every endeavour of human art. But the microscope has discovered wonders that are vastly superior, and such indeed as were utterly unknown to our forefathers, before the invention of that noble instrument.

Insects have been discovered so small as not to exceed the 10,000th part of an inch: so that 1,000,000,000,000 of them might be contained within the space of one cubic inch; yet each animalcule must consist of parts connected with each other; with vessels, with fluids, and with organs necessary for its motions, for its increase, for its propagation, &c. How inconceivably small must those organs be! and yet they are unquestionably composed of other parts still smaller, and still farther removed from the perception of our senses.

Several writers, when treating of the divisibility of matter, have mentioned two curious theorems, which are established on the supposition that matter is divisible without end.

Theorem I. A quantity of matter, however small, and any finite space, however large, being given; it is possible that that matter may be diffused through all that space, and so fill it, as not to leave in it a pore, whose diameter will exceed a given right line.

Let the given space be a cube, whose side is AB, so that the cube be equal to $\overline{AB}^3$ and let the quantity of matter be represented by b^3; also let a line D be the limit of the diameter of the pores.

The side AB being a finite quantity, may be conceived to be divisible into parts equal to the line D. Let the number of those parts be represented by n, so that $n\,D = AB$, and $n^3\,D^3 = \overline{AB}^3$. Conceive the given space to be divided into cubes, each of whose sides be equal to the right line D, and the number of those cubes will be n^3, which cubes may be represented by E, F, G, H. Again, let the particle b^3 be supposed to be divided into parts whose number is n^3; and in each cubic space let there be placed one of those particles, by which means the matter b^3 will be diffused through all the given space. Besides, each particle being placed in its cell, may be formed into a concave sphere, whose diameter may be equal to the given line D; whence it will follow, that each sphere will touch that which is next to it; and thus the quantity of matter b^3, be it ever so small, will fill the given finite space, however large, in such a manner as not to leave in it a pore larger in diameter than the given line D.

Corollary. There may be a given body, whose matter if it be reduced into a space absolutely full, that space may be any given part of the former magnitude.

Theorem II. There may be two bodies equal in bulk, whose quantities of matter may be very unequal, and though they have any given ratio to each other, yet the sums of the pores or empty spaces in those bodies may almost approach the ratio of equality.

The demonstration of this theorem is easily derived from the foregoing: for since the matter of a body may be conceived to be condensable into any part of the original bulk; therefore supposing two bodies, A and B, of equal bulk, to be such that the matter of A be 100 times the matter of B; the matter of B may be conceived to be condensed into 1,000,000th part of its original bulk, and of course the matter of A will be condensed into one hundred 1,000,000th parts of the same bulk; in which case the spaces left in the original bulk of B will be to the spaces left in the original bulk of A, as 999,999 to 999,900, which numbers are nearly equal to each other.

Instead of the above-mentioned numbers, the proportions of the quantities of matter may be increased at pleasure, and so may the proportion of the original bulks of the bodies to the spaces into which they may be conceived to be condensable.

DIVISION, in arithmetic, one of the four fundamental rules, by which we find how often a less number, called the divisor, is contained in a greater, called the dividend; the number of times which the divisor is contained in the dividend being termed the quotient. See ARITHMETIC, and ALGEBRA.

DIVISION, in natural philosophy, is the taking a thing to pieces, in order to have a more complete conception of the whole: this is frequently necessary in examining very complex beings, the several parts of which cannot be surveyed at one view. Thus to learn the nature of a watch the workman takes it to pieces, and shews us the spring, wheels, axles, pinions, balances, dial-plate, pointer, case, &c. and after describing the uses and figures of each of them apart, explains how they contribute to form the whole machine. See CLOCKWORK.

DIVISION, in music. This word bears two constructions. With theoretical musicians it implies the division of the intervals of the octave; but taken in a practical sense signifies a long series of notes so running into each other as to form one connected chain of sounds; and which, in vocal music, is always applied to a single syllable. The sing-

ing or playing a passage of this kind is called running a division.

DIVISION, in the sea language, the third part of a fleet of men of war, and sometimes the ninth part; which last happens when the fleet is divided into three squadrons: for then each squadron is distributed into three divisions.

DIVORCE, a separation of two de facto married together, of which there are two kinds; one a vinculo matrimonii, from the very bond of marriage; the other a mensa et thora, from bed and board.

Causes for separation a vinculo are consanguinity or affinity within the degrees prohibited, also impuberty or frigidity; where the marriage was actually void ab initio, and the sentence of divorce only declaratory of its being so. This divorce enables the parties to marry again; but in the other case a power for so doing must be obtained by act of parliament. The woman divorced a vinculo matrimonii receives all again she brought with her.

Divorce a mensa et thora is where the use of matrimony, as the use of cohabitation of the married persons, or their mutual conversation, is prohibited for a time, or without limitation of time. And this is in cases of adultery, cruelty, or the like; in which case the marriage having been originally good is not dissolved or affected as to the vinculum or bond. The woman under separation by this divorce may sue by her next friend; and she may sue her husband in her own name for alimony. Wood's Inst. 62. But the children which she has after her divorce shall be deemed bastards; for a due obedience to the sentence will be intended, unless the contrary be shewn. Walk. 123.

DIURETICS, in pharmacy, such medicines as increase the discharge of urine; or which are supposed to have a power of removing obstructions in the urinary passages. See MATERIA MEDICA.

DIURNAL, in astronomy, something relating to the day, in opposition to nocturnal, which regards the night.

DIURNAL ARCH, the arch or number of degrees that the sun, moon, or stars, describe between their rising and setting.

DIURNAL *motion of a planet*, is so many degrees and minutes as any planet moves in 24 hours. Hence the motion of the earth about its axis is called its diurnal motion. See ASTRONOMY.

DIURNARY, *diurnarius*, an officer in the Greek empire, who wrote down in a book, kept for that purpose, whatever the prince did, or ordered, &c. every day.

DIVOTO, in music, a term signifying that the piece before which it is written is to be performed in a grave, solemn style, proper to inspire devotion.

DIVUS and DIVA, in antiquity, appellations given to men and women as had been deified. We find this title on medals struck for the consecration of an emperor or empress: thus, DIVVS IVLIVS, DIVA FAVSTINA AVG. &c.

DO, in music, a monosyllable long since substituted by the Italians for that of *ut*, which Guido applied to the first note of the natural major, diatonic scale. Guido's monosyllable was rejected as too hard and rough.

DOCIMASIA, in Greek antiquity, a probation of the magistrates and persons employed in public business at Athens. It was performed publicly in the forum, where they were obliged to give account of themselves and their past life before certain judges. Among several questions proposed to them we find the following: Whether they had been dutiful to their parents, had served in the wars, and had a competent estate.

DOCIMASTIC ART, a name given to the art of assaying by operations on a small scale, the nature and quantity of metallic or other matters which are obtained from minerals, &c.

DOCK, or DOCKING, in law, an expedient for cutting off an estate-tail in lands or tenements, that the owner may be enabled to sell, give, or bequeath the same.

DOCK, in maritime affairs, is an artificial bason, by the side of an harbour, made convenient either for the building or repairing of ships. It is of two sorts, 1. Dry-dock, where the water is kept out by great flood-gates, till the ship is built or repaired, when the gates are opened, and the water let in to float and launch her. 2. Wet-dock, a place where the ship may be hauled into, out of the tide's way, and so dock herself, or sink herself a place to lie in.

The West India docks, in the isle of Dogs. These immense works are intended to receive the whole of the ships in the West India trade; and may be accounted among the prominent curiosities of British commerce. They were undertaken according to an act of parliament, passed in 1799, entitled "the West India Dock Act." The entrances into them are at Blackwall and Limehouse-hole; their site is wholly on the isle of Dogs; and upon the wharfs and quays adjoining them, all West India ships are to unload and load their cargoes.

The northern dock for unloading inwards covers a space of thirty acres, and is capable of containing from two to three hundred sail of ships. The smaller dock, situated to the south of the other, covers an area of 24 acres, and is devoted solely to the business of loading outwards. Both docks are surrounded by a series of immense warehouses.

The proprietors of this capital improvement are styled "the West India Dock company:" they commenced their undertaking with a subscription of 500,000*l.* and are empowered to increase it to 600,000*l.* if needful. They are reimbursed by a tonnage of 6*s.* upon the burthen of every ship which enters the docks; for wharfage, landing, housing, weighing, cooperage, and warehouse-room, they are entitled to certain rates upon all goods that are discharged, such as 8*d.* per cwt. upon sugar; 1*d.* per gallon upon rum; 1*s.* 6*d.* per cwt. upon coffee; 2*s.* 6*d.* per cwt. upon cotton-wool, &c. &c.

Notwithstanding these docks occasion a very important trade to be removed to a considerable and even inconvenient distance from the metropolis, yet the advantages to the port of London will, upon the whole, be considerable. The West India trade generally arrives in fleets, and occasions so much crowding, confusion, and damage, in the river, that the ships being disposed of in these docks, the overgrown trade of the port may be carried on with pleasure and convenience

Canal at the isle of Dogs. To enable shipping in their passage up and down the Thames to avoid the circuitous and inconvenient course round the isle of Dogs, a canal is now cut across this peninsula, through which, upon paying certain moderate rates, all ships, vessels, and craft, will be permitted to pass in their passage up and down the Thames. For three years after its completion ships above two hundred tons will be required to pay 1*d.* per ton; from two hundred to one hundred tons 1½*d.* per ton; from one hundred to 50 tons 10*s.* per vessel; from fifty to twenty tons 5*s.* per vessel; and for boats and craft 1*s.* each.

The docks at Wapping. This important improvement is made in the angle formed by the Thames, between Hermitage dock and Shadwell dock. One immense dock, called St. George's dock, covers the space extending from Virginia-street, almost to Old Gravel-lane, in one direction, and in the other from Artichoke-lane to the south side of Pennington-street. This dock alone is capable of holding two hundred ships, with room for shifting. Another dock, called Shadwell dock, adjoining to the other, will hold about fifty ships. The entrance to the docks is from the Thames by three basons, capable of containing an immense quantity of small craft; and the inlets from the Thames into the basons are at the Old Hermitage dock, at Old Wapping dock, and Old Shadwell dock.

The capital of the company is 1,200,000*l.* The shares bear a premium. The ultimate profits upon the scheme are limited to 10 per cent.; an interest which it is sure to realize.

On the 26th of June, 1802, the foundation of the entrance bason was laid by the then chancellor of the exchequer, the right honourable Henry Addington; and the first stone of a tobacco warehouse, which is the largest in the world, the roof of which covered six acres of ground; and also the first stone of a range of warehouses for general merchandise, were laid at the same time.

The warehouses for the reception of tobacco are situated at the eastern extremity; they are two in number. The largest is 762 feet long, and 160 feet wide, equally divided by a strong partition-wall, with double iron doors; the smallest is 250 feet by 200. Both of them consist of a ground-floor and vaults; the first is to be wholly applied to the reception of tobacco; the cellars in the smaller warehouses are appropriated to the housing of wine. They are solely under the care and controul of the officers of the customs: the proprietors of the docks having nothing more to do with them than to receive the rent.

DOCK-YARDS, in ship-building, are magazines of all sorts of naval stores. The principal in England are those of Chatham, Portsmouth, Plymouth, Woolwich, Deptford, and Sheerness. In time of peace ships of war are laid up in these docks; those of the first rate mostly at Chatham, where, and at other yards, they receive from time to time such repairs as are necessary. These yards are generally supplied from the northern powers with hemp, pitch, tar, rosin, &c. but as for masts, particularly those of the larger size, they are brought from America.

DOCKET, or DOGGET, a brief in writing, on a small piece of paper or parchment, containing the effect of a larger writing, and

annexed to other papers for particular purposes. In law a docket is necessary in all judgments; and no debts will be entitled to a preference, in debts due from a party deceased, as judgment debts, unless such judgments be regularly docketed.

DOCTOR, a teacher, or person who has passed all the degrees of a faculty, and is impowered to teach or practise the same: thus we say, doctor in divinity, doctor in physic, doctor of laws.

The title of doctor seems to have been created in the twelfth century, instead of master, and established with the other scholastic degrees of bachelors and licentiates, by Peter Lombard and Gilbert Porreus, then the chief divines of the university of Paris. Gratian did the same thing, at the same time, in the university of Bologna. Though the two names of doctor and master were used a long time together, yet many think that their functions were different, the masters teaching the human sciences, and the doctors those sciences depending on revelation and faith. Spelman takes the title of doctor not to have commenced till after the publication of Lombard's Sentences, about the year 1140, and affirms that such as explained that work to their scholars were the first that had the appellation of doctors.

To pass doctor in divinity at Oxford, it is necessary that the candidate have been four years bachelor of divinity. For doctor of laws he must have been seven years in the university to commence bachelor of law, five years after which he may be admitted doctor of laws. Otherwise, in three years after taking the degree of master of arts, he may take the degree of bachelor in laws, and in four years more that of doctor: which same method and time are likewise required to pass the degree of doctor in physic. At Cambridge, to take the degree of doctor in divinity, it is required the candidate have been seven years bachelor of divinity: though in several colleges the bachelor's degree is dispensed with, and they may go out per saltum. To commence doctor in laws, the candidate must have been five years bachelor of laws, or seven years master of arts. To pass doctor in physic, he must have been bachelor in physic five years, or seven years master of arts.

Doctors, and bachelors of divinity and law, may have a dispensation for nonresidence. 21 Hen. VIII. cap. 13. Doctors of civil law may exercise ecclesiastical jurisdiction, although laymen. 37 H. VIII. c. 17.

DOCTOR is also an appellation adjoined to several specific epithets, expressing the merit of some of the schoolmen: thus Alexander Hales is called the irrefragable doctor; Thomas Aquinas the angelic doctor; St. Bonaventure the seraphic doctor; John Duns Scotus the subtile doctor; Raimond Lully the illuminated doctor; Roger Bacon the admirable doctor, &c.

DOCTORS'-COMMONS. See COLLEGE of CIVILIANS.

DODARTIA, a genus of the didynamia angiospermia class and order of plants, the flower of which consists of one ringent petal, with the upper lip erect and semibifid; and the lower lip patent, twice broader than long, and trifid: the fruit is a globose bilocular capsule, containing a great number of very small seeds. There are two species, herbaceous plants of the East.

DODECAGON, in geometry, a regular polygon, consisting of twelve equal sides and angles.

DODECAHEDRON, in geometry, one of the Platonic bodies, or regular solids, contained under twelve equal and regular pentagons.

Its solidity is found by multiplying the area of one of the pentagons by 12, and then this product by one-third of the distance of the face from the centre of the dodecahedron, which is the same with the centre of the circumscribing sphere.

The side of a dodecahedron, inscribed in a sphere, is the greater part of the side of a cube, inscribed in the same sphere, cut into extreme and mean proportion. If the diameter of the sphere be 1·0000, the side of the dodecahedron, inscribed in it, will be ·35682 nearly.

All dodecahedrons are similar, and are to one another as the cubes of their sides; their surfaces are also similar, and therefore they are as the squares of their sides; whence as ·509282 is to 10·51462, so is the square of the side of any dodecahedron to the superficies thereof; and as ·3637 is to 2·78516, so is the cube of the side of any dodecahedron to the solidity of it.

DODECANDRIA, the name of the 11th class in Linnæus's sexual system, consisting of plants with hermaphrodite flowers, that, according to the title, have twelve stamina. This class, however, is not limited with respect to the number of stamina. Many genera have sixteen, eighteen, and even nineteen stamina: the essential character seems to be, that, in the class in question, the stamina, however numerous, are inserted into the receptacle: whereas in the next class, icosandria, which is as little determined in point of number as the present, they are attached to the inside of the calyx, or flower-cup.

DODECAS, a genus of the trigynia order, in the dodecandria class of plants. The calyx is half-quadrifid, having the corolla above; the corolla quinquefid; the capsule unilocular, conjoined with the calyx. There is but one species, a shrub of Surinam.

DODECATHEON, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 21st order, preciæ. The corolla is verticillated and reflexed; the stamina placed in the tube; the capsule unilocular and oblong. There is one species, the D. media, a beautiful perennial plant, a native of Virginia, but sufficiently hardy to bear our climate.

DODO. See DIDUS.

DODONÆA, a genus of plants of the octandria monogynia class: it has no corolla; the fruit is a roundish trilocular capsule, with prominent inflated angles, containing solitary seeds. There are two species.

DODRANS, in antiquity, three-fourths of the as. See As, and COINS.

DOG, in zoology. See CANIS.

DOGS. The owner of a dog is bound to muzzle him if mischievous, but not otherwise; and if a man keep a dog that is known to bite cattle, &c. if after notice given to him of it, his dog shall do any hurt, the master shall answer for it.

The duty on dogs. The act 36 G. III. contains the following provisions:

1. That the duty shall not extend to dogs not six months old, the proof of which is to lie on the owner, on an appeal to the commissioners.

2. If any person shall be desirous of compounding for the number of hounds by him kept, and shall give notice thereof to the collector, and shall pay within thirty days after April 5, yearly the sum of 30*l.*, such person shall not be liable to be assessed in respect of any hounds by him kept in the preceding year: and if they are kept in two or more parishes, he shall give notice in which parish such composition is intended to be made.

By 42 Geo. III. cap. 17, any person keeping two or more dogs shall pay annually for every greyhound, pointer, setting-dog of whatsoever description or denomination, spaniel, lurcher, and terrier, and for every dog above one, whatever the same be, the sum of 10*s.*

And for any dog (not being a greyhound, hound, setting-dog, spaniel, lurcher, &c.) kept by or for use of any person inhabiting a dwelling-house assessed to any of the duties on houses, windows, or lights, where one such dog and no more shall be kept by or for the use of such person, the annual sum of 6*s.*

DOG'S-BANE. See APOCYNUM.

DOGE, formerly the chief magistrate in the republics of Venice and Genoa; but now, like many other venerable relics of antient grandeur, absorbed in the modern Gothicism and tyranny of the abominable French revolution.

DOGMATISTS, a sect of antient physicians, of which Hippocrates was the first author. They are also called logicians, from their using the rules of logic in subjects of their profession. They laid down definitions and divisions, reducing diseases to certain genera, and those genera to species, and furnishing remedies for them all; supposing principles, drawing conclusions, and applying those principles and conclusions to particular diseases under consideration: in which sense the dogmatists stand contradistinguished from empirics and methodists. They reject all medicinal virtues that they think not reducible to manifest qualities: but Galen has long ago observed of such men, that they must either deny plain matter of fact, or assign but very poor reasons and causes of many effects they pretend to explain.

DOLE, in our antient customs, signified a part or portion, most commonly, of a meadow, where several persons have shares. It also still signifies a distribution or dealing of alms, or a liberal gift made by a great man to the people.

DOLE, in the law of Scotland, is used for malevolent intention. This, which implies deceit, as well as dolum, in the civil law, whence it is taken, is an essential ingredient to constitute an action criminal. In crimes wherein the will, not the event, must be regarded, no negligence can equal dole, unless the negligence be so extremely supine as not to be conceivable without implying dole. Under this term are comprehended the vices and errors of the will, which are immediately productive of the criminal fact, though not premeditated, but the effect of sudden passion. In this respect dole differs from what the English law calls malice prepense.

DOLICHOS, a genus of the decandria order, in the diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ. The basis of the

vexillum has two callous knobs, oblong, parallel, and compressing the alæ below. There are 38 species, the most remarkable of which are: 1. The lablab, with a winding stalk, is a native of warm climates, where it is frequently cultivated for the table. Mr. Hasselquist informs us, that it is cultivated in the Egyptian gardens, but is not a native of that country. The Egyptians make pleasant arbours with it in their houses and gardens, by supporting the stem and leading it where they think proper. They not only support it with sticks and wood, but tie it with cords, by which means the leaves form an excellent covering, and afford an agreeable shade in sultry weather. 2. The soja, a native of Japan, where it is termed daidsu; and, from its excellence, mame; that is, "the legumen or pod," by way of eminence. It grows with an erect, slender, and hairy stalk, to the height of about four feet. The leaves are like those of the garden kidney-bean. The flowers are of a blueish white, and produced from the bosom of the leaves, and succeeded by bristly hanging pods resembling those of the yellow lupin, which commonly contain two, sometimes three, large white seeds. There is a variety of this kind, with a small black fruit, which was once employed in medicine. Kempfer affirms, that the seeds of this give relief in the asthma. This legumen is doubly useful in the Japanese kitchens. It serves for the preparation of a substance named miso, that is used as butter; and likewise a pickle celebrated among them, and frequent also at our own tables, under the name of sooju or soy. To make the first, they take a measure of the beans produced by the plant: after boiling them to a proper degree of softness, they beat them into a paste; incorporating with it a large quantity of common salt. They then add a certain preparation of rice named koos; and having formed the whole into a mass, remove it into a wooden vessel, and, in about two months, it is fit for use. The koos gives it a grateful taste; and the preparing of it, like the polenta of the Germans, requires some experience. To make sooju or soy, they take equal quantities of the same beans boiled, and of muggi, that is, barley or wheat roughly ground, and of common salt. Having properly mixed the beans with the pounded corn, they keep it covered in a warm place, in order to ferment; then putting the mass into a pot, they cover it with the salt, pouring over the whole two measures and a half of water. This they frequently stir for two or three months, at the end of which time, they filtrate and express the mass, and preserve the liquor in wooden vessels. The older it is, the better and the clearer; and if made of wheat, it is the blacker. 3. The pruriens, or cow-itch, is also a native of warm climates. It has a fibrous root, and an herbaceous climbing stalk, which is naked, dividing into a great number of branches; and rises to a great height when properly supported. The leaves are alternate and trilobate, rising from the stem and branches about 12 inches distant from each other. The footstalk is cylindrical, from 6 to 14 inches long. From the axilla of the leaf descends a pendulous solitary spike, from 6 to 14 inches long, covered with long blood-coloured papilionaceous flowers, rising by threes in a double alternate manner from small fleshy protuberances, each of which is a short pedunculus of three flowers. These are succeeded by leguminous, coriaceous pods, four or five inches long, crooked like an italic *f*; densely covered with sharp hairs, which penetrate the skin, and cause great itching. This will grow in any soil in those countries where it is a native: but it is generally eradicated from all cultivated grounds; because the hairs from the pods fly with the winds, and torment every animal they happen to touch. If it was not for this mischievous quality, the beauty of its flowers would entitle it to a place in the best gardens. It flowers in the cool months, from September to March, according to the situation. The spiculæ, or sharp hairs, of this plant, have been long used in South America in cases of worms; and have of late been frequently, and, as some writers have said, successfully employed in Britain for the like purpose. The spiculæ of one pod mixed with syrup or melasses, and taken in the morning fasting, is a dose for an adult. 4. The dolichos lignosus is a handsome flowering shrub, introduced into our greenhouses, and easily propagated from seed, which it perfects in this country.

DOLIOCARPUS, a genus of the polyandria monogynia class and order. The calyx is five-leaved; corolla three-petalled, plaited; stigma subtrifid; berry globular, crowned with the style, one-celled, two-seeded. There are three species, shrubs of Guiana.

DOLPHIN. See DELPHINUS.

DOMBEYA, a genus of the class and order diœcia monadelphia. The male, calyx of the ament. scales; corolla none; anthers 10 or 12, without filaments. Female, calyx ament. with many germs; corolla none; stigma bivalve, unequal; seeds many, in a roundish strobile. There is one species, a tree of Chili.

DOME. See ARCHITECTURE.

DOMESDAY, is a very antient record, made in William the Conqueror's time, and now remaining in the exchequer, fair and legible, consisting of two volumes, containing a survey of all the lands in England. It was begun by five justices, assigned for that purpose in each county, in the year 1081, and finished in 1086.

It is generally known, that the question whether lands are antient demense or not, is to be decided by the Domesday-book of William the Conqueror; whence there is no appeal. And it is a book of that authority, that even the Conqueror himself submitted in some cases, wherein he was concerned, to be determined by it.

DOMESTIC, in antiquity, was a particular officer in the court of Constantinople.

According to some this officer was one entrusted to manage affairs of importance: others say the Greek domestici were the same with the Roman comites; and that they began first to be used when count became a dignity: domestics therefore were such as served the prince in the administration of affairs, as well those of the family as the affairs of justice and the church.

DOMINANT OF A MODE, in music, is that sound which makes a fifth to the final, or tonic.

DOMINICAL LETTER, in chronology, is that letter of the alphabet which points out in the calendar the Sundays throughout the year, thence also called Sunday-letter. The distribution of days into weeks is made by the seven first letters of the alphabet A, B, C, D, E, F, G, beginning, at the first of January, to place the letter A; to the second of January B is joined; to the third C; and so on to the seventh, where G is figured; and then again beginning with A, which is placed at the eighth day, B will be at the ninth, C at the tenth, and so continually repeating the series of these seven letters, each day of the year has one of them in the calendar. By this means the last of December has the letter A joined to it, for if the 365 days, which are in the year, are divided by seven, we shall have 52 weeks, and one day over. If there had been no day over, all the years would constantly begin on the same day of the week, and each day of a month would constantly have fallen on the same day of the week; but now, since, besides the 52 weeks in the year, there is one day more, it happens, that on whatever day of the week the year begins, it ends upon the same day, and the next year begins with the following day.

The letters being ranked in this order, that letter which answers to the first Sunday of January, in a common year, will shew all the Sundays throughout the year, and to whatever days in the rest of the months, that letter is put, these days are all Sundays. If the first day of January be on a Sunday, the next year will begin on Monday, and the Sunday will fall on the seventh day, to which is annexed the letter G, which therefore will be the Sunday letter for that year: the next year beginning on Tuesday, the first Sunday will fall on the sixth of January, to which is adjoined the letter F, which is the Sunday letter for that year; and in the same manner, for the next following, the dominical letter will be E; and so on. By this means the Sunday letters will go on in a retrograde order, viz. G, F, E, D, C, B, A. But because every fourth year consists of 366 days, the series of letters will be interrupted, and the order will not return till twenty-eight years, or four times seven; and hence arises the cycle of 28 years.

Thus, if in a leap year the first of January is Sunday, and consequently the dominical letter A, the twenty-fourth day of February will fall on a Friday, and the twenty-fifth on a Saturday; and since both these days are marked in the calendar with the letter F, the following day, which is Sunday, will be marked with G, which letter will mark out all the Sundays, and consequently be the dominical letter, the remaining part of the year; and hence it is that every leap year has two dominical letters, the first of which serves from the beginning of the year to the twenty-fourth or twenty-fifth day of February, and then the other takes place and serves for the rest of the year.

The intercalary day is placed between the twenty-third and twenty-fourth days of February, and so makes two twenty-fourths of February, which in the calendar are esteemed one and the same day, and have the same letter affixed to them; but by our way of reckoning they are called the twenty-fourth and twenty-fifth days of February.

For finding the dominical letters, reject the figures or cyphers to the place of hundreds in the given year; divide the remaining figures or cyphers by 4; from this quotient subtract 1, and this number subtract from the hundred years; and then this last remainder taken from the least number of sevens possible, leaves a number which must

be added to the year and its fourth, in order to find the dominical letter. Example: what will be the dominical letter for the year 1842? This question, by the above rule, will be solved in the following manner: $18 \div 4 = 4$; from which subtracting 1, and the remainder 3 taken from 18, gives 15, which being subtracted from 21, the nearest sevens, gives 6, the number to be added. Then to the given year 1842, add its fourth part 460, and the number found 6, the sum is 2308; which being divided by 7, gives 329 for the quotient, and the remainder is 5; which taken from 7, leaves 2, the index of the letter B, the dominical letter required. By the same mode we find that E is the dominical letter for the present year, 1806.

DOMINICANS, an order of religious, called, in France, jacobins, and, in England, black friars, or preaching friars. This order, founded by St. Dominic, a native of Spain, was approved by Innocent III. in 1215, and confirmed by a bull of Honorius III. in 1216. The design of their institution was, to preach the gospel, convert heretics, defend the faith, and propagate christianity. They embraced the rule of St. Augustine, to which they added statutes and constitutions, which had formerly been observed by the Carthusians. The principal articles enjoined perpetual silence, abstinence from flesh at all times, wearing of woollen, rigorous poverty, and several other austerities. This order has spread into all the parts of the world. It has produced a great number of martyrs, confessors, bishops; and they reckon three popes, sixty cardinals, one hundred and fifty archbishops, and eight hundred bishops of their order, besides the masters of the sacred palace, who have always been dominicans. The nuns, or sisters of this order, owe their foundation to St. Dominic himself, who built a monastery at Prouilles, where poor maids might be brought up and supplied with all necessaries for their subsistence. The habit of these religious was a white robe, a tawny mantle, and a black veil. Their founder obliged them to work at certain hours of the day, and particularly to spin yarn and flax to make their own linen.

DONATIA, a genus of the trigynia order, in the triandria class of plants. The calyx is a triphyllous perianthium, with short subulated leaves standing at a distance from one another. The corolla has from eight to ten petals of an oblong linear shape, twice as long as the calyx. The stamina are three subulated filaments the length of the calyx; the antheræ roundish, didymous, and two-lobed at the base. There is one species.

DONATION, an act whereby a person transfers to another either the property or the use of something, as a free gift. In order to be valid, it supposes a capacity both in the donor and donee, and requires consent, acceptance, and delivery; and, by the French law, also registry. Civilians distinguish donation into pure and conditional. Donatio pura is when one gives a thing with an intention that it become immediately the property of the donee, never to revert to the donor; and this from no other motive than his generosity. Donatio conditionalis is when one gives a thing with an intention that it become the property of the donee, upon performing some condition stipulated.

DONATISTS, christians in Africa, who took their name from their leader Donatus. A secret hatred against Cæcilian, elected bishop of Carthage about the year 311, excited Donatus to form this sect. He accused Cæcilian of having delivered up the sacred books to the pagans, and pretended that his election was void, and all his adherents heretics. He taught that baptism administered by heretics was null, that every church but the African was become prostituted, and that he was to be the restorer of religion. Some accuse the Donatists of Arianism. Constantius and Honorius made laws for their banishment, and Theodosius and Honorius condemned them to grievous mulcts.

DONATIVE, a gratuity or present made to any person. Donative, among the Romans, was properly a gift made to the soldiers, as congiarium was that made to the people. Salmasius says, the common and legitimate rate of a donative was three pieces of gold per head; and Casaubon observes, that the legal donative was 20,000 denarii; and that it was not customary to give less, especially to the prætorian soldiers; that the centurions had double, and the tribunes, &c. more in proportion.

DONATIVE, in the canon law, is a benefice given by the patron to a priest, without presentation to the ordinary, and without institution or induction. The king may found a church or chapel, and exempt it from the jurisdiction of the ordinary. He may also, by his letters patent, grant licence to a common person to found such a church, and ordain it to be made donative. The resignation of a donative must be to the donor or patron, nor may the ordinary visit the same, but the patron by commissioners appointed by him. There can be no lapse of this benefice, though the bishop may compel such patron to nominate a clerk by ecclesiastical censures; and the clerk must be qualified as other clerks of churches are.

DONAX, a genus of insects belonging to the order of vermes testacea. It is an animal of the oyster kind; and the shell has two valves, with a very obtuse margin in the fore part. There are 10 species, principally distinguished by the figure of their shells. See Plate Nat. Hist. fig. 172.

DONJON, in fortification, signifies a strong tower, or redoubt of a fortress, whither the garrison may retreat, in case of necessity, and capitulate with greater advantage.

DONOR, in law, the person who gives lands or tenements to another in tail, &c. as he to whom such lands, &c. are given is the donee.

DORÆNA, a genus of the pentandria monogynia class and order. The cor. is five-cleft; stigma emarginate; caps. one-celled. There is one species, a dwarf tree about six feet high, a native of Japan.

DORIC ORDER, in architecture, the second of the five orders, being that between the Tuscan and Ionic. See ARCHITECTURE.

DORIC DIALECT, in grammar, one of the five dialects, or manners of speaking, which were principally in use among the Greeks. It was first used by the Lacedemonians, particularly those of Argos; afterwards it passed into Epirus, Lybia, Sicily, and the islands of Rhodes, Crete, &c. According to the Doric dialect, the vowels η, ε, ο, ω, are changed into α; the diphthong ει into α or αι; and the consonants β into γ; ζ into σδ; κ and ε into τ; τ and ρ into κ; λ with a τ or θ following it, into ν. Thus for φημη, τριχω, κλειδας, βλεφαρα, &c. they say φαμα, τραχω, κλαδος, γλεφαρα, &c. They likewise change ο into ω, as λογω for λογη; also ευς for ευς, as βατιλευς for βασιλευς: εα, αε, and αει, into η, as χρης for χρεας, ἐγελης for ἐγελαες, and γελης for γελαεις; with other transmutations of the like nature.

DORIC MODE, in music, the first of the authentic modes of the antients; its character is to be severe, tempered with gravity and joy; and is proper upon religious occasions, as also to be used in war.

DORIS, a genus of insects, belonging to the order of vermes testacea. The body is oblong, flat beneath, creeping: mouth placed below: vent behind surrounded with a fringe: two feelers, retractile. There are several species. The argo, or lemon doris, has an oval body, convex, marked with numerous punctures, of a lemon-colour, the vent beset with elegant ramifications. It inhabits different parts of our seas, and is properly called the sea-lemon. There are four species.

DORMANT, in heraldry, is used for the posture of a lion, or any other beast, lying along in a sleeping attitude, with the head on the fore paws; by which it is distinguished from the couchant, where though the beast is lying, yet he holds up his head.

DORMOUSE, in zoology. See MUS, and SCIURUS.

DORONICUM, LEOPARD'S BANE; a genus of the polygamia superflua order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is naked, the pappus simple; the scales of the calyx in a double row, longer than the disc. The seeds of the radius naked without any pappus. There are three species; of which the only one worthy of notice is the pardalianches, with obtuse heart-shaped leaves. It grows naturally in Hungary, and on the Helvetian mountains; but is frequently preserved in the English gardens. It has thick fleshy roots, which divide into many knobs or knees, sending out strong fleshy fibres which penetrate deep into the ground; from these arise in the spring a cluster of heart-shaped leaves, which are hairy, and stand upon footstalks: between these arise the flowerstalks, which are channelled and hairy, near three feet high, putting out one or two smaller stalks from the side. Each stalk is terminated by one large yellow flower. The plant multiplies very fast by its spreading roots; and the seeds, if permitted to scatter, will produce plants wherever they happen to fall; so that it very soon becomes a weed in the places where it is once established. It loves a moist soil and shady situation. The roots were formerly used in medicine, but their operation was found so violent that they are now entirely laid aside.

DORSAL MUSCLES are the muscles of the back and loins, which are for the most part common.

DORSIFEROUS PLANTS, among botanists, such as are of the capillary kind, without stalks, and which bear their seeds on the back-side of their leaves.

DORSTENIA, CONTRAYERVA; a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 53d order, scabridæ. The receptacle is common, monophyllous, and carnous; the seeds lying singly in the carnous substance. There are eight species, all of

them low herbaceous plants, growing in the warm countries of America and China. The root is used in medicine, under the name of contrayerva. It is full of knots; an inch or two in length; about half an inch thick; externally of a reddish-brown colour, and pale within; long, tough, slender fibres shoot out from all sides of it, which are generally loaded with small round knots. The root has a peculiar kind of aromatic smell, and a somewhat astringent, warm, bitterish taste, with a light and sweetish kind of acrimony when chewed. The fibres have little taste or smell; the tuberous part, therefore, should only be chosen. Contrayerva is indisputably a good and useful diaphoretic. Its virtues are extracted both by water and rectified spirit, and do not arise by evaporation with either. The plants cannot be propagated in this country without the greatest difficulty. See Plate Nat. Hist. fig. 173.

DORSUM, BACK. See ANATOMY.

DORYPHORI, in antiquity, an appellation given to the life-guard men of the Roman emperors.

DOSITHEANS, in church-history, a sect among the Hebrews, being one of the branches of the Samaritans. They abstained from eating any creature that had life, and were so superstitious in keeping the sabbath, that they remained in the same place and posture wherein that day surprised them, without stirring till the next day. They married but once, and a great number never married. Dositheus, their founder, being dissatisfied among the Jews, retired to the Samaritans, who were reputed heretics, and invented another sect; and, to make it more authentic, he went into a cave, where, by too long abstinence, he killed himself. The name of Dositheans was also given to some of the disciples of Simon Magus.

DOSSER, in military matters, a sort of basket, carried on the shoulders of men, used in carrying the overplus earth from one part of a fortification to another, where it is wanted.

DOSSIL, in surgery, lint made into a cylindric form, used in dressing a disordered part.

DOTE ASSIGNANDA, in law, a writ that formerly lay for a widow, on its being found by office, that the king's tenant was seized of lands in fee or tail at the time of his death, and that he held of the king in chief, &c. in which case the widow was to come into the court of chancery, and there make oath that she would not marry wtihout the king's leave; upon which she had this writ to the escheator, to assign her dower.

DOTE UNDE NIHIL HABET, a writ of dower which the widow may have against a person that bought land of her husband in his life-time, whereof he was seized in fee simple or fee tail, and of which she is endowable.

DOUBLE-CAST, in husbandry, a term used by the farmers for that method of sowing that does not dispense the necessary quantity of seed for a piece of land at one sowing, but requires going over every place twice. See HUSBANDRY.

DOUBLE *horizontal dial*, one with a double gnomon, one of which points out the hour on the outward circle, and the other shews the hour upon the stereographic projection drawn upon it. This dial not only finds the meridian, hour, &c. but shews the sun's place, rising and setting, declination, amplitude, altitude, and azimuth, with many other useful propositions.

DOUBLE LETTER, in grammar, a letter which has the force and effect of two. The Greeks have three of these, viz. Z, Ξ, Ψ; the Latins have two X and Z; and most of the modern languages have the same.

DOUBLE PLEA, in law, is where the defendant in a suit alleges two several matters in bar of the plaintiff's action, when one of them is sufficient. This is not admitted in common law. Thus, when a person pleads several things, the one having no dependance upon the other, such plea is accounted double, and will not be admitted; but where the things pleaded, mutually depend on each other, and the party cannot have the last plea without the first, there the whole shall be received.

DOUBLE QUARREL, is a complaint made by any clerk, or other, to the archbishop of the province against an inferior ordinary, for delaying justice in any cause ecclesiastical; as to give sentence, to institute a clerk presented, or the like: the effect whereof is, that the archbishop taking notice of such delay, directs his letters under his authentic seal, to all and singular clerks of his province, thereby commanding and authorising them, and every of them, to admonish the said ordinary, within a certain time, nine days, to do the justice required, or otherwise to cite them to appear before him the said archbishop, or his official, at a day in the said letters prefixed, and there to allege the cause of his delay. And lastly, to intimate to the said ordinary, that if he neither perform the thing enjoined, nor appear at the day assigned, he himself will, without delay, proceed to perform the justice required; and this seems to be termed a double quarrel, because it is most commonly made both against the judge and him at whose petition justice is delayed. Clark's Prax. Tit. 84, 5.

DOUBLES, nearly the same as letters patent. Stat. 14 H. VI.

DOUBLETS, a game on dice within tables: the men. which are only fifteen, being placed thus; upon the sice, cinque, and quarter points, there stand three men a-piece; and upon the trey, duce, and ace, only two. He that throws highest has the benefit of throwing first, and what he throws he lays down, and so does the other: what the one throws, and has not, the other lays down for him, but to his own account; and thus they do till all the men are down, and then they bear. He that is down first bears first, and will doubtless win the game, if the other throws not doublets to overtake him; which he is sure to do, since he advances or bears as many as the doublets make, viz. eight for two fours.

DOUBLING, in the military art, is the putting two ranks or files of soldiers into one. Thus, when the word of command is, double your ranks, the second, fourth, and sixth ranks march into the first, third, and fifth, so that the six ranks are reduced to three, and the intervals between the ranks become double what they were before. To double by half-files, is when the fourth, fifth, and sixth ranks march up to double the first, second, and third, or the contrary. To double the files to the right, is when every other file faces to the right, and marches into the next file to it, so that the six ranks are turned into twelve, and every file is twelve deep. To double the files to the left, is when every other file faces to the left, and marches into the next. In doubling the files, the distance between the files becomes double.

DOVE-TAILING, in carpentry, is the manner of fastening boards together by letting one piece into another, in the form of the tail of a dove. The dovetail is the strongest of the assemblages or jointings, because the tenon, or piece of wood which is put into the other, goes widening to the extreme, so that it cannot be drawn out again, because the extreme or tip is larger than the hole.

DOUGLASSIA, a genus of the class and order polyadelphia polyandria. The cal. is half six-cleft; cor. none; nect. six; filam. none; germ superior; stigma six-cleft; berry ovate, one-celled, seed one. There is one species, a shrub of Guiana.

DOULEIA, in Grecian antiquity, a kind of punishment among the Athenians, by which the criminal was reduced to the condition of a slave. It never was inflicted but upon the ατιμοι, sojourners, and freed servants.

DOWER, the portion which a widow has of the lands of her husband, after his decease, for the sustenance of herself, and the education of her children.

To the consummation of dower, three things are necessary, viz. marriage, seisin, and the husband's death.

There were formerly five kinds of dower in this kingdom, viz. 1. Dower by the common law. 2. Dower by custom. 3. Dower ad ostium ecclesiæ. 4. Dower ex assensu patris, and 5. Dower de la plus belle. But of all these kinds of dower, only the first two are now in use.

Dower by the common law, is a third part of such lands or tenements whereof the husband was sole seized in fee-simple, or fee-tail, during the marriage, which the wife is to enjoy during her life; for which there lies a writ of dower. See DISTRIBUTION OF INTESTATE'S EFFECTS.

Dower by custom varies according to the custom and usage of the place, and is to be governed accordingly; and where such custom prevails, the wife cannot wave the provision thereby made for her, and claim her thirds at common law, because all customs are equally antient with the common law itself. Co. Lit. 39 b.

Dower ad ostium ecclesiæ, is where a man of full age, seized of lands in fee, after marriage, endows his wife at the church-door of a moiety, a third, or other part of his lands, declaring them in certainty; in which case, after her husband's death, she may enter into such lands without any other assignment, because the solemn assignment at the church-door is equivalent to the assignment in pais by metes and bounds; but this assignment cannot be made before marriage, because *before*, she is not entitled to dower. Lit. sect. 39.

Dower ex assensu patris, is where the father is seized of land in fee; and his son and heir apparent *after* marriage endows his wife by his father's assent, ad ostium ecclesiæ, of a certain quantity of them; in which case, after the death of the son, his wife may enter into such parcel without any other assignment, though the father be living; but this assent of the father's must be by deed, because his

estate is to be charged *in futuro*, and this may likewise be of more than a third part. Co. Lit. 35, 36.

The dowers ad ostium ecclesiæ, or ex assensu patris, if the wife enter and assent to them, are a good bar of her in common law; but she may, if she will, wave them, and claim her dower at common law, because being made after marriage, she is not bound by them. Br. 97.

DOWER *de la plus belle*, is where there is a guardian in chivalry, and the wife occupies lands of the heir as guardian in soccage: if the wife bring a writ of dower against such guardian in chivalry, he may shew this matter, and pray that the wife may be endowed *de la plus belle* of the tenements in soccage, and it will be adjudged accordingly; and the reason of this endowment was to prevent the dismembering of the lands holden in chivalry, which are pro bono publico, and for the defence of the realm. Lit. sect. 48.

After judgment given, the wife may take her neighbours, and in their presence endow herself of the plus belle, or fairest part, of the tenements which she has in soccage, for her life. Lit. sect. 48.

DOWN, the fine feathers from the breasts of several birds, particularly of the duck kind. That of the eider duck (see ANAS) is the most valuable. These birds pluck it from their breasts, and line their nests with it. We are told that the quantity of down found in one nest more than filled the crown of a hat, yet weighed no more than three quarters of an ounce. Three pounds of this down may be compressed into a space scarcely larger than one's fist; yet is afterwards so dilatable as to fill a quilt five feet square. That found in the nests is most valued, and termed *live down;* it is infinitely more elastic than that plucked from the dead bird, which is little esteemed in Iceland. The best sort is sold at 45 fish per pound when cleansed, and at 16 when not cleansed. There are generally exported every year, on the company's account, 1500 or 2000 lb. of both sorts, exclusive of what is privately exported by foreigners. In 1750, the Iceland company sold as much in quantity of this article as amounted to 3745 banco dollars, besides what was sent directly to Gluckstadt.

DOWNS, a bank or elevation of sand, which the sea gathers and forms along its shores, and which serves it as a barrier.

DOWRY, in antient time, applied to that which the wife brings her husband in marriage, otherwise called maritagium, or marriage-goods; but these are termed more properly goods given in marriage, and the marriage-portion. 1 Inst. 31.

DOWRY, is used in a monastic sense for a sum of money given along with a maid, upon entering her in some religious order. In France, the dowry of persons entering a monastery, to make profession of a religious life, was limited by law. That given upon entering a monastery of Carmelites, Ursulines, and others not regularly founded, but established since the year 1600, by letters patent, did not exceed the sum of 8000 livres in towns where parliaments were held, nor 6000 in other places.

DRABA, a genus of the siliculosa order, in the tetradynamia class of plants, and in the natural method ranking under the 39th order, siliquosæ. The silicula is entire, and oval-oblong; with the valves a little plane, parallel to the partition; there is no style. There are nine species; of which the only one worthy of notice is the verna, or early whitlow-grass. It has naked stalks, with leaves a little serrated. The blossoms are white, and at night the flowers hang down. It grows on old walls and dry banks. It is one of the earliest-flowering plants we have, and is good to eat as a salad. Goats, sheep, and horses eat it; cows are not fond of it; swine refuse it.

DRABLER, in the sea language, a small sail in a ship, which is the same to a bonnet that a bonnet is to a course, and is only used when the course and bonnet are too shoal to clothe the mast.

DRABLING, in angling, is a method of catching barbels. Take a strong line of six yards, which, before you fasten to your rod, must be put through a piece of lead, that if the fish bite it may slip to and fro, and that the water may something move it on the ground. Bait with a lob-worm well secured, that by its motion the barbel may be enticed into the danger without suspicion. The best places are in running water near piles, or under wooden bridges, supported with oaks floated and slimy.

DRABS, in the salt-works, a kind of wooden boxes for holding the salt when taken out of the boiling-pan. The bottoms of them are made shelving or inclining forwards, that the briny moisture of the salt may drain off.

DRACÆNA, a genus of the monogynia order, in the hexandria class of plants. The corolla is sexpartite and erect; the filaments a little thicker about the middle; the berry trilocular and monospermous. There are 14 species, most of them having the habit of the palms, and one of them at least (the D. draco, which is a magnificent plant, or rather tree) affording a red powder, like the eastern dragon's-blood. See that article.

DRACHM, a Grecian coin, of the value of $7\frac{3}{4}d$. Drachm is also a weight used by our physicians; containing just sixty grains, three scruples, or the eighth part of an ounce.

DRACO, the dragon, in zoology, a genus belonging to the order of amphibia reptilia; the characters of which are these: it has four legs, a cylindrical tail, and two membranaceous wings, radiated like the fins of a fish, by which he is enabled to fly, but not to any great distance at a time. There are two species.

1. The volans, or flying-dragon, with the wings entirely distinct from the fore-legs. It is found in Africa and the East Indies.

2. The præpos, with the wings fixed to the fore-legs. It is a native of America. They are both harmless little creatures, and feed upon flies, ants, and small insects. See Plate Nat. Hist. fig. 174.

DRACO VOLANS, in meteorology, a fiery exhalation, frequent in marshy and cold countries. It is most common in summer; and though principally seen playing near the banks of rivers, or in boggy places, yet sometimes mounts up to a considerable height in the air, to the no small terror of the amazed beholders; its appearance being that of an oblong, sometimes roundish, fiery body, with a long tail. It is entirely harmless, frequently sticking to the hands and clothes of people without injuring them in the least.

DRACO, in astronomy, a constellation of the northern hemisphere, whose stars, according to Ptolemy, are 81; according to Tycho, 32; according to Hevelius, 40; according to Bayer, 33; and according to Mr. Flamsteed, 80. See ASTRONOMY.

DRACOCEPHALUM, dragon's-head, a genus of the gymnospermia order, in the didynamia class of plants. The throat of the corolla is inflated, the upper lip concave. There are 15 species, most of them herbaceous, annual, or perennial plants, from 18 inches to three feet high, mostly with entire leaves and whorled spikes of small monopetalous and ringent flowers, of a blue, white, or purple colour. They are all easily propagated by seeds, which may be sown either in the spring or autumn; and after the plants are come up, they will require no other culture but to be kept clear from weeds. The D. canariense is well known by the name of balm of Gilead.

DRACONARIUS, in antiquity, dragon-bearer. Several nations, as the Persians, Parthians, Scythians, &c. bore dragons on their standards; whence the standards themselves were called *dracones*, dragons. The Romans borrowed the same custom from the Parthians; or, as Casaubon has it, from the Dacæ; or, as Codin, from the Assyrians. The Roman dracones were figures of dragons painted in red on their flags, as appears from Ammianus Marcellinus: but among the Persians and Parthians they were like the Roman eagles, figures in full relievo; so that the Romans were frequently deceived, and took them for real dragons. The soldier who bore the dragon or standard, was called by the Romans *draconarius;* and by the Greeks δρακοναριος and δρακοντειοφορος; for the emperors carried the custom with them to Constantinople.

DRACONTIUM, dragons, a genus of the polyandria order, in the gynandria class of plants, and in the natural method ranking under the first order, palmæ. The spatha is cymbiform, or shaped like a boat; the spadix covered all over; there is no calyx; there are five petals; the berries polyspermous. There are five species, all natives of the Indies. The only one which makes any appearance is the pentusum, with leaves having holes, and a climbing stalk. This is a native of most of the West India islands. It has trailing stalks, which put out roots at every joint, that fasten to the trunks of trees, walls, or any support which is near them, and by that means rise to the height of 25 or 30 feet. The leaves are placed alternately upon long footstalks: they are four or five inches long, two and a half broad, and have several oblong holes in each, which at first sight appear as if eaten by insects, but they are natural to the leaves. The flowers are produced at the top of the stalk, which always swells to a much larger size in that part than in any other: these are covered with an oblong spatha or hood of a whitish-green colour, which opens longitudinally on one side, and shows the pistil, which is closely covered with flowers of a pale yellow, inclining to white. This plant is easily propagated by cuttings, which if planted in pots filled with poor sandy earth, and plunged into a hot-bed, will soon put out roots; but the plants are so tender, that they must be preserved in a stove.

DRACUNCULI, in medicine, small long worms, which breed in the muscular parts of the arms and legs, called Guinea-worms.

This distemper is very common in Guinea, and principally among the natives: Kempfer found it so also at Ormuz, upon the Persian Gulph, and likewise in Tartary. Dr. Tawne, in his Treatise on the Diseases of the West Indies, informs us, that this distemper is not so frequent any where as on the gold-coast, at Anamaboe, and Cormantyn. The worm is white, round, and uniform, very much resembling white round tape, or bobbin. It is lodged between the interstices and membranes of the muscles, where it insinuates itself, sometimes exceeding five ells in length. It occasions no great pain at the beginning; but at such times as it is ready to make its exit, the part adjoining to the extremity of the worm, where it attempts its exclusion, begins to swell, throb, and be inflamed: this generally happens about the ancle, leg, or thigh, and rarely higher.

The countries where this distemper is observed, are very hot and sultry, liable to great droughts, and the inhabitants make use of stagnating and corrupted water, in which it is very probable that the ova of these animalcula may be contained; for the white people who drink this water are obnoxious to the disease as well as the negroes.

The surgeons seldom attempt to extract this worm by making an incision; but as soon as they perceive the tumour rise to a competent bulk, they endeavour to bring it to a suppuration, with all convenient expedition; and then the head of the worm discovers itself, which they secure, by tying it to a bit of stick or cotton, that it may not draw itself up again: thus they continue to roll it round the stick, sometimes one inch, sometimes two or more, each day, taking great care not to break the worm, else it will be very difficult to recover the end of it again; and an abscess will be formed, not only at the suppurated part, but likewise through the whole winding of the muscles, where the dead putrifying worm remains, which generally occasions very obstinate ulcers. During the extraction of the worm, the patient should be plied with bitter aloetic and other anthelmintic medicines, in order to dislodge the worm the sooner from his tenement. When the worm is totally extracted, the remaining ulcer may be treated in the same manner as other common ulcers; nor does any farther inconvenience remain in the parts of which it had possession. This disease, simply considered, very rarely, if ever, proves mortal.

DRAG, in sea language, is a machine consisting of a sharp, square, iron ring, encircled with a net, and commonly used to take the wheel off from the platform or bottom of the decks.

DRAGOMAN, or DROGMAN, a term of general use through the East, for an interpreter whose office is to facilitate commerce between the orientals and occidentals. These are kept by the ambassadors of Christian nations residing at the Porte for this purpose. The word is formed from the Arabic *targeman* or *targiman*, of the verb *taragem*, he has interpreted. From *dragoman* the Italians formed *dragomano*, and, with a nearer relation to its Arabic etymology, *turcimanno*; whence the French and our *trucheman*, as well as dragoman and drogman.

DRAGON's *head and tail*, are the nodes of the planets, or the two points wherein the ecliptic is intersected by the orbits of the planets, and particularly that of the moon; making with it angles of five degrees and eighteen minutes. One of these points looks northward, the moon beginning then to have northward latitude; and the other southward, where she commences south. Thus her deviation from the ecliptic seems (according to the fancy of some) to make a figure like that of a dragon, whose belly is where she has the greatest latitude; the intersection representing the head and tail, from which resemblance the denomination arises. But it must be observed that these points abide not always in one place, but have a motion of their own in the zodiac and retrogradewise, three minutes eleven seconds per day, completing their circle in 18 years 225 days: so that the moon can be but twice in the ecliptic during her monthly period, but at all other times she will have a latitude or declination from the ecliptic. It is about these points of intersection that all eclipses happen. They are usually denoted by these characters, ☊ dragon's head, and ☋ dragon's tail.

DRAGON, in zoology. See DRACO.

DRAGON's *blood*, a gummy resinous substance so called, which is brought from the East Indies, either in oval drops wrapped up in flag leaves, or in large masses composed of smaller tears. It is said to be obtained from the palmijuncus draco, the calamus rotang, the dracena draco, the pterocarpus draco, and several other vegetables. In the present practice of medicine, it is very little if at all used, either externally or internally. A solution of dragon's-blood in spirit of wine is used for staining marble, to which it gives a red tinge, which penetrates more or less deeply according to the heat of the marble during the time of application. But as it spreads at the same time that it sinks deep, for fine designs the marble should be cold. M. du Fay says, that by adding pitch to this solution the colour may be rendered deeper.

DRAGON-FLY. See LIBELLULA.

DRAGON-SHELL, in natural history, a name given by people curious in shells to a species of concamerated patella or limpet. This has a top very much bent, and is of an ash-colour on the outside, but of an elegant and bright flesh-colour within. It has been found sticking on the back of a tortoise, as the common limpets do on the sides of rocks, and some have been found affixed to large shells of the pinna marina.

DRAGONNE'E, in heraldry: a lion dragonnée is where the upper half resembles a lion, the other half going off like the hinder part of a dragon. The same may be said of any other beast as well as a lion.

DRAGOON, in military affairs, a musqueteer mounted on horseback, who sometimes fights or marches on foot, as occasion requires. Menage derives the word dragoon from the Latin *draconarius*, which in Vegetius is used to signify soldier. But it is more probably derived from the German *targen* or *dragen*, which signifies *to carry*, as being infantry carried on horseback. Dragoons are divided into brigades as the cavalry, and each regiment into troops, each troop having a captain, lieutenant, cornet, quarter-master, two serjeants, three corporals, and two drummers: some regiments have hautboys. They are very useful on any expedition that requires dispatch; for they can keep pace with the cavalry, and do the duty of infantry. They encamp generally on the wings of the army, or at the passes leading to the camp; and sometimes they are brought to cover the general's quarters: they march in the front and rear of the army. The first regiment of dragoons raised in England was in 1681, and called the regiment of dragoons of North Britain. In battle or attacks they generally fight sword in hand after the first fire.

DRAGOONING, one of the methods used by papists for converting refractory heretics, and bringing them within the pale of the Romish church. The following method of dragooning the French protestants after the revocation of the edict of Nantes, under Louis XIV. is taken from a French work, translated in 1686. The troopers, soldiers, and dragoons, went into the protestants' houses, where they marred and defaced their household-stuff, broke their looking-glasses and other utensils and ornaments, let their wine run about their cellars, and threw about their corn and spoiled it. And as to those things which they could not destroy in this manner, such as furniture of beds, linen, wearing-apparel, plate, &c. they carried them to the market-place, and sold them to the Jesuits and other Roman-catholics. By these means the protestants in Montaubon alone were stripped of above a million of money. But this was not the worst. They turned the dining-rooms of gentlemen into stables for their horses; and treated the owners of the houses where they quartered with the highest indignity and cruelty, lashing them about from one to another, day and night, without intermission, not suffering them to eat or drink; and when they began to sink under the fatigue and pains they had undergone, they laid them on a bed; and when they thought them somewhat recovered, made them rise, and repeated the same tortures. When they saw the blood and sweat run down their faces and other parts of their bodies, they sluiced them with water; and putting over their heads kettle-drums turned upside down, they made a continual din upon them, till these unhappy creatures lost their senses. To recount all the ingenious cruelties exercised in the practice of dragooning by these religious savages, would curdle the blood of even the most insensible.

DRAGS, in the sea language, are whatever hangs over the ship in the sea, as shirts, coats, or the like; and boats when towed, or whatever else after this manner may hinder the ship's way when she sails, are called drags.

DRAINING, the art of clearing wet and boggy lands of their superfluous moisture, an art of the highest importance not only to the agriculture, but to the health of a country. It is only in modern times that the principles of this art have been well understood, and it seems yet susceptible of great improvement.

Land becomes charged with moisture from two causes: 1. from water collected in the higher grounds, and filtrating among the different beds of gravel and other porous materials, forming springs below, and flowing over the surface, or stagnating underneath it. 2. From rain or water lodging and becoming

stagnant on the surface, from the clayey or impervious nature of the soil or superior stratum. The first of these causes bogs, swamps, and morasses, and is the most difficult to be remedied.

It may be laid down as a maxim, that springs are formed in the bowels of the earth, by water percolating through the strata where they are of a porous texture, and it continues to descend till it meets with a stratum of clay that intercepts it in its course; where, being collected in large quantities, it is forced to seek a passage through the porous strata of sand, gravel, or rock, that may be above the clay, following the course of these strata till they approach the surface of the earth, or are interrupted by any obstacle which occasions the water to rise, thus forming springs, bogs, and the other phenomena of this nature; which being variously diversified in different circumstances, produce that variety of appearances in this respect that we often meet with.

This being the case, we may naturally conclude, that an abundant spring need never be expected in any country that is covered to a great depth with sand without any stratum of clay to force it upwards, as is the case in the sandy deserts of Arabia, and the immeasurable plains of Lybia: neither are we to expect abundant springs in any soil that consists of an uniform bed of clay from the surface to a great depth; for it must always be in some porous stratum that the water flows in abundance; and it can be made to flow horizontally in that, only when it is supported by a stratum of clay, or other substance that is equally impermeable by water. Hence the *rationale* of that rule so universally established in digging for wells, that if you begin with sand or gravel, &c. you need seldom hope to find water till you come to clay; and if you begin with clay, you can hope for none in abundance till you reach to sand, gravel, or rock.

It is necessary that the farmer should attend to this process of nature with care, as his success in draining bogs and every species of damp and spouting ground, will in a great measure depend upon his thorough knowledge of this, his acuteness in perceiving in every case the variations that may be occasioned by particular circumstances, and his skill in varying the plan of his operations according to these. As the variety of cases that may occur in this respect is very great, it would be a tedious task to enumerate the whole, and describe the particular method of treating each; we shall therefore content ourselves with enumerating a few particular cases to show in what manner the principles above-established may be applied to practice.

Let fig. 57, Plate Miscel. represent a perpendicular section of a part of the earth, in which AB is the surface of the ground, beneath which are several strata of porous substances that allow the water to sink through them till it reaches the line CD, that is supposed to represent the upper surface of a solid bed of clay; above which lies a stratum of rock, sand, or gravel. In this case it is plain that when the water reaches the bed of clay, and can sink no farther, it must be there accumulated into a body; and seeking for itself a passage, it flows along the surface of the clay, among the sand or gravel, from D towards C; till at last it issues forth, at the opening A, a spring of pure water.

If the quantity of water that is accumulated between D and C is not very considerable, and the stratum of clay approaches near the surface; in that case the whole of it will issue by the opening at A, and the ground will remain dry both above and below it. But if the quantity of water is so great as to raise it to a considerable height in the bed of sand or gravel, and if that stratum of sand is not discontinued before it reaches the surface of the ground, the water, in this case, would not only issue at A, but would likewise ooze out in small streams through every part of the ground between A and *a*, forming a barren patch of wet sandy or gravelly ground upon the side of a declivity, which every attentive observer must have frequently met with.

To drain a piece of ground in this situation is perhaps the most unprofitable task that a farmer can engage in, not only because it is difficult to execute, but also because the soil that is gained is but of very little value. It is lucky, however, that patches of this kind are seldom of great breadth, although they sometimes run along the side of a declivity in a horizontal direction for a great length. The only effectual method of draining this kind of ground, is to open a ditch as high up as the highest of the springs at *a*, which should be of such a depth as not only to penetrate through the whole bed of sand or gravel, but also to sink so far into the bed of clay below, as to make a canal in it sufficiently large to contain and carry off the water. Such a ditch is represented by the dotted lines *aez*: but as the expence of making a ditch of such a depth as this would suppose, and of keeping it afterwards in repair, is very great, it is but in very few cases that this mode of draining would be advisable; and never, unless where the declivity happens to be so small as that a great surface is lost for little depth, as would have been the case here if the surface had extended in the direction of the dotted line *ad*.

But supposing that the stratum of clay, after approaching towards the surface at A, continued to keep at a little depth below ground; and that the soil which lay above it was of a sandy or spongy nature, so as to allow the water to penetrate it easily; even supposing the quantity of water that flowed from D to C was but very inconsiderable, instead of rising out at the spring A, it would flow forward along the surface of the clay among the porous earth that forms the soil, so as to keep it constantly drenched with water, and of consequence render it of very little value.

Wetness arising from this cause is usually of much greater extent than the former; and as it admits of an easy cure, it ought not to be delayed; as a ditch of a very moderate depth opened at A, and carried through a part of the stratum of clay (as represented by the dotted lines A *k f*), would intercept and carry off the whole of the water, and render the field as dry as could be desired. It is, therefore, of very great consequence to the farmer accurately to distinguish between these two cases, so nearly allied to each other in appearance; and as this can be easiest done by boring, every one who has much ground of this kind ought to provide himself with a set of boring-irons, which he will likewise find use for on other occasions.

We might here enumerate a great variety of cases which might be reduced to the same head with the foregoing; but as any attentive reader may, after what has been said, be able easily to distinguish these, we shall only in general observe, that every soil of a soft and porous texture that lies upon a bed of hard clay, whatever its situation in other respects may be, will in some measure be subjected to this disease. And if it is upon a declivity of any considerable length, the undermost parts of the field will be much damaged by it, unless ditches are thrown up across the declivity at proper distances from one another, to intercept the water in its descent.

It may likewise be not improper here to observe, that in cases of this nature, unless where the soil is of a very great depth, the malady will always be increased by raising the ridges to a considerable height; as will appear evident by examining fig. 58: in which the line AB represents the surface of a field of this nature, and CD the surface of the bed of clay. Now if this field was raised into high ridges, as at FFF, so that the furrows EEE descended below the surface of the clay, it is plain that all the water that should sink through the middle of the ridge, would run along the surface of the clay till it came to the sides of the ridge LLLLLL, which would thus be kept continually soaked with water. Whereas, if the ground had been kept level, as in the part of the field from G to H, with open furrows H, at moderate distances from each other, the water would immediately sink to the clay, and be carried off by the furrows, so as to damage the soil far less than when the ridges are high. If the soil is so thin as that the plough can always touch the clay, the ridges ought to be made narrow and quite flat, as from G to H: but if there is a little greater depth of soil, then it ought to be raised into ridges of a moderate height, as from H to B, so as to allow the bottom of the furrow to reach the clay: but neither is this necessary where the soil is of any considerable depth.

Some industrious farmers having ground in this situation, have been at the very great expence of making a covered drain in each furrow. But, had they rightly understood the nature of the disease, they never would have thought of applying such a remedy, as must appear evident at first sight to those who examine the figure. The success was what might be expected from such a foolish undertaking.

These observations, it is hoped, will be sufficient as to the manner of treating wet, sandy, or porous soils. We now proceed to take notice of such as are of a stiff clayey nature, which are often very different in appearance, and require a different treatment, from these.

Suppose that the stratum of sand or gravel DC, fig. 59. should be discontinued, as at E and that the stratum above it should be of a coherent clayey nature: in this case, the water that flowed towards E, being there pent in on every side, and being accumulated there in great quantities, it must at length force a passage for itself in some way; and pressing strongly upon the upper surface, if any one part is weaker than the rest, it there would burst forth and form a spring (as sup-

pose at A). But if the texture of every part of this stratum was equally strong, the water would squeeze through many small crannies, and would ooze out in numberless places, as between A and F, so as to occasion that kind of wetness that is known by the name of a spouting clayey soil.

The cure, in this case, is much more easily effected than in any of the former; for if a ditch of a considerable size is opened, as at A, towards the lowermost side of the spouting ground, so deep as to penetrate through the upper stratum of clay, and reach to the gravel, the water will rise up through it at first with very great violence, but will gradually decrease as the pressure from the water behind is diminished; and when the whole of the water accumulated in this subterraneous reservoir is run off, there being no longer any pressure upon the clay above it, the whole soon becomes as dry as could be desired, and continues so ever afterwards, if the ditch is always kept open.

It will hardly be necessary in this place to put the farmer upon his guard to be particularly careful in his observations, that he may distinguish between the wetness which is produced from this cause, and that which proceeds from the cause before-mentioned; because the treatment that would cure the one would be of no use at all to the other. The attentive observer likewise will readily perceive, that if any field that is wet from this cause admits of being ploughed, it will be in equal danger of being hurt by being raised into high ridges with the other kind of damp ground before-mentioned. For as the depth of earth above the reservoir would be smaller in the deep furrows than any where else, there would be less resistance to the water in that place, so that it would rise there in greater abundance. And if, in this case, a farmer should dig a drain in each furrow, as a considerable quantity of water would rise into them, in some cases, the ground might be improved or even quite drained by it, especially if they should have accidentally reached the gravel in any one place, although at an expence much greater than was necessary. We take notice of this circumstance, in some measure to prevent the prejudice that some inattentive observers might entertain against what was said before of this method of draining, from their having accidentally seen some fields that may have been bettered by it.

Bogs are only a variety of this last-mentioned kind of wet ground, and therefore ought in general to be drained after the same manner with them. Clay is a substance that strongly resists the entrance of water into it; but when it is long drenched with it, it is, in process of time, in some measure dissolved by it, loses its firmness of texture and consistence, and becomes a sort of semifluid mass, which is called a bog; and as these are sometimes covered with a strong scurf of a particular kind of grass, with very matted roots, which is strong enough to bear a small weight without breaking, although it yields very much, it is in these circumstances called a shake-bog. But whatever is the nature of the bog, it is invariably occasioned by water being forced up through a bed of clay, as just now described, and dissolving or softening a part of it: we say only a part, because whatever may be the depth of the bog or swaggle, it generally has a partition of solid clay between it and the reservoir of water under it, whence it originally proceeds: for if this was not the case, and the quantity of water was considerable, it would meet with no sufficient resistance from the bog, and would issue through it with violence, and carry the whole semifluid mass along with it. But this would more inevitably be the case if there was a crust at the bottom of the bog, and if that crust should ever be broken, especially if the quantity of water under it was very considerable: and as it is probable that, in many cases of this sort, the water slowly dissolves more and more of this undercrust, we make no doubt that, in the revolution of many ages, a great many eruptions of this kind may have happened, although they may not have been deemed of importance enough to have the history of them transmitted to posterity. Of this kind, although formed of a different substance, we consider the flow of the Solway-moss in Northumberland to have been; which, upon the 16th of November 1771, burst its former boundaries, and poured forth a prodigious stream of semifluid matter, which in a short time covered several hundred acres of very fine arable ground. Nor will any one who is acquainted with the nature of moss, who knows its resemblance to clay in its quality of absorbing and retaining water, and its very easy diffusibility in it, be surprised at this; as, from all these properties, it is much better adapted for forming an extensive bog, and therefore in greater danger of producing an extensive devastation by an eruption of the water into it, than those that are formed of any kind of clay whatever.

If the bog or swampy ground is upon a declivity, the ditch ought to be carried across the field about the place where the lowest springs arise. But if the surface of the ground is level, or nearly so, as between A and B, fig. 60. and the springs break out in several places, *qqqqq*, so as to form soft quagmires interspersed through the whole of the field, it will be of little consequence in what part the drain is opened; for if it is dug up so deep as to allow the water to rise in it with freedom, it will issue through that opening, and the field will be left perfectly dry.

But as it may frequently happen that the stratum of gravel is at a considerable depth beneath the surface of the earth, and as it may be sometimes even below the level of the place into which the drain must be emptied, it might sometimes be extremely difficult to make a ditch so deep as to reach the bed of sand or gravel. But it is lucky for us that this is not absolutely necessary in the present case; as a drain of two or three feet deep, as at D, will be equally effectual with one that should go to the gravel. All that is necessary in this case is, to sink pits (P) in the course of the drain, at a moderate distance from one another, which go so deep as to reach the gravel; for as the water there meets with no resistance, it readily flows out at these openings, and is carried off by the drain without being forced up through the earth, so that the ground is left entirely dry ever after.

Let it be carefully noted, that if you attempt to make your pit in one of these soft quaggy places where the water is found in great abundance, you will meet with very great difficulty in forming it; for as the substance of which it is composed is soft, it will always flow into the hole as fast as you dig it; on which account we should advise not to attempt to make the pit in the swaggle or shake-bog, but as near it in the solid earth as you conveniently can. However, if it is pretty firm, and of no great extent, it is sometimes practicable to make a pit in the soft bog at the driest time of the year. This soft quaggy ground has seldom been found above three or four feet deep, below which there is always found a stratum of hard tough clay, usually mixed with stones, and so firm that nothing but a mattock or pick-axe could penetrate it; and as this is comparatively so much drier than the ground above it, an inexperienced operator is very apt to imagine that this is the bottom that he is in search of. In digging through this stratum, you will frequently meet with small springs oozing out in all directions; some of them that might fill the tube of a small quill, and others so small as to be scarcely perceptible: but without regarding these, you must continue to dig on without intermission till you come to the main body of the reservoir, if we may so call it, that is contained in the rock, gravel, or sand, which you will generally find from two to four feet below the bottom of the swaggle, and which you will be in no danger of mistaking when you come to it; for if there has been no opening made before that in the field, as soon as you break the crust immediately above the gravel or rock, the water bursts forth like a torrent, and on some occasions rises like a jet-d'eau to a considerable height above the bottom of the ditch, and continues to flow off with great impetuosity for some time, till the pent-up water being drained off, the violent boiling up begins to subside, and the strength of the current to abate; and in a short time it flows gently out like an ordinary spring: allowing it to remain in this state, the quaggy earth begins to subside, and gradually becomes firmer and firmer every day; so that, in the space of a few months, those bogs which were formerly so soft as hardly to support the weight of a small dog, become so firm, that oxen and horses may tread upon them without any danger of sinking, at the very wettest season of the year. We have known a field of this nature that, by having only one such pit as has now been described opened in it, was entirely drained to the distance of above a hundred yards around it in every direction. But as it is possible that the stratum in which the water runs may be in some places interrupted, it will be in general expedient to make several of these pits, if the field is of great extent, always carrying the drain forward through the lowermost part of the field, or as near the quag as you conveniently can, and sinking a pit wherever you may judge it will be most necessary. But if the stratum of gravel is not interrupted, there will be no violent burst of water at opening any of these after the first. To keep these wells from closing up after they are made, it is always expedient to fill them up with small stones immediately after they are made, which ought to rise to the height of the bottom of the drain.

If the whole field that is to be drained consists of one extensive bog, it will require a long time before the whole work can be entirely finished, as it will be impossible to

Halley's Diving Bell.

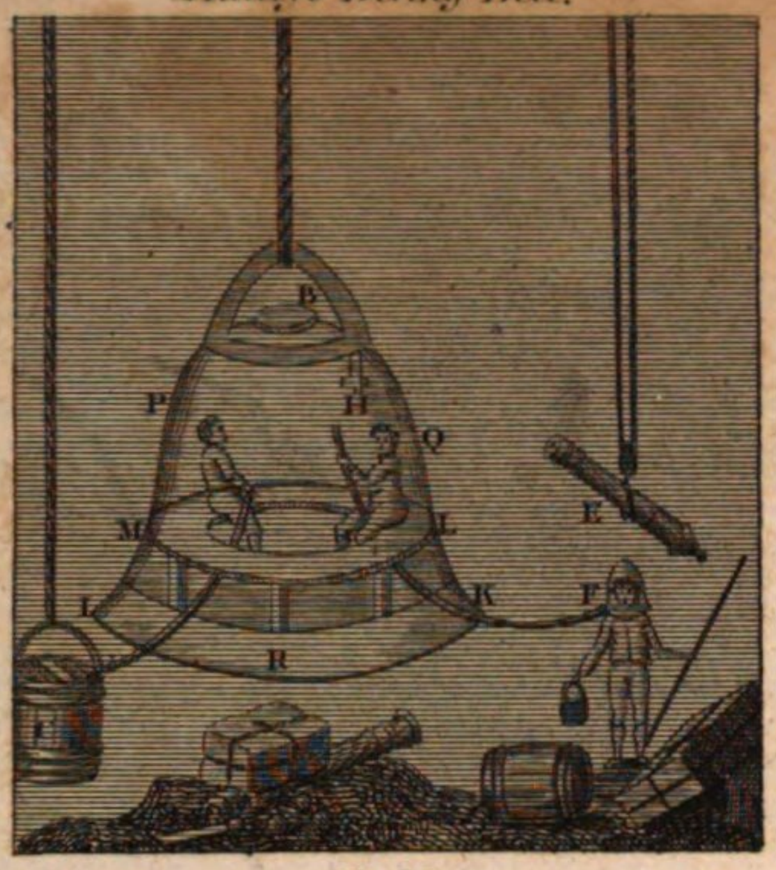
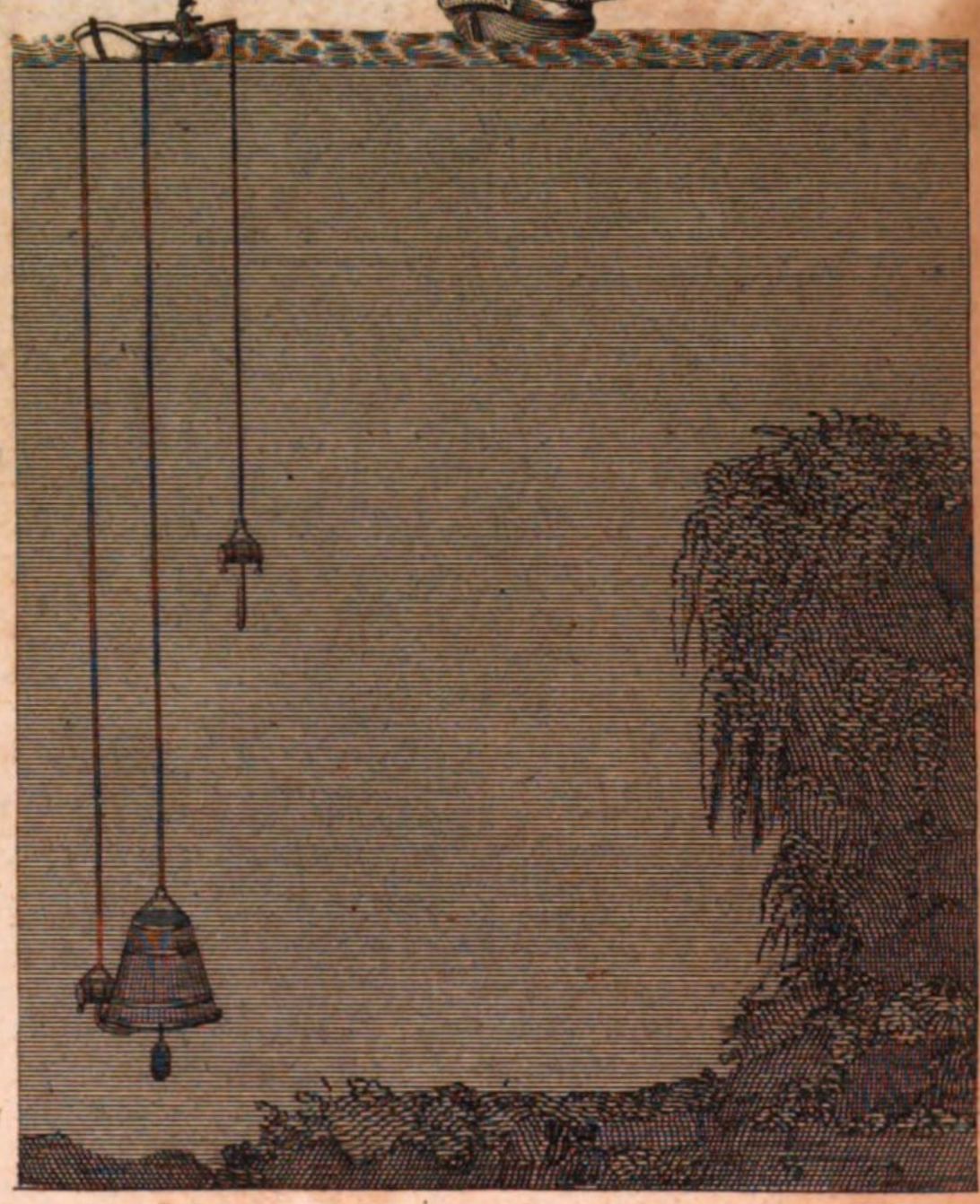


Fig. 50.

Tricwald's.

Fig. 51.

Fig. 53.



Walker's Diving Bell.

Fig. 54.

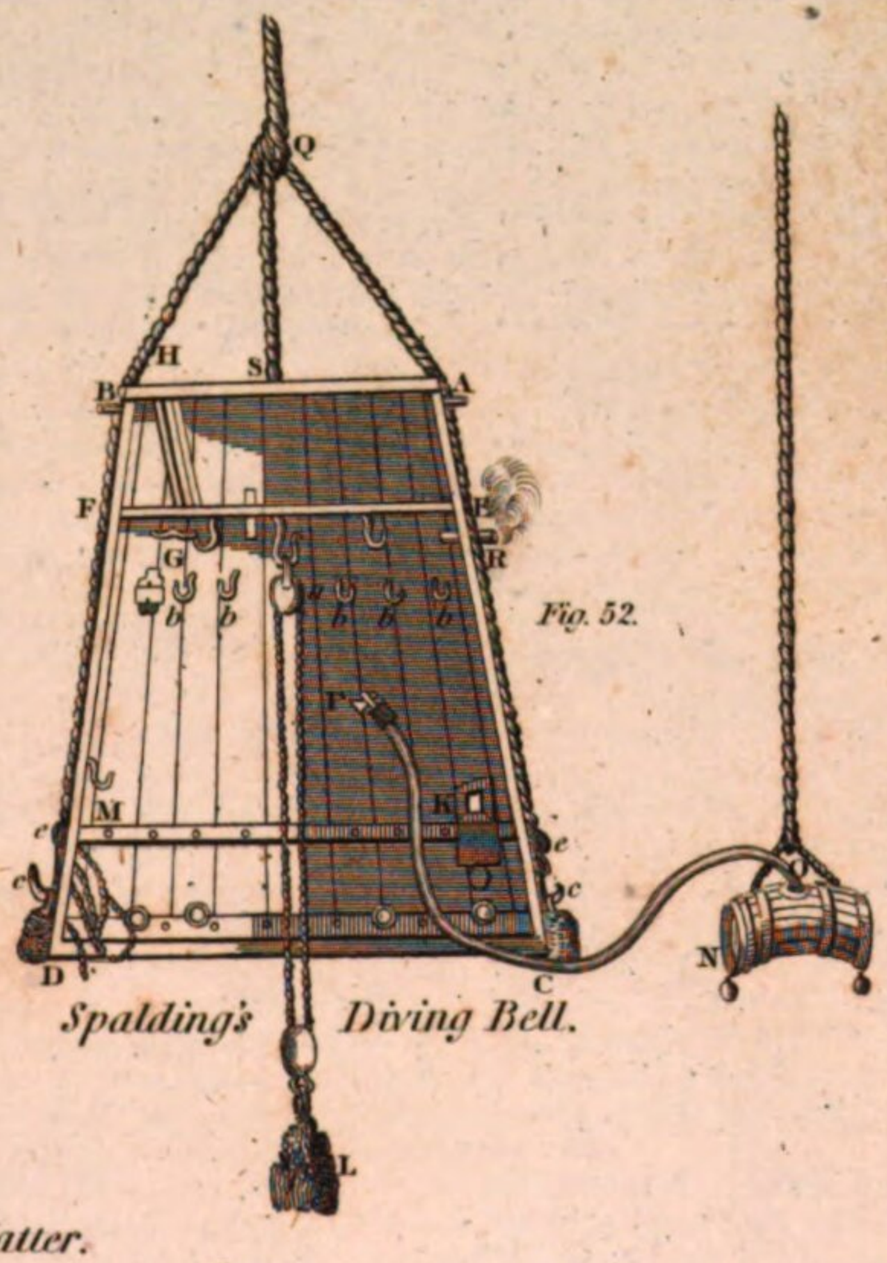


Fig. 52.

Spalding's Diving Bell.

Divisibility of Matter.

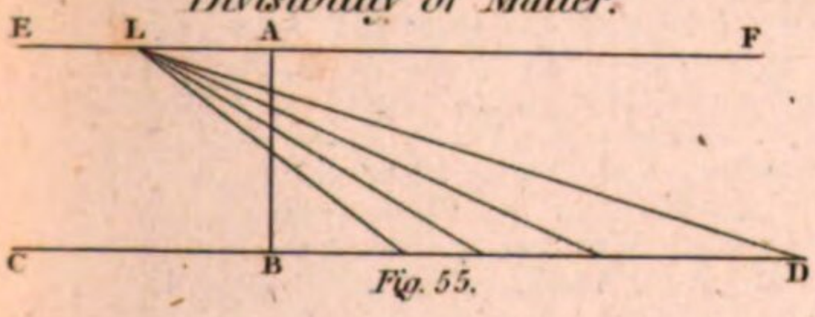


Fig. 55.

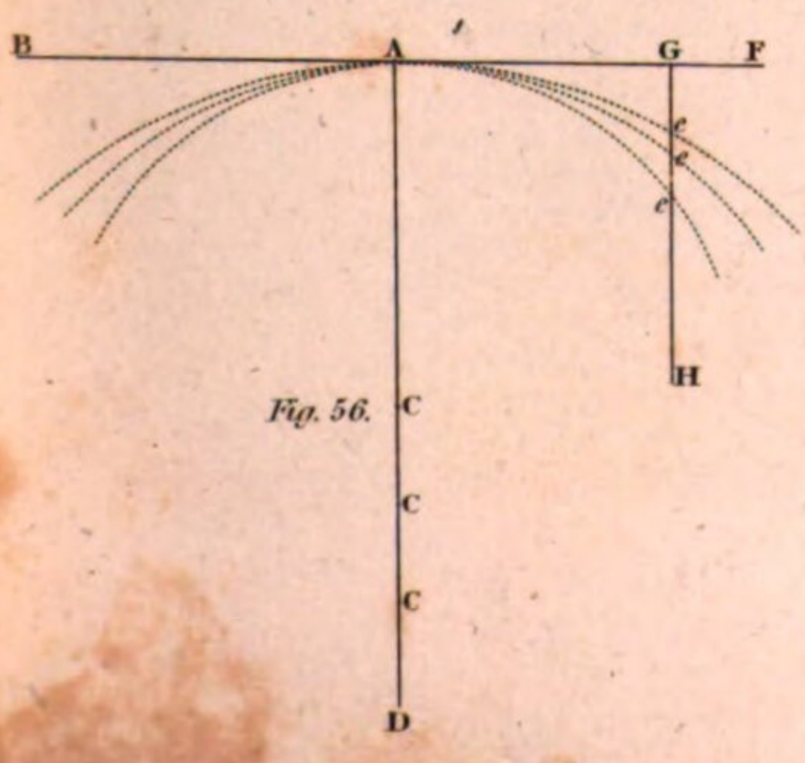
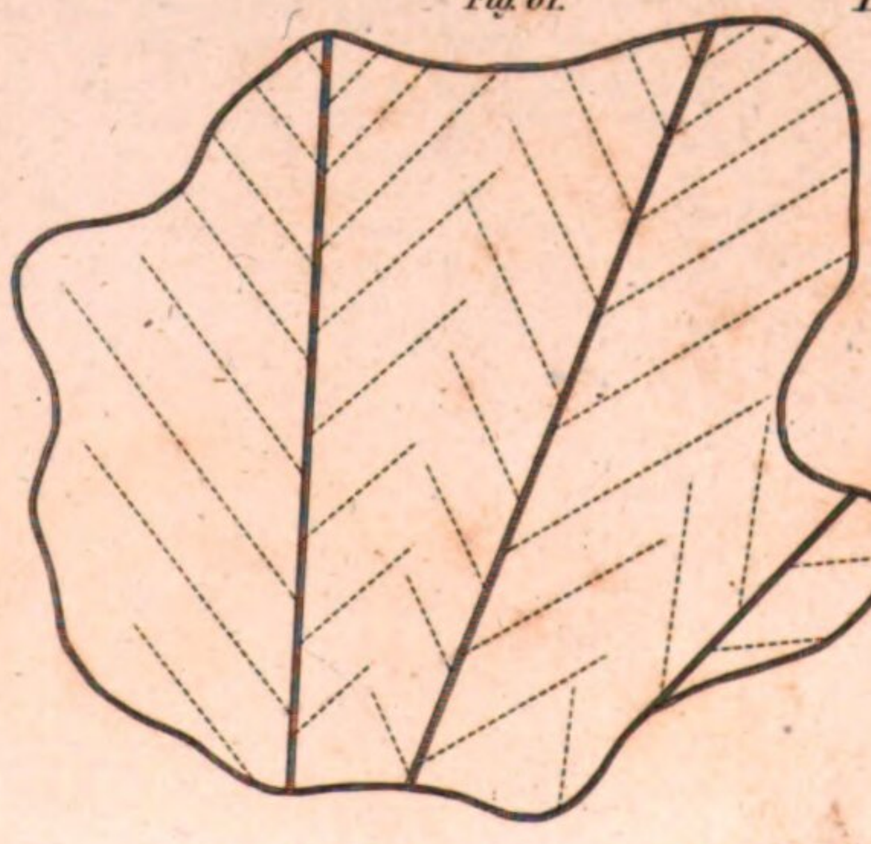


Fig. 56.

Fig. 61.



Drains.

Fig. 57.

Fig. 60.

Fig. 59.

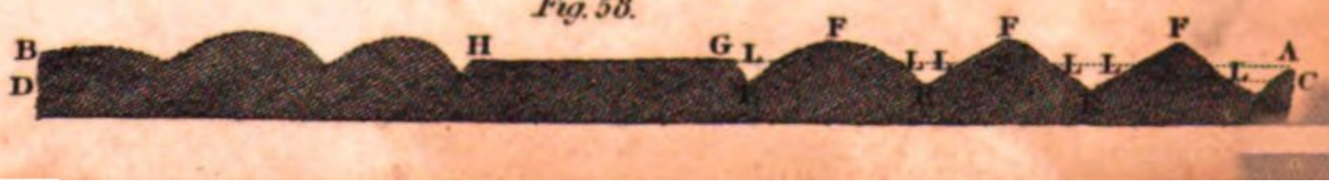


Fig. 58.

open a drain through it till one part of it is first drained, and becomes solid ground. In a situation of this kind, the undertaker, after having opened a drain to convey the water from the lowest part of the bog, must approach as near to the swampy ground as he can, and there make his first pit, which will drain off the water from the nearest parts of the bog. When this has continued open for some time, and that part of the bog is become so solid as to admit of being worked, let him continue the ditch as far forward through it as the situation it is in will admit of, and there sink another pit, and proceed gradually forward in the same manner, making cross-cuts where necessary, till the whole is finished.

In this manner may any bog or track of spouting ground of this nature be rendered dry at a very inconsiderable expence; and as there can be no other method of draining ground of this sort effectually, we recommend the study of it to the attention of every diligent farmer who may have occasion for it. Let him first be extremely cautious in examining all the circumstances of his particular fields, that he may be certain which of the classes above enumerated it may be ranked with; and when he is perfectly sure of that, he may proceed without fear, being morally certain of success.

There is, however, one kind of damp ground not yet particularly specified. The soil we have now particularly in view consists of a deep strong clay that does not vary its nature even on the surface, but in as far as manures may have rendered it more friable and tender; the colour usually inclines to a reddish cast, and for the most part it is situated upon the side of some declivity. This bed of clay reaches to a great depth, without any variation, and is intermixed with a considerable quantity of small round stones. Many soils of the sort now described are apt to be continually moist and full of water during the winter season; but when the dry weather of summer sets in, the moisture is diminished, and the surface becomes hard, and it is rent into many large gaps which allow free admission to the sun and air, so as to scorch up almost every plant that is sown upon it: and as these soils are usually in themselves naturally fertile when drained, it is to be wished that some method could be discovered that would be less expensive than what is usually practised with regard to soils of this kind in Essex; where they make covered drains of two and a half feet deep, running diagonally through the whole field, at the distance of 20 feet from each other.

With regard to the making of these drains we have the following directions by T. B. Bayley, esq. of Hope, near Manchester: First make the main drains down the slope or fall of the field. When the land is very wet, or has not much fall, there should, in general, be two of these to a statute acre; for the shorter the narrow drains are, the less liable they will be to accidents. The width of the trench for the main drains should be 30 inches at top; but the width at the bottom must be regulated by the nature and size of the materials intended to be used. If the drain is to be made of bricks ten inches long, three inches thick, and four inches in breadth, then the bottom of the drain must be twelve inches; but if the common sale bricks are used, then the bottom must be proportionably contracted. In both cases there must be an interstice of one inch between the bottom brick and the sides of the trench, and the vacuity must be filled up with straw, rushes, or loose mould. For the purpose of making these drains, the bricks should be moulded ten inches long, four broad, and three thick, which dimensions always make the best drain.

The method to be pursued in constructing the main drains is as follows: When the ground is soft and spongy, the bottom of the drain is laid with bricks placed across. On these, on each side, two bricks are laid flat, one upon the other, forming a drain six inches high and four broad, which is covered with bricks laid flat. When the bottom of the trench is found to be a firm and solid body, as clay or marle, the bottom of the drain does not then require being laid with bricks. In that case the sides are formed by placing one brick edgeways instead of two laid flat.

This latter method is much cheaper, and in such land equally durable with the other. When stones are used instead of bricks, the bottom of the drain should be about eight inches in width. And here it will be proper to remark, that in all cases the bottom of the main drains must be sunk four inches below the level of the narrow ones, even at the point where the latter fall into them.

The main drains should be kept open till the narrow ones are begun from them, after which they may be finished; but before the earth is returned upon the stones or bricks, it will be advisable to throw in straw, rushes, or brushwood, to increase the freedom of the drain.

The small narrow drains should be cut at the distance of 16 or 18 feet from each other, and should fall into the main drain at very acute angles, to prevent any stoppage. At the point where they fall in, and eight or ten inches above it, they should be made firm with brick or stone. These drains should be 18 inches wide at top, and 16 at bottom. Fig. 61. represents a field with drains laid out according to Mr. Bayley's method. The black lines represent the main drains, and the dotted lines represent the narrow drains communicating with the former from all parts of the field.

The celebrated Mr. Elkington's method differs very little from that which we have now laid down, except that in draining lands of the first description pointed out in this article, viz. those which are rendered wet by waters confined under the surface, and attempting to rise in the manner of springs, he employs that very useful instrument, a draining auger, which he observes need not be above two inches in diameter. He was led to this discovery by attempting to drain a piece of ground of this kind on his farm at Princethorp, by making a trench of five feet deep, but without success: he thought it might be of use to know what kind of strata lay under the trench. Accordingly he forced an iron crow, of about one inch and a half in diameter, three feet down; and upon taking it out, was agreeably surprised to find a great quantity of water burst forth, and run down the trench. This led him to think of applying an auger, an instrument fitter for the purpose of boring, which upon trial he found equalled his expectations; and by continuing the same plan with the auger he at last drained all the wet parts of his farm, which were numerous, and had proved destructive to his sheep, by inducing the rot. When a morass is to be drained, his first object is to ascertain the direction in which the trench is to be dug. The principal of his rules for this, as laid before the Board of Agriculture, are these: 1. To obtain as much knowledge as possible respecting the strata in the neighbourhood. 2. To direct the trench so as to hit the bottom of the bed, which occasions the mischief, and the particular spot where the main-spring lies. 3. If there are various beds through which the water issues, to prefer the stone one for draining the whole; and to make the trench from six to eight yards from the tail of the bed, where the rock ends, because in limestone and other rocks, the *tail*, as it is technically termed, is harder than any other part of the rock; but a few yards above it, it is softer, and the water is more accessible. The tail of these beds may often be found jutting out in a point. 4. To direct the trench in a line with the bottom of the hill; as it makes the best separation between the upland and meadow inclosures, where the spring can be best intercepted. The trench, however, must be carried in or near the line of the spring; for if it diverges to any distance, all chance of reaching the spring by tapping is over, and the labour of digging it probably lost. 5. To make a new trench rather than to tap the spring in any old brook or run of water. 6. and lastly, Having fixed on the line of direction, and marked out the trench, to begin at the bottom or lowest level, carrying the trench gradually up. The fall of the water need not be above a few inches in one hundred yards.

With respect to the main drain or trench, if it can be made a fence, Mr. Elkington prefers leaving it open; if not, he advises it to be covered. He then makes it either of brick or flat stones, and adds, that a trench made of a particular kind of bricks, invented by him, will last for 50 or 100 years.

DRAMA, a poem containing some certain action, and representing a true picture of human life, for the delight and improvement of mankind.

The principal species of the drama are two, comedy and tragedy. Some others there are of less note, as pastoral, satire, tragi-comedy, opera, &c. See POETRY.

DRANK, among farmers, a term used to denote wild oats, which never fail to infest worn-out lands; so that when plowed lands run to these weeds and thistles, the farmer knows it is high time to fallow them, or else to sow them with hay-seed, and make pasture of them. Some indeed destroy the drank, by sowing the lands with beans, and letting loose sheep upon them when young. This must be done in dry weather, and the sheep will eat up the drank and other weeds, without touching the beans.

DRAPERY, in sculpture and painting, signifies the representation of the clothing of human figures, and also hangings, tapestry, curtains, and most other things that are not figures or landscapes. See DRAWING, and PAINTING.

DRASTIC, in physic, an epithet bestowed on such medicines as are of present efficacy, potent in their operation, and is commonly applied to cathartics.

DRAUGHT, or DRAFT. See ARCHITECTURE.

DRAUGHT-HOOKS, are large hooks of iron, fixed on the cheeks of a cannon-carriage, two on each side, one near the trunnion-hole, and the other at the train, distinguished by the name of fore and hind draught-hooks. Large guns have draught-hooks near the middle transum, to which are fixed the chains that serve to keep the shafts of the limbers on a march. The fore and hind hooks are used for drawing a gun backwards or forwards, by men with strong ropes, called draught-ropes, fixed to these hooks.

DRAW, in the sea-language. A ship is said to draw so much water, according to the number of feet she sinks into it; so that if a ship sinks into the water 18 feet perpendicularly, she is said to draw 18 feet water; and according as she draws more or less, she is said to be of more or less draught.

DRAWBACK, in commerce, certain duties, either of the customs or of the excise, allowed upon the exportation of some of our own manufactures; or upon certain foreign merchandize that has paid duty on importation. The oaths of the merchants importing and exporting are required to obtain the drawback of foreign goods, affirming the truth of the officer's certificate of the entry, and the due payment of the duties; and these may be made by the agent of any corporation or company, or by the known servant of any merchant usually employed in making his entries and paying his customs. In regard to foreign goods entered outwards, if less quantity or value is fraudulently shipped out than is expressed in the exporter's certificate, the goods mentioned in it, or their value, are forfeited, and no drawback allowed. Foreign goods exported by certificate, in order to obtain the drawback, if they are not shipped or exported, or if they are relanded in Great Britain, unless in case of distress, to save them from perishing, are to lose the benefit of the drawback, and are forfeited, all their value, with the vessels, horses, carriages, &c. employed in the relanding them; and the persons employed in the relanding, or by whose privity they are relanded, or into whose hands they shall knowingly come, are to forfeit double the amount of the drawback. Officers of the customs conniving at, or assisting in, any fraud relating to certificate goods, besides other penalties, are to forfeit their office, and to suffer six months imprisonment, without bail or mainprize; as are also masters, or persons belonging to the ships employed therein. Bonds given for the exportation of certificate goods to Ireland, must not be delivered up, nor drawback allowed for any goods, till a certificate under the hands and seals of the collector or comptroller, &c. of the customs is produced, testifying the landing.

DRAWBRIDGE, a bridge made after the manner of a floor, to draw up, or let down, as occasion serves, before the gate of a town or castle. See BRIDGE.

A drawbridge may be made after several different modes, but the most common are made with plyers, twice the length of the gate, and a foot in diameter. The inner square is traversed with a cross, which serves for a counterpoise; and the chains which hang from the extremities of the plyers, to lift up or let down the bridge, are of iron or brass. In navigable rivers it is sometimes necessary to make the middle arch of bridges with two moveable platforms, to be raised occasionally, in order to let the masts and rigging of vessels pass through.

DRAWING, in painting, is the accurate representation and just symmetry of forms and proportions; whence a painter or sculptor is said to know much or little of drawing, according to his skill in these respects; and in like manner a figure of a man or other animal, a building, or any other object represented, is said to be in drawing or out of drawing. Drawing may justly be considered as the basis of painting; for it is but labour lost, when the painter endeavours to disguise by ingenious artifices of colour, the defects of forms which are fundamentally incorrect and incoherent.

Amongst the artists of antiquity, Apelles is recorded as the most eminent for the beauty of his drawing. Since the revival of the arts in Italy, Michael Angelo appears the most learned draughtsman, Raffaelle the most correct and graceful. The Roman and Florentine schools have excelled all others in this fundamental part of painting. Of the former, Raffaelle, Giulio Romano, Polydore, and their scholars; of the latter, M. Angelo, Leonardo da Vinci, and Andrea del Sarto, have been the most excellent. In the Bolognese school Annibal Caracci is particularly distinguished. In the French school Poussin, Le Sueur, and Le Brun; in our own, Mortimer and Barry have been the most celebrated.

DRAWING: a representation of objects on paper, by means of chalk, lead, charcoal, crayon, or common ink, or of Indian ink, or water-colours. When the latter method is used, it is called a washed or coloured drawing. This mode has of late years been improved in a singular degree, and it is at present practised with unprecedented excellence in England and other countries.

The drawings of great masters are frequently nothing more than such studies as they have made of various parts of their works, diligently designed after nature; as, in an historical subject, heads, hands, feet, or entire figures, draperies, animals, trees, and, in short, every object that can enter into the composition of the work.

DRAWING, *art of*. The art of delineating objects on the surface of any substance whatever. The fundamental part of this art is a knowledge of geometry and perspective: the study of both is therefore the first step towards the attainment of the art of drawing. See GEOMETRY and PERSPECTIVE.

The study of this art has at all times been held in high estimation by all polished nations, not only on account of the delightful amusement it is capable of affording, but from the superior consideration of its influence on the intellect and judgment, by forming the eye, and with it the mind, to habitual discriminations of dimension, regularity, proportion, and order. There is on record, a saying of Thomas earl of Arundel, lord-marshal of England, "that one who could not draw a little would never make an honest man."

The organ of sight is one of the quickest we possess, and takes in at a single glance an infinite variety of forms, but it cannot perfectly comprehend more than one object at a time, nor even that one accurately, without study and repeated observation. In order, therefore, to acquire a true notion of forms, the student must begin by studying successively each component part, and not pass to a second till he has well stored his memory by a sufficient practice of the first, otherwise he will lose his time, and infallibly protract his studies. Let him be careful also to acquire accuracy before he attempts quickness.

The surest mode therefore for the attainment of excellence in drawing, is to begin with such plain geometrical figures, as squares, arches, circles, ovals, cones, and cylinders, which will be useful in numerous forms of similar proportions; and having acquired sufficient facility and readiness in these figures, then to give to every object its due light and shade, according to its concavity or convexity, so as to convey the perfect idea of the elevation or depression, nearness or distance, of every part.

From this, the next step is the imitation of the forms of fruits, with their leaves; of flowers, herbs, trees of various kinds, &c. giving also to each its proper light and shade.

The third step is the representation, in the same manner, of beasts, birds, fishes, &c. &c.

From this the student may safely proceed to the imitation of the human figure, beginning, as before remarked, with its various parts, as the eye, mouth, hand, foot, &c. &c.; and thence the head, arm, leg, trunk; and lastly, the whole figure, carefully observing all its due proportions. When he is sufficiently master of the naked form, let him proceed to the study of drapery, learning how to clothe a figure, so as to give it every advantage of ornament, without interruption of its air and motion, grace or symmetry.

To these acquisitions are to be added is study of architecture, landscape, and all inanimate objects, or still life. See ARCHITECTURE, LANDSCAPE, and STILL LIFE.

The implements and materials most requisite for the young draughtsman are:

Drawing-boards for fixing the paper upon, so that it may not shift, and also for straining it, to prevent the colours, when laid wet upon the paper, from causing it to swell up, so as to be uneven. The simplest sort is made of a deal-board, framed square, with a strong piece across each end, to prevent warping. Upon this the paper may be fixed down with pins, wafers, or sealing-wax, or it may be strained with paste or glue as follows: having wetted the paper well with a sponge, lay it upon the board, and turning up the edges about half an inch, run a little good paste or glue all round on the under side, and press the paper down upon the board with a cloth, then set it by to dry; the paper, which had expanded and blistered up much when wet, will contract in drying, while the edges, being fixed immoveably, will strain quite flat and tight, and will be much better for drawing upon than when loose.

The best kind of drawing-boards, however, are made with a frame and a moveable pannel, upon which the paper is simply put wet, and then forced into the frame, where it is confined by wedges at the back. This strains equally well, without the trouble of pasting, so that you may dry it at the fire; and it also looks much neater. These drawing-boards may be bought at most colour-shops. It is necessary to mention, that all the angles of drawing-boards should be exactly square.

Parallel rulers are for drawing parallel lines very readily; they are made of two pieces of ebony fastened together by brass bars, so as always to move parallel to each other. They may be bought of different kinds and prices, at the mathematical instrument-makers'. See INSTRUMENT, MATHEMATICAL.

T-squares are rulers made in the form of the letter T, which are used with the drawing-boards; the short end, called the stock, being applied to the edge of the board, so as to slide forwards and backwards, while the long part, called the blade, is used for drawing lines by. These are more convenient than parallel rulers, when a drawing-board is used, as by them you draw lines at right angles to each other at once, without using the compasses.

Dividing-compasses are instruments of brass and steel, for dividing lines, and laying down measures from scales, &c. They are generally sold in cases, containing also a steel pen, for drawing lines cleaner than can be done by a common pen, which is very useful where neatness is required; and points with a black-lead pencil, for putting into the compasses, when circles are to be described. These cases also contain scales of equal parts, such as are described under GEOMETRY, and protractors for laying down angles. All these may be had at the instrument-makers'.

Black-lead pencils are made of a mineral substance called plumbago, or black-lead, which is a carburet of iron, sawed into slips, and fitted into sticks of cedar. They are of various qualities: the best are fine, without any grit, not too soft, and that cut easily without breaking. An inferior kind is made, by mixing up the dust of black-lead with gum or glue, and forming a composition, which is fitted into sticks in the same manner as the best: these are always gritty, and do not answer so well for most drawings, yet, being cheaper, they may be used upon many occasions. It is necessary to examine pencils before any quantity is bought, by cutting one of them, because the composition-pencils, having the same outward appearance, are often sold for the best.

Indian rubber, or elastic gum, as it is also called, is a substance very much like leather, which has the curious and useful property of erasing or defacing lines drawn with black-lead; it is therefore much used for this purpose. It is brought chiefly from South America, in the form of small bottles, which are cut up into slips. It is originally the juice of a tree that grows very abundantly in Surinam, and is like milk when exuded from the tree, but soon becomes solid when exposed to the air. The natives form balls of clay, which they smear over with this milk; when this coating is almost dry, they apply another, and so on, till it is of the required thickness; they then moisten the clay with water, which does not dissolve the Indian rubber, and wash it out. These bottles are used by the natives for containing water, or other liquors. It is a production common to the East Indies also, whence it is imported in various forms, more convenient for use than the bottles above-mentioned. See CAOUTCHOUC.

Indian ink. This very useful substance comes from China, where it is used for common writing, which is there performed with a brush instead of a pen. It is a solid substance, of a brownish-black colour; and the composition is not known, but is conjectured to be the gall of a species of cuttle-fish. When ground up with water upon a clean tile or earthenware plate, it may be made either lighter or darker, as required, by adding to it more or less water. The best Indian ink is always stamped with Chinese characters, breaks with a glossy fracture, and feels smooth, and not gritty, when rubbed against the teeth. An inferior kind is made in this country, but it may be easily known by its grittiness. This is made of lamp-black or ivory-black, ground up with gum.

Hair-pencils are made of camel's hair, put into a goose or swan's quill. To choose these, moisten them a little, and if they come to a point without splitting, they are good; if they do not, they are not fit for drawing with. The brushes used by the Chinese, made of a white hair fitted up in reeds, are very excellent for drawing, being much superior for landscapes and many other purposes, to ours made of camel's hair, as they are more elastic. They are not sold here in common, but they may sometimes be met with.

Charcoal is used for slightly sketching the outlines of figures, in order to get the proportions, previous to making a drawing in chalk. The best charcoal for this purpose is that of the willow; it is cut into slips, and the strokes made with it may easily be rubbed out with a feather of goose's or duck's wing.

Black-chalk is a fossil substance, resembling slaty coal, which is cut into slips for drawing. It is generally used in an instrument called a port-crayon, which is made either of steel or brass. It is much employed for drawing figures, and is the best substance for this purpose, in making drawings from plaister, or after the life. It is more gritty than black lead, but is of a deeper black, and has not the glossiness of the former. It is of two kinds, French and Italian: the former is soft, the latter hard.

For mellowing and softening the shadows into each other, when black chalk is used, stumps are necessary. They are pieces of soft shamoy leather, or blue paper, rolled up quite tight, and cut to a point.

White chalk is used, together with black, for laying on the lights. This is different from common chalk, being much harder. Tobacco-pipe clay will do very well instead of it.

Red chalk is a fossil substance of a red ochrey colour, which is sometimes used for drawing, but not so much now as it formerly was, the black being preferred; however, the red being cheaper, will do very well for some purposes.

Drawing-paper. Any paper that will do for writing will do for drawing; but as the wire-marks in common writing-paper are injurious, paper made without any wire-marks, called wove-paper, is generally used for this purpose. It is made of various sizes and thickness.

Middle-tint paper, is paper of a brownish or of a grey colour, which is used for drawing upon with black and white chalk. Being of a dark colour, the strokes of the white chalk are distinctly seen; and it saves a great deal of time in making drawings, as the tint of the paper answers for the half-shadow, so that all that is necessary to be done is to lay in the dark shadows and the lights.

To proceed to directions for the practice of these rules, and the use of the materials which have been mentioned.

Mechanical Drawing.—In giving instructions for the study of drawing, attention must be paid to the particular branch of this art, to which the student wishes most to apply himself. If circumstances lead him to the study of architecture, machinery, or the delineation of objects perfectly regular; and if he wishes to draw plans, elevations, sections, &c. then geometry will form the entire foundation of all his future acquirements. The study of perspective necessarily follows, and with these two sciences he must be intimately acquainted. To these he must add a knowledge of the doctrines of the reflection of rays of light; since not only the outlines of regular objects may be drawn correctly and truly, by the rules of geometry and perspective, but even the forms and intensity of the various parts of the shadows of such objects may be found by certain and invariable rules, founded upon the principles of the reflection of the rays of light; and geometrical drawings should always be shadowed according to these rules. The materials and instruments necessary in this sort of drawing have been already described.

Pencils of black-lead are used for drawing the outlines, previous to their being drawn with ink, as it has the advantage of being easily rubbed out by the Indian rubber, when false lines are made. The Indian ink is rubbed down upon a plate or tile, and may be put into the drawing-pen belonging to the case of instruments, with a pen or hair-pencil. This ink is better to draw the lines with than common ink, the latter being liable to run, or spread, when the drawing is shadowed.

Having completed the outlines, Indian-ink is used for shadowing, as it may be diluted with water, so as to be of any required darkness, and may be softened off, where the objects require it, with water only and a hair-pencil. This branch of drawing we consider as a useful rather than an ornamental art. It should be learned by every person, as answering the same purposes with writing, but in a much more perfect manner, in those cases to which it is applicable. This is particularly striking in descriptions of apparatus, and machinery of every kind. Every one must be sensible how imperfect are all written descriptions of those objects; whereas a drawing conveys, at a single glance, more satisfactory information than it is possible to give by words. In the first rudiments of drawing, that is, in drawing geometrical figures and others of similar forms, genius and taste therefore have nothing to do: this degree of art is merely of a mechanical nature, which, like writing, may be acquired by every person possessed of moderate talents.

Drawing of flowers, fruits, herbs, trees, &c.—This first advance in art is so easy as to require little else than strict attention to imitate the objects placed before the eye, observing well those particularities which give the peculiar character of each, and mark the distinctness of the several species. In trees especially, care is to be taken that the oak, ash, elm, &c. &c. may each have its proper and distinct trunk, boughs, and foliage, in such a manner, that it shall be no more possible to

mistake one kind of tree for another in the drawing than it is in nature. Nothing is more prejudicial to the student's progress than a habit of indiscriminate forms, which, although they denote a tree in general, do not decide its species.

In all these the process is the same as in the first rudiments, making first a correct outline, and afterwards giving the lights and shades, agreeably to the rules already learned.

Drawing of beasts, birds, fishes, &c.—In this step the student must not only study the forms of each class of the several animals, in the same manner as, in the preceding stage, he studied those of trees, but he must begin to observe the varieties of form, induced by the motions of the muscles, in all the actions of the head, body, or limbs, as well as the expression of face, characteristic action, and every other circumstance which distinguishes these from inanimate objects. In drawing beasts, he will begin to find a necessity of acquiring a general knowledge of anatomy.

The student who is unacquainted with the form and construction of the several bones which support and govern the animal frame, or does not know in what mode the mucsles, moving those bones, are fixed to them, can make nothing of what appears of them through the integuments with which they are covered, which appearance, however, is the object of his pencil. It is impossible even for an artist to copy faithfully what he sees, unless he thoroughly understands it; let him employ ever so much time and study in the attempt, it cannot but be attended with many and great mistakes; just as it must happen to a man who undertakes to copy something in a language which he does not understand, or to translate into his own what has been written in another on a subject with which he is not acquainted. This subject will be more fully treated under the ensuing head, where, as well as in the subsequent articles, will also be found more particular instructions for the use of the proper materials for drawing.

Drawing the human figure.—The study of the human figure has always been considered by artists as the most important part of the art. It is the most difficult, and is by many considered as contributing the most of any to general improvement; though there are some who carry this idea to too great an extent, saying, that a person who can draw the human figure well, can draw every thing besides. But this, it is well known, is not the case, there being many artists who can draw the figure very well, who cannot draw landscape nor architecture. To draw any thing well, requires a particular study. The study of the figure, however, includes all the finest principles of the art; and when the eye of the student has been accustomed to copy faithfully all the minute circumstances which constitute the character of a figure, and to attend to the innumerable beauties and graceful forms which it presents, he will be better qualified to pursue with advantage every other branch of the fine arts.

In learning to draw the human figure, it is necessary to begin with each of the parts separately, and after sufficient practice in that way, to proceed to put them together in the complete figure. For instance, the head being the most important part of the human body, it should be studied first. For this purpose, the student should copy the best drawings he can procure of the eye, mouth, nose, and ear, separately, and on a large scale; and of these a front view, profile or side view, oblique view, &c.

The readiest materials for drawing these, as well as all other parts of the figure, are black chalk, or black lead; the former may be used either upon white paper, or upon middle-tint paper; and in that case, white chalk may be used for laying on the lights. Black lead is only used upon white paper. A piece of soft charcoal may be made use of, for first slightly sketching in the general form, which must afterwards be gone over and corrected with the black chalk. The false lines of the black lead may be removed by the Indian rubber; but the student must remember to be as sparing as possible of this, as it is more improving to endeavour to draw every thing correct and decided at once, and not trust to the being able to erase the lines which are wrong.

The shadows may be laid on by drawing parallel curve-lines, according to the situation of the part, crossing them occasionally, and softening them in with more delicate lines, where necessary.

All the parts of a human figure are composed of curved surfaces; no straight lines are ever admissible, but every line should have a graceful turn; and it is this circumstance particularly, that occasions the study of the figure to give so much freedom in drawing. Care should be taken that no lines ever cross each other at right angles, which gives a disagreeable net-like appearance; neither should the crossings be too oblique, as then they are confused; a proper medium will be acquired by the study of good drawings or prints; in general, however, crossing should be avoided as much as possible. Sometimes the shadows are rubbed in, or their edges are softened, with a stump, which is a very expeditious way, and produces a fine effect; but it should be used with discretion, as it is better to execute the shadows in a clear and regular manner by soft lines. Care should be taken not to make the lines harsh and hard, like those of an engraving; they should be softer and more mellow. On this account, drawings are much better to learn from than prints, as, by copying the latter, the student is very apt to acquire a dry and hard manner. But we particularly caution him to avoid copying with a pen all the lines in engravings used for the shadows, which some, who have not been accustomed to see good drawings, are apt to do.

Many productions of this kind have been executed with an immensity of labour, and have been thought very fine by those who had but little knowledge of the art; yet artists, and those who are good judges, always consider them as very disgusting, and lament to see so much patience and labour misapplied.

In copper-plate engravings, there are no other means of producing shadows than by lines, at least with an equal effect; but this arises from the nature of the process; and in drawing, which is of a very different nature, there is not the same necessity for them. In general it should be observed, that the less labour there appears in any drawing, the better it is; and that though every possible pains should be taken to make drawings or paintings excellent, yet this labour should be always disguised as much as possible, and the whole should appear as if executed with the greatest ease.

In learning to draw, it is of more importance than is generally supposed, to copy from the finest works only. The most prejudicial quality of a model is mediocrity. The bad strike and disgust, but those that are not good, nor absolutely bad, deceive us by offering a dangerous facility. It is for this reason that engraving contributes to the progress of the arts, when it is employed on subjects that are judiciously chosen; but is too often prejudicial by the indifferent works it multiplies without number. But let Raffaelle be copied by skilful engravers, let a young artist profit by his labours, and works without dignity and expression will soon become intolerable to him; he will perceive to what an elevation the excellence of the art can raise him.

The way to avoid mediocrity is by the study and imitation of beautiful productions, or, in want of them, of the most finished translations that have been made from them; for so we may call beautiful prints. Let a young draughtsman study the heads of Raffaelle, and he will not see without disgust the sordid figures of indifferent painters. But if you feed him with insipid substances, he will soon lose the taste necessary to relish great excellences. In the one case he will advance firmly in his career; in the other he will continually totter, and even not be sensible of his own weakness.

Having copied frequently the parts of a face, he is next to proceed to the entire head, drawing first a front view, then a profile, a three-quarter, and so on, varying it in every possible direction, till he is thoroughly acquainted with the appearance of all the principal lines in every situation.

The student should now accompany his lessons by making observations on good casts and living models; but more particularly the former, as individual nature is seldom fine, and there is danger of copying what is bad, and acquiring false ideas of beauty. By these exercises he will have acquired some facility in handling his pencil, and he will be thus prepared for the study of the whole figure. But before he can proceed to this with advantage, we would recommend to him the study of anatomy, for the same reasons which have been given under the preceding head. But it is to be remarked, that it is not necessary for the designer to study anatomy as a surgeon, nor to make himself acquainted with all the nerves, veins, &c. It is sufficient to study the skeleton, and the muscles which cover them, and of these he should most particularly make himself familiar with those muscles which most frequently appear and come into action. For this purpose he should procure plaister casts of the anatomy of the human body, and consult treatises written upon the subject; and if he has opportunity, it will be proper afterwards to attend discussions and lectures on anatomy. He should also use every possible opportunity of making observations on the actions of the muscles in nature. Being thus thoroughly prepared, he will be enabled to draw the human figure with great advantage, and he will make a more rapid progress than he could have done without these previous studies.

Until the student, however, has imbibed a proper relish for beautiful proportions, and been well-grounded in their principles, he should not proceed to draw from living models.

In drawing from plaister casts, a good deal depends upon choosing a proper view, and placing the model properly with regard to the light, which should always come in obliquely from above, as it generally does in the day-time. If a candle is used, it should be so high as to cast the light downwards upon the model. The light should only come from one part, as cross-lights will distract and spoil the shadows.

Attitude and action of the muscles.—The general knowledge of the bones and muscles having been acquired by the study of anatomy, it remains that the draughtsman be careful not to represent any appearance of them contradictory to the attitude of the figure, and the exertion required by it. This demands, in fact, nothing more than a strict attention to nature, who never directs a muscle to act, unless it is necessary to the purpose designed. In this attention the Greek statuaries have particularly excelled. Regard is also to be had to the difference of character in the person represented, as whether a man be strong or weak, and likewise to sex, age, &c.

The muscles in general do not appear in the female so strongly as in the male. No action of a woman, although she exert her utmost strength, will occasion such swellings of the muscles as appear in men; the greater quantity of fat, which lies under the skin of women, clothing the muscles so generally, as to prevent every such appearance.

In order to represent properly and consistently the attitude or action of the figure, it is of the highest importance to attend to the parts or limbs employed in performing the action and producing the attitude. For instance, if the figure is standing, the foot must be placed in a right line, or perpendicular to the trunk or bulk of the body, where the centre of gravity may be supposed to fall. This centre is determined by the heel; or, if the figure is upon tiptoe, then the ball of the great toe is in the centre. The muscles of the leg which supports the body ought to be swelled, and their tendons drawn more to an extension than those of the other leg, which is only placed so as to receive the weight of the body towards that way to which the action inclines it. For example, suppose a man striking with a club at any thing before him towards the left side; then let his right leg be placed so as to receive the whole weight of the body, and the left loosely touching the ground with its toes. Here the external muscles of the right leg ought to be expressed very strongly, but those of the left scarcely more than if it was in some sedentary posture, except that, in the present case, the foot being extended, the muscles which compose the calf of the leg are in action, and appear very strong. It is not meant that all the muscles of the right leg, which supports the weight of the body, ought to be expressed very strong or equally swelled, but those principally which are most concerned in the action or posture that the leg is then in. For example, if the leg or tibia is extended, then the extending muscles placed on the thigh are most swelled; if it is bent, then the bending muscles and their tendons appear most. The like may be observed of the whole body in general when it is put into vigorous action. The Greek statue of Laocoon furnishes an example of this muscular appearance through the whole; but in the Antinous Apollo, and other figures disposed in postures where no considerable actions are designed, the muscles are expressed more faintly.

It is of great importance to an artist to be acquainted with the most obvious effects of the action of those muscles which are placed externally on the human body, for these vary with every alteration of posture, and are variously enlarged and changed in their appearance by every effort that is dictated by the will.

The following are frequently given as a few instances of the natural actions of the muscles, and will serve to direct the student to a fuller investigation of the subject.

Effects of the exertions of the muscles.—If either of the mastoid muscles act, the head is turned to the contrary side, and the muscle which performs that action appears very plain under the skin. If the arms are lifted up, the deltoid muscles placed on the shoulders, which perform that action, swell, and make the extremities of the spines of the shoulder-blades, called the tops of the shoulders, appear indented or hollow. The shoulder-blades following the elevation of the arms, their bases incline at that time obliquely downward. If the arms are drawn down, put forwards, or pulled backwards, the shoulder-blades necessarily vary their positions accordingly. All these particulars are to be learned by consulting the life only: when being well acquainted with what then appears in every action, the student will be able to form an adequate idea how it ought to be expressed.

When the cubit or fore-arm is bent, the biceps has its belly very much raised. The same happens in the triceps, when the arm is extended. The straight muscles of the abdomen appear very strong when rising from a decumbent posture. Those parts of the great serratus muscle which are received into the teeth or beginnings of the obliquus descendens muscle immediately below, are very much swelled when the shoulder on the same side is brought forwards; that serratus muscle then being employed in drawing the scapula forwards.

The long extending muscles of the trunk act alternately in walking, after this manner: if the right leg bears the weight of the body, and the left is in translation as on tiptoe, the last-mentioned muscles of the back on the left side may be observed to be tumefied on the other side about the region of the loins, and so on the other side. The trochanters, or outward and uppermost heads of the thigh-bones, vary so greatly in their positions, that no precise observations can explain their several appearances; but the study after the life ought to be chiefly relied on. If the thigh is extended, as when the whole weight of the body rests on that side, the glutæus or buttock-muscle alters its appearance; and if the thigh be drawn backwards, that muscle appears still more and more tumefied. When the whole leg is drawn upwards and forwards, and at the same time the foot is inclined inwards, the upper part of the sartorius muscle appears to rise very strongly; in other positions of the thigh, that muscle makes a furrowing appearance in its whole progress. If a man is upon tiptoe, the extending muscles of the leg placed on the fore-part of the thigh, and those of the foot that compose the calf of the leg, appear very strong, and the long peronæus makes a considerable indentation or furrowing at that time, in its progress on the outside of the leg. See MUSCLES.

Symmetry, or proportion, will be best learned by copying after the antique statues, of which plaister casts may be easily procured. Nature, which in the formation of every species, seems to have aimed at the last degree of perfection, does not appear to have been equally solicitous in the production of individuals. Parts of individuals are frequently as beautiful as possible, but a complete whole is never to be met with.

The practice of the antient Greek statuaries was, to select from various individuals the most beautiful parts, and by combining them, to produce figures more perfectly beautiful than nature ever presented. See PROPORTION, STATUES ANTIQUE.

Measures of the several parts of the human figure.—The moderns ordinarily divide the human figure into ten faces; that is, from the crown of the head to the sole of the foot, in the manner following. From the crown of the head to the forehead, is the third part of the face. The face begins at the lowest hairs which are upon the forehead, and ends at the bottom of the chin. The face is divided into three proportional parts: the first contains the forehead, the second the nose, and the third the mouth and chin. From the chin to the pit between the collar-bones are two lengths of a nose. From the pit betwixt the collar-bones to the bottom of the breast one face. From the bottom of the breast to the naval one face. From the naval to the genitals one face. From the genitals to the upper part of the knee two faces. The knee contains half a face. From the lower part of the knee to the ancle two faces. From the ancle to the sole of the foot half a face.

A man, when his arms are stretched out, is from the longest finger of his right hand to the longest of his left, as broad as he is long. From one side of his breast to the other, two faces. The bone of the arm, called humerus, is the length of two faces, from the shoulder to the elbow. From the end of the elbow to the root of the little finger, the bone called cubitus, with part of the hand, contain two faces. From the box of the shoulder-blade to the pit betwixt the collar-bones, one face. If you will be satisfied in the measures of breadth, from the extremity of one finger to the other, so that this breadth should be equal to the length of the body, you must observe that the boxes of the elbows with the humerus, and of the humerus with the shoulder-blade, bear the proportions of half a face, when the arms are stretched out. The sole of the foot is the sixth part of the figure. The thumb contains a nose. The inside of the arm, from the place where the muscle disappears, which makes the breast, called the pectoral muscle, to the middle of the arm, four noses. From the middle of the arm to the beginning of the hand, five noses. The longest toe is a nose long. The two utmost parts of the teats, and the pit betwixt

the collar-bones of a woman, make an equilateral triangle.

For the breadth of the limbs no precise measures can be given; because the measures themselves are changeable, according to the quality of the persons, and according to the movement of the muscles. In general, however, the hands are twice as long as they are broad, and each of their parts has its length, breadth, and thickness. The nail upon the finger is about half the joint it is upon. The length of the foot is a sixth part of the height of a person; and the length is five-eighths more than the breadth. The length of the face and hands ought to be exactly equal, and makes but just the tenth part of a person's height.

The rules in drawing children are as follow: Some make a child to contain five measures of the head, viz. from the top of the head to the privities three, and in the thighs and legs two more; the breadth between the two shoulders the length of a head and a half; the breadth of the body above the navel the length of one head; and the breadth of the upper part of the thigh is the third part of two lengths of the head; the breadth of the knee is just the measure there is betwixt the eyes and the chin; the small of the leg, and the brawn of the arm, are of the thickness of the neck.

As to the order and manner of proceeding in drawing the human figure, it is first requisite to mark the exact extent which you propose to give to the whole figure, both in height and breadth; next divide, agreeably to the most general proportions; and having thus ascertained the place where each part is to be drawn, sketch the head, then the shoulders, in their exact breadth; then draw the trunk of the body, beginning with the arm-pits (leaving the arms till afterwards) and so down to the hips on both sides, being sure to observe the exact breadth of the waist. When you have done this, then draw that leg which the body stands upon, and afterwards the other, which stands loose, then draw the arms, and last of all the hands.

Endeavour to form all the parts of your figure with truth, and in just proportion, not one arm or one leg bigger or less than the other; not broad shoulders with a thin slender waist, nor raw and bony arms with thick and gouty legs; but let there be a kind of harmony and agreement amongst the members, and an agreeable symmetry throughout the whole figure.

But as the essence of drawing consists in making at first a good sketch, you must in this particular be very careful and accurate; draw no part perfect or exact, till you see whether the whole draught be good; and when you have altered that to your mind, you may then finish one part after another as curiously as you can. In drawing the eyes, ears, legs, arms, hands, feet, &c. great care, study, and practice are requisite; this must be learned, as before remarked, by carefully imitating the best drawings you can get of eyes, ears, &c. for as to the mechanical rules of drawing them by lines and measures, they are not only perplexed and difficult, but also contrary to the practice of the best masters. The actions and postures of the hand are so many and various, that no certain rules can be given for drawing them that will universally hold good; and as the hands and feet are difficult members to draw, it is necessary, and well worth while, to bestow due time and pains about them, carefully imitating their various postures and actions, so as not only to avoid all lameness and imperfection, but also to give them life and spirit.

In drawing a labouring man, you must represent him with strong limbs and raised muscles, swelling and standing out, especially in bearing burdens, drawing weights, leaping, walking, combating, or such-like violent exercises. In representing persons asleep, you must carefully avoid giving any such postures or actions in their lying as would not in all probability afford rest; for a great want of judgment would appear in representing their limbs or bodies supported by their own force, and not by the help of something else.

Let it be remembered, as a general observation, always to begin with the right side of the draught you are making, that is, on your own left side, as is customary in writing, for by so doing, you will always have the part that is done before your eyes, and the rest will follow with ease; whereas, if you begin with the left side, your hand and arm will cover what you do first, and deprive you of the sight of it.

Expression of the passions.—With regard to the representations of the passions, Mr. de Piles observes, that it is absurd, as well as impossible, to pretend giving such particular demonstration of them as to fix their expression to certain strokes which the painter should be obliged to make use of, as essential and invariable rules. See EXPRESSION.

Drawing of drapery.—In the art of clothing the figures, or casting the drapery properly and elegantly upon them, many things are to be observed. 1. The eye must never be in doubt of its object; but the shape and proportion of the part or limb, which the drapery is supposed to cover, must appear, at least so far as art and probability will permit. 2. The drapery must not sit too close to the parts of the body, but let it seem to flow round, as it were to embrace them, yet so as that the figure may be easy, and have a free motion. 3. The draperies which cover those parts that are exposed to great light, must not be so deeply shaded as to seem to pierce them; nor should those members be crossed by folds that are too strong, lest by the too great darkness of their shades the limbs look as if they were broken. 4. The great folds must be drawn first, and then stroked into lesser ones; and great care must be taken that they do not cross one another improperly. 5. Folds in general should be large, and as few as possible: however, they must be greater or less according to the quantity and quality of the stuffs of which the drapery is supposed to be made. The quality of the persons is also to be considered in the drapery. If they are magistrates, their draperies ought to be large and ample; if country clowns or slaves, they ought to be coarse and short; if ladies or nymphs, light and soft. 6. Suit the garments to the body, and make them bend with it, according as it stands in or out, straight or crooked, or as it bends one way or another; and the closer the garment fits to the body, the narrower and smaller must be the folds. 7. Folds well imagined give much spirit to any kind of action; because their motion implies a motion in the acting member, which seems to draw them forcibly, and makes them more or less stirring as the action is more or less violent. 8. An artful complication of folds in a circular manner greatly helps the fore-shortenings. 9. All folds consist of two shades and no more; which you may turn with the garment at pleasure, shadowing the inner side deeper, and the outer more faintly. 10. The shades in silk and fine linen are very thick and small, requiring little folds, and a light shadow. 11. Observe the motion of the air or wind, in order to draw the loose apparel all flying one way; and draw that part of the garment that adheres closest to the body before you draw the looser part that flies off from it, lest, by drawing the loose part of the garment first, you should mistake the position of the figure, and place it improperly. 12. Rich ornaments, when judiciously and sparingly used, may sometimes contribute to the beauty of draperies; but such ornaments are far below the diguity of angels or heavenly figures; the grandeur of whose draperies ought rather to consist in the boldness and nobleness of the folds, than in the quality of the stuff, or the glitter of ornaments. 13. Light and flying draperies are proper only to figures in strong motion, or in the wind: but when in a calm place, and free from violent action, their draperies should be large and flowing; that, by their contrast and the fall of the folds, they may appear with grace and dignity.

Drawing of landscapes.—Every one who wishes to learn to draw landscapes will particularly find the advantages arising from the previous study of perspective. This will enable him not only to understand and draw all the parts of buildings which so frequently form a principal feature in views of places, but will also give him true ideas of the method of expressing distances, the winding of roads, and a variety of particulars that are continually occurring.

Having made himself master of the principal difficulties in perspective, he should next copy some good drawings; and here it is of great importance that what he copies first should be very excellent; for it is an absurd notion, though entertained by many, that indifferent drawings will do to begin with, or to bring the hand in, as it is termed; but, as a great master justly observes, the most likely effect these can produce, will be to put the hand out.

In choosing drawings to copy for beginners, particular attention should be paid to select those where the outlines or forms of the objects are distinctly and correctly drawn, and not those in which a good effect only has been principally aimed at. The first thing to be studied is, to be able to express with the black-lead pencil, decidedly and truly, the forms of all sorts of objects; and till this is attained, no attempt should be made at finished drawings or pictures.

By neglecting this important circumstance, many who would have excelled, if they had been put into the right way, have completely lost themselves, and run quite wild, by aiming at producing merely dashing effects, which, though very captivating at first, do not continue to maintain that power over the mind, as when they are accompanied by true drawing, and beautiful and correct forms.

Black lead is the most useful material for drawing the outlines of landscapes, which are best executed with this alone, and should not be gone over afterwards by the pen, which, except it be very judiciously managed, generally gives an appearance of hardness.

Indian ink alone should be used for the shadows till the student has advanced very considerably; nor till then should colours of any kind be used. Beginners are always desirous of producing pictures and making coloured drawings; but nothing is more hurtful than the practising this too early. The first thing to be learned is, to draw forms correctly; next, the mode of shadowing objects truly; then the general light and shadow of a drawing, and, with this, good composition. All this is best learned by using black lead, black chalk, white chalk, Indian ink, and these separately or combined, according to the taste of the student; but he should never think of colours till he has made very considerable progress.

When colours are employed, they should be used with great caution and judgment. Nothing is so disgusting as to see coloured drawings where the reds, greens, and blues, are laid on in the most violent manner, without any regard to harmony. Those who execute such vile daubings, will say in their defence, that nothing can be greener than grass, nor bluer than the sky; but they should consider, that nature employs such a multitude of little shadows, and such a variety of different tints intermixed with her colours, that the harshness of the original colour is corrected, and the effect of the whole is very different from a raw and distinct colour laid upon white paper. A single distinct colour is always bad in a landscape; and the tints should always be varied and broken in every part. Though we should have recourse to the study of nature, in preference to any master, for the study of colouring, yet it requires some judgment to know what part of nature is to be studied, and what is to be avoided; for in nature herself, there are many parts which are bad, and to copy them would do more harm than good. The student in colouring must examine, with every possible attention, the colouring of old walls, broken and stained by time and the weather, old thatch, old tiles, rotten wood; in short, all objects which are covered with moss, stains, and tints of various kinds; there he will find all that is most perfect and harmonious in colouring. Let him copy these with every possible care, and avoid as bad all objects which are of a uniform decided colour. This has been the practice of all the great masters who have excelled in this captivating part of the art. In short, after learning the first principles of drawing, he cannot too soon have recourse to nature; he will obtain from her the materials for acquiring every species of excellence, in a greater degree than from the works of the first masters. The study of these, however, will greatly abridge his labour, and it should go hand in hand with drawing from nature.

In landscapes, the scenes most generally to be met with, and which are most generally interesting, are of the picturesque kind, such as cottages and rustic scenery. In these, straight lines should be avoided, and every thing that is regular and formal. In general every thing that is old and broken is preferable to what is new, as affording more variety. Old thatch, old tiles, old plaister, old fencing, are more picturesque, and fitter for the pencil, than the same species of objects when new and entire. An old house almost tumbling down, whose parts are broken and ruinous, some bulging out, and the whole stained and tinted with a variety of chaste and harmonious colours by the pencil of nature, is infinitely preferable, as a subject for a picture, to any new house or gentleman's seat, though the latter may be a more comfortable habitation to live in.

In the same way, an old worn-out cart-horse is a much fitter animal to draw from, and a finer subject for the pencil, than a sleek and clean poney; and an ass with a rough coat is more picturesque than the same animal kept in nice order.

In subjects of the grand kind on the contrary, such as magnificent buildings, cities, streets, &c. straight lines are often necessary and proper, as these objects are rather of the sublime than the picturesque kind; and straight lines, and a degree of regularity, form part of the sublime. The employment of straight lines, however, requires great skill and knowledge of the art, to prevent them from appearing bad, and they can only be employed with success by those who have attained to considerable eminence.

The fewer colours that are used in a drawing the better, as harmony is most easily preserved, and by the mixture of a few, every possible tint may be obtained.

The sun's rays were considered by sir Isaac Newton to be composed of seven primitive colours; but later observations have made them to consist only of three; red, blue, and yellow; so that all the vast variety of tints which we see in nature, is formed by the mixture of these in various proportion. If we had pigments of these colours perfectly pure, we should have no occasion for more than these three; but this is not the case, and therefore we are obliged to have recourse to materials of other broken tints. The colours that are found to be the most useful in drawing landscapes in water-colours are, lake, indigo, Prussian blue, gamboge, light red, yellow-ochre, burnt terra Sienna, burnt umber, and Cologne earth. Some of the other colours may be occasionally useful, but these are all that are necessary for general use.

The best sort of water-colours are those mixed with gum and made up into cakes, as these may be used by rubbing upon a tile, in the same manner as Indian ink.

For a more particular account of the colours used in washing of drawings, and best methods of preparing them, see WASHING, and WATER-COLOURS.

GENERAL RULES.

Correctness of outline.—This is the first point to be attained, and can only be the result of patient diligence and long practice. To gain the free use of the pencil or port-crayon, let the student accustom himself to hold it farther from the point than a pen is held in writing, by which means he will have the full command and direction of it. In drawing of figures in Indian ink, the use of the pencil is to draw the first sketches or outlines; as any stroke or line that is amiss, may in this be more easily rubbed out than in any other thing; and when you have made your sketch as correct as you can with the pencil, you may then draw carefully the best outline you have got, with your crow-quill pen and ink. The ink made use of for this purpose, must not be the common, but Indian ink; being much softer than the other, and not running; and by mixing it with water, it may be made to any degree of strength, and may be used in a pen like common ink. After using the ink, you may wipe out the pencil-lines by rubbing the piece gently with the crumb of stale bread. Having thus got your outline discharged, your next work is to shade the figures, as directed; either by drawing fine strokes with your pen, where it requires to be shaded, or by washing it with the hair-pencil and the Indian ink. As to the rule and compasses, they are never or rarely to be used, except in measuring the proportion of your figures, after you have drawn them, to prove whether they are right or not; or in houses, fortifications, and other pieces of architecture.

Red lead and red or black chalk are used in the same manner as black lead. White chalk and tobacco-pipe clay are used in heightening or giving strong lights, and in drawing on coloured paper. Pastils or crayons are any colours, mixed with tobacco-pipe clay, which, while soft and in the consistency of a paste, is rolled up in pieces, about the thickness of a quill, and two or three inches in length, and then dried: they are generally used on coloured paper; and the colours are rubbed and wrought one into another in such a manner that no strokes appear, but the whole looks as if it was done with a brush.

Of the general distribution of lights and shades.—As soon as the learner has made himself acquainted with the drawing of forms, his next endeavour must be to learn the art of disposing the light and shade of every object properly. The best rule for doing this is, to consider from what point, and in what direction, the light falls upon the objects which he is delineating, and to let all his lights and shades be placed according to that direction throughout the whole work. It is the artful management of light and shade that gives the appearance of substance, roundness, and distance, to whatever bodies are represented by drawing. Draw a circle on a piece of paper; fill it up with any even colour, and it will appear to be a body with a round circumference and flat sides: but by colouring it stronger in the middle, and causing it gradually to weaken towards the circumference, it will receive a convex appearance like that of a ball or globe: wherever the vivacity of colour is strongest, that part of the object catches the sight first, and appears nearest to it: whereas its weakness and goings off are more and more broken and faint, and seem to fly farther off from the sight. In rounding the parts of any object, the extremities in turning must lose themselves insensibly and confusedly, without precipitating the light all of a sudden into the shadows, or shadows into the light, but the passage of the one into the other must be common and imperceptible; that is, by degrees of light into shadow, and shadow into light. O jects that are painted light, must have a sufficient breadth of shadow to sustain them; and dark bodies must

have a sudden light behind, to detach them from the ground, or from those objects that are placed behind them; otherwise they will appear confusedly as sticking upon each other; whereas the opposition of shade to a light object, and of light to a dark one, gives a projection, and separates them from other bodies.

There should be a balance preserved between the lights and shadows: a broad light ought not to be introduced into a draught without a large shadow. The nearer any object is to the eye, it is seen so much the stronger and plainer: the sight is weakened by distances, and the more remote any object is, it is seen in a more imperfect manner. Therefore, those objects which are placed foremost to the view, ought to be more finished than those that are cast behind; and they should have such a relative dominion over each other, that as one object by its heightenings causes others to retire more backwards, so the same object must be chased, and made to appear farther from the sight than others which are more strongly illuminated.

It is not sufficient that remote objects be only coloured in a more faint and languid manner; but, according to their distance, the parts must appear more or less confused; the eye not being able to discover minutely what is far separated from it. Pure and unmixed white either draws an object nearer, or carries it off to a greater distance. If it be accompanied with black, the opposition of light and dark renders the object more sensible, and brings it nearer to the advanced part; but pure white, being the lightest of colours, unless it be forced forwards, and supported by black, will fly off to the remotest view. As for pure black, it is the heaviest, most earthy, and most sensible of all colours, and brings the objects nearer to the sight: it must be placed in masses, be insensibly confused, and have its proper reposes.

In the representation of bodies give them always such lights as are most proper and convenient to their supposed situations. If the objects are in the fields or open air, and the sun not visible, or obscured by clouds, you must then introduce almost an universal light, though not warm and strong, and your shades must be faint; but when the sun is conspicuous, and shines in its full lustre, then the light must be very strong and bold, and the shadows very dark. If the objects you represent be supposed in a room, a little, but not very much illuminated, and you survey it from without, and stand on a level with the light that strikes upon it, the shadows of that figure must be very soft, whereby the figure itself will appear beauteous to the eye; and will, notwithstanding the softness of the shadow, seem as imbossed, and come boldly out. A small light illuminating the body occasions the shadows on the dark side to be large, and their extremities to be very bold. On the other hand, a broad light makes the shadows on the darker side to be more distinct and more soft in their limitations.

Reflection is to be used in delineating glittering or shining bodies, as glass, pearls, silver, &c. Let the cause of the reflection, be it more or less, be seen in the thing itself. Place all your lights one way through the whole work; and if the light falls sideways on the picture, the other side, which is the farthest from the light, must be made the darkest. That part of the body must be made lightest which has the light most opposite to it; if the light be placed above the head, then the top of the head must be made lightest; the shoulder must receive the next greater degree of light; and thus must you continue to shade, losing the light by degrees. By how much one part of the body projects more than another, it must by so much be made the lighter: and, on the contrary, those parts that bend inward must be made so much the darker. Two equal lights must never be made in one and the same picture; the greater is to strike forcibly into the middle, and with greatest lustre on those parts of the design where the principal figures and strength of the action seem to lie, diminishing it gradually as it approaches nearest the extremities of the piece.

In copying, before you begin your work, view the original with close attention; divide it in your mind into several parts; observe the length, the breadth, and the similitude of each part; consider their proportion to each other and the whole, the distances from one part to the other, and what parts lie opposite to each other.

After you have done your copy, view it afresh, by comparing it with the original, for the discovering and amending of faults, as it will not only serve to perfect you in that particular draught, but will improve your knowledge of lines and proportions in general, and in time enable you for the nearest imitations. Draw the outlines in a gliding manner, large and smooth, which will give them the resemblance of life and motion. Preserve in your draught a strong resemblance between the parts and the whole; every member ought to be made to agree, and the eyes, legs, hands, and feet, should be exactly paired.

Having good copies to draw after, learn to reduce them to other proportions, either larger or smaller, and this by frequent practice.

PARTICULAR DIRECTIONS.

In drawing after a picture or print, take care to place it in such a light that the gloss of the colours may not interrupt your view, but so that the light and your eye may fall equally and obliquely upon the piece. Let the piece be placed at such a distance, that upon opening your eyes, you may view it all at once: and the larger the picture is, it should be so much placed off at the greater distance; but right before you, and a little reclined.

Draw all your outlines at first very faint with a coal, which may easily be rubbed out again with the feather of a duck's wing, or the crumb of bread; and these outlines should be true, and agreeable to the pattern. The outlines next the light, should be drawn more faint; and when you have drawn one feature it should be a direction for you, in some measure, to draw another, by observing with your eye the distance from that to the next feature, making a full mark at the place with your coal, then draw it, and so on to the next, till you have drawn the whole.

Then observe the middle of the picture you would copy, and touch upon the paper with the point of your coal; afterwards observe the more conspicuous and uppermost figures, if there are more than one, which you are to touch lightly in their proper places. Thus running over the whole draught, you will see, as it were, the skeleton of the piece you are to draw.

Having made out these sketches, view them diligently, to see if they answer your pattern or not; for the gestures of the life ought to shew themselves eminently in the first and rudest draught of the piece; correct and amend whatever you perceive amiss; adding and diminishing as it varies from the pattern, by which means it will be brought nearer and nearer to the life.

Observe the distance of one limb, joint, or muscle, from another, and the same in all other accidents of the figure; their length, breadth, turnings, &c. Shadow next to the light very faintly: and where you see bold and free touches, be not timorous in expressing the same. In drawing a head after the life, or otherwise, take care to place the features exactly right upon the cross-lines, whether it be a full face or three-quarter face. In fore-shortening, you must make the cross-lines to fly upwards, but where the aspect is downwards, they must be made downwards in a circular manner.

In copying the exact appearance of prints, having drawn the outlines true with a coal, you are to proceed to trace the same lines again with a pen, Indian ink, &c. drawing them with more exactness; and by imitating all the hatches, with their exact distances one from another, their crossings, turnings, and windings, with more boldness and freedom, perfect your design.

In drawing after a naked body, bear constantly in mind what has been remarked above, that all the muscles are not to be so plainly expressed as in anatomical figures; but that side whose parts are most apparent, and of signification in the performance of any action, must be made to appear more or less, according to the force of that action.

In drawing young persons, the muscles must not appear manifestly so hard as in elder and full-grown persons; the same thing is to be observed as to fat and fleshy persons, and such as are very delicate and beautiful; and in women scarce any muscles at all are to be expressed, or but very little, unless it be in some very forcible action, and then too they are to be represented very faintly: the like is also to be observed as to children. The motion of the whole body must be considered in drawing of the muscles; as in the rising and falling of the arms, the muscles of the breast appear either more or less, and it is the same chiefly in the shoulders, sides, and neck, according to the several actions of the body.

The proportion of the figure ought to be multiplied by degrees, in proportion of one to two, three, four, &c. for herein the chief skill consists; and the diameter of the biggest place between the knee and the foot is double the least, and the largest part of the thigh triple.

Of drawing faces.—In drawing a head, it is usually divided into four equal parts: 1. From the crown of the head to the top of the forehead. 2. From the top of the forehead to the eyebrows. 3. From the eyebrows to the bottom of the nose. 4. From

hence to the bottom of the chin. But this proportion is not constant; those features, in different men, being very often different as to length and shape. In a well-proportioned face, however, they are nearly right.

To direct you, therefore, in forming a perfect face, your first business is to draw a complete oval, see the Plate fig. 1. in the middle of which from the top to the bottom, draw a perpendicular line; and through the centre, or middle of this line, draw another, directly across from one side to the other of your oval. On these two lines all the features of the face are to be drawn, as follows. Divide your perpendicular line into four equal parts: the first must be allotted to the hair of the head; the second is from the top of the forehead to the top of the nose, between the eyebrows; the third is from thence to the bottom of the nose; and the fourth includes the lips and chin. The line across the perpendicular one, or the breadth of the face, is always supposed to be the length of five eyes; you must therefore divide it into five equal parts, and place the eyes upon it so as to leave exactly the length of one eye betwixt them. This is to be understood only of a full front face; for if it turns to either side, then the distances are to be lessened on that side which turns from you, less or more, in proportion to its turning. The top of the ear is to rise parallel to the eyebrows, at the end of the diameter or cross line, and the bottom of it must be equal to the bottom of the nose; the nostrils ought not to come out farther than the corner of the eye in any face; and the middle of the mouth must always be placed upon the perpendicular line. The mouth, when shut, is as large as an eye.

The following is an ingenious device, which perhaps may somewhat assist the young practitioner, in forming the face according to its different turnings, and in placing the features properly thereon. Procure a piece of smooth wood, turned for the purpose, in the shape of an egg, which is nearly the shape of the human head; draw a line lengthways quite round it, as in the last fig. and divide this line into two equal parts by another line drawn directly across it at right angles. The features being drawn on these two lines, according to the rules delivered above, will produce a fore-right face. Turn the oval a small matter from the left hand to the right, and the perpendicular will appear bent like a bow, as you see in fig. 2.; upon which the particular features are to be drawn, as in fig. 3. always observing in what manner the nose projects beyond the round of the oval. The same must be observed, if you turn the oval from the right hand to the left, as in fig. 4. and if you incline the oval downwards and to the right, the lines of the cross will appear as in fig. 5. and the features drawn on them as in fig. 6. If you turn it upwards, reclining to the left, the lines of the cross will appear as in fig. 7. and a face drawn on them as in fig. 8. A great variety of faces may be shewn by this oval, according as you incline, recline, or turn it, more or less.

But those figures which come sideways are to be drawn by means of a perpendicular, as in fig. 9. upon which the forehead, nose, mouth, and chin, are to be drawn as you see in fig. 10.

It is to be observed, that if the face be fat, the cheeks will seem to swell; if lean, the jaw-bones will stick out, and the cheeks fall in; but if it be neither too fat nor too lean, it will be nearly round.

Touch the features lightly, where the eyes, nose, mouth, and chin, should stand: then begin to draw them more exactly, and so proceed till you have finished the face; after which draw the hair, beard, and shadows about it. You are to consider all those chief touches which give life to a face, and that discover the disposition of the mind: thus the mouth extended, and the corners turning a little up, shews a smiling countenance, &c. You must take care that the shadows are not made too dark where they should be light, because afterwards they cannot be rendered more light: and remember, that they are to be more faint and light in a fair, than in a swarthy complexion.

Of drawing mixed figures.—In order to draw the form of any beast, or bird, you must be well acquainted, as has been remarked, with its shape and actions, without which you will never perform any thing excellent in this way; and whatever beast you draw, you must be sure to give a sketch of the landscape of the country natural to that beast.

In drawing birds, the feathers, beginning at the head very small, must fall backwards one way in five ranks, still increasing till finished.

Insects, as flies, bees, wasps, grasshoppers, worms, and such-like, are drawn with great ease, provided you, for the first time, have the original before your eyes.

In drawing a flower, begin from the rose-tuft, or wart in the middle, as in a rose or marigold with the yellow tuft; which being made, draw lines equally divided from thence to the greatest compass or extent of the flower. They may be drawn either fully open, or in the bud; the leaves may be first drawn rudely, afterwards giving them their veins, or jaggedness.

Of drawing landscapes, buildings, &c.—All true drawing consists in nicely measuring the distances of each part of your piece by the eye. In order to facilitate this, you are to imagine in your mind that the piece you copy is divided into squares: as for example; suppose or imagine a perpendicular and an horizontal line crossing each other in the centre of the picture you are to copy: then suppose also two such lines crossing your own copy. Observe in the original what parts of the design those lines intersect, and let them fall on the same parts of the supposed lines in your copy. If you are to draw a landscape from nature, take your station on a rising ground, where you may have a large horizon, and mark your tablet into three divisions downwards, from the top to the bottom; and divide in your own mind the landscape you are to take into three divisions also. Then turn your face directly opposite to the middle of the horizontal line, keeping your body fixed, and draw what is directly before your eyes upon the middle division of your tablet: then turn your head, but not your body, to the left hand, and delineate what you view there, joining it properly to what you had done before. Lastly, do the same by what is to be seen on your right hand, laying down every thing exactly, both with respect to distance and proportion. Make the nearest objects in your piece the highest, and those that are further off to shoot away lower and lower, till they come almost level with the line of the horizon; lessening every thing proportionably to its distance, and observing also, to make your objects fainter and less distinct the farther they are removed from your eye. Make all your lights and shades fall one way; and let every thing have its proper motion, as trees shaken by the wind, the small boughs bending more, and the large ones less; water agitated by the wind, and dashing against ships or boats, or falling from a precipice upon rocks and stones, and spirting up again into the air, and sprinkling all about: clouds also in the air, now gathered with the winds, now violently condensed into hail, rain, and the like; always remembering that whatever motions are caused by the wind must all be made the same way.

Let the work imitate the season it is intended to represent: as, if you intend it for a winter-piece, represent the felling of woods, sliding upon the ice, fowling, hunting, &c. making the trees every where naked, or laden with snow or hoar-frost; the earth bare; the air thick or heavy; the water frozen, with carts passing over it, &c.

Let every site have its proper adjuncts, or additional graces, as the farm-house, windmill, water-mill, woods, flocks of sheep, herds of cattle, pilgrims, ruins of temples, castles and monuments, with a thousand such other things proper to particular subjects.

Of mechanical means for copying drawings.—There are various methods by which those who are ignorant of the art of drawing may copy very accurately the outlines of pictures, prints, and drawings; and these methods are often useful to those who can draw, and to engravers, when either great expedition, or great accuracy, is required; though none of them should ever be used by one who is learning to draw.

Tracing against the light.—Hold the drawing you wish to copy against one of the panes of the window; or have a pane of glass put in a frame, and fitted up like a music-stand, with a candle behind it. Lay your paper over the drawing, and you will see all the lines of the original distinctly through it, by which means you can easily trace them with a pen, or black-lead pencil.

To make tracing-paper.—Mix together equal parts of oil of turpentine and drying-oil, and with a rag rub it evenly over some fan or tissue-paper, or any other very thin paper. Hang it by to dry for a day or two, and it will be fit for use. Lay this over the print or drawing you want to copy, and you will see every line distinctly through, so that you can go over it with the black-lead pencil. If you wish to do it in ink, you must mix a little ox's gall with the ink, to make the paper take it, which it would not otherwise do on account of the oil.

To make camp-paper.—Take some hard soap, mix it with lamp-black; make it into the consistence of a jelly with water; with this, brush over one side of your paper, and let it dry. When you use it, put it between two sheets of clean paper, with its black side downwards; and with a pin, or stick with a sharp point, draw or write what you please upon the clean paper; and where the tracer

was touched, there will be an impression upon the lowermost sheet of paper as if it had been written or drawn with a pen. It may be made of any colour, by mixing with the soap black-lead, vermilion, &c.

Stenciling.—Lay the print or drawing you wish to have copied over a sheet of paper, and with a pin or needle prick all the outline over with holes, through both the papers. Then take the clean paper with the holes made in it, and lay it upon the paper you wish to have the design transferred to, and dust it over with the powder of charcoal in a small muslin bag; the dust will penetrate through the holes, and leave a correct copy of the original upon the paper.

This pricked paper will do again for any number of copies. This is very useful for ladies who work flowers upon muslin.

The method of enlarging and contracting by squares.—Divide the sides of your original with a pair of compasses into any number of equal parts, and rule lines across with a black-lead pencil from side to side, and from top to bottom. Then having your paper of the size you intend, divide it into the same number of squares, either larger or less, as you would enlarge or contract it. Then placing your original before you, draw, square by square, the several parts, observing to make the part of the figure you are drawing fall into the same part of the squares in the copy as it does in your original. To prevent mistakes, number the squares both of the original and copy. This method is much used by engravers.

To prevent the necessity of ruling across the original, which in some cases may injure it, take a square pane of crown glass, and divide its sides, and also its top and bottom, into equal parts: then from each division draw lines across the glass with lamp-black ground with gum-water, and you will divide the glass into squares. Then lay the glass upon the original which you wish to copy, and having drawn the same number of squares upon your paper, proceed to copy into each square on your paper what appears behind each corresponding square of the glass. Instead of a glass, an open frame with threads stretched across will answer the same purpose.

The pentagraph.—The pentagraph is an instrument, by means of which one may copy, enlarge, or reduce, the outlines of any picture, print, or drawing. It may be had at most mathematical instrument-makers', and is extremely useful for copying plans, maps, and other complicated figures.

Transparencies.—The effect of this kind of drawing, which has lately become very fashionable, though by no means a modern invention, is very pleasing, if managed with judgment, particularly in fire and moonlights, where brilliancy of light and strength of shade are so very desirable.

The very great expence attending the purchase of stained-glass, and the risk of keeping it secure from accident, almost precludes the use of it in ornamenting rooms; but transparencies form a substitute nearly equal, and at a very small expence.

The paper upon which you intend to draw must be fixed in a straining-frame, in order that you may be able to place it between you and the light, when you see occasion in the progress of your work. After tracing in your design, the colours must be laid on in the usual method of stained drawings. When the tints are got in, you must place your picture against the window, on a pane of glass framed for the purpose, and begin to strengthen the shadows with Indian ink, or with colours, according as the effect requires, laying the colours sometimes on both sides of the paper, to give greater force and depth of colour. The last touches for giving final strength to shadows and forms, are to be done with ivory-black, or lamp-black, prepared with gum-water, as there is no pigment so opaque and capable of giving strength and decision.

When the drawing is finished, and every part has got its depth of colour and brilliancy, being perfectly dry, you touch very carefully with spirits of turpentine on both sides those parts which are to be the brightest, such as the moon and fire; and those parts requiring less brightness, only on one side. Then lay on immediately with a pencil a varnish, made by dissolving one ounce of Canada balsam in an equal quantity of spirit of turpentine. You must be cautious with the varnish, as it is apt to spread. When the varnish is dry you tint the flame with red lead and gamboge, slightly tinging the smoke next the flame: the moon must not be tinted with colour.

Much depends upon the choice of the subject; and none is so admirably adapted to this species of effect as the gloomy Gothic ruin, whose antique towers and pointed turrets finely contrast their dark battlements with the pale yet brilliant moon. The effect of rays passing through the ruined windows, half-choked with ivy; or of a fire among the clustering pillars and broken monuments of the choir, round which are figures of banditti, or others whose haggard faces catch the reflecting light: these afford a peculiarity of effect not to be equalled in any other species of painting. Internal views of cathedrals also, where windows of stained glass are introduced, have a beautiful effect.

The great point to be attained is, a happy coincidence between the subject and the effect produced. The fine light should not be too near the moon, as its glare would tend to injure her pale silver light; those parts which are not interesting should be kept in an undistinguishable gloom, and where the principal light is, they should be marked with precision. Groups of figures should be well contrasted; those in shadow crossing those that are in light, by which means the opposition of light against shade is effected.

Having thus laid down such complete rules of instruction as may enable a young person of genius, in a remote part of the country, to teach himself drawing, we shall subjoin, for his amusement, some curious devices for drawing any object, in its outlines, as exact as nature; with instructions for shadowing, &c. without any regard to the forementioned rules, or any knowledge in the art of drawing.

Take a sheet of the thinnest, or white-brown paper, and brush it over with oil of turpentine, which will immediately render it transparent: then, after drying the paper in the air, strain it upon a frame, and fix it against the object you design to draw: this done, place right before it a piece of wood with a hole in it, fit for one's eye to look through, and as you meet any outlines of the object on the transparent paper, trace them over with a pencil; by which means you will obtain the just proportion, and true representation of any object in its outlines.

To render this still more pleasing, observe the tracings of your draught, wherever the shades are, and mark them with your pencil; for all the art in the world can never dispose the shades so regularly, as one may touch by this method; but the shades must be drawn quickly after the outlines are drawn, not at different times, because the sun instantly changes them.

Here observe, as in certain objects you will have fainter, stronger, and darker shades, in your remarks of them, to take such memorandums as may direct you how to finish them with Indian ink, or other colour, when you sit down to complete your work. To this end the best way, before you trace out your object, is to prepare three shells or gallipots of Indian ink, mixed with common water, viz. one of a very faint black, one of a middling black, and one of an intense black, numbering them 1, 2, 3; and as you make your observation on the shades of your object, mark upon your draught the same numbers as they happen to appear, so that afterwards you may finish with certainty.

In this regard the transparent paper is of great use; for, being laid upon any paper or print in a loose sheet, all the lines will be seen so perfectly through it, that you may copy them with the greatest ease; and if the print or picture be done by a good master, you can see which lines are strong, which soft, and how to imitate them.

There is yet another way to take views and landscapes, which some prefer to the transparent paper; and that is, either with white or black tiffany or lawn strained upon a frame, and used in the same manner as the paper, excepting that, as the black-lead pencil is used to the paper, on the white tiffany and on the lawn you must use charcoal very soft and finely powdered; but on the black tiffany very tender white chalk is to be used.

Other curious and easy methods of taking views, copying draughts, prints, &c. to the greatest degree of accuracy.

1. A draught may be taken regularly, from a drawing, on transparent paper, as follows: Take a piece of paper of the same size with that of the draught; rub one side of it with some powder of black lead, till it be well and equally blacked, so that a finger, touching it, will hardly be tinged with the blacking; then take the print, and laying the paper underneath it with the black side downwards, upon another piece of white paper of the same size, pin the three together in two or three places: afterwards, take a pin or needle, somewhat blunted at the point, and trace it over the outlines of your picture, which, with a little pressing, will direct the black paper to impress the white, so as to receive every stroke you draw: this done, you may carefully correct what errors you see with your black-lead pencil, cleaning the new-made draught slightly with the crumb of stale bread.

2. As for the draughts taken on tiffany or

Printed June 1 1819 by Brin & Son New Bridge Street Blackfriars

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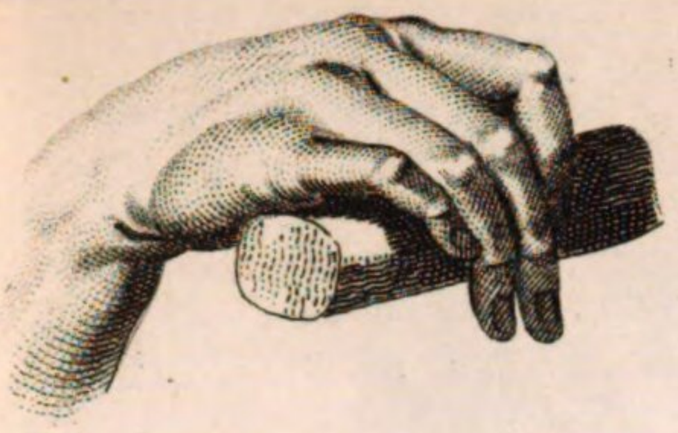
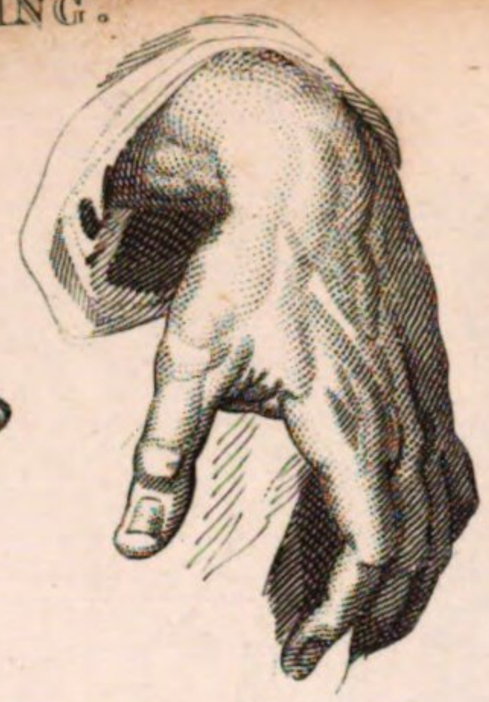
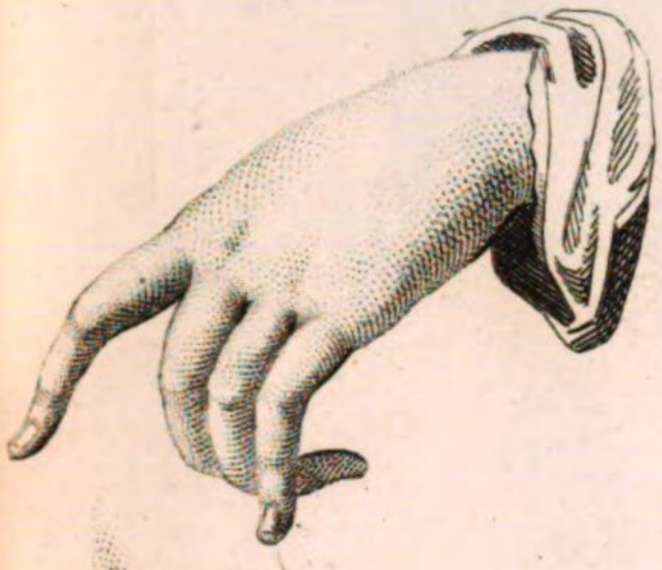
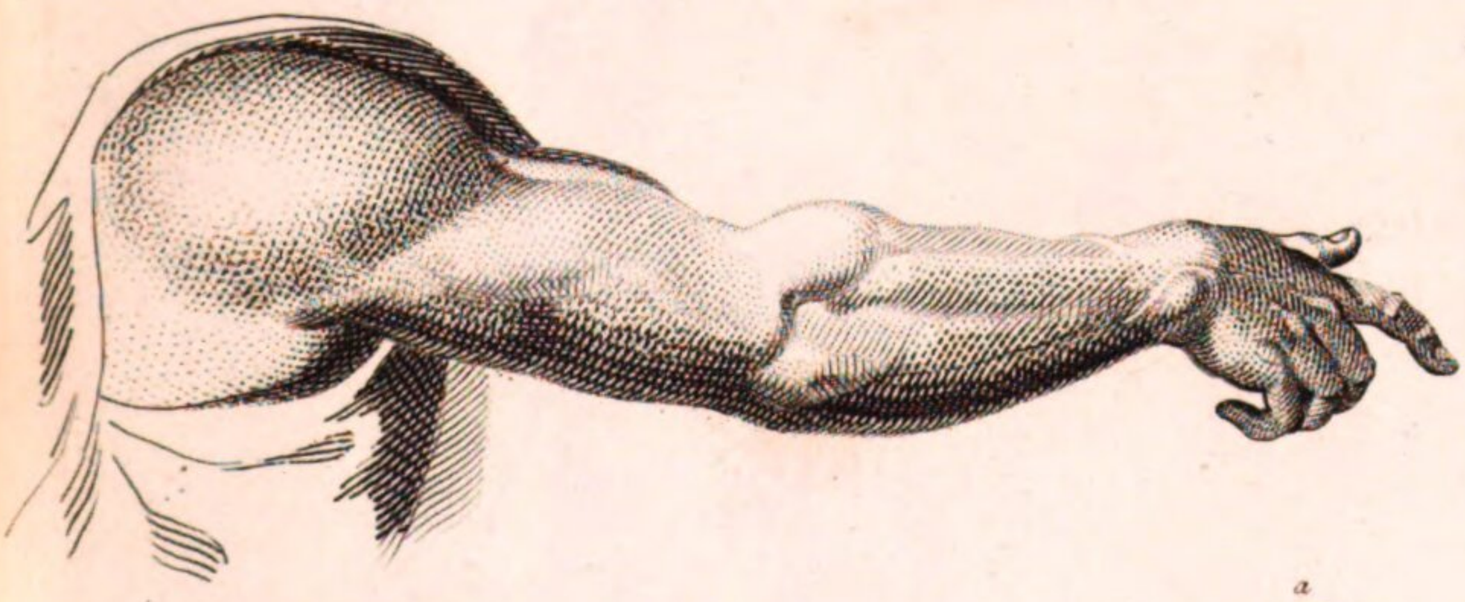
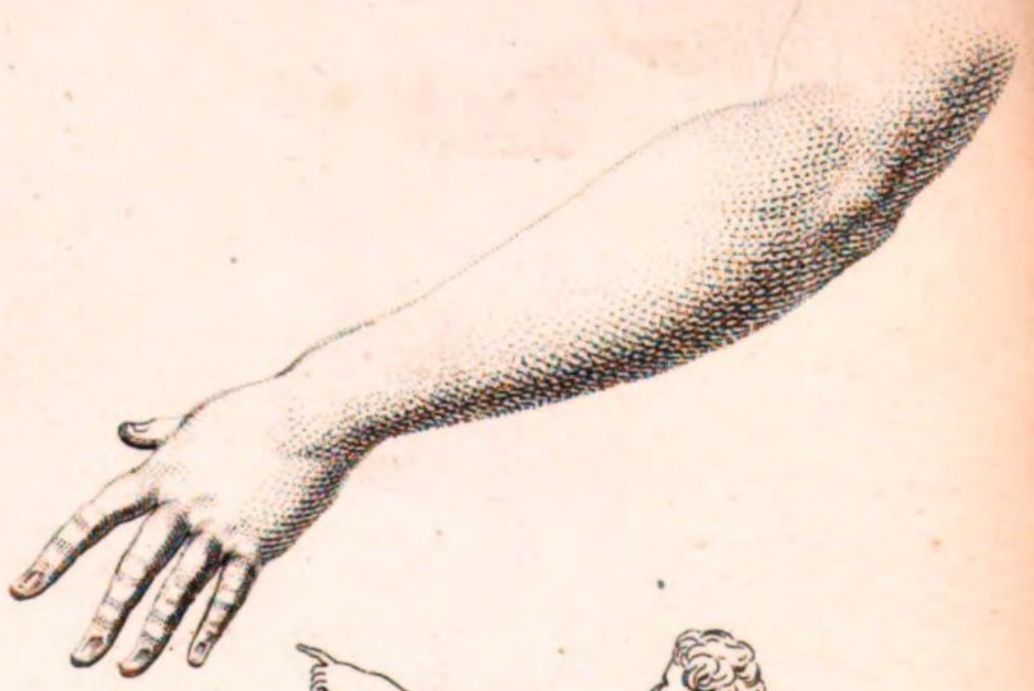
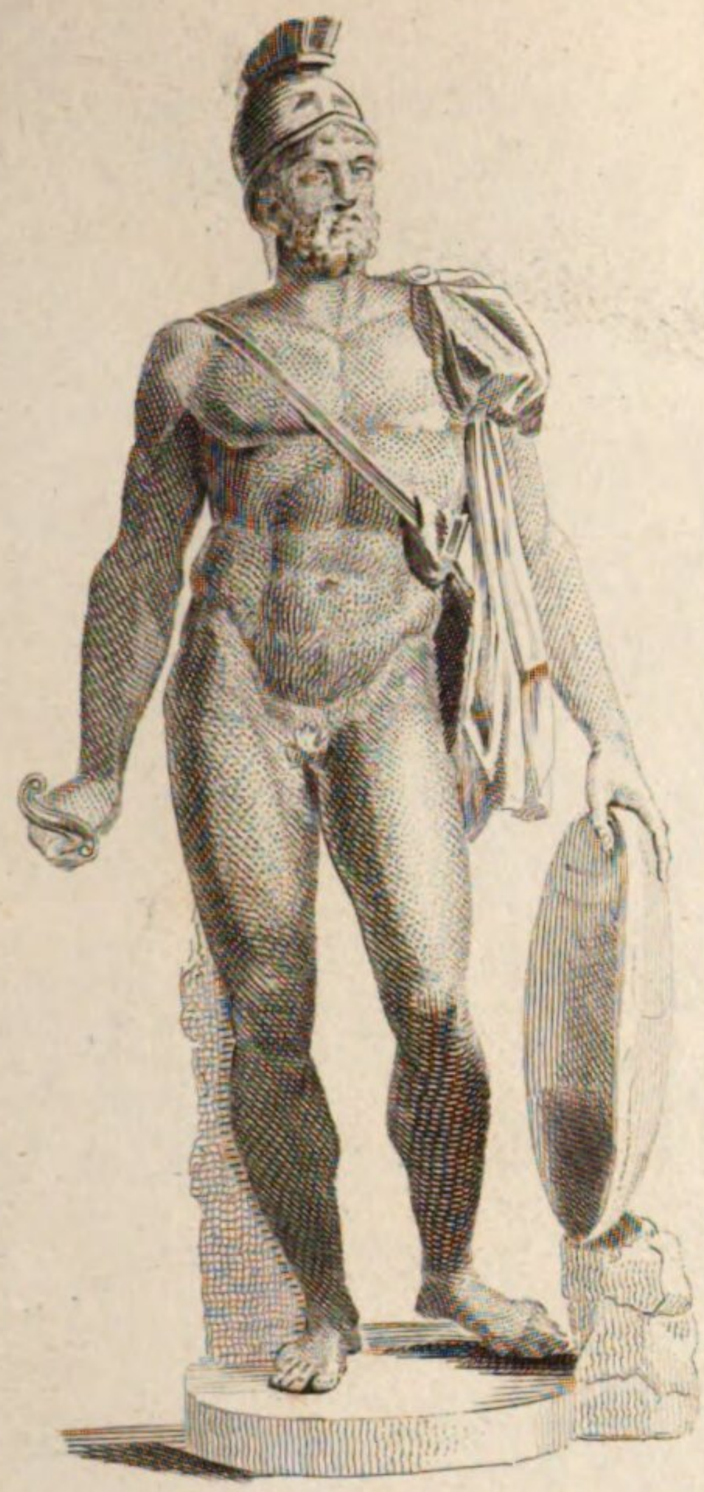








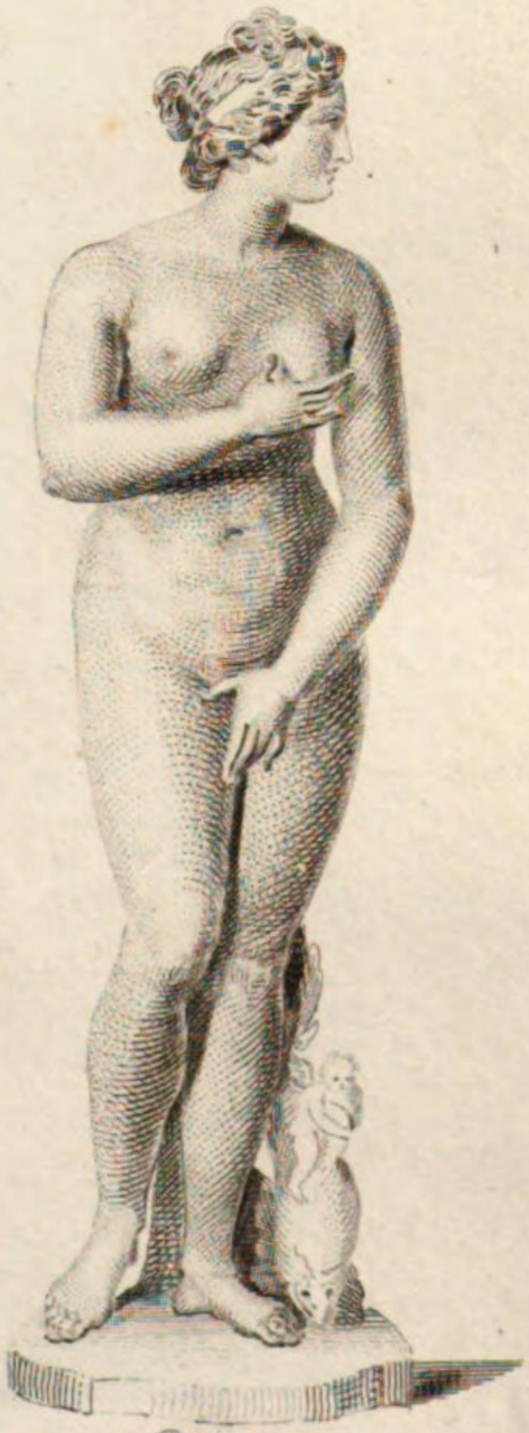




Mars

Minerva

Apollo



Venus

Printed June 1806 for Richard Phillips, New Bridge St. Blackfriars.

lawn, they are only to be laid on paper; that is, such as is drawn with charcoal upon white, and that drawn with chalk upon black or blue paper; and then, giving each of them a knock or two with the hammer, the charcoal or the chalk will fall through them upon the papers directly in the lines they were drawn, and give you the true representation of the object drawn from the life, in white lines upon the black paper, and in black lines upon the white.

Then strengthen these shadows of drawings with your black-lead pencil, chalk, or red oker, upon the pieces of paper where they made the marks; for otherwise the lines will easily be rubbed out. But it must be observed, that this amendment is to be made soon after the lines; because those tender draughts will quickly vanish, if care is not taken to strengthen them immediately. You are to begin this operation at the bottom of the drawing.

3. Another way is, by taking a thin piece of paper, and holding it against a glass-window; particularly a sashed one, because the interruption of the lead in the smaller glazed windows will hinder part of the prospect; then draw what you see from the glass, and afterwards the black-lead paper is to be used as directed before.

4. There is another way still, which may be more easy to the hand or arm of a person not accustomed to drawing upon a paper or lawn placed upright, which is by the use of a camera obscura; though to help the hand one may hold a baguette, or such a stick in the left hand as the oil-painters use to rest the right hand upon; or have some other rest made for the right hand, as may be easily screwed up and down at pleasure. But there is this difference still between drawing a piece of perspective, or view, on a transparent paper or lawn placed upright against any object, and drawing by the camera obscura; that such a piece will take in more of the view or object, and from a greater distance, than the camera obscura will: however, the portable camera obscura will, at first, be very easy to the arm of a beginner, by reason the objects appear on an horizontal plane, such as a table; and the hand, having a proper rest, will more easily follow the line represented on the plane with great exactness.

The camera obscura is a machine or apparatus wherein the images of external objects are represented distinctly, and in their genuine colours, either in an inverted or erect situation. This machine may be made as follows: Darken a chamber, one of whose windows looks into a place set with a variety of objects, leaving only one little aperture open in the window. In this aperture fit a lens, either a plane convex one, or one convex on both sides, so as to be the portion of a large sphere. At a due distance, to be determined by experience, spread a paper or white cloth on the wall, unless the wall itself be whitened so as to serve the purpose; and on this the images of the desired objects will be delineated invertedly.

In this case it is not more difficult to draw, or rather copy the objects, though they are reversed, than to draw or copy several things which we see upright on the frames of transparent paper, lawn, or tiffany; for to trace lines will be as easily done one way as the other; and though the objects falling on the paper or cloth will, while you are drawing them, be reversed, it is but turning the paper or cloth upside down, when they are done, and the drawing will be right to the eye. But to obviate this difficulty, let the paper, or what is to receive the objects, be placed against the back of a chair, and let a person look on the several objects represented thereon over the back of the chair, and this will set them right to the eye. Or, if you would rather have the images appear erect, it may be done either by means of a concave lens, or by receiving the image on a plain speculum inclined to the horizon under an angle of 45 degrees, or by means of two lenses included in a draw-tube instead of one.

It is to be observed, that if the aperture does not exceed the bigness of a pea, the objects will be represented thereon, even though there be no lens at all. To render the images clear and distinct, it is necessary that the objects be illuminated by the sun; and they will be still brighter if the spectator first stay a quarter of an hour in the dark.

Care must be likewise taken that no light escape through any chinks, and that the wall be not too much illuminated. Farther, the greater distance there is between the aperture and the wall, the larger and more distinct will the images be; but the rays becoming thus too much dilated, the brightness of the image is weakened, till at length it becomes insensible. But the portable camera obscura is more proper for beginners, as being more easy for their arm; besides, the objects appearing on an horizontal plane, may, of course, be drawn with greater exactness.

The construction of a portable camera obscura may be as follows: Provide a wooden chest, in the middle of which raise a little turret either round or square, open toward the object. Behind this aperture incline a little plain mirror to an angle of 45 degrees, which will reflect the rays upon a lens convex on both sides, included in a tube. At the end of the focus of the lens, place a table covered with a white paper to receive the image; and, lastly, make an oblong aperture to look through. By means of this machine the images will be exhibited perfectly like their objects, each clothed in their different colours; whereby any person, unacquainted with designing or drawing, will be able to delineate any thing to the greatest degree of accuracy and justness; and those even well versed in painting will find many hints by it to perfect them in this art.

5. Two other methods, both easy and entertaining, not hitherto mentioned, for taking of draughts or drawings, are as follow: 1st. Prick with a pin the outlines of the print or drawing you design to copy, and then laying the same on a sheet of paper, take a powder-puff or tuft of cotton, dipping it now and then in charcoal-dust, and beat it over the pricked lines through the picture, by which means you will have full directions marked on your cloth or paper sufficient to finish a just drawing.

2d. The other way is by making such an impression from the print as shall give a just copy of it; and it is of great use when we want to carry every stroke of the graver along with us; which method, if you are very careful, will indeed but very little sully the print.

For this end, take some white or green soap, which mix with such a quantity of water as will bring it to the consistence of a jelly; with this mixture rub the print, and with a wet sponge gently wet the paper designed for receiving the impression; then laying it on the print, cover all with two or three other pieces of dry paper, and rub it very hard all over with any thing that is smooth and polished; and thus the wetted paper will have upon it the reverse of the print you rubbed it upon, with every distinct line in the original, if you have been careful to rub it equally.

Secrets of copying drawings, &c.

To take a drawing with fixed ink.—Take a thin sheet of paper, and rub it all over with fresh butter, as equally as possible, then dry it well by the fire, and rub the buttered side with either carmine, lamp-black, black-lead powder, or blue bice finely ground, till it is all equally coloured; taking care in rubbing on any of these, that the colours will not come off by a very slight touch of the finger. Then lay the coloured side of this buttered paper upon a piece of clean paper, and lay the print you design to copy upon the buttered paper; afterwards with a fine pin or needle, blunted a little at the point, trace the outlines of the drawing carefully, by which means you will have a good copy of it upon your white paper; which may be touched afterwards with crayons, or the like colour.

To take the impression with red ink.—Mix some vermilion finely ground with linseed oil, but not so much but that it shall still be liquid enough to run or flow in a pen. With this trace the lines of your print; and then with a sponge dipt in water wet the back side of the print, and turn the printed side down upon a piece of white paper, so as to lie smooth: then lay over that a piece of dry paper, and press it hard in every part; and the lower white paper will receive the impression. But if you have a linen-press, it is better to put your papers between two of the leaves, and screw the press as tight as you can, by which means you will have a fine impression.

To take draughts, writings, &c. with red loose ink.—Take some vermilion finely ground, and mix it with fair water in a gallipot with some cotton in it, so that it may run very free in the pen: with this mixture draw over all the strokes of your print, imitating both the finer and stronger lines; then with a sponge dipt in gum-water wet a piece of clean white paper, and while it is wet turn the print upon it; and pressing it well, take off the print, and you will find all the strokes remain on the clean paper; and as soon as it is dry the vermilion will be fixed to it.

This sort of ink has been used frequently in writing any thing designed to be engraved; for by turning the writing side of the paper down upon a copper-plate covered with bees-wax, and white ground, rubbing it very equally, the impression will be upon the wax.

Taking draughts with blue loose ink.—You may likewise make such a sort of ink with blue bice and common water as will run very finely in a pen, and serve for the same use as the former ink.

To take off a drawing in a standing red colour by tracing.—Take vermilion finely ground, and mixing it with a little fresh but-

ter, rub a clean sheet of paper on one side with this mixture, so that it may bear a slight touch of the finger without leaving the paper; then laying the coloured side of this paper upon a clean sheet, lay your print upon the other side of the coloured paper; and then trace every line you think proper, as already directed in tracing a draught with fixed ink: but be sure to pin the three papers together at the corners, to prevent their slipping, which would inevitably spoil your work. This impression made by tracing will hold without rubbing or pressing the papers. The quills of a swallow, after they are thoroughly dry, are very good for tracing.

By mixing carmine with some fresh butter, and colouring a paper with it in the same manner, you will obtain a more beautiful colour; and by colouring a paper in like manner with blue bice and butter, you may have the drawing blue.

To take the natural or lively shape of any herb or tree.—First take the leaf you would copy, and gently rub the veins on the back side of it with a piece of ivory, or some such-like matter, so as to bruise them a little; afterwards wet the same side gently with linseed-oil, and then press it hard upon a piece of white paper, and you shall have the perfect figure of the leaf, with every vein in it justly expressed: this impression being afterwards coloured will seem truly natural, and may be useful to such as would remember plants.

Another way of painting the leaves of plants, so that the impression shall appear as black as if it had been done in a printing-press, is as follows.—When the leaf is dry, take such a ball as the pressmen use for blacking the types, and rubbing it equally over with printer's ink, strike it gently four or five times on the back of the leaf, till all the veins are blacked with the ink; then laying the leaf on a flat board or the like, with the back side upwards, clap a piece of white paper well moistened on the leaf; and pressing it pretty hard, but not so as to bruise the fibres, you shall have a fine impression.

But this may be done to still greater advantage by means of a piece of wood in the form of a cylinder, about a foot long, and an inch and a half diameter, the middle part about six or eight inches long, being covered with a woollen cloth rolled three or four times round it. With this cylinder roll the paper over the leaf four or five times backwards and forwards, and you will have a curious impression.

But where printer's ink is not conveniently come at, the following method may be made use of: Rub the back of the leaf, as before directed, with burnt linseed-oil: then, strewing some powder of black lead, or, for want of that, some charcoal or small-coal dust, or the powder of burnt cork, upon a smooth board, so as equally to cover it, stroke the powder gently over; and oiling the back side of the leaf, clap it upon the board; then laying the white paper upon the back of the leaf, press or roll it as before.

If none of these ingredients are conveniently had, take vermilion, and mixing it with fresh butter to the consistence of printer's ink, cover your printing-ball with it: daub it over the back of the leaf, and take your impression as before.

Where vermilion is used, bice may also be made use of, either with butter or oil, by grinding blue bice with some burnt linseed-oil, and using it as before: thus you may have a fine red or blue ink, proper for impressions of this sort; but the blue is preferable in colouring leaves, because it is an agreeable colour for the green sort.

It may be observed, that the reason why the back of the leaf is the proper side to make the impression from, is because the ribs or vessels rise on that side above the fleshy part of it; and therefore being coloured with any of those inks, they are the fittest to give an impression; whereas, in the foreside of the leaf, the fleshy parts rise, and these fine fibres are sunk between them.

DREIN, in the military art, a trench made to draw the water out of a moat, which is afterwards filled with hurdles and earth, or with fascines, or bundles of rushes and planks, to facilitate the passage over the mud.

DRESSING *of ores*, the breaking and powdering them in the stamping-mill, and afterwards washing them in a wooden trough.

DRESSING. See SURGERY.

DRIFT *of the forest*, is an exact view and examination taken at certain times to know what beasts are there; in order that none may come on the forest but such as have right, and that the forest be not overcharged with beasts.

DRIFT, in mining, a passage cut out under the earth, betwixt shaft and shaft, or turn and turn; or a passage or way wrought under the earth, to the end of a meer of ground, or part of a meer.

DRIFT, in navigation, the angle which the line of a ship's motion makes with the nearest meridian, when she drives with her side to the wind and waves, and is not governed by the power of the helm; it also implies the distance which the ship drives on that line. A ship's way is only called drift, in a storm; and then it blows so vehemently as to prevent her from carrying any sail, or at least restrains her to such a portion of sail as may be necessary to keep her sufficiently inclined to one side, that she may not be dismasted by the violent labouring produced by the turbulence of the sea.

DRIFT-SAIL, a sail used under water, veered out right ahead by sheets, as other sails are. It serves to keep the ship's head right upon the sea in a storm, and to hinder her driving too fast in a current.

DRILL, in mechanics, a small instrument for making such holes as punches will not conveniently serve for. Drills are of various sizes, and are chiefly used by smiths, turners, carpenters, and coopers.

DRILL, or *drill-box*, a name given to an instrument for sowing land in the new method of horse-hoeing husbandry.

DRILL-*sowing*, a method of sowing grain or seed of any kind, so that it may all be at a proper depth in the earth, which is necessary to its producing healthful and vigorous plants. For this purpose a variety of drill-ploughs have been invented and recommended; but partly from the expence attending the purchase, partly from the complication of their structure, and partly from the attachment of the illiterate farmer to long habits, these excellent schemes for diminishing labour have not received that share of encouragement to which they seem entitled.

DRIVING, in the sea-language, is said of a ship when an anchor being let fall will not hold her fast, nor prevent her sailing away with the tide or wind. The best help in this case is to let fall more anchors, or to veer out more cable; for the more cable she has out, the safer she rides. When a ship is a-hull or a-try, they say she drives to leeward.

DROIT, *jus*, signifies right or law, of which some distinguish six kinds: 1. Jus recuperandi, right of recovery. 2. Jus entrandi, right of entering. 3. Jus habendi, right of having. 4. Jus retinendi, right of retaining. 5. Jus percipiendi, right of receiving. 6. Jus possidendi, right of possessing.

DROIT is also the highest of all real writs; and takes its name of a writ of right, from the greatest regard being shown to it, and as it has the most assured and final judgment. There are several sorts of these writs used in our law, as droit de avowson, droit de dower, droit de garde, droit patent, droit rationabili parte, and droit sur disclaimer.

DROMEDARY, *dromedarius*, a large animal of the camel kind. See CAMELUS.

DRONE, in the history of insects, a kind of bee, larger than the common working or honey bees. See APIS.

DROPS, in meteorology, small spherical bodies which the particles of fluids spontaneously form themselves into, when let fall from any height. This spherical figure, the Newtonian philosophers demonstrate to be the effect of corpuscular attraction; for considering that the attractive force of one single particle of a fluid is equally exerted to an equal distance, it must follow that other fluid particles are on every side drawn to it, and will therefore take their places at an equal distance from it, and consequently form a round superficies. See ATTRACTION, and METEOROLOGY.

DROPSY, in medicine, an unnatural collection of watry humours in any part of the body. See MEDICINE.

DROSERA, or *sun-dew*, a genus of the pentagynia order, in the pentandria class of plants, and in the natural method ranking under the fourteenth order, gruinales. The calyx is quinquefid, the petals five; the capsule unilocular, and quinquevalved at top; the seeds very numerous. There are nine species, two of which grow naturally in boggy places in many parts of the kingdom. They seem to receive the name of sun-dew from a very striking circumstance in their appearance. The leaves, which are circular, are fringed with hairs supporting small drops or globules of a pellucid liquor like dew, which continue even in the hottest part of the day and in the fullest exposure to the sun. The whole plant is acrid, and sufficiently caustic to erode the skin: but some ladies mix the juice with milk, and apply it to remove freckles. The juice that exsudes from it unmixed, will destroy warts and corns. The plant has the same effect upon milk as the common butterwort; and like that too is supposed to occasion the rot in sheep.

DROWNING, signifies the extinction of life by immersion in water. In some

respects there seems to be a great similarity between the death occasioned by immersion in water, and that by strangulation, suffocation by fixed air, apoplexies, epilepsies, sudden faintings, violent shocks of electricity, or even violent falls and bruises. Physicians, however, are not agreed with regard to the nature of the injury done to the animal system in any or all of these accidents. It is indeed certain, that in all the cases above-mentioned, particularly in drowning, there is very often such a suspension of the vital powers as to us has the appearance of a total extinction of them; while yet they may be again set in motion, and the person restored to life, after a much longer submersion than has been generally thought capable of producing absolute death.

De Haen, in his treatise on this subject, ascribes the diversity of opinion among physicians to their having been so ready to draw general conclusions from a few experiments. Some, having never found water in the lungs, have thought it never was there; and others, from its presence, have drawn a contrary conclusion. Some have ascribed the death which happens in cases of drowning, to that species of apoplexy which arises from a great fulness of the stomach. But this opinion our author rejects, because in 13 dogs which he had drowned and afterwards dissected, no signs of such a fullness appeared. Another reason is drawn from the want of the common marks of apoplexy on the dissection of the brain, and from the actual presence of water in the lungs. He is of opinion, that the death of drowned persons happens in consequence of water getting into the lungs, and stopping the blood in the arteries, and of course that blowing into the lungs must be hurtful, as it will increase the pressure on the blood-vessels.

Dr. Cullen, in his letter on this subject to lord Cathcart, says, that very often the water does not enter the lungs, nor even the stomach, in any material quantity; and, that in most cases, no injury is done to the organization of the vital parts. Hence he argues, that the death which seems to ensue, is owing to the stoppage of respiration, and the consequent ceasing of the circulation of the blood, whereby the body loses its heat and vital principle.

In the Phil. Trans. vol. lxvi. Mr. Hunter advances the following theory.—The loss of motion in drowning seems to arise from the loss of respiration; and the immediate effect this has on the other vital motions of the animal, at least this privation of breathing, appears to be the first cause of the heart's motion ceasing. It is most probable, therefore, Mr. Hunter observes, that the restoration of breathing is all that is necessary to restore the heart's motion; for if a sufficiency of life still remains to produce that effect, we may suppose every part equally ready to move the very instant in which the action of the heart takes place, their actions depending so much upon it. What makes it very probable that the principal effect depends upon throwing air into the lungs, is, that children in the birth, when too much time has been spent after the loss of that life which is peculiar to the fetus, lose altogether the disposition for the new life: in such cases there is a total suspension of the actions of life; the child remains to all appearance dead; and would die if air was not thrown in to its lungs, and the first principle of action by that means restored. To put this in a clearer light, Mr. Hunter gives the result of some cruel and by no means justifiable experiments made on a dog in 1755. A pair of double bellows were provided, which were so constructed, that by one action air was thrown into the lungs, and by the other air was sucked out which had been thrown in by the former, without mixing them together. The muzzle of these bellows was fixed into the trachea of a dog, and by working them he was kept perfectly alive. While this artificial breathing was going on, the sternum was taken off, so that the heart and lungs were exposed to view. The heart then continued to act as before, only the frequency of its action was greatly increased. Mr. Hunter then stopped the motion of the bellows; and observed that the contraction of the heart became gradually weaker and less frequent, till it left off moving altogether; but by renewing the operation, the motion of the heart also revived, and soon became as strong and frequent as before. This process was repeated upon the same dog ten times, sometimes stopping for five or ten minutes. Mr. Hunter observed, that every time he left off working the bellows, the heart became extremely turgid with blood, and the blood in the left side became as dark as that in the right, which was not the case when the bellows were working. These situations of the animal, he observes, seem to be exactly similar to drowning.

Dr. Goodwyn, in a subsequent treatise on this subject, has endeavoured to ascertain the effects of submersion upon living animals in a still more accurate manner; and this investigation is accompanied with a most careful and ingenious inquiry concerning the causes of the different phenomena which he remarked in the course of a great number of experiments. From a review of these Dr. Goodwyn draws the following conclusions: 1. "A small quantity of fluid usually passes into the lungs in drowning. 2. This water enters the lungs during the efforts to inspire; and mixing with the pulmonary mucus, occasions the frothy appearance mentioned by authors. 3. The whole of this fluid in the lungs is not sufficient to produce the changes that take place in drowning. And hence it follows, that the water produces all changes that take place in drowning indirectly, by excluding the atmospheric air from the lungs. This naturally leads to an investigation of the uses of respiration, and the effects of the air upon the blood and lungs in that action. The author begins with attempting to determine the quantity of air drawn in at each inspiration, with the proportional quantity left after expiration. The experiments by which he endeavoured to ascertain these quantities seem to be more uncertain than the others, as indeed there are not data sufficient for them. Concerning the chemical changes produced in the air by respiration, and the effects of the air upon the blood itself, we shall only observe in general, that his experiments evidently show that the disease produced by drowning arises entirely from the exclusion of the atmospheric air or its pure part; for which reason he recommends inflating the lungs with that kind of air in preference to any other.

From these different views of the matter, physicians have differed considerably in their account of the methods to be followed in attempting the recovery of drowned persons. De Haen recommends agitation of all kinds; every kind of stimulus applied to the mouth, nose, and rectum; bleeding; heat, both by warm cloths and warm water; blowing air into the trachea; stimulants, such as blisters, warm ashes, &c. applied to the head, ankles, thighs, pit of the stomach, and other parts. Dr. Cullen's instructions on this subject, however, are of much more importance; but they are detailed too much at length to admit of an adequate abridgement in this article. For every practical purpose, indeed, the plan of recovery distributed by the Royal Humane Society of London is sufficient. It is as follows:

1. As soon as the patient is taken out of the water, the wet clothes, if the person is not naked at the time of the accident, should be taken off with all possible expedition on the spot (unless some convenient house is very near), and a great coat or two, or some blankets if convenient, should be wrapped round the body.

2. The patient is to be thus carefully conveyed in the arms of three or four men, to the nearest public or other house, where a good fire, if in the winter season, and a warm bed, can be made ready for its reception. As the body is conveying to this place, great attention is to be paid to the position of the head; it must be kept supported in a natural and easy posture, and not suffered to hang down.

3. In cold or moist weather, the patient is to be laid on a mattress or bed before the fire, but not too near, or in a moderately heated room: in warm and sultry weather, on a bed only. The body is then to be wrapped as expeditiously as possible with a blanket, and thoroughly dried with warm coarse cloths or flannels.

4. In summer or sultry weather too much air cannot be admitted. For this reason it will be necessary to set open the windows and doors, as cool refreshing air is of the greatest importance in the process of resuscitation.

5. Not more than six persons are to be present to apply the proper means; a greater number will be useless, and may retard, or totally prevent, the restoration of life, by rendering the air of the apartment unwholesome. It will be necessary, therefore, to request the absence of those who attend merely from motives of curiosity.

6. It will be proper for one of the assistants, with a pair of bellows of the common size, applying the pipe a little way up one nostril, to blow with some force, in order to introduce air into the lungs; at the same time the other nostril and the mouth are to be closed by another assistant, while a third person gently presses the chest with his hands, after the lungs are observed to be inflated. By pursuing this process, the noxious and stagnant vapours will be expelled, and natural breathing imitated. If the pipe of the bellows is too large, the air may be blown in at the mouth, the nostrils at the same time being closed, so that it may not escape that way: but the lungs are more easily filled, and natural breathing better imitated, by blowing up the nostril.

7. Let the body be gently rubbed with flannels, sprinkled with spirits. A warming-pan heated (the body being surrounded with

flannel) may be lightly moved up and down the back. Fomentations of hot brandy are to be applied to the pit of the stomach, loins, &c. and often renewed. Bottles filled with hot water, heated tiles covered with flannel, or hot bricks, may be efficaciously applied to the soles of the feet, palms of the hands, and other parts of the body. The temples may be rubbed with spirits of hartshorn, and the nostrils now and then tickled with a feather; and snuff, or eau de luce, should be occasionally applied.

8. Tobacco-fumes should be thrown up the fundament; if a fumigator is not at hand, a common pipe may answer the purpose.

The operation should be frequently performed, as it is of importance; for the good effects of this process have been experienced in a variety of instances of suspended animation. But should the application of tobacco-smoke in this way not be immediately convenient, or other impediments arise, clysters of this herb, or other acrid infusions with salt, &c. may be thrown up with advantage.

9. When these means have been employed a considerable time without success, and a brewhouse or warm bath can be readily obtained, the body should be carefully conveyed to such a place, and remain in the bath, or surrounded with warm grains, for three or four hours. If a child has been drowned, its body should be wiped perfectly dry, and immediately placed in bed between two healthy persons. The salutary effects of the natural vital warmth, conveyed in this manner, have been proved in a variety of successful cases.

10. While the various methods of treatment are employed, the body is to be shaken every ten minutes in order to render the process of animation more successful; and children in particular, are to be much agitated, by taking hold of their legs and arms frequently and for a continuance of time. In various instances agitation has forwarded the recovery of boys who have been drowned, and continued for a considerable time apparently dead.

11. If there are any signs of returning life, such as sighing, gasping, or convulsive motions, a spoonful of any warm liquid may be given; and if the act of swallowing can be performed, a cordial of warm brandy or wine may be given in small quantities and frequently repeated.

12. Electricity may be tried by the judicious and skilful, as its application neither prevents nor retards the various modes of recovery already recommended; but, on the other hand, will most probably tend to render the other means employed more certainly and more expeditiously efficacious. This stimulus promises to prove an important auxiliary in cases of apparent death, and therefore deserves the serious regard and attention of the faculty.

The methods which have been described, are to be employed with vigour for three hours or upwards, although no favourable circumstances should arise; for it is a vulgar and dangerous error to suppose that persons are irrecoverable because life does not soon make its appearance; an opinion that has consigned to the grave an immense number of the seemingly dead, who might have been restored to life by resolution and perseverance. Bleeding is never to be employed in such cases, unless by direction of one of the medical assistants, or some other gentleman of the faculty who has paid attention to the resuscitating art.

We shall now describe the apparatus made use of in recovering bodies from the water, and in restoring suspended animation.

Plate Miscel. fig. 44, is a forked instrument with blunt points for making superficial search after the drowned body, sounding the particular situation in which it sunk.

Fig. 45, a ladder with a long jointed handle.

Fig. 46, an extractor, or a linked pair of tongs, which in the plate appears closed; but on immersing it into water, opens by its own weight, as well as by the sliding down of the iron ring *o* from the part marked *x* to that of *u*. It may again be closed by pulling the double rope fastened to the ring *o*, which is thus shifted upward from *u* to *x*: by means of expanding the iron arms *n n*, which are likewise connected with this ring, the mouth or flaps of the instrument *rr* may be shut; and to prevent their opening till required, the two ropes are firmly tied round the iron bolt *ss*, in which situation they remain till the body is extracted. Great attention is required in preserving them from the effects of rust; and, independantly of the weight of iron-work, it is perhaps the most complete piece of machinery that can be contrived for this purpose.

Fig. 47, a pair of bellows with two separate bags, so contrived that by opening them when applied to the nostrils or mouth of a patient, one bag will be filled with common air, and the other with the air extracted from the lungs; and by shutting them again, pure atmospheric air will be introduced into these organs, and that drawn out consequently discharged into the room. Thus the artificial breathing may be continued, while the other operations on the surface of the body are carried on: which could not be conveniently done if the muzzle of a common pair of bellows were introduced into the nostril.

a, Is an intermediate board, but which admits of no communication between the two bags. In the external board of each side, there is the usual hole, marked *b*, provided with a valve; and the cylindrical part through which the air is expelled in common bellows, is here soldered to a copper box, within which two other valves are applied to the tubes conducting the air. The cover *d* of this box, may be unscrewed by means of an interposed leather ring, almost of the shape of a funnel, to the neck of which is fastened a flexible tube, *e*, made of varnished silk cloth, and a spiral wire that forms the cavity. To the extremity of this tube is attached a small ivory pipe *f*, the front of which may either be tubular and round, for introducing it into the nostril, or flat, like the top-piece of a clarionet, if it is intended for the mouth. The valves (which cannot be represented in a plate) consist of stiffened taffety, and are so arranged, that the corresponding ones stand in an inverted order. If therefore both bags of the bellows are expanded, two of the valves open themselves towards the internal part of the machine: one of these is fixed to one of the side boards, but the other is within the box, on the mouth of the conducting tube belonging to the opposite bag of the bellows. By this contrivance, the air enters both bags of the bellows at the same time, and is, on compression, again expelled by means of two other valves, which open from within towards the external parts. Both bags of the bellows terminate below the valve in one principal tube of communication; because, though the action of both bellows is simultaneous, the stream of air conformably to the arrangement before pointed out, can only enter and escape alternately. In using this machine, the small ivory pipe is applied either to one of the nostrils, or put into the mouth: in the former case, the other nostril and the mouth must be closed; in the latter, both nostrils. When the bellows are set in action, one of the bags receives a column of atmospheric air through its valve, while the other, by means of its flexible tube and its valve, extracts a portion of air from the lungs. But if the bellows are again shut, one of the bags parts with the impure gas drawn out of the pulmonary vessels, and the second conveys pure atmospheric air to the organs of respiration. By properly repeating this alternate process, the patient may again be enabled to exercise the important function of breathing. As, however, a precipitate and irregular method of proceeding might be productive of injury, this delicate operation ought to be performed by persons who are acquainted with the mechanism of respiration. In some cases, where the patient has, for a considerable time, lain under water, or was afterwards neglected for want of due assistance, it would be desirable to introduce into his lungs oxygen, or pure vital dephlogisticated air, instead of that of the common atmosphere; as the latter is generally more or less corrupted on such occasions by the breath of many persons in the same room. For this purpose may be used a bladder, marked *g*, which is provided with a cock and pipe fitted or screwed to the board of the inspiring valve and bag of the bellows. If, therefore, after opening the cock, the machine is set in motion, it will extract the pure air contained in the bladder, and, on the subsequent compression of the bellows, force it into the lungs of the patient.

Fig. 48, is a machine for injecting the smoke of tobacco by way of clyster, in those desperate cases which require the application of this remedy. It consists of a pair of bellows, to the muzzle of which is fitted a metal box, *a*, provided with a ring, in the middle of which it may be unscrewed, and again closed, after being filled with tobacco, and set on fire; the pipe *c* of the flexible tube *b*, is introduced into the fundament; and thus by means of the bellows *d*, the smoke is forced into the rectum. To these may be added,

A bier of wicker-work, in the form of a slanting oblong basket, for conveying the body of the drowned, in a posture somewhat raised. This simple contrivance has the advantage, that the water may easily run off, while the patient is carried: and as many unfortunate persons are materially injured by rough treatment, before they arrive at a house of reception, so that their recovery is thus often frustrated, we recommend the universal adoption of this useful implement.

The Royal Humane Society of London have, for a series of years, offered premiums for machines and other inventions to save mariners and other persons from drowning in cases of shipwreck, or other accidents at sea. The life-boat of Mr. Greathead has been

already described under the article Boat; but at the last anniversary (April 15th, 1806), a model of a life-boat was exhibited, which may be put together in the space of half an hour, in any case of shipwreck, and which cannot sink or overset, let the sea run ever so high. All that is necessary to be provided with is, a keel or plank of any convenient length, and a few pigs of iron (such as vessels commonly carry out for ballast). The officers of the ship are to take care to keep two or three empty water-casks, perfectly tight, the bungholes corked up, and a piece of tin or leather nailed over them. These casks are to be lashed with ropes to the keel, along with the pigs of iron for ballast; and any spare poles or spars may be also lashed to the sides, so as to give the raft the form of a vessel, and at each end to make a lodgment for the men. Any of the square sails of the ship will form a lug-sail, and may speedily be adapted to the new life-boat; and a strong and broad spar may be lashed on as a rudder. Several inventions have also been recommended by the committee of the society to enable persons to swim from a wreck to the shore; particularly the cork or marine spencer, already noticed under the article Cork, and "the life-preserver" invented by Mr. Daniel, of Wapping. This last is a machine of water-proof leather, which wraps round the body just under the arm-pits, and is inflated like a bladder in the space of half a minute, by blowing with the breath through a silver tube, furnished with a stop-cock, which is to be turned when the machine is full of air.

The immediate views of this committee of the Royal Humane Society for affording assistance and preventing shipwreck, are clearly developed in their resolutions of the 19th March 1798, which in the hope of exciting the attention of scientific men to so interesting a subject we insert.

"Resolved, That is the opinion of this committee,

"I. That means may be contrived for preventing vessels which are light and of particular importance, such as packets, from foundering at sea, by means of a thick lining of cork or very light timber, which may prevent the vessel from sinking in case of any of her planks starting, or other accidents happening to the hull.

"II. That, in case of shipwreck, the grand object is to form a communication with the shore: and it appears to this committee, that the most probable means of effecting this object is, to convey a rope or line by some projectile force to the nearest land; and that, the more simple the machine for this purpose (having ample power), the more likely it is to have a proper practical effect.

"III. That the construction of life-boats to go from the shore to a vessel wrecked or in distress (which life-boats ought to be lined with cork or light timber, so as to keep buoyant in almost all cases), is a most laudable and excellent invention; and this committee cannot but hope, that, if this plan was universally adopted on all our sea-coasts, at least wherever it is practicable, it would save the lives of numbers of mariners, and other persons valuable to society.

"IV. That the institution of a body of watermen ready to venture, on all occasions of shipwreck, in life-boats, or other vessels, to assist persons in distress, would be extremely useful. That such persons should have particular privileges, as protections from being impressed, and perhaps badges such as the firemen in London, and should be encouraged by the prospect of rewards to adventure on all such occasions."

DRUG, among fan-makers, is a composition of gum arabic, and some other ingredients, used in laying gold or silver leaf upon fans, or in covering them with either of these metals in powder. They use it also to paste together the papers, gauzes, taffetas, and other matters, used by them in their fans.

Drug signifies also a salt, or cinder of glass, used by some in bleaching cloth. The use of this drug is prohibited in France, as being found corrosive, destructive of the linen, and likely to injure the health of those who use it.

DRUGGET, in commerce, a stuff sometimes all wool, and sometimes half wool half thread, sometimes corded, but usually plain.

DRUIDS, the priests or ministers of religion of the antient Britons and Gauls. The Druids were chosen out of the best families; and were held, both by the honours of their birth, and their office, in the greatest veneration. They are said to have understood astrology, geometry, natural history, politics, and geography: they had the administration of all sacred things, were the interpreters of religion, and the judges of all affairs indifferently.

DRUM, is a martial musical instrument in form of a cylinder, hollow within, and covered at the two ends with vellum, which is stretched or slackened at pleasure by the means of small cords and sliding knots. Some drums are made of brass, but they are commonly of wood.

There are several beats of the drum, as assembly, chamade, reveillé, retreat, &c.

Drums, *kettle*, are large basons of copper or brass, rounded in the bottom, and covered with vellum or goat-skin, which is kept fast by a circle of iron, and several holes fastened to the body of the drum, and a like number of screws to screw up and down. They are much used among the horse, as also in operas, oratorios, concerts, &c.

DRUNGUS, a name given in the latter times of the Roman empire to a body of troops, amounting to from one thousand to four thousand men. At first it was used to denote the troops of strangers and enemies, but in the eastern empire to signify the troops of the empire itself.

DRUNKENNESS, excuses no crime; but he who is guilty of any crime whatever, through his voluntary drunkenness, shall be punished for it as much as if he had been sober; for the law, seeing how easy it is to counterfeit this excuse, and how weak an excuse it is (though real), will not suffer any man thus to privilege one crime by another. 4 Black. 26.

By several statutes temp. Jac. every person convicted of drunkenness shall forfeit 5*s.* or be committed to the stocks for six hours, and offending a second time, shall be bound in a recognizance of 10*l.* for future good behaviour. And an alehouse-keeper convicted of drunkenness, shall besides the other penalties, be disabled to keep any such alehouse for three years.

DRUPA, or *druppa*, in botany, a species of pericarpium, or seed-vessel, which is succulent or pulpy, has no valve or external opening like the capsule and pod, and contains within its substance a stone or nut. The cherry, plum, peach, apricot, and all other stone-fruit, are of this kind. The term, which is of great antiquity, is synonymous to Tournefort's fructus mollis ossiculo, "soft fruit with a stone;" and to the prunus of other botanists. The stone or nut, which in this species of fruit is surrounded by the soft pulpy flesh, is a kind of ligneous or woody cup, which contains a single kernel or seed. This definition, however, will not apply to every seed-vessel denominated drupa in the Genera Plantarum. The almond is a drupa, so is the seed-vessel of the elm-tree and the genus rumphia, though far from being pulpy or succulent; the first and third are of a substance like leather, the second like parchment. The same may be said of the walnut, pistachio-nut, guettarda, quisqualis, jack-in-a-box, and some others. Again, the seeds of the elm, schrebera, flagellaria, and the mango-tree, are not contained in a stone. The seed-vessel of burr-reed is dry, shaped like a top, and contains two angular stones.

DRYADS, in the heathen theology, deities, or nymphs, which the antients thought inhabited groves and woods. They differed from the hamadryades, these latter being attached to some particular tree, with which they were born, and with which they died; whereas the dryades were goddesses of trees and woods in general.

We likewise find mention made of a kind of prophetesses, or witches, among the Gauls, called dryades or druides.

DRYANDRIA, a genus of the class and order dioecia monadelphia. The calyx is two-leaved; corolla five-petalled; stamina nine; fruit three or four grained. There is one species, a dwarf tree of the Mauritius.

DRYAS, a genus of the icosandria-pentagynia class of plants, the flower of which consists of eight oblong, emarginated, patent petals, inserted into the cup. There is no pericarpium, but the seeds are numerous, of a roundish compressed figure, and furnished with very long hairy styles. There are two species.

DRYPIS, a genus of the class and order pentandria trigynia. The calyx is five-toothed; petals five; capsule clipped round, one-seeded. There is one species, a shrubby plant of Barbary.

DUCAT, a coin current in Germany, and other countries abroad, for the different values of which see Coin.

DUCATOON, a silver coin, likewise frequent in several parts of Europe.

DUCENARIUS, in Roman antiquity, a military officer who had the command of two hundred men. The title ducenarii is also given to certain procurators of the emperors, so called either from their having a salary of 200 sesterces, or from their being appointed to raise the tax of the two-hundredth penny.

DUCES tecum, in law, a writ that commands a person to appear in the court of chancery, and bring with them certain writings, evidences, or other things, which the court is inclined to view.

Duces *tecum licet languidus*, in law, is a writ directed to the sheriff, on a return that

he is not able to bring his prisoner without danger of death, he being adeo languidus: upon which the court grants a habeas corpus, in nature of a duces tecum licet languidus.

DUCK. See ANAS.

DUCKING, plunging in water, a diversion antiently practised among the Goths, by way of exercise; but among the Celtæ, Franks, and antient Germans, it was a sort of punishment for persons of scandalous lives. They were shut up, naked to the shift, in an iron cage, fastened to the yard of a shaloop, and ducked several times.

DUCKING *at the main-yard*, among seamen, is a way of punishing offenders on board a ship; and is performed by binding the malefactor, by a rope, to the end of the yard, whence he is violently let down into the sea, once, twice, or three times, according to his offence: and if the offence is very great, he is drawn underneath the keel of the ship, which they call keel-haleing.

DUCK-UP, at sea, is a term used by the steersman, when the mainsail, foresail, or spritsail, hinders his seeing to steer by a landmark: upon which he calls out, "Duck-up the clew-lines of these sails," that is, hale the sails out of the way. Also, when a shot is made by a chace-piece, if the clew of the spritsail hinders the sight, they call out, "Duck-up," &c.

DUCT, *ductus*, in general, denotes any tube or canal. See ANATOMY.

DUCTILITY, in physics, a property of certain bodies, whereby they are capable of being expanded, or stretched forth, by means of a hammer, press, &c. See MECHANICS.

The great ductility of some bodies, especially gold, is very surprising: the goldbeaters and wiredrawers furnish us with abundant proofs of this property; they every day reduce gold into lamellæ inconceivably thin, yet without the least aperture or pore discoverable, even by the microscope: a single grain of gold may be stretched under the hammer, into a leaf that will cover a house, and yet the leaf remain so compact as not to transmit the rays of light, nor even admit spirit of wine to transude. Dr. Halley took the following method to compute the ductility of gold: he learned from the wiredrawers, that an ounce of gold is sufficient to gild, that is, to cover or coat, a silver cylinder of forty-eight ounces weight, which cylinder may be drawn out into a wire so very fine, that two yards shall weigh only one grain; and consequently ninety-eight yards of the same wire, only forty-nine grains: so that a single grain of gold here gilds ninety-eight yards; and, of course, the ten-thousandth part of a grain is here above one-third of an inch long. And since the third part of an inch is yet capable of being divided into ten lesser parts visible to the naked eye, it is evident that the hundred-thousandth part of a grain of gold may be seen without the assistance of a microscope. Proceeding in his calculation, he found, at length, that a cube of gold, whose side is the hundredth part of an inch, contains 2,433,000,000 visible parts; and yet, though the gold with which such wire is coated, is stretched to such a degree, so intimately do its parts cohere, that there is not any appearance of the colour of the silver underneath.

Mr. Boyle, examining some leaf-gold, found that a grain and a quarter in weight took up an area of fifty square inches; supposing therefore the leaf divided by parallel lines 100th part of an inch apart, a grain of gold will be divided into five hundred thousand minute squares, all discernible by a good eye: for the same author shews, that an ounce of gold drawn out in wire would reach 155 miles and a half.

But Mr. Reaumur has carried the ductility of gold to a still greater extent. What is called gold-wire, every body knows, is only a silver one gilt. The cylinder of silver, covered with leaf-gold, they draw through the hole of an iron, and the gilding still keeps pace with the wire, stretch it to what length they can. Now Mr. Reaumur shews, that in the common way of drawing gold-wire, a cylinder of silver twenty-two inches long, and fifteen lines in diameter, is stretched to 1,163,520 feet, or is 634,692 lines longer than before, which amounts to about ninety-seven leagues. To wind this thread on silk for use, they first flatten it, in doing which it stretches at least one-seventh farther, so that the twenty-two inches are now 111 leagues; but in the flattening, instead of one-seventh, they could stretch it one-fourth, which would bring it to 120 leagues. This appears a prodigious extension, and yet it is nothing to what this gentleman has proved gold to be capable of.

DUCTILITY *of glass*. We all know that, when well penetrated with the heat of the fire, the workmen can figure and manage glass like soft wax; but what is most remarkable, it may be drawn, or spun out, into threads exceedingly long and fine.

Our ordinary spinners do not form their threads of silk, flax, or the like, with half the ease and expedition as the glass-spinners do threads of this brittle matter. We have some of them used in plumes for children's heads, and divers other works, much finer than any hair, and which bend and wave like hair with every wind.

Nothing is more simple and easy than the method of making them. There are two workmen employed; the first holds one end of a piece of glass over the flame of a lamp; and, when the heat has softened it, a second operator applies a glass hook to the metal thus in fusion; and, withdrawing the hook again, it brings with it a thread of glass, which still adheres to the mass: then, fitting his hook on the circumference of a wheel about two feet and a half in diameter, he turns the wheel as fast as he pleases; which, drawing out the thread, winds it on its rim; till, after a certain number of revolutions, it is covered with a skain of glass-thread.

The mass in fusion over the lamp diminishes insensibly: being wound out like a clue of silk upon the wheel; and the parts, as they recede from the flame, cooling, become more coherent to those next to them, and this by degrees: the parts nearest the fire are always the least coherent, and, of consequence, must give way to the effort the rest make to draw them towards the wheel.

The circumference of these threads is usually a flat oval, being three or four times as broad as thick: some of them seem scarcely bigger than the thread of a silkworm, and are surprisingly flexible. If the two ends of such threads are knotted together, they may be drawn and bent, till the aperture, or space in the middle of the knot, does not exceed one-fourth of a line, or one-forty-eighth of an inch, in diameter.

Hence M. Reaumur advances, that the flexibility of glass increases in proportion to the fineness of the threads; and that, probably, had we but the art of drawing threads as fine as a spider's web, we might weave stuffs and cloths of them for wear. Accordingly, he made some experiments this way; and found that he could make threads fine enough, viz. as fine, in his judgment, as spider's thread, but he could never make them long enough to do any thing with them.

DUEL, a single combat, at a time and place appointed, in consequence of a challenge. This custom came originally from the northern nations, among whom it was usual to decide all their controversies by arms. Both the accuser and accused gave pledges to the judges on their respective behalf; and the custom prevailed so far amongst the Germans, Danes, and Franks, that none were excused from it but women, sick people, cripples, and such as were under twenty-one years of age, or above sixty. Even ecclesiastics, priests, and monks, were obliged to find champions to fight in their stead. The punishment of the vanquished was either death by hanging or beheading, or mutilation of members, according to the circumstances of the case. Duels were at first admitted not only on criminal occasions, but on some civil ones for the maintenance of rights to estates: in latter times, however, before they were entirely abolished, they were restrained to these four cases: 1. That the crime should be capital. 2. That it should be certain the crime was perpetrated. 3. The accused must, by common fame, be supposed guilty. And, 4. The matter not capable of proof by witnesses. In England, though the trial by duel is disused, the law on which it is founded is still in force.

DUELLING, or single combat, between any of the king's subjects, of their own heads, and for private malice or displeasure, is now prohibited by the laws of this realm; for in a settled state governed by law, no man, for any injury whatever, ought to use private revenge. 3 Inst. 157.

And where one party kills the other, it comes within the notion of murder, as being committed by malice aforethought; where the parties meet with an intent to murder, thinking it their duty as gentlemen, and claiming it as their right to wanton with their own lives, and the lives of others, without any warrant for it either human or divine; and therefore the law has justly fixed on them the crime and punishment of murder. 4 Black. 199.

And the law so far abhors all duelling in cold blood, that not only the principal, who actually kills the other, but also his seconds, are guilty of murder, whether they fought or not; and it is holden that the seconds of the party slain are likewise guilty as accessaries. 12 Haw. 8.

DUETT, a composition expressly written for two voices or instruments, with or without a bass and accompaniments. In good duetts, the execution is pretty equally distributed between the two parts; and the melodies so connected, intermingled, and so dependant on each other, as to lose every effect when separated, but to be perfectly related and concinnous when heard together. Yet, how-

ever combined by the disposition of the harmony, the parts are not necessarily to be similar in their motion; indeed it is when the composer is sufficiently master of his art to be able to vary them by contrary directions, that the happiest effects of which this species of composition is capable are most frequently produced.

DUKE, is either the title of a sovereign prince, as the duke of Savoy, Parma, &c. the grand-duke of Tuscany, &c. or it is the title of honour and nobility next below princes. The commanders of armies in time of war, the governors of provinces, and wardens of marches, in time of peace, were called duces, under the latter emperors. The Goths and Vandals divided all Gaul into duchies and counties, the governors of which they sometimes called duces, and sometimes comites. In France, under the second race of kings, though they retained the name and form of ducal government, there were scarcely any dukes except those of Burgundy, Aquitaine, and France.

In England, among the Saxons, the commanders of armies, &c. were called dukes, duces, without any addition, till Edward III. made his son, the Black Prince, duke of Cornwall; after whom there were more made in the same manner, the title descending to their posterity. Duke, at present with us, is a mere title of dignity, without giving any domain, territory, or jurisdiction over the place whence the title is taken. A duke is created by patent, cincture of sword, mantle of state, imposition of a cap and coronet of gold on his head, and a verge of gold put into his hand. His title is Grace; and in the style of the heralds, Most high, potent, high-born, and noble prince.

DULCIMER, a triangular instrument, strung with about fifty wires cast over a bridge at each end; the shortest, or most acute of which, is eighteen inches long, and the longest, or most grave, thirty-six. It is performed upon by striking the wires with little iron rods. This name is also given by the translators of holy writ to an instrument used by the Hebrews, concerning the form, size, and tone of which, there have been various conjectures, but of which nothing certain is known.

DULCINO, the name formerly given to a certain small bassoon, which was used as a tenor to the hautboy.

DULEDGE, in gunnery, a peg of wood which joins the ends of the six felloes that form the round of a wheel of a gun-carriage. The plate of iron on the outside of the wheel, which strengthens the joint, is called the duledge-plate.

DUMBNESS, the privation of the faculty of speech. The most general, and frequently the sole cause of dumbness, is the want of the sense of hearing (see DEAFNESS); language being originally acquired by imitating articulate sounds. From this source of intelligence deaf people are entirely excluded: they cannot acquire articulate sounds by the ear: unless, therefore, articulation can be communicated to them by some other medium, these unhappy people must for ever be deprived of the use of language; and as language is the principal source of knowledge, whoever has the misfortune to want the sense of hearing, must remain in a state little superior to that of the brute creation. Of late years, however, it has been shewn, that although deaf people cannot learn to speak or read by the direction of the ear, there are other sources of imitation, by which the same effect may be produced. The organs of hearing and speech have little or no connection. Persons deprived of the former generally possess the latter in such perfection, that nothing further is necessary, in order to make them articulate, than to teach them how to use these organs. This indeed is no easy task; but the regular seminaries kept near the metropolis, by the late Mr. Braidwood and Mr. Telfair, in which the instruction of deaf and dumb persons has been successfully conducted, shew that it is certainly practicable. The former began with a single pupil in 1764: and since that period has taught great numbers to speak so as to be understood, to read, to write, to understand figures, the principles of religion and morality, &c.

The first thing attempted in the practice of his method is, to teach the pupil to pronounce the simple sounds of the vowels and consonants. The teacher pronounces the sound of the letter *a* very slowly, pointing out the figure of it upon paper at the same time; and makes the pupil observe the motion of his mouth and throat. He then puts his finger into his pupil's mouth, depresses or elevates the tongue, and makes him keep the parts in that position; then he lays hold of the outside of the throat, and applies such a kind of pressure as shall indicate to the pupil a certain necessary action to be performed by the muscles. All the while he is pronouncing *a*, the pupil is anxiously imitating him, but at first seems not to understand what he would have him to do. In this manner he proceeds, till the pupil has learned to pronounce the sounds of the letters. He goes on in the same manner to join a vowel and a consonant, till at length the pupil is enabled both to utter distinct words, and to read.

The pupils instructed in these academies are not only taught the mere pronunciation, but also to understand the meaning of what they read. Of this Mr. Pennant gives a remarkable instance in a young lady of about 13, who had been some time under the care of Mr. Braidwood. "She readily apprehended (says he) all I said, and returned me answers with the utmost facility. She read; she wrote well. Her reading was not by rote. She could clothe the same thoughts in a new set of words, and never vary from the original sense. I have forgotten the book she took up, or the sentences she made a new version of, but the effect was as follows:

"*Original passage.* Lord Bacon has divided the whole of human knowledge into history, poetry, and philosophy; which are referred to the three powers of the mind, memory, imagination, and reason.

"*Version.* A nobleman has parted the total, or all of man's study or understanding, into—An account of the life, manners, religion, or customs of any people or country; verse or metre; moral or natural knowledge: which are pointed to the three faculties of the soul or spirit; the faculty of remembering what is past, thought or conception, and right judgment."

A new and different method, equally laborious and successful, has been practised by the abbé de l'Epée, of Berlin, who, it is said, begins his instructions not by endeavouring to form the organs of speech to articulate sounds, but by communicating ideas to the mind by means of signs and characters: to effect this, he writes the names of things; and, by a regular system of signs, establishes a connection between these words and the ideas to be excited by them. After he has thus furnished his pupils with ideas, and a medium of communication, he teaches them to articulate and pronounce, and renders them not only grammarians but logicians. In this manner he has enabled one of his pupils to deliver a Latin oration in public, and another to defend a thesis against the objections of one of his fellow-pupils in a scholastic disputation, in which the arguments of each were communicated to the other, but whether by signs or in writing is not said; for it does not appear that the abbé teaches his pupils to discern what is spoken, by observing the motion of the organs of speech, which those instructed by other teachers do very readily.

There is perhaps no word, says the abbé, more difficult to explain by signs than the word croire, "to believe." To do this, he writes the verb with its significations in the following manner:

Je crois, Je dis oui par l'esprit, Je pense que oui.
Je dis oui par le cœur, J'aime à penser que oui.
Je dis oui par la bouche.
Je ne vois pas des yeux.

After teaching these four significations, which he does by as many signs, he connects them with the verb, and adds other signs to express the number, person, tense, and mood, in which it is used. If to the four signs corresponding with the lines abovementioned, be added that of a substantive, the pupil will write the word foi, "faith;" but if a sign, indicating a participle used substantively, be adjoined, he will express la croyance, "belief;" to make him write croyable, "credible," the four signs of the verb must be accompanied with one that indicates an adjective terminating in *able;* all these signs are rapidly made, and may be immediately comprehended.

M. Linguet, a member of the Royal Academy, having asserted that persons thus instructed could be considered as little more than automata, the abbé invited him to be present at his lessons, and expressed his astonishment that M. Linguet should be so prejudiced in favour of the medium by which he had received the first rudiments of knowledge, as to conclude that they could not be imparted by any other: desiring him, at the same time, to reflect, that the connection between ideas and the articulate sounds, by which they are excited in the mind, is not less arbitrary than that between these ideas and the written characters which are made to represent them to the eye. M. Linguet complied with the invitation; and the abbé having desired him to fix on some abstract term which he would by signs communicate to his pupils, he chose the word "unintelligibility;" which, to his astonishment, was almost instantly written by one of them. The abbé informed him, that to communicate this word he had used five signs, which, though scarce-

ly perceivable to him, were immediately and distinctly apprehended by his scholars: the first of these signs indicated an internal action; the second represented the act of a mind that reads internally, or, in other words, comprehends what is proposed to it; a third signified that such a disposition is possible; these, taken together, form the word "intelligible:" a fourth sign transforms the adjective into the substantive; and a fifth, expressing negation, completes the word required. M. Linguet afterwards proposed this question, "What do you understand by metaphysical ideas?" which being committed to writing, a young lady immediately answered on paper in the following terms: "I understand the ideas of things which are independant of our senses, which are beyond the reach of our senses, which make no impression on our senses, which cannot be perceived by our senses."

DUMBNESS, *periodical*. In the German Ephemerides is an account of an innkeeper's son affected with a periodical dumbness, which had continued for fifteen years. The loss of speech was at first instantaneous, and continued only a few minutes; but the duration of it began to lengthen every day: so that it soon amounted to half an hour, two hours, three hours, and at last to 23 hours, yet without any order. At last the return of speech kept so constant and regular an order, that, for 14 years together, he could not speak except from noon, during the space of one entire hour, to the precise moment of one o'clock. Every time he lost his speech, he felt a sense of something rising from his stomach to his throat, but in other respects was in good health. Both his internal and external senses also continued sound: he heard always perfectly well, and answered the questions proposed to him by gestures or in writing. The account states, that all suspicion of imposture was removed by his keeping exactly the same hour, though he had no access to any instruments by which time can be measured.

DUM FUIT INFRA ÆTATEM, a writ that lies for him, who, before he came to his full age, made a feoffment of his land in fee, or for a term of life, or in tail, to recover them again from him to whom he conveyed them.

DUM NON FUIT COMPOS MENTIS, a writ that lies against the alienee, or lessee, for him that not being of sound memory, aliened any lands or tenements in fee-simple, fee-tail, or for term of life, or for years.

DUNG-MEERS, in husbandry, places where soils and dungs are mixed and digested together. For this purpose it is usual to dig a pit sufficient to hold the stock of soil the husbandman is capable of making; and to prepare it at the bottom with stone and clay, that it may hold water, or the moisture of the dung; and besides, it should be so situated that the sinks and drips of the houses and barns may run into it. Into this pit they cast refuse-fodder, litter, dung, weeds, &c. where they lie and rot together, till the farmer has occasion for it. Where such a pit is wanting, it is proper to cover the dung with turf, or other stuff, to prevent the sun and wind from drawing off its virtues. See HUSBANDRY.

DUODENUM, in anatomy, the first of the small guts, intestina tenuia, so called from its length, which is about twelve fingers breadth.

DUPLE, among mathematicians, denotes the ratio of 2 to 1. Thus the ratio of 8 to 4 is duple, or as 2 to 1.

Sub-DUPLE RATIO is just the reverse of the former, or as 1 to 2. Such is 4 to 8, or 6 to 12.

DUPLICATE, among lawyers, denotes a copy of any deed, writing, or account. It is also used for the second letters patent, granted by the lord chancellor in a case wherein he had before done the same. Also, a second letter written and sent to the same party and purpose as a former, for fear of the first's miscarrying, is called a duplicate.

DUPLICATE PROPORTION, or RATIO, is a ratio compounded of two ratios: thus, the duplicate ratio of a to b, is the ratio of $a\,a$ to $b\,b$, or of the square of a to the square of b. Hence the duplicate ratio ought to be well distinguished from double.

In a series of geometrical proportionals, the first term to the third is said to be in a duplicate ratio of the first to the second: thus in 2, 4, 8, 16, &c. the ratio of 2 to 8 is duplicate of that of 2 to 4, or as the square of 2 to the square of 4. Duplicate ratio is therefore the proportion of squares, as triplicate is of cubes, &c. and the ratio of 2 to 8 is said to be compounded of that of 2 to 4, and of 4 to 8.

DUPLICATION, in general, signifies the doubling of any thing, or multiplying of it by 2: also the folding of any thing back again on itself.

The duplication of a cube is a problem famous in antiquity: it was proposed by the oracle at Delphos, as a means to stop the plague, to double Apollo's altar, which was cubical. See CUBE.

DUPLICATURE, among anatomists, a term used to denote the folds of any membrane, or vessel: thus we say, the duplicatures of the intestines, peritonæum, &c. See ANATOMY.

DUPONDIUS, in antiquity, the weight of two pounds; also a piece of money equal to two ases in value.

DURA MATER, in anatomy, one of the membranes, as they are called, which surround the brain.

DURATE', in music, a term properly applicable to whatever offends the ear by its effect. The B natural, on account of its hardness, was formerly called B duraté. There are rough or hard intervals in melody; such are those produced by the regular series of three whole tones, whether ascending or descending, and such are all false relations.

DURANTA, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is quinquefid, superior; the berry tetraspermous; the seeds bilocular. There are three species, shrubs of South America.

DURESS, in law, is where a man is kept in prison, or restrained of his liberty, contrary to the order of law; or threatened to be killed, maimed, or beaten; and if such person so in prison, or in fear of such threats, make any specialty or obligation by reason thereof, such deed is void in law; and in any action brought upon such specialty, the party may plead that it was made by duress, and so he may avoid the action. Cowel.

Every act of contract must be altogther the act of the understanding, which those are incapable of using, who are under restraint and terrors; and therefore the law requires the free assent of the parties as essential to every contract, and that they be not under any force or violence. 2 Bac. Abr. 155.

DURIO, a genus of the class and order polyadelphia polyandria. The calyx is five-cleft; corolla five-petalled; style one; stamina in five bodies; pome five-celled. There is one species, a tree of the East Indies.

DUROIA, in botany, a genus of the monogynia order, belonging to the hexandria class of plants. The calyx above is cylindrical and lobed; the border six-parted; there are no filaments; the fruit a hispid apple. There is one species, a tree of Surinam.

DUTCHY-COURT. See CHANCELLOR.

DUTY, in policy and commerce, signifies the impost laid on merchandises, at importation or exportation, commonly called the duties of customs; also the taxes of excise, stamp-duties, &c. See CUSTOMS, EXCISE, &c.

There is no task more delicate or difficult to a statesman than the laying on of duties or imposts. Experience teaches us that a very small duty laid on commodities raises the price of them considerably to the consumer, beyond the gross duty. By the fees given to officers; by tradesmen's loss of time in attending upon excisemen, or at custom-houses; by taking away a quarter of our traders' stock for duties; and forcing them to take as great pains on one quarter of their stock laid out in goods, in order to live, as they would on the whole, if duty-free; by tradesmen's profits on the duty, and advances in all the hands that all taxed goods come through to the consumer: as for example, suppose there should be no other tax but that on leather, let us see how many advances that would make on the price of shoes.

The grazier lays (1) on the beast he fats, his advanced price of shoes: he sells to the butcher, who takes (2) his profit on the grazier's advanced price of the beast; and raises (3) on the hide his advanced price of shoes: he sells to the tanner, whose journeymen raise (4) their wages, on account of the advanced price of shoes; the tanner pays (5) the tax of two-pence per pound on the leather; takes (6) his profit on the before-mentioned five advances, and raises (7) his advanced price of shoes on the tanned hide: he sells to the leather-cutter, who takes (8) his profit on the before-mentioned seven advances, and raises (9) on the hide he cuts, his advanced price of shoes: he sells to the shoemaker, whose journeymen raise (10) their wages, on account of their advanced price of shoes; the shoemaker takes (11) his profit on the before-mentioned ten advances, and raises (12) on the shoes he makes the advanced price of the shoes he wears: he sells to the consumer with all these twelve advances, highly magnified beyond the bare duty.

So much for the tax on leather only; but the grazier, butcher, tanner, leather-cutter, and shoemaker, use soap: that soap, like

leather, is taxed, and, like that leather-tax, must be raised: but that caused twelve advances on our shoes; place therefore twelve advances more on shoes for the soap-tax. These tradesmen use candles; twelve advances more for the tax on them: and the same for every other tax on necessaries. All which, duly considered, might be computed at above cent. per cent. on the gross produce of the duties; but though the large duties cause some farther advance on all the goods they are laid on, charged with profit upon profit through every hand they pass, yet as they keep not pace with the small duties, and as all calculations appear fair when moderate, let us abate in the advances, and set them down only at 50 per cent.

DUTY, in the military art, is the exercise of those functions that belong to a soldier; with this distinction, that mounting guards and the like, where there is no enemy directly to be engaged, is called duty; but their marching to meet and fight an enemy is called going on service.

DUUMVIRI, in Roman antiquity, a general appellation given to magistrates, commissioners, and officers, where two were joined together in the same functions.

DUUMVIRI CAPITALES were the judges in criminal causes: from their sentence it was lawful to appeal to the people, who only had the power of condemning a citizen to death. The judges were taken from the body of the decuriones; they had great power and authority, were members of the public council, and had two lictors to walk before them.

DUUMVIRI MUNICIPALES, were two magistrates in some cities of the empire, answering to what the consuls were at Rome: they were chosen out of the body of the decuriones; their office lasted commonly five years, upon which account they were frequently termed quinquinales magistratus. Their jurisdiction was of great extent: they had officers walking before them, carrying a small switch in their hands; and some of them assumed the privilege of having lictors, carrying axes and the fasces, or bundles of rods, before them.

DUUMVIRI NAVALES, were the commissaries of the fleet, first created at the request of M. Decius, tribune of the people, in the time of the war with the Samnites. The duty of their office consisted in giving orders for the fitting of ships, and giving their commissions to the marine officers, &c.

DUUMVIRI SACRORUM were magistrates created by Tarquinius Superbus, for the performance of the sacrifice, and keeping of the sybil's books. They were chosen from among the patricians, and held their office for life: they were exempted from serving in the wars, and from the offices imposed on the other citizens, and without them the oracles of the sybil could not be consulted.

DWARF, in general, an appellation given to things greatly inferior in size to that which is usual in their several kinds; thus there are dwarfs of the human species, dwarf dogs, dwarf trees, &c.

Dwarf fruit-trees may be propagated by grafting them on a quince-stock, about six inches above the ground; and when the bud is shot so far as to have four eyes, it must be stopped, to give rise to lateral branches; for which purpose the uppermost eye should always be left outwards. Apple, pear, plum, and cherry-trees are thus formed into dwarfs; but the summer and autumn pears are found to succeed best.

As to the planting of dwarf trees, they should be set at 25 feet square distance, and the ground between sown or planted for kitchen use while the trees are young, only keeping at some distance from their roots: stakes also should be fixed all round them, to which the branches may be nailed with list, and trimmed in an horizontal direction, and prevented from crossing one another.

DYE, in architecture, any square body, as the trunk, or notched part, of a pedestal. See ARCHITECTURE.

DYE is also used for a cube of stone placed under the feet of a statue, and over its pedestal, to raise it, and shew it the more.

DYEING. *Principles of dyeing.*—The substances commonly employed for clothing may be reduced to four; namely wool, silk, cotton, and linen.

Permanent alterations in the colour of cloth can only be induced two ways; either by producing a chemical change in the cloth, or by covering its fibres with some substance which possesses the wished-for colour. Recourse can seldom or never be had to the first method, because it is hardly possible to produce a chemical change in the fibres of cloth, without spoiling its texture, and rendering it useless. The dyer, therefore, when he wishes to give a new colour to cloth, has always recourse to the second method.

The substances employed for this purpose are called colouring matters, or dye-stuffs. They are for the most part extracted from animal and vegetable substances, and have usually the colour which they are to give to the cloth.

Since the particles of colouring matter with which cloth, when dyed, is covered, are transparent, it follows, that all the light reflected from dyed cloth must be reflected, not by the dye-stuff itself, but by the fibres of the cloth below the dye stuff. The colour therefore does not depend upon the dye alone, but also upon the previous colour of the cloth. If the cloth is black, it is clear that we cannot dye it any other colour whatever; because as no light in that case is reflected, none can be transmitted, whatever dye-stuff we employ. If the cloth was red, or blue, or yellow, we could not dye it any colour except black; because, as only red, or blue, or yellow rays were reflected, no other could be transmitted. Hence the importance of a fine white colour, when cloth is to receive bright dyes. It then reflects all the rays in abundance, and therefore any colour may be given, by covering it with a dye-stuff which transmits only some particular rays.

If the colouring matters were merely spread over the surface of the fibres of cloth by the dyer, the colours produced might be very bright, but they could not be permanent; because the colouring matter would be very soon rubbed off; and would totally disappear whenever the cloth was washed, or even barely exposed to the weather. The colouring matter then, however perfect a colour it possesses, is of no value, unless it also adheres so firmly to the cloth that none of the substances usually applied to cloth, in order to clean it, &c. can displace it. Now this can only happen, when there is a strong affinity between the colouring matter and the cloth, and when they are actually combined together in consequence of that affinity.

Dyeing then is merely a chemical process, and consists in combining a certain colouring matter with fibres of cloth. This process can in no instance be performed, unless the dye-stuff is first reduced to its integrant particles; for the attraction of aggregation between the particles of dye-stuffs, is too great to be overcome by the affinity between them and the cloth, unless they could be brought within much smaller distances than is possible while they both remain in a solid form. It is necessary, therefore, previously to dissolve the colouring matter in some liquid or other, which has a weaker affinity for it than the cloth has. When the cloth is dipped into this solution, the colouring matter, reduced by this contrivance to a liquid state, is brought within the attracting distance; the cloth therefore acts upon it, and from its stronger affinity, takes it from the solvent, and fixes it upon itself. By this contrivance too, the equality of the colour is in some measure secured, as every part of the cloth has an opportunity of attracting to itself the proper proportion of colouring particles.

The facility with which cloth imbibes a dye, depends upon two circumstances; namely, the affinity between the cloth and the dye-stuff, and the affinity between the dye-stuff and its solvent. It is directly as the former, and inversely as the latter. It is of importance to preserve a due proportion between these two affinities, as upon that proportion much of the accuracy of dyeing depends. If the affinity between the colouring matter and the cloth is too great, compared with the affinity between the colouring matter and the solvent, the cloth will take the dye too rapidly, and it will be scarcely possible to prevent its colour from being unequal. On the other hand, if the affinity between the colouring matter and the solvent is too great, compared with that between the colouring matter and the cloth, the cloth will either not take the colour at all, or it will take it very slowly and very faintly.

Wool has the strongest affinity for almost all colouring matters, silk the next strongest, cotton a considerably weaker affinity, and linen the weakest affinity of all. In order therefore, to dye cotton or linen, the dye stuff should in many cases be dissolved in a substance for which it has a weaker affinity than for the solvent employed in the dyeing of wool or silk. Thus we may use oxide of iron dissolved in sulphuric acid, in order to dye wool; but for cotton and linen, it is better to dissolve it in acetous acid.

Was it possible to procure a sufficient number of colouring matters, having a strong affinity for cloth, to answer all the purposes of dyeing, that art would be exceedingly simple and easy. But this is by no means the case; if we except indigo, the dyer is scarcely possessed of a dye-stuff which yields of itself a good colour, sufficiently permanent to deserve the name of a dye.

This difficulty, which at first sight appears insurmountable, has been obviated by a very ingenious contrivance. Some substance is employed, which has a strong affinity, both for the cloth and the colouring matter. This substance is previously combined with the

cloth, which is then dipped into the solution containing the dye-stuff. The dye-stuff combines with the intermediate substance, which, being firmly combined with the cloth, secures the permanence of the dye. Substances employed for this purpose are denominated mordants.

The most important part of dyeing, is undoubtedly the proper choice, and the proper application, of mordants; as upon them, the permanency of almost every dye depends. Every thing which has been said respecting the application of colouring matters, applies equally to the application of mordants. They must be previously dissolved in some liquid, which has a weaker affinity for them than the cloth has, to which they are to be applied; and the cloth must be dipped, or even steeped in this solution, in order to saturate itself with the mordant.

Almost the only substances used as mordants, are earths, metallic oxides, tan, and oil.

Of earthy mordants the most important, and most generally used, is alumina. It is used either in the state of common alum, in which it is combined with sulphuric acid, or in that of acetite of alumina.

Alum, when used as a mordant, is dissolved in water, and very frequently a quantity of tartar is dissolved along with it. Into this solution the cloth is put, and kept in it till it has absorbed as much alumina as is necessary. It is then taken out, and for the most part washed and dried. It is now a good deal heavier than it was before, owing to the alumina which has combined with it. The tartar serves two purposes; the potass which it contains, combines with the sulphuric acid of the alum, and thus prevents that very corrosive substance from injuring the texture of the cloth, which otherwise might happen: the tartareous acid, on the other hand, combines with part of the alumina, and forms a tartrite of alumina, which is more easily decomposed by the cloth than alum.

Acetite of alumina has been but lately introduced into dyeing. This mordant is now prepared by pouring acetite of lead into a solution of alum; a double decomposition takes place, the sulphureous acid combines with the lead, and the compound precipitates, in the form of an insoluble powder, while the alumina combines with the acetous acid, and remains dissolved in the liquid. This mordant is employed for cotton and linen, which have a weaker affinity than wool for alumina. It answers much better than alum; the cloth is more easily saturated with alumina, and takes, in consequence, both a richer and a more permanent colour.

Besides alumina, lime is sometimes used as a mordant. Cloth has a strong affinity enough for it; but, in general, it does not answer so well, as it does not give so good a colour. When used, it is either in the state of lime-water, or of sulphate of lime dissolved in water.

Almost all the metallic oxides have an affinity for cloth, but only two of them are extensively used as mordants, namely, the oxides of tin, and of iron.

The oxide of tin was first introduced into dyeing by Kuster, a German chemist, who brought the secret to London in 1543. This period forms an æra in the history of dyeing. The oxide of tin has enabled the moderns greatly to surpass the antients in the fineness of their colours; by means of it alone, scarlet, the brightest of all colours, is produced.

Tin, as Proust has proved, is capable of two degrees of oxydation. The first oxide is composed of 0.70 parts of tin, and 0.30 of oxygen; the second, or white oxide, of 0.60 parts of tin, and 0.40 of oxygen. The first oxide absorbs oxygen with very great facility, even from the air, and is rapidly converted into white oxide. This fact makes it certain, that it is the white oxide of tin alone, which is the real mordant; even if the other oxide was applied to cloth, as it probably often is, it must soon be converted into white oxide, by absorbing oxygen from the atmosphere.

Tin is used as a mordant in three states: dissolved in nitro-muriatic acid, in acetous acid, and in a mixture of sulphuric and muriatic acids. Nitro-muriate of tin is the common mordant employed by dyers. They prepare it by dissolving tin in diluted nitric acid, to which a certain proportion of muriate of soda (common salt), or of ammonia (sal ammoniac), is added. Part of the nitric acid decomposes these salts, combines with their base, and sets the muriatic acid at liberty. It was prepared at first with nitric acid alone, but that mode was very defective, because the nitric acid very readily converts tin to white oxide, and then is incapable of dissolving it; the consequence of which was, the precipitation of the whole of the tin. To remedy this defect, common salt, or sal ammoniac, was very soon added; muriatic acid having the property of dissolving white oxide of tin very readily. A considerable saving of nitric acid might be obtained, by employing as much sulphuric acid as is just sufficient to saturate the base of the common salt, or sal ammoniac, employed.

When the nitro-muriate of tin is to be used as a mordant, it is dissolved in a large quantity of water, and the cloth is dipped in the solution, and allowed to remain till sufficiently saturated. It is then taken out, and washed and dried. Tartar is usually dissolved in the water along with the nitro-muriate. The consequence of this is a double decomposition: the nitro-muriatic acid combines with the potass of the tartar, while the tartareous acid dissolves the oxide of tin. When tartar is used, therefore, in any considerable quantity, the mordant is not a nitro-muriate, but a tartrite of tin.

Iron, like tin, is capable of two degrees of oxydation; but the green oxide absorbs oxygen so readily from the atmosphere, that it is very soon converted into the red oxide. It is only this last oxide which is really used as a mordant in dyeing. The green oxide is, indeed, sometimes applied to cloth; but it very soon absorbs oxygen, and is converted into the red oxide. This oxide has a very strong affinity for all kinds of cloth. The permanency of the iron-spots on linen and cotton is a sufficient proof of this. As a mordant, it is used in two states; in that of sulphate of iron (copperas), and acetite of iron. The first is commonly used for wool. The salt is dissolved in water, and the cloth dipped in it. It may be used also for cotton, but in most cases acetite of iron is preferred. It is prepared by dissolving iron, or its oxide, in vinegar, sour beer, &c. and the longer it is kept, the more it is preferred. The reason is, that this mordant succeeds best when the iron is in the state of red oxide. It would be better then to oxidate the iron, or convert it into rust, before using it; which might be easily done, by keeping it for some time in a moist place, and sprinkling it occasionally with water

Tan has a very strong affinity for cloth, and for several colouring matters; it is therefore very frequently employed as a mordant. An infusion of nut-galls, or of sumach, or any other substance containing tan, is made in water, and the cloth is dipped in this infusion, and allowed to remain till it has absorbed a sufficient quantity of tan. Silk is capable of absorbing a very great proportion of tan, and by that means acquires a great increase of weight. Manufacturers sometimes employ this method of increasing the weight of silk.

Tan is often employed also, along with other mordants, in order to produce a compound mordant. Oil is also used for the same purpose, in the dyeing of cotton and linen. The mordants with which tan most frequently is combined, are alumina, and oxide of iron.

Besides these mordants, there are several other substances frequently used as auxiliaries, either to facilitate the combination of the mordant with the cloth, or to alter the shade of colour; the chief of these are, tartar, acetite of lead, common salt, sal ammoniac, sulphate or acetite of copper, &c.

Mordants not only render the dye permanent, but have also considerable influence on the colour produced. The same colouring matter produces very different dyes, according as the mordant is changed. Suppose, for instance, that the colouring matter is cochineal; if we use the aluminous mordant, the cloth will acquire a crimson colour; but the oxide of iron produces with it a black.

In dyeing then, it is not only necessary to procure a mordant which has a sufficiently strong affinity for the colouring matter and the cloth, and a colouring matter which possesses the wished-for colour in perfection, but we must procure a mordant and a colouring matter of such a nature, that when combined together, they shall possess the wished-for colour in perfection. It is evident too, that a great variety of colours may be produced with a single dye-stuff, provided we can change the mordant sufficiently.

The colouring matter with which the cloth is dyed, does not cover every portion of its surface; its particles attach themselves to the cloth at certain distances from each other; for cloth may be dyed different shades of the same colour, lighter or darker, merely by varying the quantity of colouring matter. With a small quantity, the shade is light; and it becomes deeper as the quantity increases. Now this would be impossible, if the dye-stuff covered the whole of the cloth.

That the particles of colouring matter, even when the shade is deep, are at some distance, is evident from this well-known fact, that cloth may be dyed two colours at the same time. All those colours to which the dyers give the name of compound, are in fact two different colours applied to the cloth at once. Thus cloth gets a green colour, by being first dyed blue and then yellow.

The colours denominated by dyers simple, because they are the foundation of all their other processes, are four; namely, first, blue; second, yellow; third, red; fourth, black. To these they usually add a fifth, under the name of root or brown colour.

Of dyeing blue.—The only colouring matters employed in dyeing blue, are woad and indigo.

Woad is a plant cultivated in this kingdom, and even growing wild in some parts of England.

Indigo is a blue powder, extracted from a species of plant which is cultivated for that purpose in the East and West Indies. These plants contain a peculiar green pollen, which in that state is soluble in water. This pollen has a strong affinity for oxygen, which it attracts greedily from the atmosphere; in consequence of which it assumes a blue colour, and becomes insoluble in water.

Indigo has a very strong affinity for wool, silk, cotton, and linen. Every kind of cloth, therefore, may be dyed with it, without the assistance of any mordant whatever. The colour thus induced is very permanent; because the indigo is already saturated with oxygen, and because it is not liable to be decomposed by those substances, to the action of which the cloth is exposed. But it can only be applied to cloth in a state of solution; and the only solvent known being sulphuric acid, it would seem at first sight, that the sulphuric acid solution is the only state in which indigo can be employed as a dye.

The sulphate of indigo is indeed often used to dye wool and silk blue; but it can scarcely be applied to cotton and linen, because the affinity of these substances for indigo is not great enough to enable them readily to decompose the sulphate. The colour given by sulphate of indigo is exceedingly beautiful; it is known by the name of Saxon blue.

One part of indigo is to be dissolved in four parts of concentrated sulphuric acid; to the solution one part of dry carbonate of potass is to be added, and then it is to be diluted with eight times its weight of water. The cloth must be boiled for an hour in a solution, containing five parts of alum, and three of tartar, for every 32 parts of cloth. It is then to be thrown into a water-bath, containing a greater or smaller proportion of the diluted sulphate of indigo, according to the shade which the cloth is intended to receive. In this bath it must be boiled till it has acquired the wished-for colour.

The alum and tartar are not intended to act as mordants, but to facilitate the decomposition of the sulphate of indigo. The alkali added to the sulphate, answers the same purpose. These substances also, by saturating part of the sulphuric acid, serve in some measure to prevent the texture of the cloth from being injured by the action of the acid, which is very apt to happen in this process.

But sulphate of indigo is by no means the only solution of that pigment employed in dyeing. By far the most common method is, to deprive indigo of the oxygen, to which it owes its blue colour, and thus to reduce it to the state of green pollen; and then to dissolve it in water by means of alkalis, or alkaline earths, which in that state act upon it very readily.

Two different methods are employed for this purpose. The first of these methods is, to mix with indigo a solution of some substance which has a stronger affinity for oxygen than the green basis of indigo; green oxide, for instance, and different metallic sulphurets. If therefore indigo, lime, and green sulphate of iron, are mixed together in water, the indigo gradually loses its blue colour, becomes green, and is dissolved; while the green oxide of iron is converted into the red oxide. The manner in which these changes take place is obvious; part of the lime decomposes the sulphate of iron; the green oxide, the instant that it is set at liberty, attracts oxygen from the indigo, decomposes it, and reduces it to the state of green pollen. This green pollen is immediately dissolved by the action of the rest of the lime.

The second method is, to mix the indigo in water with certain vegetable substances, which readily undergo fermentation. During this fermentation, the indigo is deprived of its oxygen, and dissolved by means of quick-lime or alkali, which is added to the solution. The first of these methods is usually followed in dyeing cotton and linen; the second, in dyeing wool and silk.

In the dyeing of wool, woad and bran are commonly employed as vegetable ferments, and lime as the solvent of the green base of the indigo. Woad itself contains a colouring matter precisely similar to indigo; and by following the common process, indigo may be extracted from it. In the usual state of woad, when purchased by the dyer, the indigo which it contains is probably not far from the state of the green pollen. Its quantity in woad is but small, and it is mixed with a great proportion of other vegetable matter.

When the cloth is first taken out of the vat, it is of a green colour; but it soon becomes blue, by attracting oxygen from the air. It ought to be carefully washed, to carry off the uncombined particles. This solution of indigo is liable to two inconveniences: first, it is apt sometimes to run too fast into the putrid fermentation; this may be known by the putrid vapours which it exhales, and by the disappearing of the green colour. In this state it would soon destroy the indigo altogether. The inconvenience is remedied by adding more lime, which has the property of moderating the putrescent tendency. Secondly, sometimes the fermentation goes on too languidly. This defect is remedied by adding more bran or woad, in order to diminish the proportion of quick-lime.

Silk is dyed light-blue by a ferment of six parts of bran six of indigo, six of potass, and one of madder. To dye it of a dark blue, it must previously receive what is called a ground-colour; a red dye-stuff, called archil, is used for this purpose.

Cotton and linen are dyed blue by a solution of one part of indigo, one part of green sulphate of iron, and two parts of quick-lime.

Of dyeing yellow.—The principal colouring matters for dyeing yellow are weld, fustic, and quercitron bark.

Weld is a plant which grows commonly in this country, reseda luteola.

Fustic is the wood of a large tree which grows in the West Indies, morus tinctoria.

Quercitron is a tree growing in North America, the bark of which contains colouring matter.

Yellow colouring matters have too weak an affinity for cloth, to produce permanent colours without the use of mordants. Cloth, therefore, before it is dyed yellow, is always prepared by combining some mordant or other with it. The mordant most commonly employed for this purpose, is alumina. Oxide of tin is sometimes used when very fine yellows are wanting. Tan is often employed as a subsidiary to alumina, and in order to fix it more copiously on cotton and linen. Tartar is also used as an auxiliary, to brighten the colour; and muriate of soda, sulphate of lime, and even sulphate of iron, in order to render the shade deeper.

The yellow dyed by means of fustic is more permanent, but not so beautiful as that given by weld, or quercitron. As it is permanent, and not much injured by acids, it is often used in dyeing compound colours, where a yellow is required. The mordant is alumina. When the mordant is oxide of iron, fustic dyes a good permanent drab colour.

Weld and quercitron bark yield nearly the same kind of colour; but as the bark yields colouring matter in much greater abundance, it is much more convenient, and upon the whole, cheaper than weld. It is probable, therefore, that it will gradually supersede the use of that plant. The method of using each of these dye-stuffs is nearly the same.

Wool may be dyed yellow by the following process: Let it be boiled for an hour or more with about $\frac{1}{6}$th of its weight of alum, dissolved in a sufficient quantity of water. It is then to be plunged, without being rinsed, into a bath of warm water, containing in it as much quercitron bark, as equals the weight of the alum employed as a mordant. The cloth is to be turned through the boiling liquid, till it has acquired the intended colour. Then a quantity of clean powdered chalk, equal to the hundredth part of the weight of the cloth, is to be stirred in, and the operation of dyeing continued for eight or ten minutes longer. By this method a pretty deep and lively yellow may be given, fully as permanent as weld yellow.

For very bright orange or golden yellow, it is necessary to have recourse to the oxide of tin as a mordant.

For producing bright golden yellows, some alum must be added along with the tin.

In order to give the yellow that delicate green shade so much admired for certain purposes, tartar must be added in different proportions, according to the shade.

By adding a small proportion of cochineal, the colour may be raised to a fine orange, or even an aurora.

Silk may be dyed different shades of yellow, either by weld or quercitron bark, but the last is the cheapest of the two. The proportion should be from one to two parts of bark to twelve parts of silk, according to the shade. The bark, tied up in a bag, should be put into the dyeing vessel, while the water which it contains is cold; and when it has acquired the heat of about 100°, the silk, having been previously alumed, should be dipped in, and continued till it assumes the wished-for colour. When the shade is required to be deep, a little chalk or pearl-ash should be added towards the end of the operation.

The best method of dyeing cotton and linen yellow, is as follows:

The mordant should be acetite of alumina, prepared by dissolving one part of acetite of

lead, and three parts of alum, in a sufficient quantity of water. This solution should be heated to the temperature of 100°: the cloth should be soaked in it for two hours, then wrung out and dried. The soaking may be repeated, and the cloth again dried as before. It is then to be barely wetted with lime-water, and afterwards dried. The soaking in the acetite of alumina may be again repeated; and if the shade of yellow is required to be very bright and durable, the alternate wetting with lime-water and soaking in the mordant may be repeated three or four times. By this contrivance, a sufficient quantity of alumina is combined with the cloth, and the combination is rendered more permanent by the addition of some lime. The dyeing-bath is prepared by putting 12 or 18 parts of quercitron bark (according to the depth of the shade required), tied up in a bag, into a sufficient quantity of cold water. Into this bath the cloth is to be put, and turned round in it for an hour, while its temperature is gradually raised to about 120°. It is then to be brought to a boiling heat, and the cloth allowed to remain in it after that only a few minutes. If it is kept long at a boiling heat, the yellow acquires a shade of brown.

Of dyeing red.—The colouring matters employed for dyeing red, are kermes, cochineal, archil, madder, carthamus, and Brazil-wood.

Kermes is a species of insect, affording a red colour by solution in water; but it is not so beautiful as cochineal, which is likewise an insect brought from America (see both under Coccus). The decoction of cochineal is a very beautiful crimson-colour. Alum brightens the colour of the decoction, and occasions a crimson precipitate. Muriate of tin gives a copious fine red precipitate.

Archil is a paste formed of a species of lichen pounded, and kept moist for some time with stale urine.

Madder is the root of a well-known plant, rubia tinctorum.

Carthamus is the flower of a plant (carthamus tinctorius), cultivated in Spain and the Levant. It contains two colouring matters: a yellow, which is soluble in water; and a red, insoluble in water, but soluble in alkaline carbonates. The red colouring matter of carthamus, extracted by carbonate of soda, and precipitated by lemon-juice, constitutes the rouge employed by ladies as a paint. It is afterwards ground with a certain quantity of talc. The fineness of the talc, and the proportion of it mixed with the carthamus, occasion the difference between the cheaper and dearer kinds of rouge.

Brazil-wood is the wood of a tree growing in America and the West Indies (See Cæsalpinia). Its decoction is a fine red colour.

None of the red colouring matters has so strong an affinity for cloth as to produce a permanent red, without the assistance of mordants. The mordants employed are alumina and oxide of tin; oil, and tan, in certain processes, are also used; and tartar, and muriate of soda, are frequently called in as auxiliaries.

Coarse woollen stuffs are dyed red with madder or archil; but fine cloth is almost exclusively dyed with cochineal, though the colour which it receives from kermes is much more durable. Brazil-wood is scarcely used, except as an auxiliary, because the colour which it imparts to wool is not permanent.

Wool is dyed crimson, by first impregnating it with alumina, by means of an alum bath, and then boiling it in a decoction of cochineal, till it has acquired the wished-for colour. The crimson will be finer if the tin mordant is substituted for alum; indeed, it is usual with dyers to add a little nitro-muriate of tin, when they want fine crimsons. The addition of archil and potass to the cochineal, both renders the crimson darker, and gives it more bloom; but the bloom very soon vanishes. For paler crimsons, one-half of the cochineal is withdrawn, and madder substituted in its place.

Wool may be dyed scarlet, the most splendid of all colours, by first boiling it in a solution of murio-sulphate of tin, then dyeing it pale yellow with quercitron bark, and afterwards crimson with cochineal; for scarlet is a compound colour consisting of crimson mixed with a little yellow.

Silk is usually dyed red with cochineal or carthamus, and sometimes with Brazil-wood. Kermes does not answer for silk; madder is scarcely ever used for that purpose, because it does not yield a colour bright enough. Archil is employed to give silk a bloom; but it is scarcely used by itself, unless when the colour wanted is lilac.

Silk may be dyed crimson by steeping it in a solution of alum, and then dyeing it in the usual way in a cochineal bath.

The colours known by the names of poppy, cherry, rose, and flesh-colour, are given to silk by means of carthamus. The process consists merely in keeping the silk as long as it extracts any colour, in an alkaline solution of carthamus, into which as much lemon-juice, as gives it a fine cherry colour has been poured.

Silk cannot be dyed a full scarlet; but a colour approaching to scarlet may be given it, by first impregnating the stuff with murio-sulphate of tin, and afterwards dyeing it in a bath, composed of four parts of cochineal, and four parts of quercitron bark. To give the colour more body, both the mordant and the dye may be repeated. A colour approaching scarlet may be also given to silk, by first dyeing it in crimson, then dyeing it with carthamus, and lastly, yellow without heat. Cotton and linen are dyed red with madder. The process was borrowed from the East; hence the colour is often called Adrianople or Turkey red. The cloth is first impregnated with oil, then with galls, and lastly with alum. It is then boiled for an hour in a decoction of madder, which is commonly mixed with a quantity of blood. After the cloth is dyed, it is plunged into a soda ley, in order to brighten the colour. The red given by this process, is very permanent, and when properly conducted, it is exceedingly beautiful. The whole difficulty consists in the application of the mordant, which is by far the most complicated employed in the whole art of dyeing.

Cotton may be dyed scarlet, by means of murio-sulphate of tin, cochineal, and quercitron bark, used as for silk, but the colour is too fading to be of any value.

Of dyeing black.—The substances employed to give a black colour to cloth are, red oxide of iron, and tan. These two substances have a strong affinity for each other; and when combined, assume a deep black colour, not liable to be destroyed by the action of air or light

Logwood is usually employed as an auxiliary, because it communicates lustre, and adds considerably to the fullness of the black. It is the wood of a tree (See Hæmatoxylon) which is a native of several of the West India islands, and of that part of Mexico which surrounds the Bay of Honduras. It yields its colouring matter to water. The decoction is at first a fine red, bordering on violet; but if left to itself, it gradually assumes a black colour. Acids give it a deep red colour; alkalis a deep violet, inclining to brown; sulphate of iron renders it as black as ink, and occasions a precipitate of the same colour.

Cloth, before it receives a black colour, is usually died blue: this renders the colour much fuller and finer than it would otherwise be. If the cloth is coarse, the blue dye may be too expensive; in that case, a brown colour is given, by means of walnut-peels.

Wool is dyed black by the following process. It is boiled for two hours in a decoction of nut-galls, and afterwards kept for two hours more in a bath composed of logwood and sulphate of iron, kept during the whole time at a scalding heat, but not boiled. During the operation, it must be frequently exposed to the air; because the green oxide of iron, of which the sulphate is composed, must be converted into red oxide by absorbing oxygen, before the cloth can acquire a proper colour. The common proportions are five parts of galls, five of sulphate of iron, and thirty of logwood, for every hundred of cloth. A little acetite of copper is commonly added to the sulphate of iron, because it is thought to improve the colour.

Silk is dyed nearly in the same manner. It is capable of combining with a great deal of tan; the quantity given is varied at the pleasure of the artist, by allowing the silk to remain a longer or shorter time in the decoction.

It is by no means so easy to give a full black to linen and cotton. The cloth, previously dyed blue, is steeped for 24 hours in a decoction of nut-galls. A bath is prepared, containing an acetite of iron, formed by saturating acetous acid with brown oxyd of iron: into this bath the cloth is put in small quantities at a time, wrought with the hand for a quarter of an hour, then wrung out, and aired again; wrought in a fresh quantity of the bath, and afterwards aired. These alternate processes are repeated, till the colour wanted is given: a decoction of alder-bark is usually mixed with the liquor containing the nut-galls.

Of dyeing brown.—Brown, or fawn colour, though in fact a compound, is usually ranked among the simple colours, because it is applied to cloth by a single process. Various substances are used for brown dyes.

Walnut-peels, or the green covering of the walnut, when first separated are white internally, but soon assume a brown, or even a black colour, on exposure to the air. They readily yield their colouring matter to water. They are usually kept in large casks, covered with water, for above a year before they are used. To dye wool brown with them, nothing more is necessary, than to steep the cloth in a decoction of them till it has acquired the wished-for colour. The depth of the shade is proportional to the strength of the decoction. The root of the walnut-tree

contains the same colouring matter, but in smaller quantity. The bark of the birch also, and many other trees, may be used for the same purpose. It is very probable that the brown colouring matter is in these vegetable substances combined with tan. This is certainly the case in sumach, which is often employed to produce a brown. This combination explains the reason why no mordant is necessary; the tan has a strong affinity for cloth, and the colouring matter for the tan. The dye-stuff, and the mordant, are already, in fact, combined together.

Of dyeing compound colours.—Compound colours are produced by mixing together two simple ones; or, which is the same thing, by dyeing cloth first one simple colour, and then another. These colours vary to infinity, according to the proportions of the ingredients employed. They may be arranged under the following classes.

Mixtures of, 1. Blue and yellow; 2. Blue and red; 3. Yellow and red; 4. Black and other colours.

Mixture of blue and yellow.—This forms green; which is distinguished by dyers into a variety of shades, according to the depth of the shade, or the prevalence of either of the component parts. Thus we have sea-green, grass-green, pea-green, &c.

Wool, silk, and linen, are usually dyed green by giving them first a blue colour, and afterwards dyeing them yellow; because, when the yellow is first given, several inconveniences follow: the yellow partly separates again in the blue vat, and communicates a green colour to it, and thus renders it useless for every other purpose, except dyeing green. Any of the usual processes for dyeing blue and yellow may be followed, taking care to proportion the depth of the shades to that of the green required. When sulphate of indigo is employed, it is usual to mix all the ingredients together, and to dye the cloth at once; this produces what is known by the name of Saxon or English green.

Mixtures of blue and red.—These form different shades of violet, purple, and lilac. Wool is generally first dyed blue, and afterwards scarlet, in the usual manner. By means of cochineal mixed with sulphate of indigo, the process may be performed at once. Silk is first dyed crimson, by means of cochineal, and then dipped into the indigo vat. Cotton and linen are first dyed blue, then galled, and soaked in a decoction of logwood; but a more permanent colour is given by means of oxide of iron.

Mixtures of yellow and red.—These produce orange. When blue is combined with red and yellow on cloth, the resulting colour is olive. Wool may be dyed orange, by first dyeing it scarlet, and then yellow. When it is dyed first with madder, the result is cinnamon-colour.

Silk is dyed orange by means of carthamus; a cinnamon colour by logwood, Brazil-wood, and fustic mixed together.

Cotton and linen receive a cinnamon-colour by means of weld and madder; and an olive-colour, by being passed through a blue, yellow, and then a madder-bath.

Mixtures of black with other colours.—These constitute greys, drabs, and browns. If cloth is previously combined with brown oxide of iron, and afterwards dyed yellow with quercitron bark, the result will be a drab of different shades, according to the proportion of mordant employed. When the proportion is small, the colour inclines to olive or yellow; on the contrary, the drab may be deepened or saddened, as the dyers term it, by mixing a little sumach with the bark. See CALICO-PRINTING.

DYERS. By stat. 3 & 4 Ed. VI. c. 2, no dyer may dye any cloth with orchel, or with brazil, to make a false colour in cloth, wool, &c. on penalty of 20s. By stat. 23 Eliz. c. 9, dyers are to fix a seal of lead to cloths, with the letter M, to shew that they are well maddered, &c. or forfeit 3*s*. 4*d*. per yard. By stat. 23 Geo. III. c. 15, several penalties are inflicted on dyers who dye any cloths deceitfully, and not woaded throughout with indigo and madder. Dying blue with logwood, to forfeit 20*l*. Dyers in London are subject to the inspection of the dyers' company, who appoint searchers. In other places, these are appointed by the justices, and opposing the searchers incurs a penalty of 10*l*.

DYNASTY, among ancient historians, signifies a race or succession of kings of the same line or family: such were the dynasties of Egypt. The Egyptians reckon thirty dynasties, within the space of 36525 years; but the generality of chronologers look upon them as fabulous. And it is very certain, that these dynasties are not continually successive, but collateral.

DYSENTERY. See MEDICINE.

DYSOREXY, among physicians, denotes a want of appetite, proceeding from a weak stomach.

DYSPEPSY, a difficulty of digestion, for which physicians prescribe bitters. See MEDICINE.

DYSPNŒA, a difficulty of breathing, usually called asthma. See MEDICINE.

DYSURY, in medicine, a difficulty of making urine, attended with a sensation of heat and pain. It is distinguished from a strangury, as, in the last, the urine is voided by only a drop, as it were, at a time, but however with pain; and from an ischury, as in this disorder there is an almost total suppression of urine. See MEDICINE.

DYTISCUS, THE WATER-BEETLE, in zoology, a genus of insects of the order of coleoptera; the antennæ of which are slender and setaceous, and the hind feet are hairy, and formed for swimming. There are 23 species, distinguished by their antennæ, the various colours of the elytra, &c. The larvæ of the dytiscus are often met with in water. They are oblong, and have six scaly feet. The body consists of eleven segments. The head is large, with four filiform antennæ, and a strong pair of jaws. The last segments of the body have rows of hairs on the sides; and the abdomen is terminated by two spines charged with the like hairs, forming a kind of plumes. These larvæ are frequently of a greenish variegated brown: they are lively, active, and extremely voracious: they devour and feed upon other water-insects, and often tear and destroy each other. The perfect insect is little inferior to its larvæ in voraciousness, but it can only exercise its cruelty on the larvæ; the perfect insects, like himself, being sheltered by the kind of scaly cuirass with which they are armed. This creature must be touched cautiously; for, besides its power of giving a severe gripe with its jaws, it has moreover under the thorax, another weapon, a long sharp spine, which it will drive into one's fingers by the effort it makes to move backwards. The eggs of the dytisci are rather large, and are by them inclosed in a kind of silky duskish cod, of a strong and thick texture, in form round, and terminated by a long appendix or slender tail, of the same substance. These cods are often found in the water, and from them are brought forth the eggs and larvæ of the dytisci. The strength of these cods probably serves the insect to defend their eggs from the voraciousness of several other aquatic insects, and even from that of their fellow-dytisci, who would not spare them.

Many species of the perfect insect are common in stagnated waters, which they quit in the evening to fly about. They swim with incredible agility, making use of their hinder legs after the fashion of oars. The elytra of the females are, in general, furrowed, and those of the male plain. When they first arrive at their perfect state, their elytra are almost transparent, and in many species of a beautiful dun colour, mingled with shades of a greenish brown. The best method of catching them is with a hand-net or sieve; for they are so nimble, and exercise their defensive weapons so often, and with such painful success to those who endeavour to catch them, that they are very often obliged to let them escape; the easiest way to kill them is, to let them fall into boiling-hot water, which instantly destroys them. See Plate Nat. Hist. fig. 175.

E.

E, the fifth letter of the alphabet as a numeral, stands for 250. In music, it denotes the tone *e-la-mi*. In the calendar, it is the fifth of the dominical letters. And in sea-charts, it distinguishes all the easterly points: thus, E. alone denotes east, E. by S. and E. by N. east by south and east by north.

EAGLE, in ornithology. See FALCO.

EAGLE, in heraldry, is accounted one of the most noble bearings. The reason why eagles are generally borne with their wings and tail expanded is, because this posture is best fitted to fill up the escutcheon. However, there are eagles borne in other postures, though not so common; all which will be explained under their respective articles. The arms of the emperor of Germany are, or, a spread eagle with two heads, sable; diademed, langued, beaked, and membered, gules. Some authors express the two heads by the term displayed. The kingdom of Poland bore, gules, an eagle, argent; crowned and membered, or.

EAGLE-STONE. See ÆTITES.

EAGLE, *Black*, an order of knighthood, instituted by the elector of Brandenburgh, in 1701, on his being crowned king of Prussia. The knights of this order wear an orange-coloured ribband, suspending a black eagle.

EAGLE, *White*, a like order in Poland, instituted in 1325, by Uladislaus V. on occasion of the marriage of his son Casimir to the daughter of the great-duke of Lithuania. The knights of this order wore a chain of gold, suspending a silver eagle, crowned.

EAR, *auris*, in anatomy, the organ of hearing. See ANATOMY.

EARING, in the sea-language, is that part of the bolt-rope which, at the four corners of the sail, is left open, in the shape of a ring. The two uppermost parts are put over the ends of the yard-arms, and so the sail is made fast to the yard; and into the lowermost earings, the sheets and tacks are seized or bent at the clew.

EARL, a British title of nobility, next below a marquis, and above a viscount. Earls were antiently called comites, because they were wont *comitari regem*, to wait upon the king, for council and advice. The Germans call them *graves*, as landgrave, margrave, palsgrave, rheingrave; the Saxons ealdormen, unless that title might be more properly applied to our dukes; the Danes, eorlas; and the English, earls. The title originally died with the man. William the Conqueror first made it hereditary, giving it in fee to his nobles, and allotting them for the support of their state the third penny out of the sheriff's court, issuing out of all pleas of the shire; whence they had their title. But now the matter is quite otherwise; for formerly *comes* and *comitatus* were correlatives, and there was no comes or earl but had a county or shire for his earldom; of later years, the number of earls increasing, and no more counties being left, divers have made choice of some eminent part of a county, as Lindsey, Holland, Cleveland, &c.; some of a lesser part, as Stafford, &c.; others have chosen for their title some eminent town, as Marlborough, Exeter, Bristol, &c.; and some have taken for their title the name of a small village, or their own seat or park, as Godolphin, Clarendon, &c.; and others have the title added to the family name, as earl Rivers, earl Stanhope, &c. An earl is created by cincture of sword, mantle of state put upon him by the king himself, a cap and a coronet put upon his head, and a charter in his hand.

EARL *marshal of England*, is a great officer, who had anciently several courts under his jurisdiction, as the court of chivalry, and the court of honour. Under him is also the heralds' office, or college of arms. He has some pre-eminence in the court of marshalsea, where he may sit in judgment against those who offend within the verge of the king's court. This office is of great antiquity in England, and anciently of greater power than now; and has been for several ages hereditary in the most noble family of Howard.

EARNEST, is the money advanced to bind the parties to the performance of a verbal agreement. The person who gives it, is in strictness obliged to abide by his bargain; and in case he declines, is not discharged upon forfeiting his earnest, but may be sued for the whole money stipulated, and damages; and by the statute of frauds 29 C. II. c. 3. no contract for sale of goods to the value of 10*l.* or more is to be valid, unless such earnest is given,

EARTH, in astronomy and geography, one of the primary planets, being this terraqueous globe which we inhabit.

EARTH, FIGURE OF, was accounted by some of the antients to be like that of an oblong cylinder; by others, of the form of a drum; and by others to be flat. The moderns demonstrate it to be nearly spherical, from the following among other considerations. 1. All the appearances of the heavens, both at land and at sea, are the same as they would be if the earth was a globe. 2. In eclipses of the moon, which are caused by the shadow of the earth falling upon the moon, this shadow is alway circular, and a body can be no other than a globe, which, in all situations, casts a circular shadow. 3. Several navigators have sailed quite round the globe, steering their course directly south and west till they came to the Magellanic sea, and thence to the north and west till they returned to their port from the east; and all the phænomena, which should naturally arise from the earth's rotundity, happened to them. Besides, their method of sailing was also founded upon this hypothesis, which could never have succeeded, if the earth had been of any other figure. It is true, the surface of the earth is not an exact geometrical globe, but then the inequalities are so inconsiderable, that the highest mountain bears no greater proportion to the bulk of the earth, than a grain of dust does to a common globe. The figure of the earth was formerly considered, by mathematicians and geographers, as perfectly spherical, excepting the small inequalities on its surface, of mountains and valleys; till an accident engaged the attention of sir Isaac Newton and Mr. Huygens, who demonstrated from the laws of hydrostatics, and the revolution of the earth about its axis, that its figure was not a true sphere, but an oblate spheroid flatted towards the poles. Monsieur Richer, when at the island of Cayenne, about five degrees distant from the equator, found that his clock which, at Paris, kept true time, here lost two minutes and twenty-eight seconds every day. Now, though heat will lengthen pendulums, and consequently retard their motion, it is certain the heats of Cayenne were not sufficient to solve this phænomenon, which can flow only from a diminution in the pressure of gravity. For, as the earth revolves about its axis, all its parts will endeavour to recede from the axis of motion, and the equatorial parts where the motion is quickest will tend less towards the centre than the rest; their endeavour to fly off from the axis about which they revolve, taking off part of their tendency that way; so that those parts will become lighter than such as are nearer the poles. The polar parts, therefore, will press in towards the centre, and raise the equatorial parts, till the quantity of matter in the latter is so far increased as to compensate for its lightness, and an equilibrium is restored; on which account, the form which the earth assumes will be that of an oblate spheroid, whose shorter axis passes through the poles. By virtue only of the rotation of the earth about its axis, the weight of bodies at the equator is less than at the poles, in the proportion of 288 to 289. Hence arises, as before observed, a spheroidical form of the earth; and from that spheroidical form arises another diminution of gravity at the equator, by which, if the earth was homogeneous throughout, bodies at the equator would lose one pound in 1121; and so on both accounts taken together, the gravity of bodies at the poles would be to the same at the equator as 230 to 229. Whence, if we suppose the gravity of bodies within the earth to be directly as their distance from the centre, those numbers will also express the relation between its polar and equatorial diameter.

The proportion of the two diameters was calculated by Newton in the following manner. Having found that the centrifugal force at the equator is $\frac{1}{289}$th of gravity, he assumes, as an hypothesis, that the axis of the earth is to the diameter of the equator as 100 to 101, and thence determines what must be the centrifugal force at the equator to give the earth such a form, and finds it to be $\frac{4}{505}$ths of gravity: then, by the rule of proportion, if a centrifugal force, equal to $\frac{4}{505}$ths of gravity, would make the earth higher at the equator than at the poles by $\frac{1}{100}$th of the whole height at the poles, a centrifugal force that is the $\frac{1}{289}$th of gravity will make it higher by a proportional excess, which, by calculation, is $\frac{1}{229}$th of the height at the poles; and thus he

discovered that the diameter at the equator is to the diameter at the poles, or the axis, as 230 to 229. But this computation supposes the earth to be every where of an uniform density; whereas if the earth is more dense near the centre, then bodies at the poles will be more attracted by this additional matter being nearer: and therefore the excess of the semi-diameter of the equator above the semi-axis will be different. According to this proportion between the two diameters, Newton farther computes, from the different measures of a degree, that the equatorial diameter will exceed the polar, by 34 miles and $\frac{1}{5}$.

Nevertheless, Messrs. Cassini, both father and son, the one in 1701, and the other in 1713, attempted to prove, in the Memoirs of the Royal Academy of Sciences, that the earth was an oblong spheroid; and in 1718, M. Cassini again undertook, from observations, to shew that, on the contrary, the longest diameter passes through the poles; which gave occasion for Mr. John Bernouilli, in his Essai d'une Nouvelle Physique Celeste, printed at Paris in 1735, to triumph over the British philosopher, apprehending that these observations would invalidate what Newton had demonstrated. And in 1720, M. De Mairan advanced arguments, supposed to be strengthened by geometrical demonstrations, farther to confirm the assertions of Cassini. But in 1735, two companies of mathematicians were employed, one for a northern, and another for a southern expedition, the result of whose observations and measurement plainly proved that the earth was flatted at the poles.

The proportion of the equatorial diameter to the polar, as stated by the gentlemen employed on the northern expedition for measuring a degree of the meridian, is as 1 to 0·9891; by the Spanish mathematicians as 266 to 265, or as 1 to 0·99624; by M. Bouguer as 179 to 178, or as 1 to 0·99441.

As to all conclusions deduced from the length of pendulums in different places, it is to be observed, that they proceed upon the supposition of the uniform density of the earth, which is a very improbable circumstance; as justly observed by Dr. Horsley, in his letter to captain Phipps. "You finish your article, he concludes, relating to the pendulum, with saying, 'that these observations gave a figure of the earth nearer to sir Isaac Newton's computation, than any others that have hitherto been made;' and then you state the several figures given, as you imagine, by former observations, and by your own. Now it is very true, that *if* the meridians be ellipses, or *if* the figure of the earth be that of a spheroid generated by the revolution of an ellipsis, turning on its shorter axis, the particular figure, or the ellipticity of the generating ellipsis, which your observations give, is nearer to what sir Isaac Newton saith it should be, if the globe were homogeneous, than any that can be derived from former observations. But yet it is not what you imagine. Taking the gain of the pendulum in latitude 79° 50′, exactly as you state it, the difference between the equatorial and the polar diameter, is about as much less than the Newtonian computation makes it, and the hypothesis of homogeneity would require, as you reckon it to be greater. The proportion of 212 to 211 should, indeed, according to your observations, be the proportion of the force that acts upon the pendulum at the poles, to the force acting upon it at the equator. But this is by no means the same with the proportion of the equatorial diameter to the polar. If the globe were homogeneous, the equatorial diameter would exceed the polar by $\frac{1}{230}$ of the length of the latter: and the polar force would also exceed the equatorial by the like part. But if the difference between the polar and equatorial force be greater than $\frac{1}{230}$ (which may be the case in an heterogeneous globe, and seems to be the case in ours), then the difference of the diameters should, according to theory, be less than $\frac{1}{230}$, and vice versa.

"I confess this is by no means obvious at first sight; so far otherwise, that the mistake, which you have fallen into, was once very general. Many of the best mathematicians were misled by too implicit a reliance upon the authority of Newton, who had certainly confined his investigations to the homogeneous spheroid, and had thought about the heterogeneous only in a loose and general way. The late Mr. Clairault was the first who set the matter right, in his elegant and subtle treatise on the figure of the earth. That work hath now been many years in the hands of mathematicians, among whom I imagine there are none, who have considered the subject attentively, that do not acquiesce in the author's conclusions.

"In the second part of that treatise, it is proved, that putting P for the polar force, Π for the equatorial, δ for the true ellipticity of the earth's figure, and ε for the ellipticity of the homogeneous spheriod,

$$\frac{P-\Pi}{\Pi} = 2\varepsilon - \delta: \text{ therefore } \delta = 2\varepsilon - \frac{P-\Pi}{\Pi}$$

and, therefore, according to your observation, $\delta = \frac{1}{251}$. This is the just conclusion from your observations on the pendulum, taking it for granted, that the meridians are ellipses: which is an hypothesis, upon which all the reasonings of theory have hitherto proceeded. But, plausible as it may seem, I must say, that there is much reason, from experiment, to call it in question. If it were true, the increment of the force which actuates the pendulum, as we approach the poles, should be as the square of the sine of the latitude: or, which is the same thing, the decrement, as we approach the equator, should be as the square of the co-sine of the latitude. But whoever takes the pains to compare together such of the observations of the pendulum in different latitudes, as seem to have been made with the greatest care, will find that the increments and decrements do by no means follow these proportions; and in those which I have examined, I find a regularity in the deviation which little resembles the mere error of observation. The unavoidable conclusion is, that the true figure of the meridians is not elliptical. If the meridians are not ellipses, the difference of the diameters may, indeed, or it may not, be proportional to the difference between the polar and the equatorial force; but it is quite an uncertainty, what relation subsists between the one quantity and the other; our whole theory, except so far as it relates to the homogeneous spheroid, is built upon false assumptions, and there is no saying what figure of the earth any observations of the pendulum give."

He then lays down the following table, which shews the different results of observations made in different latitudes; in this the first three columns contain the names of the several observers, the places of observation, and the latitude of each; the fourth column shews the quantity of P—Π in such parts as Π is 100000, as deduced from comparing the length of the pendulum at each place of observation, with the length of the equatorial pendulum, as determined by M. Bouguer, upon the supposition that the increments and decrements of force, as the latitude is increased or lowered, observe the proportion which theory assigns: only the second and the last value of P—Π are concluded from comparisons with the pendulum at Greenwich and at London, not at the equator. The fifth column shews the value of δ corresponding to every value of P—Π, according to Clairault's theorem:

Observers.	*Places.*	*Latitudes.*	P—Π	δ
		0° 0′		
Bouguer	Equator	9 34	741·8	$\frac{1}{714}$
Bouguer	Porto Bello	17 29	563·2	$\frac{1}{326}$
Green	Otaheitee	18 27	591·0	$\frac{1}{338}$
Bouguer	San Domingo	33 55	731·5	
Abbé de la Caille	Cape of Good Hope	48 50	585·1	$\frac{1}{351}$
- - -	Paris	66 48	565·9	$\frac{1}{329}$
The Academicians	Pello	79 50	471·2	$\frac{1}{251}$
Captain Phipps	- - -	- - -	-	-

"By this table it appears, that the observations in the middle parts of the globe, setting aside the single one at the Cape, are as consistent as could reasonably be expected; and they represent the ellipticity of the earth as about $\frac{1}{340}$. But when we come within 10 degrees of the equator, it should seem that the force of gravity suddenly becomes much less, and within the like distance of the poles much greater, than it could be in such a spheroid."

The following problem, communicated by Dr. Leatherland to Dr. Pemberton, and published by Mr. Robertson, serves for finding the proportion between the axis and the equatorial diameter, from measures taken of a degree of the meridian in two different latitudes, supposing the earth an oblate spheroid.

Let AP*ap* (Plate Miscel. fig. 88.) be an ellipse representing a section of the earth through the axis P*p*; the equatorial diameter, or the greater axis of the ellipse, being A*a*; let E and F be two places where the measure

of a degree has been taken: these measures are proportional to the radii of curvature in the ellipse at those places; and if CQ, CR, be conjugates to the diameters whose vertices are E and F, CQ will be to CR in the subtriplicate ratio of the radius of curvature at E to that at F, by cor. 1, prop. 4, part 6, of Milnes's Conic Sections, and therefore in a given ratio to one another: also, the angles QCP, RCP, are the latitudes of E and F; so that, drawing QV parallel to Pp, and QXYW to Aa, these angles being given, as well as the ratio of CQ to CR, the rectilinear figure CVQXRY is given in species; and the ratio of $VC^2 - ZC^2$ ($=QX \times XW$) to $RZ^2 - QV^2$ ($=RX \times XS$) is given, which is the ratio of CA^2 to CP^2; therefore the ratio of CA to CP is given.

Hence, if the sine and cosine of the greater latitude be each augmented in the subtriplicate ratio of the measure of the degree in the greater latitude to that in the lesser, then the difference of the squares of the augmented sine, and the sine of the lesser latitude, will be to the difference of the squares of the cosine of the lesser latitude and the augmented cosine, in the duplicate ratio of the equatorial to the polar diameter. For, Cq being taken in CQ equal to CR, and qv drawn parallel to QV, Cv, and vq, CZ and ZR will be the signs and cosines of the respective latitudes to the same radius; and CV, VQ, will be the augmentations of Cv and Cq in the ratio named.

Hence, to find the ratio between the two axes of the earth, let E denote the greater, and F the lesser of the two latitudes, M and N the respective measures taken in each, and let P denote $\sqrt[3]{\frac{M}{N}}$: then

$$\sqrt{\frac{\cos.^2 F - P^2 \times \cos.^2 E}{P^2 \times \sin.^2 E - \sin.^2 F}} \text{ is} = \frac{\text{lesser axis}}{\text{greater axis}}$$

It also appears by the above problem that when one of the degrees measured is at the equator, the cosine of the latitude of the other being augmented in the subtriplicate ratio of the degrees, the tangent of the latitude will be to the tangent answering to the augmented cosine, in the ratio of the greater axis to the less. For supposing E the place out of the equator; then if the semicircle P$lmnp$ be described, and lC joined, and mo drawn parallel to aC: Co is the cosine of the latitude to the radius CP, and CY that cosine augmented in the ratio before-named; YQ being to Yl, that is Ca to Cn or CP, as the tangent of the angle YCQ, the latitude of the point E, to the tangent of the angle YCl, belonging to the augmented cosine. Thus, if M represent the measure in a latitude denoted by E, and N the measure at the equator, let A denote an angle whose measure is

$$\cos. E \times \sqrt[3]{\frac{M}{N}} \text{ Then } \frac{\tan. A}{\tan. E} \text{ is} = \frac{\text{lesser axis}}{\text{greater axis}}$$

But M, or the length of a degree, obtained by actual mensuration in different latitudes, is known from the following table:

Names.	*Latit.* ° ′	*Value of M.* toises.	
Maupertuis, &c.	66 20	M=57438	
Cassini and La Caille	49 22	M=57074	
	45 00	M=57050	
Boscovich	43 00	M=56972	
De la Caille	33 18	M=57037	
Juan and Ulloa	00 00	M=56768	at the equator.
Bouguer	00 00	M=56753	
Condamine	00 00	M=56749	

Now, by comparing the first with each of the following ones; the second with each of the following; and, in like manner, the third, fourth, and fifth, with each of the following; there will be obtained 25 results, each shewing the relation of the axes or diameters; the arithmetical means of all of which will give that ratio as 1 to 0·9951989.

If the measures of the latitudes of 49° 22′, and of 45°, which fall within the meridian line drawn through France, and which have been re-examined and corrected since the northern and southern expedition, be compared with those of Maupertuis and his associates in the north, and that of Bouguer at the equator, there will result six different values of the ratio of the two axes; the arithmetical mean of all which is that of 1 to 0·9953467, which may be considered as the ratio of the greater axis to the less; which is as 230 to 228·92974, or 215 to 214, or very near the ratio assigned by Newton.

Now, the magnitude as well as the figure of the earth, that is, the polar and equatorial diameters, may be deduced from the foregoing problem. For, as half the latus rectum of the greater axis Aa is the radius of curvature at A, it is given in magnitude from the degree measured there, and thence the axes themselves are given. Thus, the circular arc whose length is equal to the radius being 57·29578 degrees, if this number be multiplied by 56750 toises, the measure of a degree at the equator, as Bouguer has stated it, the product will be the radius of curvature there, or half the latus rectum of the greater axis; and this is to half the lesser axis in the ratio of the less axis to the greater, that is, as 0·9953467 to 1: whence the two axes are 6533820 and 6564366 toises, or 7913 and 7950 English miles; and the difference between the two axes about 37 miles.

And very nearly the same ratio is deduced from the lengths of pendulums vibrating in the same time, in different latitudes; provided it be again allowed that the meridians are real ellipses, or the earth a true spheriod, which, however, can only take place in the case of an uniform gravity in all parts of the earth.

Thus, in the new Petersburgh acts, for the years 1788 and 1789, are accounts and calculations of experiments relative to this subject, by M. Krafft. These experiments were made at different times, and in various parts of the Russian empire. This gentleman has collected and compared them, and drawn the proper conclusions from them: thus he infers that the length x of a pendulum that swings seconds in any given latitude λ, and in a temperature of 10 degrees of Reaumur's thermometer, may be determined by this equation:

$x = 439{\cdot}178 + 2{\cdot}321 \sin^2 \lambda$, lines of a French foot,

or $x = 39{\cdot}0045 + 0{\cdot}206 \sin^2 \lambda$, in English inches,

in the temperature of 53 of Fahrenheit's thermometer.

This expression nearly agrees, not only with all the experiments made on the pendulum in Russia, but also with those of Mr. Graham in England, and those of Mr. Lyons in 79° 50′ north latitude, where he found its length to be 431·38 lines. It also shews the augmentation of gravity from the equator to the parallel of a given latitude λ: for, putting g for the gravity under the equator, G for that under the pole, and y for that under the latitude λ, M. Krafft finds $y = (1 + 0{\cdot}0052848 \sin^2 \lambda)\, g$; and theref. $G = 1{\cdot}0052848\, g$.

From this proportion of gravity under different latitudes, the same author infers that, in case the earth is a homogeneous ellipsoid, its oblateness must be $\frac{1}{191}$; instead of $\frac{1}{230}$, which ought to be the result of this hypothesis: but on the supposition that the earth is a heterogeneous ellipsoid, he finds its oblateness, as deduced from these experiments, to be $\frac{1}{297}$; which agrees with that resulting from the measurement of some of the degrees of the meridian. This confirms an observation of M. De la Place, that if the hypothesis of the earth's homogeneity is given up, then theory, the measurement of degrees of latitude, and experiments with the pendulum, all agree in their result with respect to the oblateness of the earth.

In the Philos. Trans. for 1791, Mr. Dalby has given some calculations on measured degrees of the meridian, whence he infers, that those degrees measured in middle latitudes, will answer nearly to an ellipsoid whose axes are in the ratio assigned by Newton, viz. that of 230 to 229. And as to the deviations of some of the others, viz. towards the poles and equator, he thinks they are caused by the errors in the observed celestial arcs.

Earth, Magnetism of. The notion of the magnetism of the earth was started by Gilbert; and Boyle supposes magnetic effluvia moving from one pole to the other. See Magnetism.

Earth, Magnitude of. This has been variously determined by different authors, both ancient and modern. The usual way has been, to measure the length of one degree of the meridian, and multiply it by 360, for the whole circumference. Diogenes Laertius informs us, that Anaximander, a scholar of Thales, who lived about 550 years before the birth of Christ, was the first who gave an account of the circumference of the sea and land; and it seems his measure was used by the succeeding mathematicians, till the time of Eratosthenes. Aristotle, at the end of lib. 2 De Cœlo, says, the mathematicians who have attempted to measure the circuit of the earth, make it 40000 stadia: which, it is thought, is the number determined by Anaximander.

Snellius relates, from the Arabian geographer Abulfedea, who lived about the 1300th year of Christ, that about the 800th year of Christ, Almaimon, an Arabian king, having collected together some skilful mathematicians, commanded them to find out the circumference of the earth. Accordingly these made choice of the fields of Mesopotamia, where they measured under the same meridian from north to south, till the pole was depressed one degree lower: which measure they found equal to 56 miles, or 56½: so that, according to them, the circuit of the earth is 20160 or 20340 miles.

It was a long time after this before any more attempts were made in this business. At length, however, Mr. Snell, professor of mathematics at Leyden, about the year 1620, with great skill and labour, by measuring large distances between two parallels, found one degree equal to 28500 perches, each of

which is 12 Rhinland feet, amounting to 19 Dutch miles, and so the whole periphery 6840 miles; a mile being, according to him, 1500 perches, or 18000 Rhinland feet.

The next that undertook this measurement, was Richard Norwood, who, in the year 1635, by measuring the distance from London to York with a chain, and taking the sun's meridian altitude, June 11th, old style, with a sextant of about 5 feet radius, found a degree contained 367200 feet, or 69 miles and a half and 14 poles; and thence the circumference of a great circle of the earth is a little more than 25036 miles, and the diameter a little more than 7966 miles. See the particulars of this measurement in his Seaman's Practice.

The measurement of the earth by Snell, though very ingenious and troublesome, and much more accurate than any of the ancients', being still thought, by some French mathematicians, liable to certain small errors, the inquiry was renewed, after Snell's manner, by Picard and other mathematicians, by the king's command, using a quadrant of $3\frac{1}{6}$ French feet radius; by which they found a degree contained 542360 French feet.

M. Cassini the younger, in the year 1700, by the king's command also, renewed the experiment with a quadrant of 10 feet radius, for taking the latitude, and another of $3\frac{1}{8}$ feet for taking the angles of the triangles; and found a degree, from his calculation, contained 27292 toises, or almost $69\frac{1}{2}$ English miles.

From the mean of a great many measurements, the following dimensions may be taken as near the truth:

the circumference	25000 miles,
the diameter	7957$\frac{3}{4}$ miles,
the superficies	198944206 square miles
the solidity	263930000000 cubic miles.

Also, the seas and unknown parts of the earth, by a measurement of the best maps, contain 160522026 square miles: the inhabited parts 38922180; of which Europe contains 4456065; Asia, 10768823; Africa, 9654807; and America, 14110874.

EARTH, STRUCTURE OF. After the preceding survey of the form and magnitude of this globe of earth, the next object of attention is the general arrangement of those substances of which it is composed. These are neither disposed in a regular series, according to their specific gravities, nor yet thrown together in total disorder, as if by accident or chance. Human industry has hitherto been able to penetrate but a very little way into the bowels of the earth, and we can but know little of its interior parts. The depth of the earth, from the surface to the centre, is nearly four thousand miles; and yet the deepest mine in Europe, that at Cotteberg, in Hungary, is not more than one thousand yards deep; "the greatest depth, therefore," says an excellent writer, "to which avarice has ever yet penetrated, may be compared to the puncture made in the body of an elephant by the proboscis of a gnat."

From what has been discovered, however, of those parts which lie most contiguous to our observation, naturalists have compared the structure of the earth to the leaves of a book, or the coats of an onion. Except, indeed, in some of those immense mountains, which have existed from the creation, or at least from the deluge, where the matter, from whatever cause, is more homogeneous, the earth is found to consist of various strata, or layers, which differ according to the circumstances of climate and situation. The surface, in general, evidently consists of a confused mixture of decayed animal and vegetable substances and earths rudely united together; but when we have penetrated below the surface, we find the materials of the globe arranged in a more regular manner. Sometimes, indeed, we find heaps of stone, which do not consist of layers, but are confused masses of unequal thickness, and are called rocks. The strata are, in general, extended through a whole country, and perhaps, with some interruptions and varieties, through the globe itself. These extensive bodies are found most regular when the country is flat, being, in that case, nearly parallel to the horizon, though frequently dipping downwards in a certain angle; in many places the beds have a wave, as where the country consists of gently waving hills and vales; here, too, they generally dip. In travelling a mile we, perhaps, pass through ground composed mostly of sand; in another mile we find it, perhaps, composed of clay; and this is occasioned by the edges of the different strata lying with an obliquity to the horizon. By the same kind of projection, mountains, or ridges of mountains, are produced, which, in general, have what is called a back and a face, the former smoother, and the latter more rugged. We generally find, too, on one side of a mountain, a more gradual ascent than on the other; which is occasioned by the strata, which have risen above the general level of the country, being abruptly broken off.

Dr. Woodward has considered the circumstances of these strata with great attention, viz. their order, number, situation with respect to the horizon, depth, intersections, fissures, colour, consistence, &c. He ascribes the origin and formation of them all, to the great flood or cataclysmus. At that terrible revolution he supposes that all sorts of terrestrial bodies had been dissolved and mixed with the waters, forming altogether a chaos or confused mass. This mass of terrestrial particles, intermixed with water, he supposes, was at length precipitated to the bottom; and that generally according to the order of gravity, the heaviest sinking first, and the lightest afterwards. By such means were the strata formed of which the earth consists; which, attaining their solidity and hardness by degrees, have continued distinct ever since. These sediments, he farther concludes, were at first all parallel and concentrical; and the surface of the earth formed of them, perfectly smooth and regular; but that, in course of time, divers changes happening, from earthquakes, volcanos, &c. the order and regularity of the strata were disturbed and broken, and the surface of the earth, by such means, brought to the irregular form in which it now appears.

M. De Buffon surmises that the earth, and the other planets, are also parts struck off from the body of the sun by the collision of comets; and that, when the earth assumed its form, it was in a state of liquefaction by fire. But that could not be the method of producing the planets; for if they were struck off from the body of the sun, they would move in orbits that would pass through the sun, instead of having the sun for their focus, or centre, as they are now found; so that having been struck off, they would fall down into the sun again, terminating their career, as it were, after one revolution only. See GEOLOGY.

EARTH, *its quantity of matter, density, and attractive power.* Although the relative densities of the earth and most of the other planets have been known a considerable time, it is but very lately that we have come to the knowledge of the absolute gravity or density of the whole mass of the earth. This has been calculated and deduced from the observations made by Dr. Maskelyne, at the mountain Schehallien, in the years 1774, 5, and 6. The attraction of that mountain on a plummet, was observed on both sides of it, and its mass computed from a number of sections in all directions, and consisting of stone; these data being then compared with the known attraction and magnitude of the earth, gave, by proportion, its mean density, which is to that of water as 9 to 2, and to common stone as 9 to 5: from which very considerable mean density, it may be presumed that the internal parts contain some great quantities of metals.

From the density now found, its quantity of matter becomes known, being equal to the product of its density by its magnitude. From various experiments, too, we know that its attractive force, at the surface, is such, that bodies fall there through a space of $16\frac{1}{12}$ feet in the first second of time: whence the force at any other place, either within or without it, becomes known; for the force at any part within it, is directly as its distance from the centre; but the force of any part without it, reciprocally as the square of its distance from the centre.

EARTH, MOTION OF THE. It is now generally granted that, besides the small motion of the earth which causes the precession of the equinoxes, the earth has two great and independant motions; viz. the one by which it turns round its own axis, in the space of 24 hours nearly, and causing the continual succession of day and night; and the other, an absolute motion of its whole mass in a large orbit about the sun, having that luminary for its centre, in such manner that its axis keeps always parallel to itself, inclined in the same angle to its path, and, by that means, causing the vicissitudes of seasons; spring, summer, autumn, winter.

It is, indeed, true, that, as to sense, the earth appears to be fixed in the centre, with the sun and stars moving round it every day; and such, doubtless, would be considered as the true nature of the motions in the rude ages of mankind, as they are still by the rude and unlearned. But, to a thinking and learned mind, the contrary will soon appear.

By the diurnal rotation of the earth on its axis, the same phenomena will take place as if it had no such motion, and as if the sun and stars moved round it. For, turning round from west to east, causes the sun and all the visible heavens to seem to move the contrary way, or from east to west, as we daily see them do. So, when in its rotation it has brought the sun or a star to appear just in the horizon in the east, they are then said to be rising; and as the earth continues to revolve

more and more towards the east, other stars seem to rise and advance westwards, passing the meridian of the observer, when they are due south from him, and at their greatest altitude above his horizon; after which, by a continuance of the same motions, viz. of the earth's rotation eastwards, and the luminaries' apparent counter-motion westwards, these decline from the meridian, or south point, towards the west, where being arrived, they are said to set and descend below it; and so on continually from day to day; thus making it day while the sun is above the horizon, and night while he is below it.

While the earth is thus turning on its axis, it is, at the same time, carried by its proper motion in its orbit round the sun, as one of the planets; namely, between the orbits of Venus and Mars: having the orbits of Venus and Mercury within its own, or between it and the sun, in the centre, and those of Mars, Jupiter, Saturn, &c. without or above it; which are, therefore, called superior planets, and the others, inferior ones. This is called the annual motion of the earth, because it is performed in a year, or 365 days 6 hours nearly; or rather 365 days, 5 hours, and 49 minutes, from any equinox or solstice to the same again, making the tropical year; but from any fixed star to the same again, as seen from the sun, in 365 days, 6 hours, 9 minutes, which is called the sidereal year. The figure of this orbit is elliptical, having the sun in one focus, the mean distance being about 95 millions of miles; which is upon the supposition that the sun's parallax is about $8''\frac{2}{3}$, or the angle under which the earth's semidiameter would appear to an observer placed in the sun; and the eccentricity of the orbit, or distance of the sun, in the focus, from the centre of this elliptic orbit, is about $\frac{1}{60}$th of the mean distance.

EARTHS. The word earth, in common language, has two meanings: it sometimes signifies, as we have seen, the globe which we inhabit, and sometimes the mould on which vegetables grow. Chemists have examined this mould, and have found that it consists of a variety of substances mixed together, without order or regularity. The greatest part of it, however, as well as of the stones which form apparently so large a proportion of the globe, consist of a small number of bodies, which have a variety of common properties. These bodies chemists have agreed to class together, and to denominate earths.

Every body which possesses the following properties is an earth.

1. Insoluble in water, or nearly so; or at least becoming insoluble when combined with carbonic acid. 2. Little or no taste or smell; at least when combined with carbonic acid. 3. Fixed, incombustible, and incapable while pure of being altered by the fire. 4. A specific gravity not exceeding 4.9. 5. When pure, capable of assuming the form of a white powder. 6. Not altered when heated with combustibles.

The earths at present known, are nine in number, namely,

1. Barytes.
2. Strontian.
3. Lime.
4. Magnesia.
5. Alumina.
6. Yttria.
7. Glucina.
8. Zirconia.
9. Silica.

Which see under their respective names.

Every one of the above characteristics is not, perhaps, rigorously applicable to each of these bodies; but all of them possess a sufficient number of common properties to render it useful to arrange them under one class.

EARTH NUTS, or *Ground Nuts*. See ARACHIS.

EARTHQUAKES. When we consider the very formidable nature of these phenomena, we cannot wonder that human ingenuity has been often exercised in accounting for their causes. To explain the theory of earthquakes, it will be necessary to recal to the reader's attention what was said in the preceding article on the structure of the earth, which, being formed of different strata, we compared to the leaves of a book or the coats of an onion; and if with this consideration we combine the operation of subterraneous fires, we shall have at least a probable explanation of the cause of earthquakes.

The sudden explosions which take place from volcanoes, probably depend on the access of a quantity of water, which enters through some fissure communicating with the sea, or which is derived from other sources in the earth. If this mass of water is sufficiently great, it will extinguish the volcano; if not, it will be converted into steam, the expansive force of which far exceeds that of gunpowder. The elastic fluid thus formed either finds vent at the mouth of the volcano, or, if the superincumbent weight should be too great, it will force a passage between the strata of the earth, and occasion that undulatory, but sometimes violent, motion, which is called an earthquake. From various facts demonstrative of the cohesion and elasticity of bodies, we are warranted in concluding, that the different strata of which the earth is composed will adhere together, and that a freer passage will be afforded to any intervening body between the strata than directly through them. If the confined fire or steam acts directly under a province or town, it will heave the earth perpendicularly upwards, and the shocks will be more sudden and violent. If it acts at a distance, it will raise that tract obliquely; and the motion will be more oblique, undulatory, and tremulous.

The great earthquake at Lisbon, in 1755, was felt as far as Scotland; and from the phenomena which attended it, it was evident, that the ground had a waving motion from south to north. All the oblong lakes that lay from north to south were much agitated, the wave commencing at the south end; whilst all other lakes which lay across, from east to west, were much less affected.

The great distance to which earthquakes extend, depends on the compressibility and elasticity of the earth; which may be understood from the vibration of the walls of houses, occasioned by the passing of carriages in the adjacent streets. Another instance is the vibration of steeples by the ringing of bells or gusts of wind. The Eddistone lighthouse often vibrates from the force of the waves which beat against its foundation.

Previous to an eruption of Vesuvius, the earth always trembles, and subterraneous explosions are heard. On the 1st of November 1755, the era so fatal to Lisbon, the island of Madeira was violently shaken by an earthquake, accompanied with subterraneous explosions. So thoroughly convinced, indeed, are the inhabitants of volcanic countries, of the connection between earthquakes and volcanoes, that when a great eruption takes place from a volcano, they congratulate themselves on having escaped an earthquake.

Earthquakes, as well as volcanic eruptions, are always preceded by a violent agitation of the sea. Previous to the breaking out of Vesuvius, the sea retires from the adjacent shores till the mountain is burst open, and then it returns with such impetuosity as to overflow its usual boundary. About an hour after the first shocks, which alarmed the city of Lisbon in 1755, the sea was observed to come rushing towards the city like a torrent, though against both wind and tide: it rose forty feet higher than was ever known, and as suddenly subsided. A ship, fifty leagues off at sea, received so violent a shock as greatly to injure the deck, &c. The same effect was observed at Cadiz, and at a number of ports throughout the Mediterranean; and, indeed, more or less, all over Europe.

That earthquakes are the effect of steam generated within the bowels of the earth, and that they are produced in the manner which has been described, appears highly probable from the quantities of boiling water which have occasionally been thrown up by volcanoes in different parts of the world. In 1631 and 1698, vast torrents of boiling water flowed from the crater of Vesuvius, previous to the eruption of fire; and what was, perhaps, still more remarkable, many species of seashells, in a calcined state, were found on the brink of the crater, and also in the channel formed by the flood. The same thing happened at Ætna, in 1755, when a dreadful torrent of boiling water flowed from the crater at the time of an eruption of fire. Sir William Hamilton observes, that the seashells emitted along with the water clearly indicate a communication with the sea. All warm springs probably receive their heat from the action of pyrites, near which the water passes.

Authors of very high repute have, however, attributed earthquakes entirely to the agency of the electric fluid, and regarded them chiefly as violent shocks of electricity. We must confess there is indeed an intimate, though hitherto inexplicable, connection between earthquakes and even volcanoes, and the electric fluid; and the state of the atmosphere previous either to an earthquake or a volcanic eruption is always highly electrical.

Though there is hardly any country known in which shocks of an earthquake have not at some time or other been felt, yet there are some much more subject to them than others. It has been observed, that northern countries in general are less subject to earthquakes than those situated near the equator, or in the southern latitudes; but this does not hold universally. Islands are also more subject to earthquakes than continents; but neither does this hold without exceptions. Some particular parts of continents, and some particular islands, are more subject to them than others lying in the neighbourhood, and differing very little from them in external appearance. Thus, Portugal is more subject to earthquakes than Spain, and the latter

much more than France; Mexico and Peru more than the other countries of America; and Jamaica more than the other Caribbee islands. Earthquakes are frequent, though not often violent, in Italy; but in Sicily they are often terribly destructive. Asia Minor has been remarkably subject to them from the remotest antiquity; and the city of Antioch in particular has suffered more from earthquakes than any other in that country. The same phenomena are said also to occur very frequently in the north-eastern extremities of Asia, even in very high latitudes.

From the observations that have been made, the following phenomena respecting earthquakes may be deduced, and reckoned pretty certain:

1. Where there are any volcanoes or burning mountains, earthquakes may reasonably be expected more frequently than in other countries. 2. If the volcano has been for a long time quiet, a violent earthquake is to be feared, and vice versa: but to this there are many exceptions. 3. Earthquakes are generally preceded by long droughts; but they do not always come on as soon as the drought ceases. 4. They are also preceded by electrical appearances in the air; such as the aurora borealis, falling stars, &c. but this does not hold universally. 5. A short time before the shock, the sea swells up and makes a great noise; fountains are troubled, and send forth muddy water; and the beasts seem frightened, as if sensible of an approaching calamity. 6. The air at the time of the shock is generally calm and serene, but afterwards commonly becomes obscure and cloudy. 7. The shock comes on with a rumbling noise, sometimes like that of carriages; sometimes a rushing noise like wind, and sometimes explosions like the firing of cannon, are heard; sometimes the ground heaves perpendicularly upwards, and sometimes rolls from side to side; sometimes the shock begins with a perpendicular heave, after which the other kind of motion commences. A single shock is but of very short duration, the longest scarcely lasting a minute; but they frequently succeed each other at short intervals for a considerable length of time. 8. During the shock, chasms are made in the earth, from which sometimes flames, but oftener great quantities of water, are discharged. Flame and smoke are also emitted from parts of the earth where no chasms can be perceived. Sometimes these chasms are but small; but in violent earthquakes they are frequently so large, that whole cities sink down into them at once. 9. The water of the ocean is affected even more than the dry land. The sea swells to a prodigious height, much more than we could suppose it raised by the mere elevation of its bottom by the shock. Sometimes it is divided to a considerable depth; and quantities of air, flames, and smoke, are discharged from it. The like irregular agitations happen to the waters of ponds, lakes, and even rivers. 10. The shock is felt at sea as well as on land. Ships are affected by a sudden stroke, as if they had run aground, or struck upon a rock. 11. The effects of earthquakes are not confined to one particular district or country, but often extend, as was already intimated, to very distant regions; though no earthquake has yet been known extensive enough to affect the whole globe at one time. In those places also where the shock is not felt on dry land, the irregular agitation of the waters is perceived very remarkably.

All these positions are verified by the accounts of those earthquakes which have been particularly described by witnesses of the best character. But above all, the great earthquake which happened on the 1st of November 1755, affords the clearest example of all the phenomena we have mentioned; having been felt violently in many places both on land and at sea, and extended its effects to the waters in many other places where the shocks were not perceived. At Lisbon in Portugal its effects were most severe.

The following account of that terrible phenomenon, by an eye-witness, is extracted from a volume of letters, published a few years ago by the Rev. Mr. Davy:

"There never was a finer morning seen than the 1st of November 1755: the sun shone out in his full lustre; the whole face of the sky was perfectly serene and clear; and not the least signal or warning of that approaching event, which has made this once flourishing, opulent, and populous city, (Lisbon) a scene of the utmost horror and desolation, except only such as served to alarm, but scarcely left a moment's time to fly from the general destruction.

"It was on the morning of this fatal day, between the hours of nine and ten, that I was sat down in my apartment, just finishing a letter, when the papers and table I was writing on began to tremble with a gentle motion, which rather surprised me, as I could not perceive a breath of wind stirring: whilst I was reflecting with myself what this could be owing to, but without having the least apprehension of the real cause, the whole house began to shake from the very foundation, which at first I imputed to the rattling of several coaches in the main street, which usually passed that way at this time from Belem to the palace; but on hearkening more attentively, I was soon undeceived, as I found it was owing to a strange frightful kind of noise under ground, resembling the hollow distant rumbling of thunder. All this passed in less than a minute; and I must confess I now began to be alarmed, as it naturally occurred to me, that this noise might possibly be the forerunner of an earthquake, as one I remembered, which had happened about six or seven years ago, in the island of Madeira, commenced in the same manner, though it did little or no damage.

"Upon this I threw down my pen, and started upon my feet, remaining for a moment in suspense, whether I should stay in the apartment, or run into the street, as the danger in both places seemed equal; and still flattering myself that this tremor might produce no other effects than such inconsiderable ones as had been felt at Madeira; but in a moment I was roused from my dream, being instantly stunned with a most horrid crash, as if every edifice in the city had tumbled down at once. The house I was in shook with such violence, that the upper stories immediately fell; and though my apartment (which was the first floor) did not then share the same fate, yet every thing was thrown out of its place in such a manner, that it was with no small difficulty I kept my feet, and expected nothing less than to be soon crushed to death, as the walls continued rocking to and fro in the most frightful manner, opening in several places, large stones falling down on every side from the cracks, and the ends of most of the rafters starting out from the roof. To add to this terrifying scene, the sky in a moment became so gloomy, that I could now distinguish no particular object: it was an Egyptian darkness indeed, such as might be felt; owing, no doubt, to the prodigious clouds of dust and lime, raised from so violent a concussion, and as some reported, to sulphureous exhalations; but this I cannot affirm: however, it is certain I found myself almost choaked for near ten minutes.

"As soon as the gloom began to disperse, and the violence of the shock seemed pretty much abated, the first object I perceived in the room was a woman sitting on the floor, with an infant in her arms, all covered with dust, pale, and trembling; I asked her how she got hither; but her consternation was so great, that she could give me no account of her escape. I suppose that when the tremor first began, she ran out of her own house, and finding herself in such imminent danger from the falling of stones, retired into the door of mine, which was almost contiguous to hers, for shelter; and when the shock increased, which filled the door with dust and rubbish, ran up stairs into my apartment, which was then open: be it as it might, this was no time for curiosity. I remember the poor creature asked me, in the utmost agony, if I did not think the world was at an end; at the same time she complained of being choaked, and begged for God's sake I would procure her a little drink; upon which I went to a closet where I kept a large jar with water (which you know is sometimes a pretty scarce commodity in Lisbon), but finding it broken to pieces, I told her she must not now think of quenching her thirst, but saving her life, as the house was just falling on our heads, and if a second shock came, would certainly bury us both. I bade her take hold of my arm, and that I would endeavour to bring her into some place of security.

"I shall always look upon it as a particular providence that I happened on this occasion to be undressed; for had I dressed myself, as I proposed, when I got out of bed, in order to breakfast with a friend, I should, in all probability, have run into the street at the beginning of the shock, as the rest of the people in the house did, and consequently have had my brains dashed out, as every one of them had. However, the imminent danger I was in did not hinder me from considering that my present dress, only a gown and slippers, would render my getting over the ruins almost impracticable: I had, therefore, still presence of mind enough left to put on a pair of shoes and a coat, the first that came in my way, which was every thing I saved; and in this dress I hurried down stairs, the woman with me, holding by my arm, and made directly to that end of the street which opens to the Tagus; but finding the passage this way entirely blocked up with the fallen houses to the height of their second stories, I turned back to the other end which led into the main street (the common thoroughfare to the palace); and having helped the woman over a vast heap of ruins, with no

small hazard to my own life, just as we were going into the street, as there was one part I could not well climb over without the assistance of my hands as well as feet, I desired her to let go her hold, which she did, remaining two or three feet behind me, at which time there fell a vast stone from a tottering wall, and crushed both her and the child in pieces. So dismal a spectacle at any other time would have affected me in the highest degree; but the dread I was in of sharing the same fate myself, and the many instances of the same kind which presented themselves all around, were too shocking to make me dwell a moment on this single object.

"I had now a long narrow street to pass, with the houses on each side four or five stories high, all very old, the greater part already thrown down, or continually falling, and threatening the passengers with inevitable death at every step, numbers of whom lay killed before me, or, what I thought far more deplorable, so bruised and wounded, that they could not stir to help themselves. For my own part, as destruction appeared to me unavoidable, I only wished I might be made an end of at once, and not have my limbs broken; in which case I could expect nothing else but to be left upon the spot, lingering in misery, like these poor unhappy wretches, without receiving the least succour from any person.

"As self-preservation, however, is the first law of nature, these sad thoughts did not so far prevail as to make me totally despair. I proceeded on as fast as I conveniently could, though with the utmost caution; and having at length got clear of this horrid passage, I found myself safe and unhurt in the large open space before St. Paul's church, which had been thrown down a few minutes before, and buried a great part of the congregation, which was generally pretty numerous, this being reckoned one of the most populous parishes in Lisbon. Here I stood some time, considering what I should do; and not thinking myself safe in this situation, I came to the resolution of climbing over the ruins of the west end of the church, in order to get to the river-side, that I might be removed as far as possible from the tottering houses, in case of a second shock.

"This with some difficulty I accomplished; and here I found a prodigious concourse of people, of both sexes, and of all ranks and conditions, among whom I observed some of the principal canons of the patriarchal church, in their purple robes and rochets, as these all go in the habit of bishops; several priests, who had run from the altars in their sacerdotal vestments, in the midst of their celebrating mass; ladies half-dressed, and some without shoes; all these, whom their mutual dangers had here assembled as to a place of safety, were on their knees at prayers, with the terrors of death in their countenances, every one striking his breast, and crying out incessantly, *Miserecordia meu Dios.*

"In the midst of our devotions, the second great shock came on, little less violent than the first, and completed the ruin of those buildings which had been already much shattered. The consternation now became so universal, that the shrieks and cries of *Miserecordia* could be distinctly heard from the top of St. Catherine's hill, at a considerable distance off, whither a vast number of people had likewise retreated: at the same time we could hear the fall of the parish-church there, whereby many persons were killed on the spot, and others mortally wounded. You may judge of the force of this shock, when I inform you it was so violent that I could scarcely keep on my knees; but it was attended with some circumstances still more dreadful than the former. On a sudden I heard a general outcry, 'The sea is coming in; we shall be all lost.' Upon this, turning my eyes towards the river, which in that place is near four miles broad, I could perceive it heaving and swelling in a most unaccountable manner, as no wind was stirring: in an instant there appeared, at some small distance, a large body of water, rising like a mountain; it came on foaming and roaring, and rushed towards the shore with such impetuosity, that we all immediately ran for our lives as fast as possible: many were actually swept away, and the rest above their waist in water at a good distance from the banks. For my own part, I had the narrowest escape, and should certainly have been lost, had I not grasped a large beam that lay on the ground, till the water returned to its channel, which it did almost at the same instant with equal rapidity. As there now appeared at least as much danger from the sea as the land, and I scarcely knew whither to retire for shelter, I took a sudden resolution of returning back, with my clothes all dropping, to the area of St. Paul's: here I stood some time, and observed the ships tumbling and tossing about, as in a violent storm: some had broken their cables, and were carried to the other side of the Tagus; others were whirled round with incredible swiftness; several large boats were turned keel upwards; and all this without any wind, which seemed the more astonishing. It was at the time of which I am now speaking, that the fine new quay, built of rough marble, at an immense expence, was entirely swallowed up, with all the people on it, who had fled thither for safety, and had reason to think themselves out of danger in such a place; at the same time a great number of boats and small vessels, anchored near it (all likewise full of people, who had retired thither for the same purpose), were all swallowed up, as in a whirlpool, and never more appeared.

"This last dreadful incident I did not see with my own eyes, as it passed three or four stone's-throws from the spot where I then was; but I had the account as here given from several masters of ships, who were anchored within two or three hundred yards of the quay, and saw the whole catastrophe. One of them informed me, that when the second shock came on, he could perceive the whole city waving backwards and forwards, like the sea when the wind first begins to rise; that the agitation of the earth was so great, even under the river, that it threw up his large anchor from the mooring, which swam, as he termed it, on the surface of the water; that immediately upon this extraordinary concussion, the river rose at once near 20 feet, and in a moment subsided; at which instant he saw the quay, with the whole concourse of people upon it, sink down, and at the same time every one of the boats and vessels that were near it were drawn into the cavity, which he supposes instantly closed upon them, inasmuch as not the least sign of a wreck was ever seen afterwards. This account you may give full credit to; for as to the loss of the vessels, it is confirmed by every body; and with regard to the quay, I went myself a few days after to convince myself of the truth, and could not find even the ruins of a place, where I had taken so many agreeable walks, as this was the common rendezvous of the factory in the cool of the evening. I found it all deep water, and in some parts scarcely to be fathomed.

"This is the only place which I could learn was swallowed up in or about Lisbon, though I saw many large cracks and fissures in different parts; and one odd phenomenon I must not omit, which was communicated to me by a friend, who had a house and wine-cellars on the other side of the river, viz. that the dwelling-house being first terribly shaken, which made all the family run out, there presently fell down a vast high rock near it; that upon this the river rose and subsided in the manner already mentioned, and immediately a great number of small fissures appeared in several contiguous pieces of ground, whence there spouted out like a jet-d'eau a large quantity of fine white sand, to a prodigious height.

"I had not been long in the area of St. Paul's, when I felt the third shock; which though somewhat less violent than the two former, the sea rushed in again, and retired with the same rapidity, and I remained up to my knees in water, though I had gotten upon a small eminence at some distance from the river, with the ruins of several intervening houses to break its force. At this time I took notice the waters retired so impetuously, that some vessels were left quite dry, which rode in seven-fathom water. The river thus continued alternately rushing on and retiring several times together, in such sort, that it was justly dreaded Lisbon would now meet the same fate which, in 1746, had befallen the city of Lima.

"Perhaps you may think the present doleful subject here concluded: but, alas! the horrors of the first of November are sufficient to fill a volume. As soon as it grew dark, another scene presented itself little less shocking than those already described. The whole city appeared in a blaze, which was so bright that I could easily see to read by it. It may be said, without exaggeration, it was on fire at least in a hundred different places at once, and thus continued burning for six days together, without intermission, or the least attempt being made to stop its progress.

"I could never learn that this terrible fire was owing to any subterraneous eruption, as some have reported, but to three causes, which all concurring at the same time, will naturally account for the prodigious havoc it made. The first of November being All Saints day, a high festival among the Portuguese, every altar in every church and chapel (some of which have more than twenty) was illuminated with a number of wax tapers and lamps, as customary: these setting fire to the curtains and timber-work that fell with the shock, the conflagration soon spread to the neighbouring houses; and being there joined with the fires in the kitchen chimneys, increased to such a degree, that it might easily

have destroyed the whole city, though no other cause had concurred, especially as it met with no interruption.

"But what would appear incredible to you, were the fact less public and notorious, is, that a gang of hardened villains, who had been confined, and got out of prison when the wall fell, at the first shock, were busily employed in setting fire to those buildings which stood some chance of escaping the general destruction!

"The fire, by some means or other, may be said to have destroyed the whole city, at least every thing that was grand or valuable in it; and the damage on this occasion is not to be estimated.

"The whole number of persons that perished, including those who were burnt, or afterwards crushed to death whilst digging in the ruins, is supposed, on the lowest calculation, to amount to more than sixty thousand; and though the damage in other respects cannot be computed, yet you may form some idea of it, when I assure you, that this extensive and opulent city is now nothing but a vast heap of ruins; that the rich and poor are at present upon a level; some thousands of families which but the day before had been easy in their circumstances, being now scattered about in the fields, wanting every conveniency of life, and finding none able to relieve them.

"A few days after the first consternation was over, I ventured down into the city, by the safest ways I could pick out, to see if there was a possibility of getting any thing out of my lodgings; but the ruins were now so augmented by the late fire, that I was so far from being able to distinguish the individual spot where the house stood, that I could not even distinguish the street, amidst the mountains of stone and rubbish which rose on every side. Some days after, I ventured down again with several porters, who, having long plied in these parts of the town, were well acquainted with the situation of particular houses: by their assistance, I at last discovered the spot; but was soon convinced, that to dig for any thing there, besides the danger of such an attempt, would never answer the expence.

"On both the times when I attempted to make this fruitless search, especially the first, there came such an intolerable stench from the dead bodies, that I was ready to faint away; and though it did not seem so great this last time, yet it had nearly been more fatal to me, as I contracted a fever by it, but of which, God be praised, I soon got the better. However, this made me so cautious for the future, that I avoided passing near certain places, where the stench was so excessive that people began to dread an infection. A gentleman told me, that going into the town a few days after the earthquake, he saw several bodies lying in the streets, some horribly mangled, as he supposed, by the dogs, others half-burnt, some quite roasted; and that in certain places, particularly near the doors of churches, they lay in vast heaps, piled one upon another."

The year 1783 was fatally marked by the desolation of some of the most fertile, most beautiful, and most celebrated provinces of Europe. The two Calabrias, with a part of Sicily, were doomed to be a scene of the most tremendous and the most fatal earthquakes that ever were known, even in those volcanic regions. The first shock happened about noon, on the 5th of February, and was so violent as to involve almost the whole of Calabria in ruin. This was but the commencement of a succession of earthquakes, which, beginning from the city of Amantea, on the coast of the Tyrrhene sea, proceeded along the western coast to Cape Spartivento, and up the eastern as far as Cape d'Alice; during the whole of which space not a town was left undestroyed.

During two years repeated shocks continued to agitate the affrighted minds of the inhabitants of Calabria and Sicily; but the principal mischiefs arose in the months of February and March in the first year. For several months the earth continued in an unceasing tremor, which at certain intervals increased to violent shocks, some of which were beyond description dreadful. These shocks were sometimes horizontal, whirling like a vortex; and sometimes by pulsations or beating from the bottom upwards: and were at times so violent, that the heads of the largest trees almost touched the ground on either side. The rains during a great part of the time were continual and violent, often accompanied with lightning and furious gusts of wind. All that part of Calabria, which lay between the 38th and 39th degrees, assumed a new appearance. Houses, churches, towns, cities, and villages, were buried in one promiscuous ruin. Mountains were detached from their foundations, and carried to a considerable distance. Rivers disappeared from their beds, and again returned and overflowed the adjacent country. Streams of water suddenly gushed out of the ground, and sprang to a considerable height. Large pieces of the surface of the plain, several acres in extent, were carried five hundred feet from their former situation down into the bed of the river, and left standing at nearly the distance of a mile, surrounded by large plantations of olives and mulberry-trees, and corn growing as well upon them as upon the ground from which they were separated. Amidst these scenes of devastation, the escape of some of the unhappy sufferers is extremely wonderful. Some of the inhabitants of houses which were thrown to a considerable distance, were dug out from their ruins unhurt. But these instances were few; and those who were so fortunate as to preserve their lives in such situations, were content to purchase existence at the expence of broken limbs and the most dreadful contusions.

During this calamitous scene, it is impossible to conceive the horrors and wretchedness of the unhappy inhabitants. The jaws of death were opened to swallow them up; ruin had seized all their possessions; and those dear connections to which they might have looked for consolation in their sorrows, were for ever buried in the merciless abyss. All was ruin and desolation. Every countenance indicated the extremity of affliction and despair; and the whole country formed a wide scene of undescribable horror.

One of the most remarkable towns which was destroyed was Casal Nuova, where the princess Gerace Grimaldi, with more than 4000 of her subjects, perished in the same instant. An inhabitant happening to be on the summit of a neighbouring hill, at the moment of the shock, and looking earnestly back to the residence of his family, could see no other remains of it than a white cloud which proceeded from the ruins of the houses. At Bagnara, about 3000 persons were killed; and not fewer at Radicina and Palma. At Terra Nuova 4400 perished; and rather more at Semniari. The inhabitants of Scilla escaped from their houses on the celebrated rock of that name, and, with their prince, descended to a little harbour at the foot of the hill; but, in the course of the night, a stupendous wave, which is said to have been driven three miles over land, on its return swept away the unfortunate prince, with 2473 of his subjects. It is computed that not less than 40,000 persons perished by this earthquake.

EASEL-PIECES, a denomination given by painters to such pieces as are contained in frames, in contradistinction from those painted on ceilings, &c.

EASEMENT, in law, a privilege or convenience which one neighbour has of another, whether by charter or prescription, without profit: such are a way through his lands, a sink, or the like. These, in many cases, may be claimed.

EASING, in the sea language, signifies the slackening of a rope, or the like: thus, to ease the bow-line or sheet, is to let them go slacker; to ease the helm, is to let the ship go more large, more before the wind, or more larboard.

EAST INDIA COMPANY, a corporation or "united company of merchants of England trading to the East Indies;" which name is given them in stat. 6 Anne, c. 17, s. 13. more explicitly, according to their charter and adjustment of their rights, by stat. 9 and 10 W. III. c. 44. s. 61. "trading into and from the East Indies, in the countries and ports of Asia and Africa, and into and from the islands, ports, havens, cities, creeks, towns, and places of Asia, Africa, and America, or any of them, beyond the Cape of Good Hope, to the straights of Magellan, where any trade or traffic of merchandize is or may be used and had, to and from every of them."

The temporary rights of the company consist of, 1st, the sole and exclusive trade with India, and other parts within the limits already described; so that no other of the king's subjects can go thither or trade there, but by permission of the company, or pursuant to the directions of stat. 33 Geo. III. c. 52. 2dly, They have the administration of the government and revenues of the territories in India, acquired by their conquests during their term in the exclusive trade, subject nevertheless to the various checks and restrictions contained in the several statutes, which vest that administration in them.

The rights in perpetuity are, to be a body corporate and politic, with perpetual succession; to purchase, acquire, and dispose at will of lands and tenements in Great Britain, so that the value therein do not exceed 10,000*l.* per annum; to make settlements to any extent within the limits of their exclusive trade; build forts and fortifications; appoint governors; erect courts of judicature; coin money; raise, train, and muster, forces at sea and land; repel wrongs and injuries; make reprisals on the invaders or disturbers

of their peace; and continue to trade within the said limits, with a joint stock, for ever, although their exclusive right of trading shall be determined by parliament.

The only privileges they can be constitutionally deprived of, are those of trading to the exclusion of others, and of governing the countries, and of collecting and appropriating the revenues of India. For further particulars concerning the East India company, see stat. 9 and 10 W. c. 44. s. 69.; 6 Anne, c. 3. 7 Geo. I. c. 5.; 25 Geo. II. c. 26.; 7 Geo. III. c. 47.; 12 Geo. III. c. 54.; 13 Geo. III. c. 63.; 17 Geo. III. c. 8.; 21 Geo. III. c. 70.; 24 Geo. III. c. 25.; and 33 Geo. III. c. 52.

For the history and commercial concerns of this establishment, see COMPANY.

EASTER, a festival of the Christian church, observed in memory of our Saviour's resurrection.

The Asiatic churches kept their Easter upon the same day the Jews observed their passover; and others on the first Sunday after the first full moon in the new year. This controversy was determined in the council of Nice, when it was ordained that Easter should be kept upon one and the same day, which should always be a Sunday in all Christian churches throughout the world. But though the Christian churches differed as to the time of celebrating Easter, yet they all agreed in shewing particular respect and honour to this festival. On this day, prisoners and slaves were set free, and the poor liberally provided for. The eve or vigil of this festival was celebrated with more than ordinary pomp, which continued till midnight, it being a tradition of the church that our Saviour rose a little after midnight; but in the East, the vigil lasted till cock-crowing.

It was in conformity to the custom of the Jews, in celebrating their passover on the 14th day of the first month, that the primitive fathers ordered that the 14th day of the moon, from the calendar new moon which immediately follows the 21st of March, at which time the vernal equinox happened upon that day, should be deemed the paschal full moon, and that the Sunday after should be Easter-day; and it is upon this account that our rubric has appointed it upon the first Sunday after the first full moon immediately following the 21st day of March. Whence it appears, that the true time for celebrating Easter, according to the intention of the council of Nice, was to be the first Sunday after the first full moon following the vernal equinox, or when the sun entered into the first point of Aries; and this was pope Gregory's principal view in reforming the calendar, to have Easter celebrated according to the intent of the council of Nice.

Having first found the epact and dominical letter, according to the method delivered under these articles, Easter-day may be found by the two following rules;

1. To find Easter-limit, or the day of the paschal full moon, counting from March 1 inclusive, the rule is this: add 6 to the epact, and if this sum exceeds 30, take 30 from it; then from 50 subtract this remainder, and what is left will be the limit; if the sum of the epact, added to 6, does not amount to 30, it must be subtracted from 50, and the remainder is the limit required; which is never to exceed 49, nor fall short of 21.

2. From the limit and dominical letter, to find Easter-day: add 4 to the dominical letter; subtract this sum from the limit, and the remainder from the next higher number which contains 7 without any remainder; lastly, add this remainder to the limit, and their sum will give the number of days from the first of March to Easter-day, both inclusive.

Thus, to find Easter-day for the year 1806, for instance. First find the epact 11, which added to 6 gives 17; and as this sum does not amount to 30, it must be subtracted from 50, and the remainder 33 is the limit. Then adding 4 to 5, the number of the dominical letter E, subtract this sum, viz. 9, from the limit 33, and the remainder 24 from 28, the next superior number that contains 7 a certain number of times without any remainder, and there remains 4; which being added to the limit 33, gives 37 for the number of days from the 1st of March to Easter-day, both inclusive: hence, allowing 31 for March, there remains the 6th April for Easter-day. Here follows the operation at length.

11 + 6 = 17
50 — 17 = 33 paschal limit
Dominical letter E = 5
4 + 5 = 9, and 33 — 9 = 24; and
28 — 24 = 4. Again,
33 + 4 = 37: from this subtract 31 for the number of days in March, and it is evident that Easter-day must fall on the 6th of April.

However, to save the trouble of calculation, we shall here give a table, by which Easter-day may be found by inspection till the year 1900, according to the Gregorian or new style.

Golden Number.	Dominical Letters. A.	B.	C.	D.	E.	F.	G.
I.	April 16	17	18	19	20	14	81
II.	April 9	3	4	5	6	7	8
III.	March 26	27	28	29	23	24	25
IV.	April 16	17	11	12	13	14	15
V.	April 2	3	4	5	6	March 31	April 1
VI.	April 23	24	25	19	20	21	22
VII.	April 9	10	11	12	13	14	8
VIII.	April 2	3	March 28	29	30	31	April 1
IX.	April 16	17	18	19	20	21	22
X.	April 9	10	11	5	6	7	8
XI.	March 26	27	28	29	30	31	25
XII.	April 16	17	18	19	13	14	15
XIII.	April 2	3	4	5	6	7	8
XIV.	March 26	27	28	22	23	24	25
XV.	April 16	10	11	12	13	14	15
XVI.	April 2	3	4	5	March 30	31	April 1
XVII.	April 23	24	18	19	20	21	22
XVIII.	April 9	10	11	12	13	7	8
XIX.	April 2	March 27	28	29	30	31	April 1

In this table Easter-day will be found in the common angle of meeting of the given dominical letter and the golden number; the name of the month lying in a direct line with it, towards the left hand. Thus for the year 1806, the golden number is II, and the dominical letter is E, and in the line opposite to II and E will be found April 6th for Easter-day.

EBDOMARIUS, in ecclesiastical writers, an officer formerly appointed weekly to superintend the performance of divine service in cathedrals, and prescribe the duties of each person attending in the choir, as to reading, singing, praying, &c.

EBENUS, the ebony-tree, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The segments of the calyx are the length of the corolla, and the latter has scarcely any alæ. There is one rough seed. There are two species.

The cretica is a native of the island of Crete, and some others in the Archipelago. It rises with a shrubby stalk, three or four feet high, which puts out several side-branches with hoary leaves at each joint, composed of five narrow spear-shaped lobes, which join at their tails to the footstalk, and spread out like the fingers of a hand. The branches are terminated by thick spikes of large purple flowers. The plants may be propagated from seeds sown in the autumn. In this country the plants must be protected during the winter, as they are unable to bear the cold.

The pinnata is a biennial, a native of the Levant. These plants constitute the genus ebenus of botanists; but there is reason to think that the wood of this name is produced from several different trees. See the next article.

EBONY-WOOD is brought from the Indies, exceedingly hard and heavy, susceptible of a very fine polish, and on that account used in mosaic and inlaid works, toys, &c. There are many kinds of ebony: the most usual among us are black, red, and green, all of them the product of the island of Madagascar, where the natives call them indifferently *hazon mainthi*, black wood. The island of St. Maurice, belonging to the Dutch, likewise furnishes part of the ebonies used in Europe.

Authors and travellers give very different accounts of the tree that yields the black ebony. By some of their descriptions, it should be a sort of palm-tree; by others, a cytisus, &c. The most authentic of them is that of M. Flacourt, who resided many years in Madagascar as governor. He assures us that it grows very high and large, its bark being black, and its leaves resembling those of our myrtle, of a deep dusky-green colour. Tavernier assures us, that the islanders always take care to bury their trees, when cut down, to make them the blacker, and to prevent their splitting when wrought. F. Plumier mentions another black ebony-tree, discovered by him at St. Domingo, which he calls *spartium portulacæ foliis aculeatum ebeni materiæ*. Candia also bears a little shrub, known to the botanists under the name of ebenus cretica, above described.

Pliny and Dioscorides say, the best ebony

comes from Ethiopia, and the worst from India; but Theophrastus prefers that of India. Black ebony is much preferred to that of other colours. The best is a jet black, free of veins and rind, very massive, astringent, and of an acrid pungent taste. Its rind, infused in water, is said to be antiscorbutic, and to cure venereal disorders; whence Matthiolus took guaiacum for a sort of ebony. It yields an agreeable perfume when laid on burning coals: when green, it readily takes fire from the abundance of its fat. If rubbed against a stone, it becomes brown. The Indians make statues of their gods, and sceptres for their princes, of this wood. It was first brought to Rome by Pompey, after he subdued Mithridates. It is now much less used among us than formerly; since the discovery of so many ways of giving other hard woods a black colour. As to the green ebony, besides Madagascar and St. Maurice, it likewise grows in the Antilles, and especially in the isle of Tobago. The tree that yields it is very bushy; its leaves are smooth, and of a fine green colour. Under its bark is a white substance about two inches thick; all beneath which, to the very heart, is a deep green, approaching towards a black, though sometimes streaked with yellow veins. Its use is not confined to mosaic work: it is likewise useful in dyeing, as yielding a fine green tincture. As to red ebony, called also grenadilla, we know little of it more than the name. The cabinet-makers, in-layers, &c. make pear-tree and other woods pass for ebony, by giving them the same black colour. This some do by a few washes of a strong decoction of galls, to which is added a small quantity of vitriolated iron.

EBIONITES, in church history, a sect of the first century, so called from their leader Ebion. They held the same doctrines with the Nazarenes, united the ceremonies of the Mosaic institution with the precepts of the gospel, observed both the Jewish sabbath and Christian Sunday, and in celebrating the Eucharist, made use of unleavened bread. They abstained from the flesh of animals, and even from milk. In relation to Jesus Christ, some of them held that he was born, like other men, of Joseph and Mary, and acquired sanctification only by his good works. Others of them allowed, that he was born of a virgin, but denied that he was the word of God, or had any existence before his human generation. They said he was, indeed, the only true prophet, but yet a mere man, who by his virtue had arrived at being called Christ, and the Son of God. They also supposed that Christ and the devil were two principles, which God had opposed to each other. Of the New Testament they only received the gospel of St. Matthew, which they called the gospel according to the Hebrews.

EBONY. See EBENUS.

EBRBUHARITES, an order of Mahometan monks, so called from their founder Ebrbuhar. They make great profession of piety, and contempt of the world; but are accounted heretics by the rest of the Mahometans, because they believe themselves not obliged to go in pilgrimage to Mecca.

ECATESIA, in antiquity, an anniversary solemnity observed by the Stratonicensians in honour of Hecate. The Athenians likewise had a public entertainment or supper every new moon in honour of the same goddess. The supper was provided at the charge of the richer sort; and was no sooner brought to the accustomed place, than the poor people carried all off, giving out that Hecate had devoured it.

ECATOMBÆON, in chronology, the first month of the Athenian year. It consisted of 30 days, and began the first new moon after the summer solstice, and consequently answered to the latter part of our June and beginning of July. The Bœotians called it hippodromus, and the Macedonians lous. The word is a derivative from the Greek εκατομβη, a hecatomb, because of the great number of hecatombs sacrificed in it.

ECHENEIS, the remora, in ichthyology, a genus belonging to the order of thoracici. The head is fat, naked, depressed, and marked with a number of transverse ridges; it has ten rays in the branchiostege membrane; and the body is naked. There are two species, viz.

1. The remora or sucking-fish, with a forked tail, and 18 striæ on the head. It is found in the Indian Ocean.

2. The neucrates, with an undivided tail, and 16 striæ on the head. It is likewise a native of the Indian Ocean.

These fishes are often found adhering so strongly to the sides of sharks and other great fish, by means of the structure of the head, as to be got off with difficulty. This fish was believed by all the ancients to have most wonderful powers, and to be able, by adhering to the bottom, to arrest the motion of a ship in its fullest course; and in love affairs to deaden the warmest affections of both sexes.

ECHEVIN, scabinus, in the former French and Dutch polity, a magistrate elected by the inhabitants of a city or town, to take care of their common concerns, and the decoration and cleanliness of the city.

In the confusion and irregularity of the present arbitrary government of both countries, it is impossible to specify who are the officers (if any) appointed to preserve order, &c.

ECHINOPHORA, in botany, a genus of the digynia order, in the pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The male florets are lateral, with the central one hermaphrodite; there is one seed, sunk into an indurated involucrum. There are two species, herbaceous plants of the south of Europe.

ECHINOPS, a genus of the polygamia segregatæ order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The calyx is uniflorous; the corollulæ tubulated and hermaphrodite; the receptacle bristly; the pappus indistinct. There are five species, annual and perennial plants, one of which is well known under the name of globe thistle.

ECHINORYNCHUS, a genus of the vermes intestina; body round, proboscis cylindrical, retractile, and crowned with hooked prickles. They are found fixed firmly to the viscera of various animals, generally the intestines; and often remain on the same spot during the whole life of the animal; they are mostly gregarious, and are easily distinguished from the tænia by their round inarticulate body. There are 48 species, infesting the mammalia, birds, reptiles, and fish.

ECHINUS, in zoology, the sea hedgehog, a genus of insects belonging to the order of vermes mollusca. The body is roundish, covered with a bony crust, and often beset with moveable prickles; and the mouth is below, and consists of five valves. 1. The esculentus, or eatable echinus, is of an hemispherical form, covered with sharp strong spines, above half an inch long; commonly of a violet colour; moveable; adherent to small tubercles elegantly disposed in rows. These are their instruments of motion by which they change their place. This species is taken in dredging, and often lodges in cavities of rocks just within low-water mark. They are eaten by the poor in many parts of England, and by the better sort abroad. In old times they were a favorite dish. They were dressed with vinegar, honied wine or mead, parsley or mint, and thought to agree with the stomach. They were the first dish in the famous supper of Lentulus, when he was made flamen martialis, or priest of Mars; by some of the concomitant dishes they seem to have been designed as a whet for the second course, to the holy personages, priests and vestals invited on that occasion. Many species of shell-fish made part of that entertainment. 2. The lacunosus, or oval echinus, is of an oval depressed form; on the top it is of a purple colour, marked with a quadrifoil, and the spaces between tuberculated in waved rows; the lower side studded, and divided by two smooth spaces; length, four inches. When clothed, it is covered with short thickset bristles mixed with very long ones. There are 15 other species, all natives of the sea.

ECHITES, in botany, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 30th order, contortæ. There are two long and straight follicles; the seeds pappous; the corolla funnel-shaped, with the throat naked. There are 22 species, shrubs, chiefly of South America. The corymbosa, a species of this genus, is supposed to yield the elastic gum, according to Jacquin. See CAOUTCHOUC.

ECHIUM, *viper's bugloss*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 41st order, asperifoliæ. The corolla is irregular, with the throat naked. There are 21 species, three of which are natives of Britain. None of them have any remarkable property, except that the flowers of one species (the vulgare) are very grateful to bees. It is a native of many parts of Britain. The stem is rough, with hairs and tubercles. The leaves are spear-shaped, and rough with hair. The flowers come out in lateral spikes. They are first red, afterwards blue, sometimes purple or white. Cows and sheep are not fond of this plant; horses and goats refuse it.

ECHO, a sound reflected, or reverberated from some body, and thence returned or repeated to the ear.

For an echo to be heard, the ear must be in the line of reflection; that the person who made the sound may hear the echo, it is necessary he should be in a perpendicular line to the place which reflects it; and for a multiple or tautological echo, it is necessary that there should be a number of walls and vaults, rocks and cavities, either placed behind or fronting each other. Those mur-

murs in the air, that are occasioned by the discharge of great guns, &c. are a kind of indefinite echoes, and are produced from the vaporous particles suspended in the atmosphere, which resist the undulations of sound, and reverberate them to the ear.

There can be no echo, unless the direct and reflex sounds follow one another at a sufficient distance of time; for if the reflex sound arrives at the ear before the impression of the direct sound ceases, the sound will not be doubled, but only rendered more intense. Now if we allow that nine or ten syllables can be pronounced in a second, in order to preserve the sounds articulate and distinct, there should be about the ninth part of a second between the times of their appulse to the ear; or, as sound flies about 1142 feet in a second, the said difference should be $\frac{1}{9}$ of 1142, or 127 feet; and therefore every syllable will be reflected to the ear at the distance of about 70 feet from the reflecting body; but as in the ordinary way of speaking, three or four syllables only are uttered in a second, the speaker, that he may have the echo returned as soon as they are expressed, should stand about 500 feet from the reflecting body, and so in proportion for any other number of syllables. Mersenne allows for a monosyllable the distance of 69 feet, Morton 90 feet; for a dissyllable 105 feet, a trisyllable 160 feet, a tetrasyllable 182 feet, and a pentasyllable 204 feet.

From what has been said, it follows, that echoes may be applied for measuring inaccessible distances. Thus, Mr. Derham, standing upon the banks of the Thames, opposite to Woolwich, observed that the echo of a single sound was reflected back from the houses in three seconds; consequently the sum of the direct and reflex rays must have been $1142 \times 3 = 3426$ feet, and the half of it 1713 feet, the breadth of the river in that place.

It also follows that the echoing body being removed farther off, it reflects more of the sound than when nearer, which is the reason why some echoes repeat but one syllable, or one word, and some many. Of these some are tonical, which only return a voice when modulated into some particular musical tone, and others polysyllabical. That fine echo in Woodstock-park, Dr. Plot assures us, in the day-time will return very distinctly 17 syllables, and in the night 20.

Echoing bodies may be so contrived and placed, as that reflecting the sound from one to the other, a multiple echo, or many echoes, shall arise. At Rosneath, near Glasgow, in Scotland, there is an echo that repeats a tune played with a trumpet three times completely and distinctly. At the sepulchre of Metella, wife of Crassus, there was an echo, which repeated what a man said five times. Authors mention a tower at Cyzicus, where the echo repeated seven timse. There is an echo at Brussels that answers 15 times.

One of the finest echoes we read of is that mentioned by Barthius, in his notes on Statius's Thebais, lib. 6, ver. 30, which repeated the words a man uttered 17 times. This was on the banks of the Naha, between Coblentz and Bingen. And whereas, in common echoes, the repetition is not heard till some time after hearing the words spoken, or the notes sung; in this, the person who speaks or sings, is scarcely heard at all, but the repetition very clearly, and always in surprising varieties; the echo seeming sometimes to approach nearer, and sometimes farther off; sometimes the voice is heard very distinctly, and sometimes scarcely at all: one person hears only one voice, and another several; one hears the echo on the right, and the other on the left, &c.

Addison, and other travellers in Italy, mention an echo at Simonetta palace, near Milan, still more extraordinary, returning the sound 56 times. The echo is heard behind the house, which has two wings; the pistol is discharged from a window in one of these wings, the sound is returned from a dead wall in the other wing, and heard from a window in the back-front.

Farther, a multiple echo may be made, by so placing the echoing bodies, at unequal distances, as that they may reflect all one way, and not one on the other; by which means, a manifold successive sound will be heard; one clap of the hands like many; one ha! like a laughter; one single word like many of the same tone and accent; and so one musical instrument like many of the same kind, imitating each other.

Lastly, echoing bodies may be so ordered, that from any one sound given, they shall produce many echoes, different both as to tone and intention: by which means a musical room may be so contrived, that not only one instrument playing in it shall seem many of the same sort and size, but even a concert of different ones; this may be contrived by placing certain echoing bodies so, as that any note played, shall be returned by them in 3ds, 5ths, and 8ths. See PNEUMATICS.

ECHO is also used for the place where the repetition of the sound is produced or heard. This is either natural or artificial.

In echoes, the place where the speaker stands is called the centrum phonicum, and the object or place that returns the voice, the centrum phonocampticum.

ECHO, in architecture, a term applied to certain kinds of vaults and arches, most commonly of elliptical and parabolical figures, used to redouble sounds, and produce artificial echoes. We learn from Vitruvius, that in several parts of Greece and Italy, there were brazen vessels artfully ranged under the seats of the theatres, to render the sound of the actors voices more clear, and make a kind of echo. A single arch or concavity can scarcely ever stop and reflect the sound; but if there is a convenient disposition between it, part of the sound that is propagated thither, being collected and reflected as before, will present another echo; or if there is another concavity opposed at a due distance to the former, the sound reflected from the one upon the other will be tossed back again upon this latter, &c.

ECHO, in poetry, a kind of composition wherein the last words or syllables of each verse contain some meaning, which being repeated apart, answers to some question or other matter contained in the verse, as in this beautiful one from Virgil:

Crudelis mater magis, an puer improbus ille?
Improbus ille puer, crudelis tu quoque mater.

The elegance of an echo consists in giving a new sense to the last words, which reverberate, as it were, the motions of the mind, and by that means affect it with surprise and admiration.

ECHOMETER, among musicians, a kind of scale or rule, with several lines, serving to measure the duration and length of sounds, and to find their intervals and ratios.

ECLECTICS, antient philosophers, who, without attaching themselves to any particular sect, selected whatever appeared to them the best and most rational from each. Potamon of Alexandria was the first of the eclectics; he lived in the reigns of Augustus and Tiberius; and being tired with the scepticism of the pyrrhonians, he resolved upon a scheme that would allow him to believe something, but without being so implicit as to swallow any entire hypothesis.

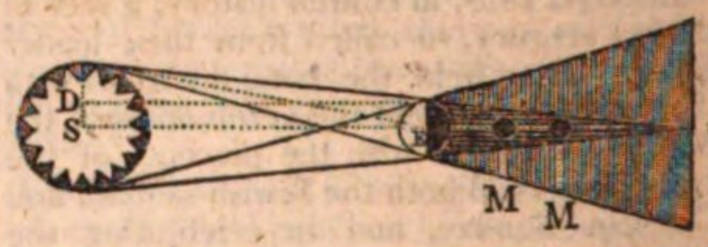
ECLIPSE, in astronomy, the deprivation of the light of the sun, or of some heavenly body, by the interposition of another heavenly body between our sight and it. See ASTRONOMY.

ECLIPSE, *partial*, is when only a part of the luminary is eclipsed. And

ECLIPSE, *total*, is that in which the whole luminary is darkened.

ECLIPSE *of the moon*, is a privation of the light of the moon, occasioned by an interposition of the body of the earth directly between the sun and moon, and so intercepting the sun's rays that they cannot arrive at the moon, to illuminate her. Or, the obscuration of the moon may be considered as a section of the earth's conical shadow, by the moon passing through some part of it.

The manner of this eclipse is represented in this figure, where S is the sun, E the earth, and M or M the moon.



Lunar eclipses only happen at the time of full moon, because it is only then the earth is between the sun and moon; nor do they happen every full moon, because of the obliquity of the moon's path with respect to the sun's, but only in such full moons as happen either at the intersection of those two paths, called the moon's nodes, or very near them, viz. when the moon's latitude, or distance between the centres of the earth and moon, is less than the sum of the apparent semidiameters of the moon and the earth's shadow.

The chief circumstances in lunar eclipses are the following: 1. All lunar eclipses are universal, or visible in all parts of the earth which have the moon above their horizon; and are every where of the same magnitude, with the same beginning and end. 2. In all lunar eclipses, the eastern side is what first immerges and emerges again, i. e. the left-hand side of the moon as we look towards her, from the north; for the proper motion of the moon being swifter than that of the earth's shadow, the moon approaches it from the west, overtakes and passes through it with the moon's east side foremost, leaving the shadow behind, or to the westward. 3. Total eclipses, and those of the longest duration, happen in the very nodes of the eclipse; because the section of the earth's shadow, then falling on the moon, is con-

siderably larger than her disc. There may however be total eclipses within a small distance of the nodes; but their duration is the less as they are farther from it, till they become only partial ones, and at last none at all. 4. The moon, even in the middle of an eclipse, has usually a faint appearance of light, resembling tarnished copper, which Gassendus, Ricciolus, Kepler, &c. attribute to the light of the sun, refracted by the earth's atmosphere, and so transmitted thither. Lastly. She grows sensibly paler and dimmer, before entering into the real shadow, owing to a penumbra which surrounds that shadow to some distance.

ECLIPTA, a genus of the class and order syngenesia polygamia superflua. The recept. is chaffy; down none; corollets of the disk four-cleft. There are five species, herbaceous plants of the East and West Indies.

ECLIPTIC, in astronomy, a great circle of the sphere, supposed to be drawn through the middle of the zodiac, making an angle with the equinoctial of about 23° 30′, which is the sun's greatest declination; or, more strictly speaking, it is that path or way among the fixed stars that the earth appears to describe to an eye placed in the sun. See ASTRONOMY.

The ecliptic approaching nearer and nearer to a parallelism with the equator, at the rate of half a second in a year nearly, or from 50″ to 55″ in 100 years, as is deduced from antient and modern observations compared together; and as the mean obliquity of the ecliptic was 23° 28′, about the end of the year 1788, or beginning of 1789, by adding half a second for each preceding year, or subtracting the same for each following year, the mean obliquity will be found nearly for any year either before or since that period. The quantity however of this change is variously stated by different authors, from 50″ to 60″ or 70″ for each century or 100 years. Hipparchus, almost 2000 years since, observed the obliquity of the ecliptic, and found it about 23° 51′; and all succeeding astronomers, to the present time, having observed the same, have found it always less and less, being now rather under 23° 28′; a difference of about 23′ in 1950 years; which gives a medium of 70′ in 100 years. There is great reason however to think that the diminution is variable.

This diminution of the obliquity of the ecliptic to the equator, according to Mr. Long, and some others, is chiefly owing to the unequal attraction of the sun and moon on the protuberant matter about the earth's equator. For if it is considered, say they, that the earth is not a perfect sphere, but an oblate spheroid, having its axis shorter than its equatorial diameter; and that the sun and moon are constantly acting obliquely upon the greater quantity of matter about the equator, drawing it in a manner towards a nearer and nearer coincidence with the ecliptic; it will not appear strange that these actions should gradually diminish the angle between the planes of these two circles. Nor is it less probable that the mutual attractions of all the planets should have a tendency to bring their orbits to a coincidence; though this change is too small to become sensible in many ages.

It is now, however well known, that this change in the obliquity of the ecliptic is wholly owing to the actions of the planets upon the earth, and especially the planets Venus and Jupiter. According to La Grange, who proceeds upon theory, the annual change of obliquity is variable, and has its limits; about 2000 years ago, he thinks it was after the rate of about 38″ in 100 years; that it is now, and will be for 400 years to come 56″ per century; but 2000 years hence 49″ per century. According to Cassini, who computes from observations of the obliquity between the years 1739 and 1778, the annual change at present is 60″ or 1′ in 100 years. But according to La Lande, the diminution is at the rate of 88″ per century; while Dr Maskelyne makes it only 50″ in the same time.

Beside the regular diminution of the obliquity of the ecliptic, at the rate of near 50 seconds in a century, or half a second a year, which arises from a change of the ecliptic itself, it is subject to two periodial inequalities, the one produced by the unequal force of the sun in causing the precession of the equinoxes, and the other depending on the nutation of the earth's axis. See the Explanation and Use of Dr. Maskelyne's Tables and Observations, pa. vi, where we are shewn how to calculate those inequalities, and where he shews that, from his own observations, the mean obliquity of the ecliptic to the beginning of the year 1769, was 23° 28′ 9″ ·7.

To find the obliquity of the ecliptic, or the greatest declination of the sun; about the time of the summer solstice, observe very carefully the sun's zenith distance for several days together, then the difference between this distance and the latitude of the place, will be the obliquity sought, when the sun and equator are both on one side of the place of observation; but their sum will be the obliquity when they are on different sides of it. Or it may be found by observing the meridian altitude or zenith distance, of the sun's centre, on the days of the summer and winter solstice; then the difference of the two will be the distance between the tropics, the half of which will be the obliquity sought.

Table of the obliquity of the ecliptic at different periods.

Authors' Names.	Years before Christ	Obliquity.
		° ′ ″
Pytheas - -	324	23 49 23
Eratosthenes and Hipchus	230 & 140 aft. Christ	23 51 20
Ptolemy - -	140	23 48 45
Almahmon - -	832	23 35
Albategnius -	880	23 35
Thebat - -	911	23 33 30
Abul Wasi and Hamed	999	23 35
Persian tables in Chrysococea - -	1004	23 35
Albatrunius - -	1007	23 35
Arzachel - -	1104	23 33 30
Almæon - -	1140	23 33 30
Choja Nassir Oddin	1290	23 30
Prophatius the Jew	1300	23 32
Ebn Shattir - -	1363	23 31
Purbach and Regiomontanus - -	1460	23 30
Ulugh Beigh -	1463	23 30 17
Walther - -	1476	23 30
Ditto corrected by refraction, &c.	——	23 29 8
Werner - -	1510	23 28 30
Copernicus - -	1525	23 28 24
Egnatio Danti -	1570	23 29
Prince of Hesse -	1570	23 31
Rothman and Byrge	1570	23 30 20
Tycho Brahe -	1584	23 31 30
Ditto corrected -	——	23 29
Wright - -	1594	23 30
Kepler - -	1627	23 30 30
Gassendus - -	1630	23 31
Ricciolus - -	1646	23 30 20
Ditto corrected -	1655	23 29
Hevelius - -	1653	23 30 20
Ditto corrected -	1661	23 28 52
Cassini - -	1655	23 29 15
Montons corrected, &c.	1660	23 29 3
Richer corrected -	1672	23 28 52
De la Hire - -	1686	23 29
Ditto corrected -	——	23 29 28
Flamstead - -	1690	23 29
Bianchini - -	1703	23 28 25
Roemer - -	1706	23 28 41
Louville - -	1715	23 28 24
Godin - - -	1730	23 28 20
Bradley - -	1750	23 28 18
Mayer - -	1756	23 28 16
Maskelyne - -	1769	23 28 10
Hornsby - -	1772	23 28 8

As to the obliquity of the ecliptic, or the angle which its plane makes with that of the equinoctial, it is found to vary.

ECLIPTIC, in geography, a great circle on the terrestrial globe, not only answering to, but falling within the plane of the celestial ecliptic. See GLOBE.

ECLOGUE, in poetry, a kind of pastoral composition, or a small elegant poem, in a natural simple style. See POETRY.

ECPHORA, in architecture commonly the distance between the extremity of a member or moulding, and the naked part of the column, or any other part it projects from.

ECSTATICI, in Grecian antiquity, a sort of diviners, who were cast into trances or ecstacies, in which they lay like dead men, or persons asleep, deprived of all sense or motion, but after some time, returning to themselves, they gave strange relations of what they had seen and heard.

ECTHESIS, in church-history, a confession of faith, in the form of an edict, published in the year 639, by the emperor Heraclius, with a view to pacify the troubles occasioned by the Eutychian heresy in the eastern church. The same prince revoked it, on being informed that pope Severinus had condemned it, as favouring the monothelites; declaring at the same time that Sergius, patriarch of Constantinople, was the author of it.

ECTHLIPSIS, among Latin grammarians, a figure of prosody, whereby the *m* at the end of a word, when the following word begins with a vowel, is elided, or cut off, together with the vowel preceding it, for the sake of the measure of the verse; thus they read mult' ille, for multum ille.

The reason of an ecthlipsis, which in Latin verse ought always to take place when the immediately following word begins with a vowel, is to prevent the harshness of an hiatus, or concourse of vowels.

ECTROPIUM, in surgery, is when the eye-lids are inverted, or retracted so as to shew their internal or red surface, and cannot sufficiently cover the eye.

ECTYPE, among antiquarians, an impression of a medal, seal, or ring, or a figured copy of an inscription, or other antient monument.

EDDY-TIDE, or EDDY-WATER, among seamen, is where the water runs back contrary to the tide; or that which hinders the free passage of the stream, and so causes it to return again.

EDGINGS, among gardeners, a series of small but durable plants, set round the edges or borders of flower-beds, &c.

The best and most durable plant for this use is box, which, if well planted, and rightly managed, will continue in strength and beauty for many years. The seasons for planting these are the autumn and very early in the spring; and the best species for this purpose is the dwarf Dutch box. The edgings of box are now only planted on the sides of borders next walls, and not, as was some time since the fashion, all round borders, or fruit-beds, in the middle of gardens, unless they have a gravel-walk between them, in which case it serves to keep the earth of the borders from washing down on the walks in hard rains, and fouling the gravel. Daisies, thrift, or sea-july-flowers, and chamomile, are also used by some for this purpose; but they grow out of form, and require yearly transplanting.

EDICT, in matters of polity, an order or instrument, signed and sealed by a prince, to serve as a law to his subjects. We find frequent mention of the edicts of the prætor, the ordinances of that officer in the Roman law. In the French law, the edicts are of several kinds; some importing a new law or regulation; others, the erection of new offices, establishments of duties, rents, &c. and sometimes articles of pacification. In France edicts are much the same as a proclamation is with us, but with this difference, that the former have the authority of a law in themselves, from the power which issues them forth, whereas the latter are only declarations of a law, to which they refer, and have no power in themselves.

Edicts cannot exist in Britain, because the enacting of laws is lodged in the parliament, and not in the king.

Edicts are all sealed with green-wax to shew that they are perpetual and irrevocable.

EEL, in ichthyology. See MURÆNA.

EELS, *microscopic*, those discovered by the microscope in pepper-water and other infusions of plants, &c. See MICROSCOPE.

EEL, *sea*, anguilla marina, a fish otherwise called conger, being a species of muræna, with the upper edge of the back-fin black. See MURÆNA.

EEL-*spear*, a cruel instrument with three or four jagged teeth, used for catching of eels; that with the four teeth is best, which they strike into the mud at the bottom of the river, and if it strikes against any eels, it never fails to bring them up.

EFFERVESCENCE. See CHEMISTRY.

EFFLUVIUM, in physiology, a term much used by philosophers and physicians, to express the minute particles which exhale from most, if not all, terrestrial bodies in form of insensible vapours.

EFT. See LACERTA.

EGG, *ovum*, in physiology, a body formed in certain females, in which is contained an embryo, or fœtus of the same species, under a cortical surface, or shell. The exterior part of an egg is the shell, which is in a hen, for instance, a white, thin, and friable cortex, including all the other parts. The shell becomes more brittle by being exposed to a dry heat. It is lined every where with a very thin, but pretty tough, membrane, which, dividing at, or very near, the obtuse end of the egg, forms a small bag, where only air is contained. In new-laid eggs this folliculus appears very little, but becomes larger when the egg is kept. Within this membrane are contained the albumen, or white, and the vitellus, or yolk, each of which have their different virtues. The albumen is a cold, viscuous, white liquor in the egg, differing in consistence in its different parts. It is observed, that there are two distinct albumens, each of which are inclosed in its proper membrane; of these, one is very thin and liquid, and the other more dense and viscuous, and of a somewhat whiter colour, but in old and stale eggs, after some days incubation, inclining to a yellow. As this second albumen covers the yolk on all sides, so it is itself surrounded by the other external liquid. The albumen of a fecundated egg is as sweet and free from corruption, during all the time of incubation, as it is in new-laid eggs; as is also the vitellus. As the eggs of hens consist of two liquors separated one from another, and distinguished by two branches of umbilical veins, one of which goes to the vitellus, and the other to the albumen, so it is very probable that they are of different natures, and consequently appointed for different purposes. When the vitellus grows warm with incubation, it becomes more tumid, and like melting wax, or fat; whence it takes up more space, for as the fœtus increases, the albumen insensibly wastes away, and condenses; the vitellus, on the contrary, seems to lose little or nothing of its bulk, when the fœtus is perfected, and only appears more liquid and humid when the abdomen of the fœtus begins to be formed. The chick in the egg is first nourished by the albumen; and, when this is consumed, by the vitellus, as with milk. Not long before the exclusion of the chick, the whole yolk is taken into its abdomen; and the shell, at the obtuse end of the egg, frequently appears cracked, some time before the exclusion of the chick. The chick is sometimes observed to perforate the shell with its beak. After exclusion, the yolk is gradually wasted, being conveyed into the intestines by a small duct. See COMPARATIVE ANATOMY.

According to a chemical analysis of eggs, they consist of four parts; an osseous covering, called the shell, a membrane which covers the constituent parts of the egg; the white, or albumen, and the yolk. In 100 parts of the shell of hen's-eggs there are,

89.6 of carbonat of lime
5.7 of phosphat of lime
4.7 of animal matter

100.0

The white, or albumen, is nearly of the same nature as the serum of blood. See ALBUMEN.

The yolk contains a lymphatic substance, mixed with a certain quantity of mild oil. There is a considerable analogy between the eggs of animals and the seeds of vegetables. The yolk of eggs renders oils and resins soluble.

EGYPTIANS, *gipsies*, are a kind of commonwealth among themselves of wandering impostors and jugglers, who made their first appearance in Germany, about the beginning of the sixteenth century, and have since spread themselves over all Europe and Asia. By the laws of England, gipsies were formerly subject to imprisonment and forfeiture of goods, but they are now considered chiefly as rogues and vagabonds, and are described as such in the vagrant act. 4Black. 166.

EHRETIA, in botany, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 41st order, asperifoliæ. The fruit is a bilocular berry; the seeds solitary and bilocular; the stigma emarginated. There are five species, trees and shrubs of the West Indies.

EHRHARTA, a genus of the monogynia order, in the hexandria class of plants. The calyx is a two-valved, one-flowered glume; the corolla is a double glume, each two-valved; the exterior one compressed, and scymitar-shaped, transversely wrinkled, and gashed at the base. There are six stamina, three on each side the pistil, in a parallel line. The stigma is simple, compressed, four-tufted, and torn at the top. There are five species; grasses of the Cape.

EJECTIONE CUSTODIÆ, a writ which lies against him who casts out the guardian from any land during the minority of the heir.

EJECTMENT. An ejectment is a mixed action, by which a lessee for years, when ousted, may recover his term and damages; it is real in respect of the lands, but personal in respect of the damages. Since the disuse of real action, this mixed proceeding is become the common method of trying the title to lands or tenements. Runn. on Ejectments.

The modern method of proceeding in ejectment, entirely depends on a string of legal fictions; no actual lease is made; no actual entry by the plaintiff; no actual ouster by the defendant; but all are merely ideal for the sole purpose of trying the title. To this end, a lease for a term of years is stated in the proceedings to have been made by him who claims title to the plaintiff, who is generally an ideal fictitious person, who has no existence, though it ought to be a real person to answer for the defendant's costs. In this proceeding, which is the declaration, (for there is no other process in this action) it is also stated, that the lessee, in consequence of the demise to him made, entered into the premises; and that the defendant, who is also now another ideal fictitious person, and who is called the casual ejector, afterwards entered thereon, and ousted the plaintiff; for which ouster the plaintiff brings this action. Under this declaration is written a notice, supposed to be written by this casual ejector, directed to the tenant in possession of the premises; in which notice the casual ejector informs the tenant of the action brought by the lessee, and assures him, that as he, the casual ejector, has no title at all to the premises, he shall make no defence, and therefore he advises the tenant to appear in court, at a certain time, and defend his own title, otherwise he, the casual ejector, will suffer judgment to be

had against him, by which the actual tenant will inevitably be turned out of possession. 2 Cromp. Prac. 152.

The antient way of proceeding was by actual sealing a lease on the premises, by the party in interest who was to try the titles; and this method is still in use in the following cases:

First, Where the house or thing for which ejectment is brought is empty. Secondly, When a corporation is lessor of the plaintiff, they must give a letter of attorney to some person to enter and seal a lease on the land; for a corporation cannot make an attorney or a bailiff except by deed; nor can they appear but by making a proper person their attorney by deed, therefore they cannot enter and demise upon the land as natural persons can. L. Raym. 135. Thirdly, When the several interests of the lessor of the plaintiff are not known, for in that case it is proper to seal a lease on the premises, lest they should fail in setting out in their declaration the several interests which each man possesses. Fourthly, Where the proceedings are in an inferior court, they must proceed by actually sealing a lease, because they cannot make rules confess lease, entry, and ouster, inasmuch as inferior courts have not authority to imprison for disobedience to their rules.

It is a general rule, that no person can in any case bring an ejectment, unless he has in himself at the time a right of entry; for although by the modern practice the defendant is obliged by rule of court, to confess lease, entry, and ouster, yet that rule was only designed to expedite the trial of the plaintiff's right, and not to give him a right which he had not before; and therefore, when it happens that the person claiming title to the lands has no right of entry, he cannot maintain his action. 3 Black. 206.

The damages recovered in these actions, though formerly their only intent, are now usually (since the title has been considered as the principal question) very small and inadequate, amounting commonly to one shilling, or some other trivial sum. In order therefore to complete the remedy, when the possession has been long detained from him that has right, an action of trespass also lies, after a recovery in ejectment, to recover the mesne profits which the tenant in possession had wrongfully received; which action may be brought in the name of either the nominal plaintiff in the ejectment, or his lessor, against the tenant in possession, whether he is made party to the ejectment, or suffers judgment to go by default.

EKEBERGIA, a genus of the class and order decandria monogynia. The calyx is four-parted; petals four; berry contains five oblong seeds. There is one species, a tree of the Cape.

ELÆAGNUS, *oleaster*, or *wild olive*, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 16th order, calycifloræ. There is no corolla; the calyx is campanulated, quadrifid, superior; the fruit is a plum below the campanulated calyx. There are nine species: The most remarkable are, 1. orientalis, or eastern broad-leaved olive, with a large fruit, is a native of the Levant and some parts of Germany. The leaves are about two inches long, and one and a half broad in the middle. They are placed alternate, and of a silver colour; at the footstalk of every leaf there comes out a pretty long sharp thorn, which are alternately longer; the flowers are small, the inside of the empalement is yellow, and they have a strong scent when fully open. 2. The angustifolia, without thorns, is that kind commonly preserved in the gardens of this country. The leaves are more than three inches long, and half an inch broad, and have a shining appearance like satin. The flowers come out at the footstalks of the leaves, sometimes singly, at other times two, and sometimes three, at the same place. The outside of the empalement is silvery and studded; the inside of a pale yellow, and having a very strong scent. The flowers appear in July, and are sometimes succeeded by fruit. 3. The latifolia, with oval leaves, is a native of Ceylon, and some other parts of India.

The two first may be propagated by laying down the young shoots in autumn. They will take root in one year; when they may be cut off from the old trees, and either transplanted into a nursery for two or three years to be trained up, or into places where they are to remain. The proper time for this is in the beginning of March, or early in the autumn. They should be placed where they may be screened from high winds, for they grow very freely, and are apt to be split by the wind if they are too much exposed. The third sort is too tender to endure the open air of this country; and therefore must be kept in a warm stove, except during a short time in the warmest part of the summer. From the flowers of these plants an aromatic and cordial water has been drawn, which is said to have been successfully used in putrid and pestilential fevers. The genus elæagnus is not to be confounded with the oleaster, or wild olive of Gerard, Parkinson and Ray. The last is only a particular species of olive, called by Tournefort and Caspar Bauhine olea sylvestris.

ELÆIS, a genus belonging to the natural order of palmæ. The male calyx is hexaphyllous; the corolla sexfid; the stamina six: the female calyx is hexaphyllous; the corolla hexapetalous; the stigma three; the fruit is a fibrous plum, with a three-valved nut or kernel. There is one species, from the fruit of which, resembling an olive in shape, the negroes extract the famous palm oil.

ELÆOCARPUS, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is pentapetalous and lacerated; the calyx is pentaphyllous; and the fruit is a plum, with a wrinkled shell. There are six species, trees of the East Indies. One of them, the copalliferus, yields the resin so useful as a varnish, called gum copal.

ELÆODENDRUM, olive wood, a genus of the pentandria monogynia class and order. The corolla is five-petalled; drupe ovate, with a two-celled nut. There are two species, trees of Africa.

ELAPHEBOLIUM, in Grecian antiquity, the ninth-month of the Athenian year, answering to the latter part of February and beginning of March. It consisted of 30 days, and its name from the festival elaphebolia, kept in this month, in honour of Diana the huntress, on which occasion, a cake made in the form of a deer was offered to her.

ELASMIS, in natural history a genus of talcs, composed of small plates in form of spangles, and either single, and not farther fissile, or if complex, only fissile to a certain degree, and that in somewhat thick laminæ.

Of these talcs there are several varieties, some with large and others with small spangles, which differ also in colour, and other peculiarities. See TALC.

ELASTICITY, or *elastic force*, that property of bodies with which they restore themselves to their former figure, after any external pressure; being the same with what is otherwise called springiness, very observable in a bent bow, steel springs, and the like.

There are in nature as varieties of activities; in some of which the causes are rendered manifest by experimental inquiries; in others, and amongthese we may reckon elasticity, where no cause at all is discoverable by the senses.

A variety of experiments prove the existence of an elastic force. The separation of two bodies after impact, is a proof of elasticity. Metals, semi-metals, stones, gems, fossils, cartilages, most fluids, as air, and even water, exert an influence opposite to the direction of the force compressing them, and discover a tendency to return to their natural state: which tendency is in all of them imperfect, and less than the force impressed; but most perfect in glass, ivory, hardened steel, and cartilages.

Elasticity is increased by augmenting the density of a body: thus metals are rendered more elastic by being beaten by a hammer: and their elasticity, which was scarcely sensible before, by this process becomes very sensible. Steel is more elastic when tempered, and its density is increased in the ratio of 7809 to 7738.

Elasticity is sometimes increased by cold; thus the range of a cannon-ball is said to be greater when the cannon is cold, than when heated; and the string of violin, or a steel lamina, is inflected, and also recovers its situation, with less force in hot than in cold weather.

Metal fibres, and thin steel laminæ, exhibit no elasticity, unless stretched to a certain degree, and inflected by a certain force; as appears from lax cords, which, if a little stretched and removed from their natural state, discover no tendency to return to it; and when the inflection of a fibre is very great, the influence of elasticity seems to be in some cases annihilated; as appears by the fibres of wood, which, inflected to a certain degree, remain quiescent, and have no tendency to recover their former situation. The limits where the elastic power beigns, or where it terminates, are unknown.

Motion is supposed to be communicated or diffused, in elastic bodies, from the point of impact to the remote parts; and this supposition is grounded on the following experiments.

If two ivory balls are suspended, so that their centres are in one line. The surface of one of them, B, is fresh painted. By letting them touch each other gently, A receives a small point of paint upon its surface. Now by raising the ball A, so that it may impinge with some violence on B, it will be evident that the surface of each ball has been flattened by the blow; for there is on each a circular mark, shewn by the paint struck

off, and the other by the paint received; and, as the balls retain their spherical figure after the impact, it is clear that the parts of the surface not only lost, but recovered their figure.

Two glass balls may, with a proper degree of velocity, so impinge on each other, that the interior parts of the ball will be broken, though the exterior contiguous to the point of impact, be unbroken.

Suspend two ivory balls from the same point, by strings of the same length, and let the smaller ball A, impinge upon B, at rest, with a given velocity. A will be reflected always to the same height, and B will be impelled to the same height. But if either A or B is hollowed, and lead inserted in the centre or near to the posterior surface, neither ball, though the weight be the same, will ascend as high as before the insertion of the lead. The progressive motion of the parts from the point of impact is stopped by the insertion of the lead; and consequently, the force of restitution and the change of figure, is less than before it was inserted.

The motion diffused from the point of impact to the remote parts of an elastic body, is continued for some time, and diminishes gradually till it vanishes: and there seem to be two kinds of vibrations in the parts of an elastic body; one of which is quick, and called a tremor of its minute parts; and the other slower and longer, by which its figure is changed, and an impinging body repelled.

A stroke or friction upon the edge of a glass, communicates a tremulous motion to the parts of the glass, which is visibly communicated to the water it may contain. A reed or stick placed across the bottom of a large glass bell, will fall when the glass is struck, the stroke producing a change of figure. If you hold a piece of metal near the brim or lip of a bell, without touching it, and the bell is stricken by a hard body, you will see it touch the piece of metal, and will hear a succession of sounds gradually decaying. If the edge of the bell is pinched, and the fingers suddenly withdrawn, the same sound is heard, without producing any sensible motion towards the piece of metal, or displacing the reed across it.

Those laws according to which alterations are produced in the rest and motion of bodies upon their collision, are called the laws of communication of motion.

When one body strikes against another, if the line of direction of the impulse passes through the centre of gravity of both the bodies, the impulse is called full or direct, otherwise it is called an oblique impulse.

The relative velocity of two bodies, is that velocity with which they approach to, or recede from, each other; and is equal either to the difference of the velocities of bodies moving the same way, or to the sum of the velocities of bodies moving contrary ways; for, if one of the bodies was at rest, and the other moved towards it or from it, with the forementioned difference or sum of velocities, the body in motion would approach to, or recede from, the body at rest, just as fast as the two moving bodies approached to, or receded from, each other.

If two bodies move in the same direction with equal velocities, they are relatively at rest.

When the iupulse is direct, and the bodies are void of elasticity, the laws of the communication of motion are as follow:

(1.) In all cases, the velocities after the stroke are equal; for the impulse ceases when the impinging bodies are relatively at rest, and not before. (2.) If two bodies move the same way, and in the same right line, that which moves fastest will overtake the other, and the sum of their motions will be the same after the stroke as before: for, by the third law of motion, so much motion as the slowest body gains, the swiftest body loses. (3.) If two bodies move contrary ways, the sum of their motions after the stroke will be equal to the difference of their motions before the stroke; for, whilst the strongest motion destroys the weakest, it also loses an equal part of itself, the third law of motion. (4.) If the sum of two conspiring motions, or the difference of two contrary motions, be divided by the sum of the quantities of matter in both the moving bodies, the quotient will give their common velocity after the stroke. (5.) If the velocity after the stroke be multiplied into the quantity of matter in each body, the product will express the quantities of motion in each body, after the stroke. (6.) The difference between the quantities of motion in either of the moving bodies before and after the stroke, is equal to the quantity of the stroke.

Example 1. Let a ball of three ounces, moving with nine degrees of velocity, overtake another ball, of two ounces, moving with four degrees of velocity: then will the quantities of motion before the stroke be 27 and 8, the common velocity after the stroke will be 7, the quantities of motion after the stroke will be 21 and 14, and the quantity of the stroke will be 6.

Example 2. Let the same balls move with the same velocities contrary ways; then will the quantities of motion before the stroke be as before; the common velocity after the stroke will be $3\frac{4}{5}$, the quantities of motion after the stroke will be $11\frac{2}{5}$, and $7\frac{1}{5}$, and the quantity of the stroke $15\frac{3}{5}$.

Wherefore, if two equal bodies move in contrary directions, with equal velocities, as soon as they strike, both motions will be destroyed. And if a body in motion strikes an equal body at rest, it will communicate half its velocity or half its motion. And if one moving body overtakes another moving body equal to the first, the common velocity after the stroke will be equal to half the difference of their velocities before the stroke. But if they move in contrary directions, the velocity after the stroke will be equal to half the sum of the velocities before the stroke. (7.) If a moving body strikes against an immoveable obstacle, after the stroke the whole will be destroyed, and the quantity of the stroke will be equal to the whole quantity of the motion. (8.) If the moving body gravitates towards the immoveable obstacle, as when a stone falls upon the earth, the quantity of the stroke is equal to the sum of the quantity of motion added to the weight of the moving body; for the weight remains upon the obstacle when the impulse is destroyed.

The sum of the motions of two bodies void of elasticity, may be less after the stroke than it was before, but it cannot be more. (9.) If a body moves after the stroke, the same way that it moved before, the difference of the velocities before and after the stroke will be equal to the velocity lost or gained. Thus, in the first example, the velocity lost is 2, and the velocity gained 3. (10.) If the direction of the motion after the stroke is contrary to the direction of the motion before the stroke, the sum of the velocities before and after the stroke will express the quantity of the velocity gained. Thus, in the second example, the velocity is $5\frac{1}{5}$, the velocity gained $7\frac{4}{5}$.

When the impulse is direct, and the bodies perfectly elastic, the laws of the communication of motion are different from the foregoing. For,

(1.) Upon the collision of two elastic bodies, the force of elasticity is equal to the force of compression; and the force of compression in each body is equal to the quantity of the stroke. (2.) The whole force of elasticity exerted at the restitution of both the springs, is double the quantity of the stroke; for it is the result of two forces in contrary directions, each of which is equal to the quantity of the stroke. Or if it may be conceived thus: the sum of the elasticities is equal to the sum of the quantities of the stroke in both bodies together; that is, to double the quantity of the stroke in each single body. (3.) The effect of the elasticity in each body, will be equal to the effect of the stroke, and in the same direction; for the two equal and contrary elasticities in the former case, are equivalent to action and reaction in the latter. (4.) Wherefore, to find the velocity of either body after the collision, first find the common velocity with which the bodies would move after the stroke, if they had been void of elasticity, and find also the velocity lost or gained; then subtract the velocity lost from the common velocity, or to the common velocity add the velocity gained; so shall the difference or sum be the velocity sought. But if the velocity lost be greater than the common velocity, then subtract the common velocity from the velocity lost, and the remainder will give the velocity sought in a contrary direction.

Thus, in the first example before stated, if we suppose the bodies to be elastic, the velocities after collision will be 5 and 10, and, consequently the quantities of motion will be 15 and 2.

In the second example, the velocities after collision will be $1\frac{2}{5}$ and $11\frac{3}{5}$, and the quantities of motion $4\frac{1}{5}$ and $23\frac{1}{5}$.

For a third example, let us suppose two bodies in proportion as three to two; the first at rest, and the second moving towards the first with 40 degrees of velocity: then will the quantities of motion before the stroke be 0 and 80, the common velocity after the stroke 16, the quantities of motion after the stroke 48 and 32, the quantity of the stroke 48, the velocity gained 16, the velocity lost 24, the velocities after the restitution of the springs 32, and 8 in a contrary direction; the quantities of motion after collision 96 and 16.

In the first example, the sum of the motion before collision is equal to the sum of the motion after collision; in the second, it is greater; in the third, less.

Two elastic bodies always recede from each other after collision, and that with the same relative velocity with which they tended towards each other before collision. Thus the relative velocity before and after collision, is 5 in the first example, 13 in the second, and 40 in the third.

And in all cases, whether the impinging

bodies are elastic or not, the sum of the motions in the same direction, and the difference of the motions in a contrary direction, are the same both before and after collision.

If two equal elastic bodies move towards each other with equal velocities, they will recede from each other after collision each with the same velocity. If one of them in motion strikes against the other at rest, it will communicate the whole velocity, and remain at rest itself. If one overtakes the other, they will interchange velocities, and continue to go on the same way as before. If they meet each other with different velocities, they will interchange velocities, and fly off from each other in contrary directions.

If an elastic body strikes upon an immoveable elastic obstacle, it will rebound with the same velocity that it came.

If one of the impinging bodies is hard, and the other elastic, the laws of the communication of motion are the same as if both the bodies were elastic; for the spring will give way, till the force of elasticity becomes equal to the force of compression, that is, double to the quantity of the stroke in each body; and the re-action of a hard body against double the quantity of elasticity, will produce the same effect as a single quantity of elasticity in each body, acting in contrary directions.

If the impulse be oblique, it must be resolved into two impulses, one direct, and the other parallel to the tangent at the point of collision. The effect of the direct impulse must be computed according to the laws before mentioned: the parallel impulse will continue after the collision the same in all respects that it was before; nor will it produce any other effect, except by means of the friction to make the bodies revolve each about its own centre of gravity.

It often happens that the communication of motion is the indispensable means of obtaining some other effect; thus it is used to nail and flatten bodies; in these cases it is not sufficient, that the striking body has a certain quantity of motion, the mass or quantity of matter must be so proportioned with the velocity, as to produce the required effect, without splitting or destroying the body struck.

In architecture there are many occasions, where it is necessary to drive piles; if the mass which strikes the pile is small, it will not have force sufficient to drive it and if it is moved with considerable velocity, it will split the head of the pile; a large mass must therefore be used, moving with less velocity. If small hammers and a great velocity are used to drive pivots of iron into large pieces of wood, the head of the pivot will yield, and yet not be driven into the wood; whereas the effect will be answered by using hammers of considerable weight, moving with less velocity.

Gold-beaters and other workmen who flatten metals, make use of heavy hammers, and move them slowly; if they used small hammers, and moved them swiftly, the parts of the metal would be broken and divided by the strokes.

To prevent the propagation of motion, and to deaden the blow, those that work in their chambers, and are obliged to use anvils, place the blocks that hold the anvil upon a roll of matting, or upon springs; without this precaution, great part of the force impressed by the hammer would be transmitted to the floor, and would create a shaking to the prejudice of the building.

The principles above laid down will assist in explaining the recoil of cannon, fusees, and other arms; for you may consider the gunpowder as a spring which unbends or expands itself in every direction, but which can only act efficaciously against the breech of the cannon and the ball.

The action of the powder is that of two equal forces against two unequal powers of resistance, the ball and the cannon; it may therefore be supposed, cæteris paribus, to impress them both with an equal quantity of motion, but with different degrees of velocity; that of the ball being as much greater as its mass is less than that of the cannon, &c.

The cannon, the musket, &c. especially if you take into the account the obstacles which retain them, are much more difficult to move than the ball with which they are charged; which, of course, receives from the inflamed powder a much greater degree of velocity.

There are other circumstances which contribute to augment the velocity of the ball, as the length of the piece, &c. which do not come properly before us. As to the recoil in general, supposing the quantity and quality of the powder the same, a gun recoils so much the more as the bullet makes more resistance either by its weight or the wadding.

A rocket flies upwards, because its lower part, which is fired, performs the office of a spring, which acts one way against the body of the rocket, and the other way against a volume of air; and as this spring is continually renewed by the successive inflammation of all the parts of the rocket, its motion is accelerated, first, because it is contained in the body itself, and is therefore continually adding to its velocity; and secondly, because the weight or resistance of the rocket is diminishing every instant by the dissipation of the parts as they burn away.

ELATE, a genus belonging to the natural order of palmæ. There is no male calyx; the corolla is tripetalous, with three stamina. There is no female calyx; the corolla is tripetalous, with one pistil; the fruit is an oval acuminated plum. There is one species, a native of the East Indies, which grows to the height of 14 feet. The natives chew the nut in the same manner as the areca or the leaf of the betel.

ELATER, in zoology, a genus of insects, belonging to the order of coleoptera. The antennæ are setaceous; and an elastic spring or spine projects from the hinder extremity of the breast or under side of the thorax. By means of this kind of spring, the animal, when turned upon its back, contrives to leap up into the air, and so turn itself. It varies in size; and when the insect is young and newly metamorphosed, its elytra are of a beautiful deep red; but in a few days they change to a much darker hue, and are nearly of a chesnut colour. In the state of larvæ it inhabits the trunks of decayed trees, and is there transformed. With the help of its wings it issues from its prison, flutters upon flowers, wanders over the fields, and conceals itself in thickets or under the bark of trees. There are 38 species.

ELATERIUM, a genus of the monandria order, in the monœcia class of plants; and in the natural method ranking under the 34th order, cucurbitaceæ. There is no male calyx; the corolla is salver-shaped; there is no female calyx; the corolla is salver-shaped; the capsule inferior, unilocular, and bivalved. There are two species, natives of America.

ELATINE, a genus of the tetragynia order, in the octandria class of plants; and in the natural method ranking under the 15th order, inundatæ. The calyx is tetraphyllous; the petals four; the capsule quadrilocular, quadrivalved, and depressed. There are two species, annual aquatics of Europe.

ELCESAITES, in church-history, a sect who made their appearance in the reign of the emperor Trajan, and took their name from their leader Elcesai. The Elcesaites kept a mean between the Jews, Christians, and Pagans; they worshipped but one God, observed the Jewish sabbath, circumcision, and the other ceremonies of the law. They rejected the Pentateuch and the Prophets; nor had they more respect for the writings of the apostles, particularly those of St. Paul.

ELECTION, is where a person has by law two remedies, and is compelled to declare which he will abide by: thus a creditor, in cases of bankruptcy, may either prove his debt under the commission, or proceed at law; but in this case he is compelled to make his election. Where also a person having obtained a judgment, and is entitled to execution, he may either take his remedy against the goods or the person, and he may choose either; but if he proceed against the person in the first instance, he cannot afterwards have recourse to the goods; but if he takes the goods, and these should be found inadequate to his demand, he may afterwards take the body.

ELECTION OF BISHOPS. See BISHOPS.

ELECTION OF A CLERK OF STATUTES-MERCHANT, a writ that lies for the choice of a clerk assigned to take and make bonds, called statutes-merchant, and is granted out of the chancery upon suggestion made, that the clerk formerly assigned is gone to dwell in another place, or is hindered from following that business, or has not land sufficient to answer his transgression if he should deal amiss. F. N. B. 164.

ELECTION OF ECCLESIASTICAL PERSONS. If any person that has a voice in elections, takes any reward for an election in any church, college, school, &c. such election shall be void; and if any such societies resign their places to others for reward, they incur a forfeiture of double the sum; and the party giving, and the party taking it, are thereby rendered incapable of such place. 31 Eliz. c. 6. See BISHOPS.

ELECTION OF MEMBERS OF PARLIAMENT. Qualification of the candidates. No member shall sit or vote in either house of parliament unless he be 21 years of age. 4 Inst. 47.

They must not be aliens-born; they must not be any of the twelve judges, because they sit in the lords' house. But persons who have judicial places in the other courts, ecclesiastical or civil, are eligible. 4 Inst. 47. Nor of the clergy; the reason assigned for which is, that they might sit in the convocation. Nor persons attainted of treason or felony, for they are unfit to sit any where. Id.

By the 30 C. II. st. 2. c. 1. and 1 Geo. I. c. 13. in order to prevent papists from sitting in either house of parliament, no person shall sit or vote in either till he has, in the presence of the house, taken the oaths of allegiance, supremacy, and abjuration, &c.

Sheriffs of counties, and mayors and bailiffs of boroughs, are not eligible in their respective jurisdictions, as being returning officers; but a sheriff of one county may be chosen knight of another. 1 Black. 175.

By several statutes, no persons concerned in the management of any duties or taxes created since 1692, except the commissioners of the treasury; nor any of the officers following, viz. commissioners of prizes, transports, sick and wounded, wine licences, navy and victualling; secretaries or receivers of prizes; comptrollers of the army accounts; agents for regiments; governors of plantations; officers of Minorca or Gibraltar; officers of the excise and customs; clerks or deputies in the several offices of the treasury, exchequer, navy, victualling, admiralty, pay of the army or navy, secretaries of state, salt, stamps, appeals, wine licences, hackney-coaches, hawkers, and pedlars; nor any persons that hold any new office under the crown, created since 1705, are capable of being elected. 1 Black. 175.

But this shall not extend to, or exclude the treasurer or comptroller of the navy, secretaries of the treasury, secretary to the chancellor of the exchequer, secretaries of the admiralty, under secretary of state, deputy paymaster of the army, or any person holding any office for life, or so long as he shall behave himself well in his office. 15 Geo. II. c. 22.

By the 6 Anne, c. 7. s. 26. if any member shall accept an office of profit under the crown, except an officer of the army or navy accepting a new commission, his election shall be void, but he shall be capable of being re-elected.

No person having a pension from the crown during pleasure, shall be capable of being elected. 6 Anne, c. 7. s. 25.

By the 22 Geo. III. c. 45. no contractor with the officers of government, or with any other person for the service of the public, shall be capable of being elected, or of sitting in the house, as long as he holds any such contract, or derives any benefit from it. But this does not extend to contracts with corporations, or with companies, which then consisted of ten partners; or to any person to whom the interest of such a contract shall accrue by marriage or operation of law, for the first twelve months. And if any person disqualified by such a contract shall sit in the house, he shall forfeit 500*l.* for every day; and if any person who engages in a contract with government admits any member of parliament to a share of it, he shall forfeit 500*l.* to the prosecutor.

No person shall be capable to sit or vote in the house of commons for a county, unless he has an estate, freehold or copyhold, for his life, or some greater estate, of the clear yearly value of 600*l.* nor for a city or borough, unless he has a like estate of 300*l.* and any other candidate, or two electors, may require him to make oath thereof at the time of election, or before the day of the meeting of parliament; and before he shall vote in the house of commons, he shall deliver in an account of his qualification, and the value thereof under his hand, and make oath of the truth of the same. But this shall not extend to the eldest son or heir apparent of a peer, or of any person qualified to serve as knight of a shire, nor to the members of either of the two universities. 9 Anne, c. 5. 33 Geo. II. c. 20.

Qualifications of electors. No person shall be admitted to vote under the age of twenty-one years. This extends to all sorts of members, as well for boroughs as counties. 7 & 8 W. c. 25.

Every elector of a knight of a shire, shall have freehold to the value of 40*s.* a year within the county, which is to be clear of all charges and deductions, except parliamentary and parochial taxes. 1 Black. 172.

No person shall vote in right of any freehold, granted to him fraudulently, to qualify him to vote, and every person who shall prepare or execute such conveyance, or shall give his vote under it, shall forfeit 40*l.* 10 Anne, c. 23.

No person shall vote for a knight of the shire without having been in the actual possession of the estate for which he votes, or in the receipt of the rents or profits thereof to his own use, above twelve calendar months, unless it come to him by descent, marriage, marriage-settlement, devise, or promotion to a benefice or office. 18 Geo. II. c. 1.

No person convicted of perjury shall be capable of voting at an election.

No person shall vote in respect of an annuity or rent-charge, unless registered with the clerk of the peace twelve calendar months before. Such annuity or rent-charge issuing out of a freehold estate.

No person shall vote for a knight of a shire, in respect of messuages, lands, or tenements, which have not been charged to the land-tax six calendar months before. 20 Geo. III. c. 17.

No person shall vote for any estate holden by copy of court-roll. 31 Geo. II. c. 14.

In mortgaged, or trust-estates, the mortgagor, cestuy que trust, shall vote, and not the trustee or mortgagee, unless they be in actual possession.

All conveyances to multiply voices, or to sport votes, shall be void; and no more than one voice shall be admitted for one and the same house or tenement.

The right of election in boroughs is various, depending entirely on the several charters, customs, and constitutions of the respective places: but by 2 Geo. II. c. 24, this right of voting for the future shall be allowed according to the last determination of the house of commons concerning it. And no person, claiming to vote in right of his being a freeman of a corporation (other than such as claim by birth, marriage, or servitude,) shall be allowed, unless he has been admitted to his freedom twelve calendar months before. 3 Geo. III. c. 15.

Of election. As it is essential to the very being of parliaments that election should be absolutely free, all undue influence whatever upon the electors, is illegal, and strongly prohibited. As soon, therefore, as the time and place of election within counties or boroughs are fixed, all soldiers quartered in the place are to remove, at least one day before the election, to the distance of two miles or more, and not to return till one day after the poll be ended, except in the liberty of Westminster, or other residence of the royal family, in respect of his majesty's guards, and in fortified places. 8 Geo. II. c. 30.

By the 7 & 8 W. c. 4. to prevent bribery and corruption, no candidate, after teste of the writ of summons, or after a place becomes vacant in parliament time, shall, by himself, or by any other ways or means on his behalf, or at his charge, before his election, directly, or indirectly, give, or promise to give, to any elector any money, meat, drink, provision, present, reward, or entertainment, to, or for, any such elector in particular; or to any county, city, town, borough, port, or place in general, in order to his being elected, on pain of being incapacitated.

To guard still more against gross and flagrant acts of bribery, it is enacted by 2 Geo. II. c. 24. explained and enlarged by 9 Geo. II. c. 38. and 16 Geo. III. c. 11. that if any money, gift, office, employment, or reward, be given, or promised to be given, to any voter, at any time, in order to influence him to give or withhold his vote, as well he that takes, as he that offers such a bribe, forfeits 500*l.* and is for ever disabled from voting and holding any office in any corporation, unless before conviction he will discover some other offender of the same kind, and then he is indemnified for his own offence.

If the election shall not be determined upon view with the consent of the freeholders there present, but a poll shall be demanded, the same shall commence on the day on which such demand is made, or on the next day at farthest, (if it be not Sunday, and then on the day after) and shall be proceeded in from day to day (Sundays excepted) until it be finished, and shall not continue more than fifteen days (Sundays excepted) and the poll shall be kept open seven hours at least each day, between eight in the morning and eight in the evening. 25 Geo. III. c. 84. The sheriff shall allow a cheque-book for every poll-book for each candidate, to be kept by their inspectors at the place of taking the poll. 19 Geo. II. c. 28.

By the 34 Geo. III. c. 73. in order to expedite the business at elections, the returning officers are enabled, on request of the candidates, to appoint persons to administer to voters the oaths of allegiance, supremacy, the declaration of fidelity, the oath of abjuration, and the declaration or affirmation of the effect thereof, previously to their coming to vote; and to grant the voters certificates of their having taken the said oath, without which certificate they shall not be permitted to vote, if they are required to take the oaths.

And every freeholder, before he shall be admitted to poll for a knight of the shire, shall, if required by a candidate, or any elector, make oath of his qualification to vote, in which case the sheriff and clerks shall enter the place of his freehold, and the place of his abode, as he shall disclose the same at the time of giving his vote, and shall enter jurat against the name of every such voter who shall have taken the oath. 10 Anne, c. 23. s. 5.

Of the return. After the election, the names of the persons chosen shall be written in an indenture, under the seals of the electors, and tacked to the writ.

The election being closed, the returning officer in boroughs returns his precept to the sheriff, with the persons elected by the ma-

jority. And the sheriff returns the whole, together with the writ for the county, and the names of the knights elected thereupon, to the clerk of the crown in chancery, before the day of meeting, if it is a new parliament; or within fourteen days after the election, if it is an occasional vacancy; and this under the penalty of 500*l*. If the sheriff does not return such knights only as are duly elected, he forfeits by stat. H. VI. 100*l*. and the returning officer of a borough, for a like false return 40*l*. and by the late statutes they are liable to an action at the suit of the party duly elected, and to pay double damages, and the like remedy shall be against an officer making a double return. 1 Black 180.

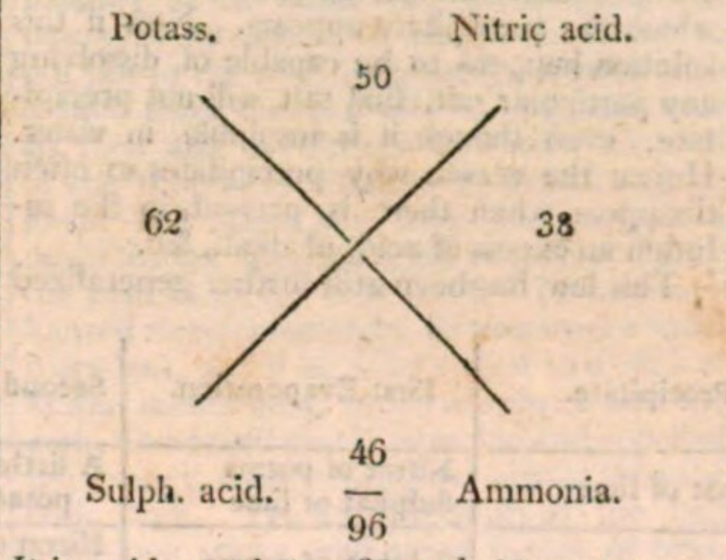
If two or more sets of electors make each a return of a different member (which is called a double election), that return only which the returning officer to whom the sheriff's precept was directed, has signed and sealed, is good; and the members by him returned shall sit until displaced on petition. Sim. 184.

On petition to the house of commons, complaining of an undue election, forty-nine members shall be chosen by ballot, out of whom each party shall alternately strike out one, till they are reduced to thirteen, who, together with two more, of whom each party shall nominate one, shall be a select committee for determining such controverted election. 10 and 11 Geo. III. c. 16.

ELECTION, in numbers, is with regard to combinations, the different ways of taking any number of quantities given: thus, the quantities *a b c* may be taken different ways, as *a b c*, or *a b*, *a c*, and *a*, *b*, *c*.

ELECTIVE attraction, in chemistry. The union of heterogeneous substances is effected in many instances by elective attraction, *i. e.* a substance quits another with which it was before combined, to unite with a third, to which it is then said to have a superior affinity. Thus, when potass is added to sulphat of magnesia, in water, the sulphuric acid seizes the potass by its superior affinity, and the magnesia is *precipitated*. This is *simple affinity*: but if the potass is added in union with carbonic acid, the latter will seize the magnesia at the moment of its disengagement, forming carbonat of magnesia; and the sulphuric acid having combined with the potass, forming sulphate of potass, we have a case of double affinity. When several bodies are mixed, decompositions and new combinations often take place, which would not have been produced had the bodies been presented in a separate state. If for instance, into a solution of sulphat of ammonia there is poured nitric acid, no decomposition is produced, because the sulphuric acid has a stronger affinity for ammonia than nitric acid has. But if nitrat of potass is poured in, we obtain by evaporation two new bodies, sulphat of potass and nitrat of ammonia. Such cases of decomposition were called by Bergman cases of double elective attraction; a name which is exceedingly proper when there are only four bodies concerned. But as there are often more than four, it is necessary, as Mr. Morveau observed, to employ some more comprehensive term. The phrase compound affinity may be employed with propriety, comprehending under the term all cases where more than three bodies are present, and produce combinations which would not have been formed without their united action. In these cases the affinity of all the various bodies for each other acts; and the resulting combination has been supposed to be produced by the action of those affinities which are strongest.

The manner in which these combinations and decompositions take place, was thus explained by Dr. Black. Let the affinity between potass and sulphuric acid be = 62; that between nitric acid and ammonia = 38; that between the same acid and potass = 50; and that between the sulphuric acid and ammonia = 46. Now, let us suppose that all these forces are placed so as to draw the ends of two cylinders crossing one another, and fixed in the middle in this manner:



It is evident, that as 62 and 38 = 100 are greater than 50 + 46 = 96, they would overcome the other forces and shut the cylinders. Just so the affinity between ammonia and nitric acid, together with that between sulphuric acid and potass, overcomes the affinity between ammonia and sulphuric acid, and that between nitric acid and potass, and produces new combinations.

It has been supposed that in all cases of compound affinity, there are two kinds of affinities to be considered: 1st. Those affinities which tend to preserve the old compound, these Mr. Kirwan has called quiescent affinities; and those which tend to destroy them, which he has called divellent affinities.

Thus, in the instance above given, the affinity between ammonia and sulphuric acid, and that between nitric acid and potass, are quiescent affinities, which endeavour to preserve the old compound; and if they are strongest, it is evident that no new compound can take place. On the contrary, the affinity between potass and sulphuric acid, and that between nitric acid and ammonia, are divellent affinities; and as they are in this case strongest, they actually destroy the former combinations and form new ones.

It has been supposed that when two of those salts which mutually decompose each other are mixed together, the decomposition instantly takes place in consequence of the force of affinities alone, independant of the proportions of the ingredients.

Thus when sulphat of potass and nitrat of lime are mixed together, it was supposed that the sulphuric acid, if present in sufficient quantity, combines with the whole of the lime, and disengages the nitric acid and the potass, which also combine till the least abundant of the two is saturated. But if this was the case, some of the four ingredients must be left disengaged, as the proportions of the ingredients of the salts formed by the four ingredients are not such as to saturate each other. According to Mr. Kirwan's experiments, the proportions of acid and alkali in the four following salts are as under:

Sulphat of potass	Acid	100
	Potass	121.48
Sulphat of lime	Acid	100
	Lime	70
Nitrat of potass	Acid	100
	Potass	117.7
Nitrat of lime	Acid	100
	Lime	55.7

Now let sulphat of potass and nitrat of lime be mixed together; let the quantity of sulphat of potass be such, that the acid contained in it amounts to 100; and let a more than sufficient quantity of nitrat of lime be added, to saturate the sulphuric acid with lime. It is evident that for that purpose 70 of lime must be present; and the quantity of nitric acid combined with these 70 must be 123.8. This quantity would require for saturation 145.7 of potass, but there are only 121.48 in the mixture; consequently there ought to exist in the mixture, after the mutual decomposition of the salts, a quantity of nitric acid in a state of liberty. But the fact is, that no such excess of acid exists in the mixture. This is a sufficient proof that the decomposition does not take place in the manner that has been supposed. It may be said, indeed, that the composition of these salts may not be sufficiently known to warrant reasoning from it. But be the proportion of the ingredients what it may, still if the decomposition was absolute, as has been supposed, when mixed in any proportion whatever, except in one, some of the ingredients ought to remain disengaged: but as this does not happen either in this case or in any other, we have a right to conclude that the decomposition is not what it has been considered.

2. When two saline solutions are mixed together, either no apparent change takes place, or a precipitate is formed. Let us consider each of these cases.

When no precipitation takes place, the two salts no doubt combine together, and form a compound consisting of the two acids and their bases; and the degree of saturation must be the same as before mixture, because the proportions and the affinities must continue the same. Hence the reason that in these cases there are never any indications of any one of the ingredients being disengaged from the others. Hence also the reason that when two salts are dissolved in water, they increase the solubility of each other, their mutual affinity serving as an additional counterbalance to the cohesion of each. Thus Vauquelin has shewn that saturated solutions of sulphat of lime, alum, and sulphat of potass, are capable of dissolving a greater proportion of common salt than pure water is.

3. When two salts may be mixed together without any precipitation taking place, it is a proof that all the salts capable of being formed by the component parts of each are soluble. Hence the alkaline salts very rarely occasion a precipitate when mixed together, nor the earthy salts when the acid combined in each is such as to form soluble salts with all the earthy bases, as nitric acid, muriatic acid. On the other hand, when a precipitation takes place, some two of the in-

gredients form an insoluble compound; consequently we can easily determine beforehand whether or not a precipitate will take place. It is from this precipitation chiefly that double decompositions have been determined. It is obvious that they are occasioned not by the superiority of the affinity of the ingredients which precipitate, but by the strong tendency which these ingredients have to cohere together; the consequence of which tendency is, the exclusion of the other component parts, and the precipitation of the masses as they form. It may be considered, then, as a general law, that "whenever a salt is insoluble, the two ingredients which compose it, whenever they meet in a solution, precipitate in combination." For this general law we are indebted to Mr. Berthollet.

Thus barytes forms an insoluble compound with sulphuric acid, phosphoric acid, oxalic acid, tartarous acid, &c. Consequently when a salt, whose base is that earth, is mixed with a salt containing any of these acids, a precipitation takes place consisting of the barytes combined with the acid. Salts of lime form a precipitate with oxalats, tartrites, citrats, phosphats, fluats, and sometimes with sulphats. The alkaline carbonats occasion a precipitate in all the earthy salts, because all the earthy carbonats are insoluble. Acetite of lead occasions a precipitate in sulphats, muriats, phosphats, mucitates, &c. Nitrat of silver in the muriats. But it would be endless to run over all the precipitates occasioned by the mixture of salts; every person may ascertain them merely by observing what salts are insoluble.

It ought to be observed, however, that the precipitation takes place, not because the salts are insoluble in water, but because they are insoluble in the particular solution in which the precipitate appears. Now if this solution happens to be capable of dissolving any particular salt, that salt will not precipitate, even though it is insoluble in water. Hence the reason why precipitates so often disappear when there is present in the solution an excess of acid, of alkali, &c.

This law has been still further generalized by Berthollet. When different salts are mixed together, they separate either spontaneously, or on evaporation, according to the order of their solubility. Those which are insoluble precipitate immediately on the mixture, and those which are least soluble crystallize first when the solution is evaporated. Potass forms with sulphuric acid a salt much less soluble than sulphat of soda. Hence the reason why it has been supposed to have a stronger affinity for sulphuric acid, and by analogy for acids in general, than soda: for if sulphat of soda is mixed with the greater number of the salts of potass, sulphat of potass is obtained by evaporation.

But in cases where two salts are mixed together, the resulting salts are much influenced by the proportions of the ingredients. The same salts are not obtained if the ingredients are mixed in one proportion, that would be obtained if they were mixed in another proportion. This will appear evidently from the following experiments of Berthollet.

Salts Mixed.	Proportions.	Precipitate.	First Evaporation.	Second Evaporation.	Mother Water.
Nitrat of lime Sulphat of potass	1 1	Sulphat of lime	Nitrat of potass Sulphat of lime	A little sulphat of potass	Little
Ditto - -	1 2	Ditto	Sulphat of potass Sulphat of lime	Nitrat of potass Sulphat of potass Sulphat of lime	Very little
Ditto - -	2 1	Ditto - -	Sulphat of lime Nitrat of potass	Nitrat of potass A very little sulphat of lime	Abundant
Sulphat of soda Nitrat of lime	1 1	Sulphat of lime	Nitrat of soda	Nitrat of soda	Abundant
Ditto - -	2 1	Ditto -	Ditto	Ditto	Abundant.

Salts Mixed.	Proportions.	First Evaporation.	Second Evaporation.	Third Evaporation.	Mother Water.
Sulphat of soda Nitrat of potass	1 1	Sulphat of potass A little nitrat of potass	Nitrat of potass Some sulphat of potass	Nitrat of soda Some nitrat of potass	Considerable
Ditto - -	2 1	Sulphat of potass	Sulphat of potass Some nitrat of potass	Sulphat of potass Nitrat of potass Nitrat of soda	Considerable
Nitrat of potass Muriat of lime	1 1	Nitrat of potass	Muriat of potass Some nitrat of do.		Abundant
Ditto - -	1 2	Muriat of potass			Abundant
Muriat of potass Nitrat of lime	1 1	Nitrat of potass Some muriat of do.	Muriat of potass Some nitrat of do.		Abundant
Sulphat of potass Muriat of magnesia	1 1	Sulphat of potass	Sulphat of potass Muriat of do. Sulph. of pot. & mag.	Muriat of potass Sulph. of magnesia	Considerable
Ditto - -	1 2	Ditto	Muriat of potass Sulphat of potass-and-magnesia	Ditto	Ditto.

The mother-water, or the liquid which remains when mixtures of salts are separated by crystallization, always contains several salts, or rather their component parts, which are prevented from crystallization by their mutual action on each other. Hence the quantity of this mother-water is always the greater, the more soluble the salts are: that is to say, the less disposition they have to crystallize.

ELECTOR, a person who has a right to elect or choose another to an office, honour, &c. Elector is particularly, and by way of eminence, applied to those princes of Germany in whom lies the right of electing the emperor; being all sovereign princes, and the principal members of the empire. The electoral college, consisting of all the electors of the empire, is the most illustrious and august body in Europe. Bellarmine and Baronius attribute the institution of it to pope Gregory V. and the emperor Otho III. in the tenth century; of which opinion are the generality of historians, and particularly the canonists: however, the number of electors was unsettled, at least till the thirteenth century. In 1356 Charles IV. by the golden bull, fixed the number of electors at seven; three ecclesiastics, viz. the archbishops of Mentz, Treves, and Cologne; and four se-

culars, viz. the king of Bohemia, count palatine of the Rhine, duke of Saxony, and marquis of Brandenburg. In 1648, this order was changed, the duke of Bavaria being put in the place of the count palatine, who, having accepted the crown of Bohemia, was outlawed by the emperor; but being at length restored, an eighth electorate was erected for the duke of Bavaria. In 1692, a ninth electorate was created by the emperor Leopold, in favour of the duke of Hanover, of the house of Brunswic Lunenburg.

There are now, or at least were a short time since, ten electors, viz. the king or elector of Bohemia; the elector of Bavaria, now a king also; the elector of Saxony; the elector of Brandenburg (king of Prussia); the elector of Hanover, at this moment, by an usurped authority, king of Prussia also; the elector arch-chancellor of the empire, whose residence is at Ratisbon; the elector of Saltsburgh; the elector of Baden; the elector of Wurtemburgh; and the elector of Hesse.

ELECTRICITY, is a term used to denote the operations of a very subtile fluid, in most cases invisible, but which sometimes becomes the object of our senses, proving itself to be one of the principal agents employed in producing the phenomena of nature.

History of discoveries relative to electricity.

The attractive power which amber and other electric bodies acquire by friction, was long known to philosophers; and it is almost unnecessary to remark, that this branch of science derives its name from ελεκτρον (electron), the Greek word for amber. The other electric properties were slowly discovered. Mr. Boyle was the first who had a glimpse of the electric light; as he remarked, after rubbing some diamonds in order to give them the power of attraction, that they afforded light in the dark.

Otto Guericke, burgomaster of Magdeburg, made an electric globe of sulphur; and by whirling it about in a wooden frame, and rubbing it at the same time with his hand, he performed various electrical experiments. He added to the stock of knowledge the discovery that a body once attracted by an excited electric was repelled by it, and not attracted again till it had touched some other body. Thus he was able to keep a feather suspended in the air over his globe of sulphur; but he observed, that if he drove it near a linen thread, or the flame of a candle, it instantly recovered its propensity for approaching the globe again. The hissing noise, and the gleaming light, which his globe afforded, both attracted his notice.

These circumstances were, however, afterwards accurately remarked by Dr. Wall: who, by rubbing amber upon a woollen substance in the dark, found also that light was produced in considerable quantities, accompanied with a crackling noise; and what is still more extraordinary, he adds, "this light and crackling seems in some degree to represent thunder and lightning."

Mr. Hawksbee first observed the great electric power of glass. He constructed a wooden machine, which enabled him conveniently to put a glass globe in motion. He confirmed all the experiments of Dr. Wall. He observed, that the light emitted by the friction of electric bodies, besides the crackling noise, was accompanied by an acute sense of feeling when applied to his hand. He says that all the powers of electricity were improved by warmth, and diminished by moisture.

Hitherto the distinction between those bodies which are capable of being excited to electricity and those which are only capable of receiving it from the others, appears scarcely to have been suspected. About the year 1729, this great discovery was made by Mr. Grey, a pensioner of the Charter-house. After some fruitless attempts to make metals attractive by heating, rubbing, and hammering, he conceived a suspicion, that as a glass tube, when rubbed in the dark, communicated its light to various bodies, it might possibly at the same time communicate its power of attraction to them. In order to put this to the trial, he provided himself with a tube three feet five inches long, and near an inch and one-fifth in diameter: the ends of the tube were stopped by cork; and he found that when the tube was excited, a down feather was attracted as powerfully by the cork as by the tube itself. To convince himself more completely, he procured a small ivory ball, which he fixed at first to a stick of fir four inches long, which was thrust into the cork, and found that it attracted and repelled the feather even with more vigour than the cork itself. He afterwards fixed the ball upon long sticks, and upon pieces of brass and iron wire, with the same success; and lastly, attached it to a long piece of packthread, and hung it from a high balcony, in which state he found that by rubbing the tube the ball was constantly enabled to attract light bodies in the court below.

His next attempt was to ascertain whether this power could be conveyed horizontally as well as perpendicularly: with this view he fixed a cord to a nail which was in one of the beams of the ceiling, and making a loop at that end which hung down, he inserted his packthread, with the ball which was at the end of it, through the loop of the cord, and retired with the tube to the other end of the room; but in this state he found that his ball had totally lost the power of attraction. Upon mentioning his experiments to a friend, it was suggested, that the cord which he had used to support his packthread might be so coarse as to intercept the electric power, and they accordingly attempted to remedy this evil by employing a silk string, which was much stronger in proportion to its size than a hempen cord. With this apparatus the experiment succeeded far beyond their expectations. Encouraged by this success, and attributing it wholly to the fineness of the silk, they proceeded to support the packthread to which the ball was attached by very fine brass and iron wire; but, to their utter astonishment, found the effect exactly the same as when they used the hempen cord; the electrical virtue utterly passed away; while, on the other hand, when the packthread was supported by a silken cord, they were able to convey the electric virtue 765 feet.

It was evident, therefore, that these effects depended upon some peculiar quality in the silk, which prevented it from conducting away the electrical power, as the hempen cord and the wire had done. This, probably, immediately led to the discovery of other non-conducting bodies; and hair, rosin, glass, &c. were presently made use of to insulate the bodies which were electrified. The next obvious improvement was to electrify separate bodies, by placing them upon non-conductors; and in this manner Mr. Grey and his friend Mr. Wheeler electrified a large map, a table-cloth, &c. &c. In the latter part of the same summer, Mr. Grey found that he could electrify a rod as well as a packthread, without inserting any part into his excited tube, and that it only required to be placed nearly in contact with the apparatus.

Mr. Grey proceeded to try the effects of electricity upon animal bodies. He suspended a boy on hair lines in a horizontal position; and bringing the excited tube near his feet, he found that leaf-brass was attracted very vigorously by the head of the boy. He found also, that he could communicate electricity to fluid bodies, by insulating them upon a cake of rosin; and observed, that when an excited tube was held over a cup of water, the water was presently attracted, in a conical form, towards the tube; that the electric matter passed from the tube to the water with a slight flash and a crackling noise; and that the fluid subsided with a tremulous and waving motion.

After this period the spirit of philosophy in this branch was no longer confined to England. M. Du Fay, intendant of the French king's gardens, added to the stock of discoveries. He found that all bodies, except metallic, soft, and fluid ones, might be made electric by first heating them, and then rubbing them on any sort of cloth. He also excepts those substances which grow soft by heat, as gums, or which dissolve in water, as glue. In pursuing Mr. Grey's experiments with a packthread, &c. he perceived that they succeeded better by wetting the line. To prove the effects of this wonderful agent on the animal body, he suspended himself by silk cords, as Mr. Grey had suspended the boy, and in this situation he observed, that as soon as he was electrified, if another person approached him, and brought his hand or a metal rod within an inch of his body, there immediately issued from it one or more prickling shoots, attended with a snapping noise; and he adds, that this experiment occasioned a similar sensation in the person who placed his hand near him. In the dark he observed that these snappings were occasioned by so many sparks of fire.

Mr. Grey, on resuming his experiments, immediately concluded from that of M. Du Fay, in which a piece of metal drew sparks from the person electrified, and suspended on silk lines, that if the person and the metal changed places, the effect would be the same. He accordingly suspended a piece of metal by silk threads near his excited tube, and found that he drew sparks from it at pleasure. This was the origin of metallic conductors. Mr. Grey suspected that the electric fire might be of the same nature with thunder and lightning.

To the philosophers of Germany we are indebted for most of the improvements in the electrical apparatus. They revived the use of the globe, which had been invented by Mr. Hawksbee, which was afterwards superseded by a cylinder, and to which they imparted a circular motion by means of wheels, and used a woollen rubber instead of the

hand. By the great force also of their machines they were able to set on fire some of the most inflammable substances, such as highly rectified spirits, by the electric spark.

But the most surprising discovery was that which immediately followed these attempts, in the years 1745-6, viz. the method of accumulating the electric power by the Leyden phial. M. Von Kleist, dean of the cathedral of Camnin, was the first who found that a nail or brass wire, confined in an apothecary's phial, and exposed to the electrifying glass, or to the prime conductor, had a power of collecting the electric virtue so as to produce the most remarkable effects. He soon found that a small quantity of fluid added to it increased the power; and successive electricians found that fluid matter, or any conducting body confined in a glass vessel, had this power of accumulating and condensing the electric virtue. The shock which an electrician is enabled to give by means of the Leyden phial is well known; and this was soon followed by another improvement, that of forming what is called the electric battery, by increasing the number of phials, or jars, by which means the force is proportionably increased. By these means the electric shock was tried upon the brute creation, and proved fatal to many of the smaller animals, which appeared as if killed by lightning. By these means also the electric matter was conveyed to great distances: by the French philosophers, for near three miles; and by Dr. Watson, and some other members of the Royal Society, it was conveyed by a wire over the river Thames, and back again through the river, and spirits were kindled by the electric fire which had passed through the river. In another experiment by the same gentleman, it was found that the electric matter made a circuit of about four miles instantaneously.

The next discovery respects the nature, or rather the origin, of the electric matter. Dr. Watson was first induced to suspect that the glass tubes and globes did not contain the electric power in themselves, by observing, that upon rubbing the glass tube while he was standing on cakes of wax, in order to prevent, as he expected, any of the electric matter from discharging itself through his body on the floor, the power was so much lessened, that no snapping could be observed upon another person's touching any part of his body; but that if a person not electrified held his hand near the tube while it was rubbed, the snapping was very sensible. The event was the same when the globe was whirled in similar circumstances; for if the man who turned the wheel, and who, together with the machine, was suspended upon silk, touched the floor with one foot, the fire appeared upon the conductor; but if he kept himself free from any communication with the floor, no fire was produced. From these and other decisive experiments, Dr. Watson concludes, that these globes and tubes are no more than the first movers or determiners of the electric power.

M. Du Fay had made a distinction of two different species of electricity, one of which he called the vitreous, and the other the resinous electricity; and soon after the discovery of the Leyden phial, it was found, that by coating the outside of the phial with a conducting substance, which communicated by a wire with the person who discharged the phial, the shock was immensely increased; and indeed it appeared that the phial could not be charged unless some conducting substance was in contact with the outside. Dr. Franklin, however, was the first who explained these phenomena. He shewed that the surplus of electricity, which was received by one of the coated surfaces of the phial, was actually taken from the other; and that one was possessed of less than its natural share of the electric matter, while the other had a superabundance. These two different states of bodies, with respect to their portion of electricity, he distinguished by the terms plus or positive, and minus or negative; and it was inferred from the appearances that bodies which exhibited what M. Du Fay called the resinous electricity, were in the state of minus, that is, in the state of attracting the electric matter from other bodies, while those which were possessed of the vitreous electricity were bodies electrified plus, or in a state capable of imparting electricity to other bodies. By this discovery Dr. Franklin was enabled to increase the electric power almost at pleasure, namely, by connecting the inside of one phial with the inside of another, in such a manner that the fluid which was driven out of the first would be received by the second, and what was driven out of the second would be received by the third, &c. and this constitutes what we now call an electrical battery.

But the most astonishing discovery which Franklin, or perhaps any other person, ever made in this branch of science, was the demonstration of what had been slightly suspected by others, the perfect similarity, or rather indentity, of lightning and electricity. The doctor was led to this discovery by comparing the effects of lightning with those of electricity, and by reflecting that if two gun-barrels electrified will strike at two inches, and make a loud report, what must be the effect of ten thousand acres of electrified cloud. Not satisfied, however, with speculation, he constructed a kite with a pointed wire fixed upon it, which, during a thunder-storm, he contrived to send up into an electrical cloud. The wire in the kite attracted the lightning from the cloud, and it descended along the hempen string, and was received by a key tied to the extremity of it, that part of the string which he held in his hand being of silk, that the electric virtue might stop when it came to the key. At this key he charged phials, and from the fire thus obtained he kindled spirits, and performed all the common electrical experiments.

Dr. Franklin, after this discovery, constructed an insulated rod to draw the lightning from the atmosphere into his house, in order to enable him to make experiments upon it: he also connected with it two bells, which gave him notice by their ringing when his rod was electrified. This was the origin of the metallic conductors now in general use.

It was afterwards discovered by Mr. Canton, that the positive and negative electricity, which were supposed to depend upon the nature of the excited body, and therefore had obtained the names of resinous and vitreous, depended chiefly upon the nature of the surface; for that a glass tube, when the polished surface was destroyed, exhibited proofs of negative electricity as much as sulphur or sealing-wax, and drew sparks from the knuckle when applied to it, instead of giving fire from its own body; when the tube was greased, and a rubber with a rough surface was applied to it, its positive power was restored, and the contrary when the rubber became smooth by friction.

General principles of electricity.—From the brief account which has been given of discoveries relative to this branch of science, the reader will be prepared to admit that electricity is the action of a body put in a state to attract or repel light bodies placed at a certain distance; to give a slight sensation to the skin, resembling in some measure that which we experience in meeting with a cobweb in the air; to spread an odour like the phosphorus of Kunkell; to dart pencils of light from the surface, attended with a snapping noise, on the approach of certain substances; lastly, that the body put in this state is capable of communicating to other bodies the power of producing the same effects during a certain time.

The electric power is indubitably the effect of some matter in an active state, either within or round the electrified body; since, if we place either our hands or face before an excited tube of glass, or before an insulated conductor which is electrified, we shall perceive emanations sensible to the touch; and if we approach nearer, we shall feel it distinctly, and hear a weak noise: in the dark we perceive sparks of vivid light, especially from angular points; we see emitted pencils of rays, or small flashes of divergent flame; it is certain, therefore, that some subtile matter put in motion is alone capable of making these impressions upon our senses; and we may conclude that every electrified body is encompassed by some matter in motion, which is, without doubt, the immediate cause of all the electrical phenomena, and which we term the electric matter or fluid.

Thus far, and no farther, are we warranted in affirming, on the only evidence to be admitted in philosophy, that of experiment, fact, and observation. There is, however, in man, a curiosity that prompts us to look beyond effects, and a disposition that leads us to theorize, even on the most difficult subjects. Let us, however, do it with diffidence and caution. What, then, is this electric matter? or whence does it derive its origin? It apparently proceeds not from the electrified body, for that suffers no sensible diminution. It depends not on any property inherent in the air of the atmosphere, for three obvious reasons: first, because electrical phenomena may be produced in a space from which the air has been most carefully exhausted. Secondly, because the electrical matter has qualities which are not inherent in air: it penetrates certain bodies impervious to air, such as metals; it has a sensible odour; it appears itself inflamed; it is capable of inflaming other bodies, and of melting metals; effects which air cannot produce. Thirdly, its motion is considerably more rapid than that of sound, which is a motion of the air the most rapid that we are acquainted with.

It is, however, generally agreed, that the electric matter has a strong analogy with the matter of heat and light. It appears, indeed, that Nature, who is so very economical in

the production of principles, whilst she multiplies their properties so liberally, has in no case established two causes for one effect. We may apply this remark to the electric matter; and the more we inquire into the properties of the electric matter, and those of the matter of heat and light, the more shall we discover of this analogy between them, and the more probable will it appear, that fire, light, and electricity, depend upon the same principle, and that they are only three different effects from the same matter or essence.

1st. Of all the means necessary to excite the matter of heat, there is none more efficacious than that which is most necessary to produce electricity, namely, friction. 2dly. As caloric extends itself with more facility in metals and humid bodies than in any other substances, so metals and water are conductors of electricity in the same manner as they are of heat; and, in general, the same conductors are found equally good for both. 3dly. Caloric is the most elastic of all bodies, and is considered by most philosophers as the principal cause of that repulsion which takes place between the particles of bodies; and to a similar cause the electric repulsion may be referred. 4thly. The pulse and perspiration of animals are increased by electricity as by the actual application of heat. 5thly. Actual ignition is produced by the electric fluid. Thus it is a common experiment to inflame spirit of wine by the electric spark; inflammable air is set on fire by the same means in the common electrical pistol; and even gunpowder may be exploded by a spark from a powerful conductor. 6thly. Metals are melted by electricity; and most inflammable substances are affected by it as by common fire, but in a weaker degree. 7thly. The light emitted by the electrical apparatus has all the properties of that which is emitted from the sun; the composition differing in some respects, according to circumstances, as to the predominancy of certain rays, the light in different instances inclining to blue, red, white, &c. according to its intensity. 8thly. The motion of light is exceedingly rapid, whether it is reflected or refracted; in the same manner the electric fluid is found to move with almost infinite velocity, for it has been proved by experiments, that a cord 1200 feet long has become instantly electric in its whole extent. The abbé Nollet has communicated the electric shock to 200 persons at the same time, or at the least perceptible instant.

Notwithstanding these considerations, it must be confessed, that there are some facts which seem to indicate that the electric fluid is not purely and simply the matter of heat or light unmixed with other substances: for 1st, it has been observed, that the electric matter has the property of affecting the organs of scent, which is a property that belongs neither to light nor heat.

2dly. It is well known also, that an accumulation of caloric increases the fluidity of all bodies, and prevents them from congealing, whereas congealed fluids may be highly charged with electricity; nor does it appear to have the smallest effect in increasing their fluidity.

3dly. Heat spreads in every direction, whereas the electrical fluid may be arrested in its progress by certain bodies, which, on that account, have obtained the name of non-conductors. The Torricellian vacuum, on the contrary, affords a ready passage to the electric fluid, but is a bad conductor of heat.

4thly. Whenever the matter of heat penetrates bodies, it warms as well as expands them. The electric fluid does not produce these effects; bodies, however long they may be electrified, become neither hotter to the touch, nor more extended in dimensions.

5thly. The singular property of adhering to certain conductors, without diffusing itself to other substances, which may be even in contact with them, so observable in the electrical fluid, is a property not common to caloric or elementary fire. Thus we have seen that spirits were kindled by an electrical spark drawn by a wire through the water of the Thames; and large pieces of iron wire have been heated red-hot, while immersed in water, by an electrical explosion.

6thly. With respect to the identity of light and electricity, it should also be recollected, that light pervades glass with the greatest facility, whereas that substance is penetrated by the electrical fluid only in certain circumstances, and with the utmost difficulty; if, therefore, it should be admitted, that the basis of the electric matter is radically the same with the matter of heat or light, it seems necessary to admit also, that it retains some other matter in combination with it, of the nature of which we are as yet uninformed; and it is probably this combination of foreign matter which disables it, in ordinary cases, from penetrating glass. At present, however, we know nothing for a certainty concerning the electrical fluid, but some of its effects.

Electrical phenomena are produced by friction, and by communication. In general, bodies which electrify the best by friction, electrify the worst by communication (except glass in certain circumstances); and on the contrary, substances which electrify the best by communication electrify the worst by friction. We shall begin with those experiments which gave rise to the principal technical terms made use of in this science.

If a dry glass tube is rubbed with a piece of dry silk, and if light bodies, as feathers, pith balls, &c. are presented to it, they will be first attracted and then repelled. The best rubber for a smooth glass tube is a piece of black or oiled silk, on which a little amalgam has been spread: sealing-wax, rubbed with new and soft flannel, will produce the same effect. By this friction an agent or power is put in action, and this power is called the electrical fluid: a certain quantity of this fluid is supposed to exist latent in all bodies, in which state it makes no impression on our senses; but when by the powers of nature or of art, this equilibrium is destroyed, and the agency of the fluid is rendered perceptible to the senses, then those effects are produced which are termed electrical, and the body is said to be electrified.

If a homogeneous body is presented to the excited tube, so as to receive electricity from it, and the electricity remains at or near the end or part presented, without being communicated to the rest of the body, it is called a non-conductor or electric; but if, on the contrary, the electricity is communicated to every part, the body is called a conductor, or non-electric. A body is said to be insulated when it communicates with nothing but electrics, as when it is placed upon glass pillars, or a ball of wax or rosin, or any non-conducting substance.

A conductor cannot be electrified while it communicates with the earth, either by direct contact or by the interposition of other conductors, because the electricity is immediately conveyed away to the earth.

A mutual attraction is exerted between a body in a state of electricity and all non-electric bodies, which, if not large and heavy, will pass rapidly through the air to the electrified body, where they remain till they have, by communication, acquired the same state, when they will be repelled. If an uninsulated conductor is at hand, it will attract the small body when electrified, and deprive it of its electricity, so that it will be again attracted by the electrified body, and repelled as before, and will continue to pass and repass between the two, till the electric state is entirely destroyed.

The following is a list of electrics, and also of conductors, disposed according to the order of their perfection, beginning in each column with the most perfect of their class: thus glass is a more perfect electric than amber, and gold is a better conductor than silver.

ELECTRICS.	CONDUCTORS.
Glass of all kinds.	All the metals in the following order:
All precious stones, the most transparent the best.	Gold; silver; platina; brass; iron; tin; quicksilver; lead.
Amber.	The semi-metals.
Sulphur.	Metallic ores.
All resinous substances.	Charcoal.
Wax of all kinds.	The fluids of the animal body.
Silk and cotton.	Water, especially salt water, and other fluids, except oil.
Dry external animal substances, as feathers, wool, and hair.	Ice, snow.
Paper.	Most saline substances.
Loaf sugar.	Earthy substances.
Air when dry.	Smoke, steam, and even a vacuum.
Oils and metallic oxides.	
Ashes of animal and vegetable substances.	
Most hard stones.	

M. Achard, of Berlin, has proved by experiment, that under certain circumstances a body will become a conductor of electricity, which before was a non-conductor. The principal of these circumstances are the degrees of heat to which the body is subjected.

It must be observed, however, that electrics and non-electrics are not so strongly marked by nature as to be defined with precision; for the same substance has been differently classed by different writers: besides, the electric properties of the same substance vary according to changes of circumstances: thus a piece of green wood is a conductor; and the same piece, after it has been baked, becomes a non-conductor; when it is formed into charcoal, it again conducts the electric matter; but when reduced to ashes, is impervious to it. Indeed, it might perhaps be generally said, that every substance is in a certain degree a conductor of this fluid,

though some conduct it with much more facility than others.

When electricity became a science, so far as to attract the notice of philosophers, various modes were employed for producing or accumulating the electrical matter.

The first electrical machine made use of was a tube of glass, which, being excited by friction, was then put in a state to communicate electricity to other bodies. The best glass for this purpose is the fine white English crystal. The most convenient dimensions for these tubes are about three feet in length, twelve or fifteen lines in diameter, and the glass quite a line in thickness. It is of little importance whether the tube is open or closed at the extremities; yet it is necessary that the air within should be in the same state as that without: for this reason the tube should at least be open at one end; but care must be taken that dust should not be admitted into the inside, for that would considerably impede its effects. If, notwithstanding these precautions, the tube receives either dust or moisture, some dry and fine sand should be introduced into the inside, and it should be afterwards cleaned out with fine dry cotton.

When it is intended to electrify a tube, it is only necessary to take the end in one hand, and to continue to rub the tube with the other hand, from one end to the other, until it affords marks of its being sufficiently charged with the electric fluid. This friction may be performed with the naked hand when it is dry and clean, otherwise with a piece of soft brown paper, or waxed taffeta. When the tube has been rubbed in this manner, the circumambient air being dry, if light substances are presented to it, they will be first attracted towards it, and immediately afterwards repelled.

The electric fluid may be excited in nearly a similar manner, by rubbing a stick of sulphur or sealing-wax.

These tubes being but small, the quantity of electricity produced is but feeble in its effects. We have seen that a method was contrived to turn a globe of glass upon its axis by means of a machine with a winch or multiplying wheel: this method admitted of a larger surface, and the friction was performed with greater ease, by means of a rubber being placed close to the revolving globe. The electrifying machine has however since undergone various improvements, and perhaps is cap ble of still more.

In the plate, fig. 1. is a representation of an electrical machine with a prime conductor. ABC represents the bottom board of the machine, D and E the two perpendicular supports which sustain the glass cylinder FG. The axis of the cap K passes through the support D; on the extremity of this axis a simple winch L is fixed. The axis of the other cap runs in a small hole, which is made in the top of the supporter E.

P is the glass pillar to which the cushion is fixed; T a brass screw at the bottom of this pillar, which is to regulate the pressure of the cushion against the cylinder. This adjusting screw is peculiarly advantageous: by it the operator is enabled to lessen or increase gradually the pressure of the cushion, which it effects in a much neater manner than it is possible to do when the insulating pillar is fixed on a sliding-board.

Y represents the positive prime conductor, or that which takes the electric fluid immediately from the cylinder; M the glass pillar by which it is supported and insulated; and X a wooden foot or base for the glass pillar.

Fig. 2. is a plate-glass machine, of the most portable construction, with a double Leyden phial made square to suit the base, which answers all the purposes of medical electricity. ABC is a wooden frame to which the four rubbers are affixed, and by means of screws may be made to bear with proper pressure on the circular glass plate DF; this plate has a hole through its middle, to which an axis is firmly fixed, and it is turned by the winch L; GG is a Leyden phial (with the collectors *oo* fixed on the top) fixed in a larger one H: when a strong shock is wanted, the long pin I is let in to touch the bottom, by which means the large jar acts; but when drawn out, the small one acts alone but much quicker, from being inclosed in the other. K is the electrometer. When this machine is constructed on a large scale for experiments, a prime conductor M, fig. 4, may be attached to the wooden frame opposite the axis of the plate-glass instead of the jar. Fig. 3 is a side view of the machine, with a clamp N to fix it to the table when used.

The advantages of this machine are, that it may be made portable, and is of so simple a construction, that any gentleman in the country, after procuring a plate of a reasonable thickness from a glass-house, may, by the aid of a common cabinet-maker, construct one for his own use; the conductor may be equally insulated by rosin, wax, silk, or any other electric or non-conducting substance.

When of a large diameter, these plate machines are by far the most powerful of any; and this power is greatly increased by a second plate parallel to the other, and turning on the same axis. The most powerful machine of which we have ever heard is one made in this country for the museum of Teylar, at Harlem. It consists of two circular plates of five feet five inches diameter. The plates are about 7½ inches asunder, and each is excited by four rubbers. The prime conductor is divided into two branches which enter between the plates, and by means of points collect the electrical fluid. These plate machines, however, with two plates, are turned with great labour, and are liable to more accidents when large than the common cylinders.

Previous to the consideration of these circumstances, by which a large quantity of the electric fluid may be excited, it may be necessary to premise, that the resistance of the air seems to be lessened where the cushion is in close contact with the cylinder; and that the electric matter, agreeably to the law observed by all other elastic fluids, is pressed towards that part where it finds least resistance; the same instant, therefore, that the cylinder is separated from the cushion, the fire issues forth in abundance, because the resistance made to it by the action of the atmosphere is lessened at that part. The more perfect the continuity is made, the greater is the quantity of electricity which will proceed from the cushion.

To excite, therefore, an electrical machine effectually, it is necessary first to discover those parts of the cushion which are pressed by the glass cylinder, and then the amalgam must be applied to those parts only. The line of contact between the cylinder and cushion must be made as perfect as possible, and the fire which is collected must be prevented from escaping. The breadth of the cushion should not be great, and it should be placed in such a manner that it may be easily raised or lowered.

In order to find the line of contact between the cylinder and cushion, place a line of whiting which has been dissolved in spirit of wine, on the cylinder: on turning this round, the whiting is deposited on the cushion, and marks those parts of it which bear or rub against the cylinder. The amalgam is to be put on those parts only which are thus marked by the whiting.

Whenever the electricity of the cylinder grows less powerful, it is easily renewed by turning back the silk which lies over it, and then rubbing the cylinder with the amalgamated leather, or by altering the pressure of the adjusting screw.

A small quantity of tallow placed over the amalgam is observed to give more force to the electric powers of the cylinder; or the same end may be effected by rubbing the cylinder with a coarse cloth, which has been a little greased, and afterwards wiping it with a clean cloth.

As air not only resists the emission of the electric fluid, but also dissipates what is collected, on account of the conducting substances which are floating in it, over the cylinder a piece of black or oiled silk should be placed, from the line of contact to the collecting points of the prime conductor, and these points should be placed within its atmosphere.

Sometimes the silk will adhere so strongly to the cylinder, when zinc amalgam is used, as to render it very difficult to turn; but this may be obviated by rubbing a small quantity of aurum musivum, or a little whiting, over the silk, when it is wiped clean.

The following directions of Mr. Adams, relative to exciting the machine, will be useful to the experimentalist:

"To excite your machine, clean the cylinder, and wipe the silk.

"Grease the cylinder by turning it against a greasy leather, till it is uniformly obscured. The tallow of a candle may be used.

"Turn the cylinder till the silk flap has wiped off so much of the grease as to render it semi-transparent.

"Put some amalgam on a piece of leather, and spread it well, so that it may be uniformly bright: apply this against the turning cylinder, the friction will immediately increase, and the leather must not be removed until it ceases to become greater.

"Remove the leather, and the action of the machine will be very strong.

"The pressure of the cushion cannot be too small, when the excitation is properly made."

There are now in use two kinds of amalgam: one is made of quicksilver five parts, zinc one part, which are melted together with a small quantity of bees-wax; the other is the aurum musivum of the shops, which is tin and sulphur. Before either of these will adhere closely to the silk it is necessary to

grease it, to wipe off the superfluous grease, and then spread the amalgam.

One property of the electric fluid it will be necessary to notice before the conclusion of this branch of the subject, and that is, that it is more forcibly attracted by points than by balls or any blunt or rounded surfaces. This may be demonstrated by a variety of easy experiments, and may be seen by presenting a metal ball at a given distance to a conductor in the act of being charged, when it will be found that a metal point presented at a much greater distance will draw off the whole of the electrical matter from the conductor. In the one case also (the point) the electricity goes off invisibly, and without noise; in the other case there are both a flash and a report.

Of the theory of electricity.—In a very early stage of the science we have seen, that a distinction was observed with respect to the attractive and repulsive powers of certain electric bodies. Thus, if we electrify with the same substance, for instance either with excited glass or with sealing-wax, two cork balls in an insulated state, that is, suspended by silk lines about six inches long, the balls will separate and repel each other; but if we electrify one of the balls with glass, and the other with sealing-wax, they will be mutually attracted. This circumstance gave rise to the opinion, that two different species of electricity existed; and the one was termed the vitreous electricity, or that produced from glass; and the other, which was produced from sealing-wax, resinous substances, and sulphur, was termed the resinous electricity.

Subsequent experiments served to shew, that in the common electrical machine, the rubber exhibited the appearance of the resinous electricity, and the cylinder that of the vitreous, while the former was connected with the earth. A divergent cone or brush of electrical light was observed to be the obvious mark of the vitreous electricity; and a single globular mass of light distinguished the resinous kind. The hand or body also which approached the vitreous or glassy substance, when excited, appeared to receive the matter from the electric; but when one of the resinous kind was excited, the electrical matter appeared to proceed from the hand or other approaching body.

Notwithstanding, however, the names by which these different forms of electricity were distinguished, as the vitreous and resinous, it was at length discovered, that the different phenomena depended rather upon the surface, than upon the nature and composition of the electric; for a glass tube, when the polished surface was destroyed; by being ground with emery, and being rubbed with a smooth body, exhibited all the proofs of the resinous electricity, as much as sulphur or sealing-wax; yet afterwards, when it was greased and rubbed with a rough surface, it resumed its former property. It seems, therefore, to be a rule, that the smoothest of two bodies, upon friction, exhibits the phenomena of the vitreous electricity; for baked wooden cylinders with a smooth rubber are resinously electrified, but with a rubber of coarse flannel they exhibit the appearances of the vitreous kind; and even polished glass will produce the phenomena of the resinous electricity, if rubbed with the smooth hair of a cat's skin.

Amidst this embarrassing variety of experiments, those philosophers who applied to this branch of science, were eagerly employed in inventing theories to account for these phenomena, and electricians are still divided with respect to the cause.

The theory of Franklin, though not without its defects, possesses simplicity, and accounts for facts in an easy and natural manner. It may be resolved into the following axioms:

1st. The electric matter is one and the same in all bodies, and is not of two distinct kinds.

2d. All terrestrial bodies contain a quantity of this matter.

3d. The electric matter violently repels itself, but attracts all other matter.

4th. Glass and other substances, denominated electrics, contain a large portion of this matter, but are not to be penetrated by it.

5th. Conducting substances are permeable by it, and do not conduct it merely over their surface.

6th. A body may contain a superfluous quantity of the electrical fluid, when it is said, according to this theory, to be in a *positive* state, or electrified *plus;* and when it contains less than its proper share, it is said to be *negative*, or electrified *minus*.

7th. By exciting an electric, the equilibrium of the fluid is broken, and the one body becomes overloaded with electricity, while the other is deprived of its natural share.

Thus, according to the Franklinean theory, that electricity, which was before called *vitreous*, is now called *positive* electricity; and that which was termed the *resinous*, is now denominated *negative* electricity.

It is evident, that it is only in passing from one body to another, that the effects of the electrical fluid are apparent. When all the adjacent bodies, therefore, are equally charged with electricity, no effects whatever will appear. The equilibrium must, according to the principles of Dr. Franklin, be destroyed, that is, the fluid must be made rarer in some one part, before any of the phenomena will be exhibited. In that case, the dense fluid rushing in to supply the deficiency in that part where it is rarer, produces the flash of light, the crackling noise, and the other effects of electricity.

The different effects on rough and smooth bodies, when excited, have been previously remarked. The Franklinean theory is, if a rough and smooth body are rubbed together, the smooth body will generally be electrified *plus*, and that with a rough uneven surface, *minus*. Thus, in the ordinary operation of the common machine, the cylinder is positively electrified, or plus, and the rubber negative, or minus. The redundance of the positive electricity is sent from the cylinder to the prime conductor, and may be communicated from it to any conducting body. If, however, the prime conductor is made to communicate with the earth, which has a great attraction for the electrical matter (and which, being one great mass of conducting substances, will not permit the accumulation of the fluid in a particular part); and if, at the same time, the rubber is in an insulated state, supported, for instance, by glass or any electric; these effects will be reversed, for the prime conductor will then be negatively electrified, and the rubber will be plus or positive.

Dr. Franklin supposed that the electric fluid is collected from the earth, and this hypothesis he supported by the following experiment.

Let one person stand on wax (or be insulated) and rub a glass tube, and let another person on wax take the fire from the first, they will both of them (provided they do not touch each other) appear to be electrified to a person standing on the floor; that is, he will perceive a spark on approaching either of them with his knuckle or finger; but if they touch each other during the excitation of the tube, neither of them will appear to be electrified. If they touch one another after exciting the tube, and draw the fire as before, there will be a stronger spark between them than was between either of them and the person on the floor. After such a strong spark, neither of them discovers *any electricity*.

He accounts for these appearances by supposing the electric fluid to be a common element, of which each of the three persons has his equal share before any operation is begun with the tube.

A, who stands upon wax and rubs the tube, collects the electrical fire from himself into the glass, and his communication with the common stock being cut off by the wax, his body is not again immediately supplied.

B, who also stands upon wax, passing his knuckle along the tube, receives the fire which was collected from A, and, being insulated, he retains this additional quantity.

To the third person C, who stands upon the floor, both appear electrified; for he, having only the middle quantity of electrical fire, receives a spark on approaching B, who has an over quantity, but gives one to A, who has an under quantity.

If A and B approach to touch each other, the spark is stronger, because the difference between them is greater. After this touch there is no spark between either of them and C, because the electrical fluid in all is reduced to the original equality. If they touch while electrifying, the equality is never destroyed, the fire is only circulating; hence we say that B is electrified positively, A negatively.

Such is the famous Franklinean hypothesis, which, it must be confessed, is not entirely without its difficulties, and, it is much to be feared, that we have as yet no complete theory of electricity. The fact most difficult to be explained on the Franklinean system is, that of two bodies negatively electrified repelling each other; for if the repulsion in the case of positive electricity is caused entirely, as there is reason to believe it is, by the electric matter, how should a deficiency of that matter produce the same effect? Attempts have been made to explain the fact, by having recourse to the electricity of the air, which (when not charged with moisture) is certainly an electric, or non-conducting substance, and in all cases is an imperfect electric. The cork balls, or other light substances, which are electrified negatively, are therefore supposed to be acted upon by the positive electricity of the air, which produces an effect adequate to the being positively electrified. This solution, however, is not quite satisfactory; though it is perhaps un-

philosophical to reject an hypothesis, which explains some facts greatly to our satisfaction, merely because it has not as yet explained every thing.

But leaving theories, especially in the present very imperfect state of this science, let us endeavour to keep our attention on those facts which are well known, and generally admitted. The following statement seems to comprise the general principles on which this wonderful fluid is known to act. It is extracted from M. Brisson, a French writer of deserved reputation, and it is such as a few easy experiments will serve to confirm.

The electric fluid is probably the same in essence with that of light and heat, but combined with a substance which affects the organs of scent.

When bodies are electrified by glass, they furnish tufts or pencils of light; but if electrified by sulphur, or resinous substances, they only produce points, or sparks of light; bodies presented to those electrified by glass, produce only luminous points; while those which are presented to bodies which are electrified by sulphur, produce beautiful pencils, or tufts of light.

Bodies are electrified either by friction or communication. To electrify bodies by communication, it is necessary to insulate them; and the substances the most proper for insulating others are those which electrify the best by friction.

Glass, however, though it electrifies very well by friction, electrifies also by communication, even without any preliminary preparation; yet it is very proper for insulating.

The electrical matter is not produced entirely from the bodies upon which the electrifying machine acts; the adjacent bodies, or substances, contribute towards its production.

The energy of the electric virtue is augmented, in conductors, more by an increase of surface, than by an augmentation of the mass.

Electrified bodies adhere one to another, so that, on some occasions, they cannot be separated without a considerable effort.

Electricity accelerates the evaporation of liquors, and the perspiration of animals.

The pencils or tufts of light, which are seen at the extremities or angles of electrified bodies, are always composed of divergent rays when they pass through the air; but if a *non-electric*, or conducting body, is presented to them, they lose a great deal of their divergency; their rays sometimes become even convergent, in order that they may approach towards that body which is more permeable than the air; and if they are made to pass into a vacuum, they will assume the form of a large branch of light nearly cylindrical, or in the form of a spindle.

The spark which shines between two bodies is capable of setting combustible matters on fire.

Electrical instruments, or apparatus.—The experiments in electricity are so various, that the apparatus may be increased almost agreeably to every man's fancy; and, in general, he who wishes to make new experiments, will find it necessary to make an addition suited to the object of his inquiry. It will be, therefore, proper, on the present occasion, and most consistent with the design of this work, only to specify and describe those parts of the apparatus which are most in use, and essential to the performance of the experiments which are already before the public.

The instruments commonly employed in this branch of science, may be classed under six heads: 1st. The instruments used for exciting electricity, viz. glass tubes, plates, and cylinders. 2d. Those for conducting the electric matter, which are chiefly of metal. 3d. Those intended for accumulating the fluid, or, in technical language, for receiving a *charge*, such as coated bottles or jars, commonly called Leyden phials. 4th. Those which are intended to produce more formidable effects, such as electric batteries. 5th. The instruments employed for ascertaining the quantity of electricity, called electrometers; and lastly, those employed for retaining the electric power.

I. Of the first class of these instruments it was necessary to treat, in explaining the first principles of electricity; and there is nothing that can be added in further illustration of the nature of electrical machines.

II. The nature and uses of such conductors as are attached to the machine, have been also explained; but any instrument which serves to convey the electrical influence from one body to another, may be regarded as a conductor. With this view, wires and chains are employed to form a communication between different bodies; and under this head we may also class the common discharging rod, the principle of which consists in a rod of metal, sometimes with knobs at the ends, which is furnished with a glass handle, to prevent the shock from passing through the body of the operator. In plate, fig. 5, is the jointed discharging rod, which is most commonly used. D is the glass handle cemented into the brass socket C; and *e f* are the brass wires, which are curved, and may be opened by the joint to any extent that may be required. The wires are pointed, as it is sometimes necessary to draw off a charge in that way; and the knobs *a b* are made to screw, or sometimes only to fit on to the ends of the wires. It is most frequently used with the knobs, particularly in discharging large jars and batteries. See fig. 6.

Henley's universal discharger consists of two wires, supported by glass feet, with a small table between them to support any thing that may be the object of the experiment. It is found to be a very useful instrument for a variety of purposes, and is composed of the following parts: A (fig. 7.) is a flat board, about fifteen inches long, four broad, and one thick. BB are two glass pillars, cemented in two holes upon the borad A, and furnished at top with brass caps, each of which has a turning joint, and supports a spring tube, through which the wires DD slide. Each of the caps is composed of three pieces of brass, connected so that the wires DD, besides their sliding through the sockets, have a horizontal and vertical motion. Each of the wires DD is furnished with an open ring at one end, and at the other it has a brass ball, which, by a short spring socket, is slipt upon the pointed extremity, and may be removed. E is a circular piece of wood, having on its surface a slip of ivory inlaid, and furnished with a foot, which is fastened in the middle of the bottom A.

There is another part of an electrical apparatus, originally of German invention, which, before we conclude this branch of the subject, it may not be improper to notice, as it is chiefly illustrative of the electrical attraction. This apparatus consists of three small bells, (fig. 8.) suspended from a narrow plate of metal; the two outermost by chains, and that in the middle (from which a chain *y* RS passes to the floor) by a silken string. Two small knobs of brass are also hung, by silken strings, on each side of the bell in the middle, which serve for clappers.

If an apparatus of this kind is joined to one of those conducting rods, erected to protect buildings from the effects of lightning, it will serve to give notice of the approach and passage of an electrical cloud.

III. In the infancy of every science, the inventions are simple. The first telescope was formed of two spectacle-glasses fixed upon a board; the first electrical bottle was a common apothecaries' phial, with an iron nail in the inside, which was afterwards changed for a wire. The artist who framed the one, did not expect that his discovery would enable future philosophers to explore and measure the face of a planet, or to count the host of heaven; nor did the inventor of the other, probably, suppose that his little phial, in the hands of future operators, would enable human power to vie with the most formidable of nature's efforts, to melt the hardest metals, and even to deprive plants and animals of life.

It would be an error, however, to suppose that on the form of the glass depends the success of the experiment. If any piece of glass, of whatever form, cylindrical or otherwise, is coated with a conducting substance, it may be made to accumulate the electrical matter. In this case, one side of the glass, if it does not exceed a given thickness, will be positively electrified, and the other negatively.

As, however, flat plates are neither necessary nor convenient for this purpose, jars, or bottles with wide necks, are usually employed. These are made of various shapes and magnitudes, but the most useful are thin cylindrical glass vessels, about four inches in diameter, and fourteen in height, coated within and without (except about two or three inches from the top) with tin-foil, or any other conducting substance.

If one side of this jar is electrified, while the other side communicates with the earth, it is said to be charged.

When a communication is formed from one side of the jar to the other by a conducting substance, after it has been charged, an explosion will take place, and this is called discharging the jar. The jar, however, is incapable of being charged when it is insulated; that is, when neither side communicates with the earth. When it is charged, the two sides are in contrary states; the one being positively, the other negatively electrified.

A jar is said to be positively electrified, when the inside receives the fluid from the conductor, and the outside is connected with the earth. It is negatively electrified when the outside receives the fluid from the conductor, and the inside communicates with

the earth; but it is necessary that the jar charging negatively should be insulated, because the fluid is, in the first instance, conveyed to the coating, and would be immediately carried to the earth if it was not prevented by the interposition of an electric substance.

The most usual forms of the Leyden phial, or electrical jar, are represented in figs. 6, 9, and 10, and its nature may be exemplified by the following easy experiments.

Place the jar (fig. 6) on a table, or any other non-electric body which communicates with the earth, and let the ball on the top be about one-eighth of an inch from the ball of the conductor *y*. If the machine is turned, sparks may be perceived passing from the ball of the conductor to the ball of the jar. When this effect ceases, and no more sparks are perceived to pass from the conductor, the jar may be considered as charged, the inside positively, and the outside negatively. To discharge the jar, all that is necessary is to form a communication between the outer and the inner coating of the jar or phial, that the surplus electricity may be conveyed from the one to the other. To avoid the painful sensation which is the consequence of the shock, this is usually performed with the discharging rod, see figs. 5 and 6. The operator then holds the rod by the glass handle D, and all that is necessary is to place one knob close to the outer coating, and then bring the other knob near the ball of the jar, when it will be discharged with an explosion proportioned to the quantity of electricity it has received. If, when the jar is charged, a person touches the outside with one hand, and brings the other near the knob of the jar, he will then receive the shock. A chain is sometimes concealed under the carpet, connected with the outside coating, and another is connected with the top of the jar; if then a person standing on the one, is induced to put his hand incautiously on the other chain, he will receive a shock, to his great surprise and the entertainment of the company: but care should be taken that the shock should not, in this case, be too strong. Mr. Canton used to amuse himself in this way, by electrifying the latch of his door, which was insulated, and giving a shock to the venders of old clothes, whom he allured by a well known signal, to the magic ground. An optician in London, some years ago, being teazed by an impertinent neighbour, who amused himself with knocking at his door, contrived to insulate the knocker, which was connected, by a wire, with a charged jar, and, on the unfortunate adventurer attempting to repeat his accustomed intrusion, he received a charge, which, it is reported, felled him to the ground.

To illustrate further the nature of the Leyden phial, place the same jar, fig. 6, on an insulated stand; bring the coating in contact with the conductor; turn the machine, and, after a few turns, remove the phial from the conductor; then form a communication between the outside and the inside of the phial, by means of the discharging rod; in this case, there will be no explosion, because, both sides being insulated, the bottle was not charged; but if a chain is suspended from the brass ball of the phial to the table, and the coating brought in contact with the conductor, after a few turns of the machine, remove the phial as before; then if the discharger is applied, an explosion will be heard, and the bottle will be discharged; because, in this case, the insulation of the inside is destroyed by the chain, and the phial becomes capable of receiving a charge.

That the charge of a coated jar resides in the glass, and not in the coating, is proved in the following manner: Set a plate of glass between two metallic plates, about two inches in diameter, smaller than the plate of glass; charge the glass, and then remove the upper metallic plate by an insulated handle; take up the glass plate, and place it between two other plates of metal unelectrified and insulated, and the plate of glass thus coated afresh will still be charged. The following experiments are further illustrative of the nature of the Leyden phial.

A cork ball, or an artificial spider made of burnt cork, with legs of linen thread, suspended by silk, will play between the knobs of two bottles, one of which is charged positively, the other negatively, and will, in a little time, discharge them. See fig. 10.

A ball suspended on silk, and placed between two brass balls, one proceeding from the outside, the other from the inside of a Leyden jar, when the bottle is charged, will fly from one knob to the other, and by thus conveying the fluid from the inside to the outside of the bottle will soon discharge it.

An insulated cork ball, after having received a spark, will not play between, but be equally repelled by two bottles, which are charged with the same power.

A wire is sometimes fixed to the under part of the insulated coated phial (fig. 13); and *b c* is another wire fitted to the former, and at right angles with it; a brass fly (fig. 14) is placed on the point of this wire; charge the bottle, and all the time the bottle is charging the fly will turn round; when it is charged the motion will cease. If the top of the bottle is touched with the finger, or any other conducting substance, the fly will turn again till the bottle is discharged. The fly will electrify a pair of balls positively while the bottle is charging, and negatively when it is discharging.

When a Leyden phial, positively charged, is insulated, it will give a spark from its knob to an excited stick of wax, but not a spark will pass at that time between it and an excited glass tube.

An additional quantity of the fluid may be thrown on one side of the jar, if, by any contrivance, an equal quantity be made to escape from the other, and not otherwise.

IV. Electricians, in order to increase the force of the electric explosion, connect several jars, or Leyden phials, together in a box; and this is called an electrical battery.

Fig. 12 is a battery composed of twelve jars, coated in the inside and outside with tin-foil, which altogether contain about twelve feet of coated glass. About the middle of each of these jars is a cork that sustains a wire, which, at the top, is fastened round, or soldered to the wire, knobbed at each end; which connects the inside coatings of three jars; and by four wires, such as C, D, E, F, the inside coatings of all the twelve jars may be connected together.

The square box that contains these jars is of wood, lined at the bottom with tin-foil, and has two handles on two opposite sides, by which it may be easily removed. In one side of the box is a hole, through this an iron hook passes, which communicates with the metallic lining of the box, and consequently with the outside coating of all the jars. To this hook is fastened a wire, the other end of which is connected with the discharging rod.

The battery represented in the plate, is a small one, in comparison to those now frequently used, and much too weak for the purpose of some experiments. But it is sufficient to give an idea of its construction; and when a large battery is to be constructed, it is better to make two, three, or more small ones, as represented in the plate, than a single large battery, which is heavy, and, on several accounts, inconvenient. The force of several small batteries may be easily united by a wire or chain; and thus they may be made to act in every respect like a large one. The best construction of a battery is to have a wire from every jar, connected with a ball at the top, in form of a wire-cage.

The force of accumulated electricity, great as it appears by the experiments performed with a single coated jar, is very small when compared with that which is produced by a number of jars connected together; and if the effects of a single jar are surprising, the prodigious force of a large battery is certainly astonishing. Experiments of this kind should be conducted with great caution; and the operator ought to be attentive not only to the business in hand, but also to the persons who may happen to be near him, prohibiting their touching, or even coming too near any part of the apparatus: for if a mistake in performing other experiments may be disagreeable, those in the discharge of a large battery may be attended with dangerous consequences.

When a battery is to be charged, instead of a large prime conductor, a small one is much more convenient: for, in this case, the dissipation of the electricity is not so considerable. The quadrant electrometer, hereafter to be described, which shews the height of the charge in the battery, may be fixed either upon the prime conductor, or upon the battery; in which case, it should be fixed upon a rod proceeding from the wires of the jars; and if the battery is very large, it should be elevated two or three feet above them.

The index to the electrometer, in charging a large battery, will seldom rise so high as 90, because the machine cannot charge a battery so high in proportion as a single jar. Its limits are often about 60° or 70°, more or less, in proportion to the size of the battery and the force of the machine.

Every broken jar in a battery must be taken away, before it is possible to charge the rest.

It has been recommended, not to discharge a battery through a good conductor, if the circuit is not at least five feet long; but it must be observed, that in proportion to the lengthening of the circuit the force of the shock will be lessened.

Jars made of the green glass manufactured at Newcastle, are said to endure an explosion without a probability of breaking.

If the spark from the explosion is concentrated, by causing it to pass through small circuits of non-conducting substances, the force of the battery will be considerably increased. For this purpose, cause the sparks

to pass through a hole in a plate of glass, one-twelfth or one-sixth of an inch in diameter, by which means it will be more compact and powerful. By wetting the part round the hole, the spark, by converting this into vapour, may be conveyed to a greater distance, with an increase of rapidity, attended with a louder noise than common. Mr. Morgan, by attending to these and some other circumstances, has melted wires, &c. by the means of small bottles.

If the charge of a strong battery is passed through two or three inches of small wire, the latter will sometimes appear red-hot, first at the positive side; and the redness will proceed towards the other end.

If a battery is discharged through a small steel needle, it will, if the charge is strong, communicate magnetism to the needle.

If the discharge of a battery passes through a small magnetic needle, it will destroy the polarity of the needle, and sometimes invert the poles; but it is often necessary to repeat this several times.

Dr. Priestley could melt nine inches of small iron wire at the distance of fifteen feet, but at the distance of twenty feet he could only make six inches of it red-hot, so that we may infer from this, that notwithstanding their conducting power, still metals resist in some degree the passage of the electric fluid, and therefore in estimating the conducting powers of different substances, their length must not be forgotten.

If a slender wire is inclosed in a glass tube, and a battery discharged through this wire, it will be thrown into globules of different sizes, which may be collected from the inner surface of the tube; they are often hollow, and little more than the scoria or dross of the metal.

Dr. Watson and some other gentlemen made several curious experiments to ascertain the distance to which the electric shock might be conveyed, and the velocity of its motion, which may be briefly mentioned. In the first experiment, the shock was given, and spirits inflamed by the electric matter which had been conveyed through the river Thames. In another experiment, the electric fluid was made to pass through a circuit of two miles, crossing the New River twice, going over several gravel-pits and a large field, and afterwards conveyed through a circuit of four miles. This motion was so instantaneously performed by the electric fluid, that an observer, in the middle of a circuit of two miles, felt himself shocked at the same instant that he saw the phial discharged.

V. The instruments for ascertaining the presence and the quantity of electricity in different bodies, are various. The simplest of all is a pair of little balls of cork, or rather of the pith of the elder, which is still lighter, and suspended by silk threads. When brought into contact with an electrified body, the balls will immediately diverge, and according to the degree of divergence, a judgment is formed of the degree in which the body in question is electrified. A similar effect will be produced by a light and downy feather. The pith-balls have received the name of Canton's electrometer, from the ingenious electrician who first employed them for this purpose, and they are found useful in many experiments.

For a more accurate admeasurement, that is, for ascertaining precisely the degree in which any body is electrified, an instrument somewhat less simple is required, and Henley's quadrant electrometer is in most general use. It consists (fig. 15.) of a perpendicular stem formed at top like a ball, and furnished at its lower end with a brass ferule and pin, by which it may be fixed in a hole made in the conductor, as at fig. 1. or at the top of a Leyden bottle. To the upper part of the stem, a graduated ivory semicircle is fixed, about the middle of which is a brass arm or cock, to support the axis of the index. The index is a very slender stick, which reaches from the centre of the graduated arch to the brass ferule; and to its lower extremity is fastened a small pith-ball nicely turned in a lathe. When this electrometer is in a perpendicular position, and not electrified, the index hangs parallel to the pillar; but when it is electrified, the index recedes more or less, according to the quantity of electricity.

Lane's discharging electrometer, as it is commonly called, is employed chiefly by the practitioners of medical electricity.

It is represented by F D E, in fig. 16, and is fixed to the wire that proceeds from the inside of the jar Z. The ball B touches the prime conductor A, which is supposed to stand before an electrical machine, fig. 1. The electrometer consists in a glass rod F D, furnished with brass caps F, D: from the latter proceeds a strong brass wire, to which is attached an horizontal spring-socket: through this, the wire C E, having the ball C at one end, and the open ring E at the other, may be slided backwards and forwards, so as to place the ball C at any required distance from the ball B. Suppose the distance between B and C to be $\frac{1}{8}$th of an inch or less, and that by means of a chain X, a communication be formed from E to the outside coating of the jar. When the jar is charged so high that the fluid can leap from B to C, the discharge will take place, and the stroke pass through X from the inside to the outside of the jar. When the shocks are to be given through any part of the body, as the arm, then, instead of the chain X, wires E L and I L are to be fastened, one to the ring E, and the other to a hook at I of the stand H I which communicates with the outside of the jar. The other extremities of the wire must be fastened to the directors K, L, which consist of brass wires and balls as L fastened into glass handles K, see also fig. 11. The mode of operation is easily understood from a view of the figure (16), for when the chain X is away, the electric fluid must, in passing from the inside of the jars to the outside, go through the wire E L; the brass of the director; the part of the arm between the balls of the directors; and through the wire L I. By moving C nearer to, or farther from B, the strength of the shocks will be regulated to any degree.

The instrument represented in fig. 17, has been used successfully in the cure of the tooth-ache. A is a strong piece of box-wood in which the wires *a b c* and *e f* are fixed and then bent, the tooth and gum are placed between *c* and *f*, and the circuit between the outside and inside of the jar is to be made by means of the chains *g* and *h*, which may be fastened in the same manner as the wires E L and I L in fig. 16, and by bringing C very near to B so as not absolutely to touch, the shocks which pass through the tooth and gum will be very slight.

Several instruments have also been invented for ascertaining the state of the atmosphere with respect to the quantity of electricity it may contain, at any given time. The best of them are improvements upon Canton's electrometer, which is made by inclosing the pith-balls, or rather two slips of gold leaf, in a cylindrical glass vessel, to prevent their being affected by the wind.

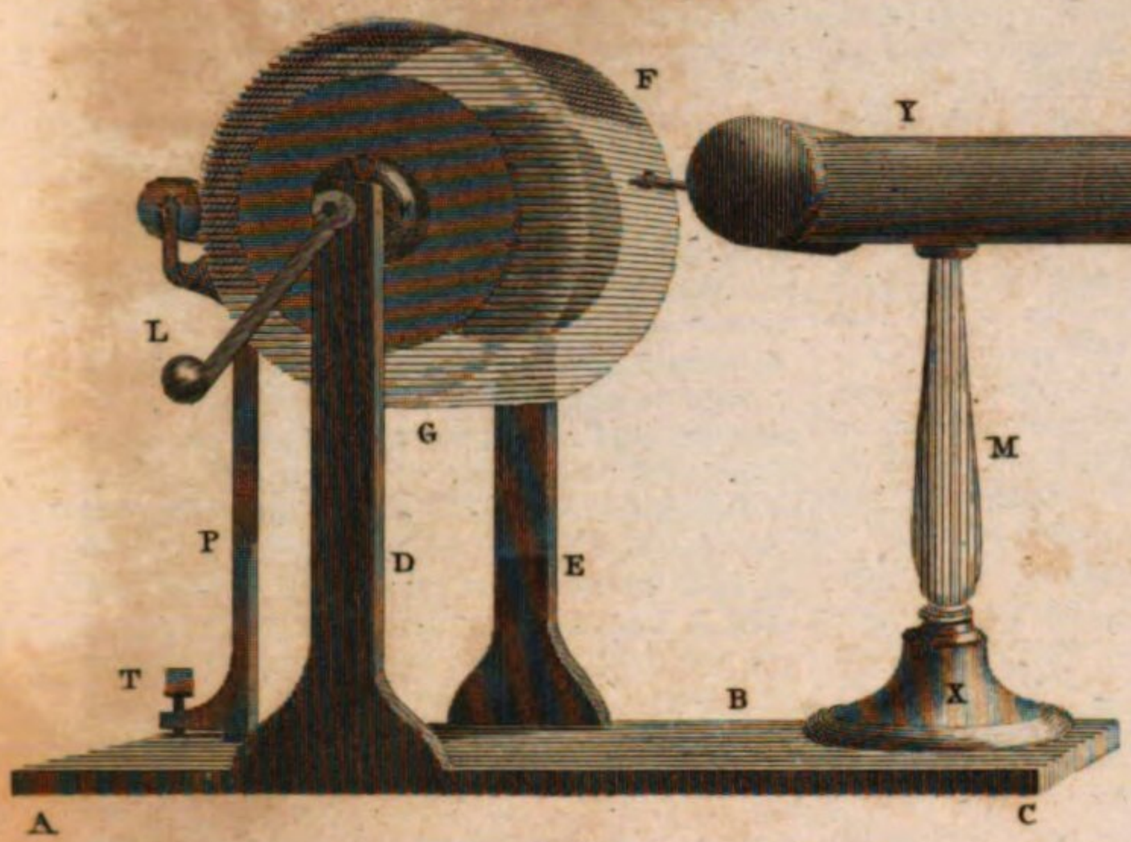
Bennet's electrometer, fig. 18. is a very delicate instrument, and capable of distinguishing small quantities of electricity. It consists of two slips of leaf gold A, suspended in a glass B. The foot C may be of wood or metal; the cup D of metal. The cup is made flat on the top, that plates, books, evaporating water, or other things to be electrified, may be conveniently placed upon it. The cup is about an inch wider in diameter than the glass, and its rim about three quarters of an inch broad; which hangs parallel to the glass, to turn off the rain, and keep it sufficiently insulated. Within this is another circular rim, about half as broad as the other, which is lined with silk or velvet, and fits close upon the outside of the glass; thus the cap fits well, and may be easily taken off to repair any accident happening to the leaf gold. Within this rim is a tin tube, hanging from the centre of the cap, somewhat longer than the depth of the inner rim. In the tube a small peg is placed, and may be occasionally taken out. To the peg, which is made round at one end and flat at the other, the slips of leaf gold are fastened with paste, gum-water, or varnish. These slips suspended by the peg, and that in the tube fast to the centre of the cap, hang in the middle of the glass, about three inches long, and a quarter of an inch broad. On one side of the cap there is a small hole to place wires in. It is evident, that without the glass, the leaf gold would be so agitated by the least motion of the air, that it would be useless: and if the electricity should be communicated to the surface of the glass, it would interfere with the repulsion of the leaf gold; therefore two long pieces, H H, of tin-foil are fastened with varnish on opposite sides of the internal surface of the glass, where the leaf gold may be expected to strike, and in connection with the foot. The upper end of the glass is covered and lined with sealing-wax as low as the outermost rim, to make its insulation more perfect.

The sensibility of this instrument is so great as even to astonish the most experienced electricians who have been witnesses of its effects. The brush of a feather, the throwing of chalk, hair-powder, or dust, against its cap, evince strong signs of electricity. The electricity of vapour is elegantly shewn by pouring a tea-spoonful of water on an ignited coal placed in a metallic cup upon the cap of this electrometer; and a very great and pleasing variety of other experiments may be made with this excellent instrument.

"In performing several atmospherico-electrical experiments about the year 1776, I found," says Mr. Cavallo, "that the use of Canton's cork-ball electrometer was much obstructed by the wind, in consequence of which I attempted to inclose it in a bottle,

ELECTRICITY.

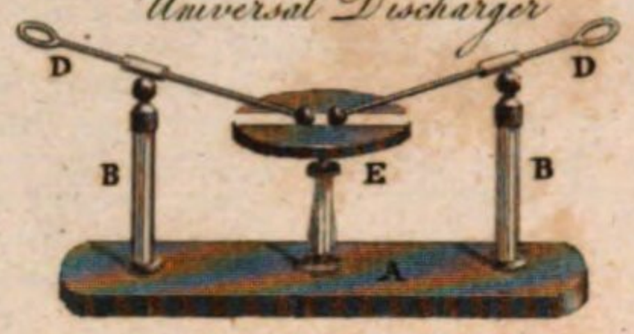
1
Electrical Machine



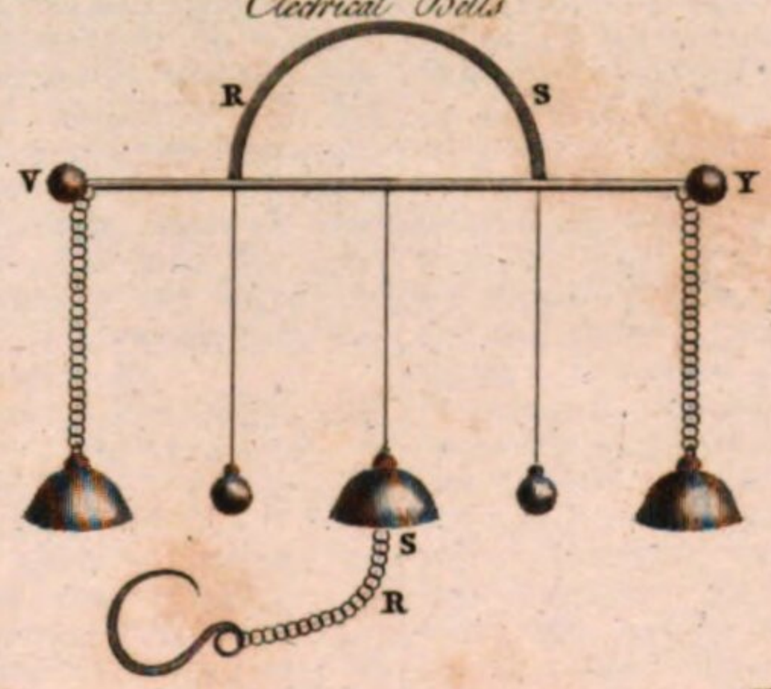
5
Discharging Rod

6
Leyden Jar

7
Universal Discharger



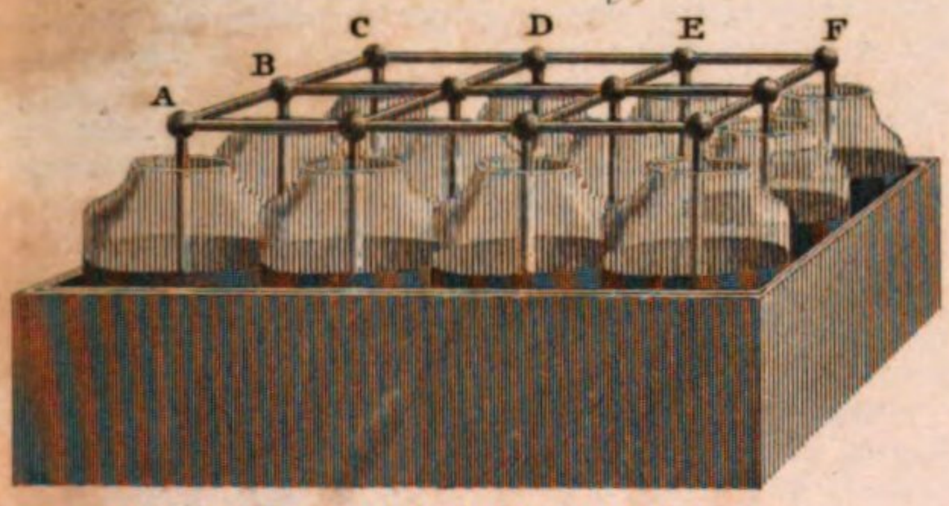
8
Electrical Bells



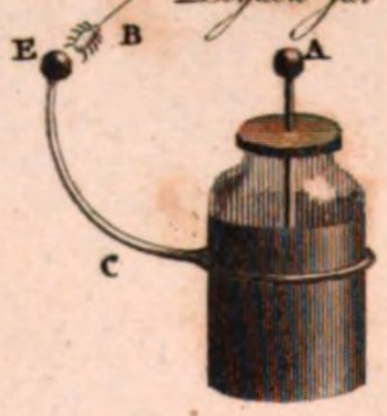
9
Leyden Jar

11

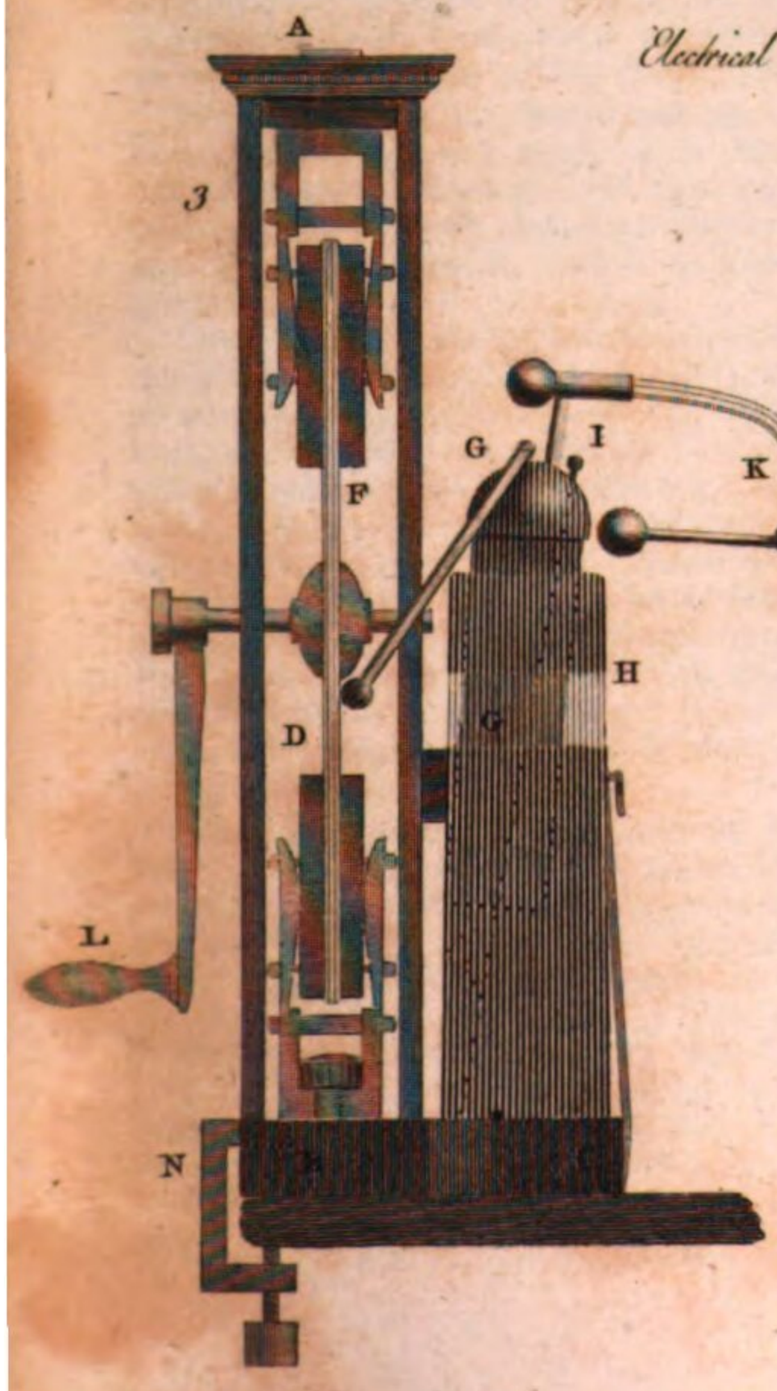
12
Battery

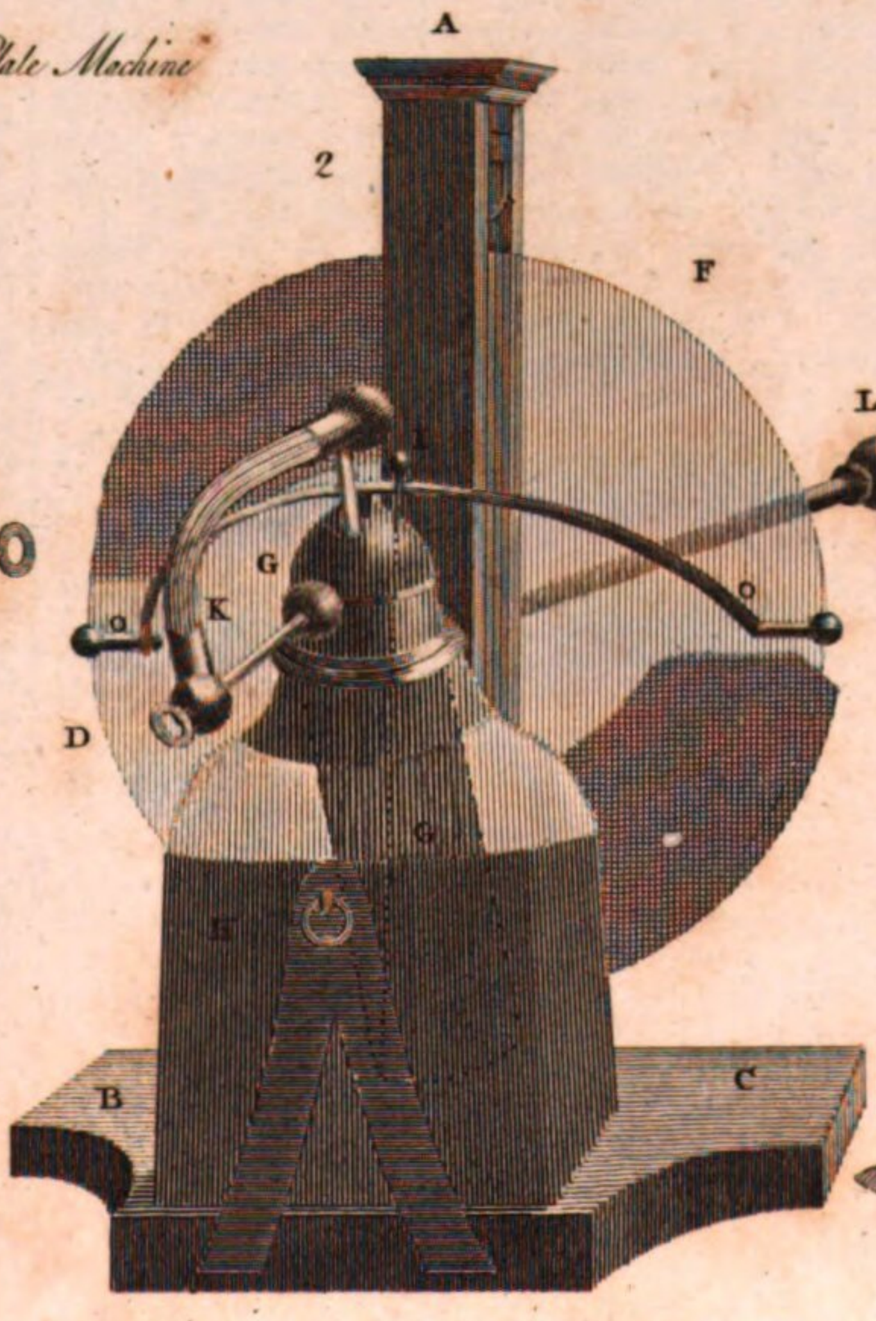


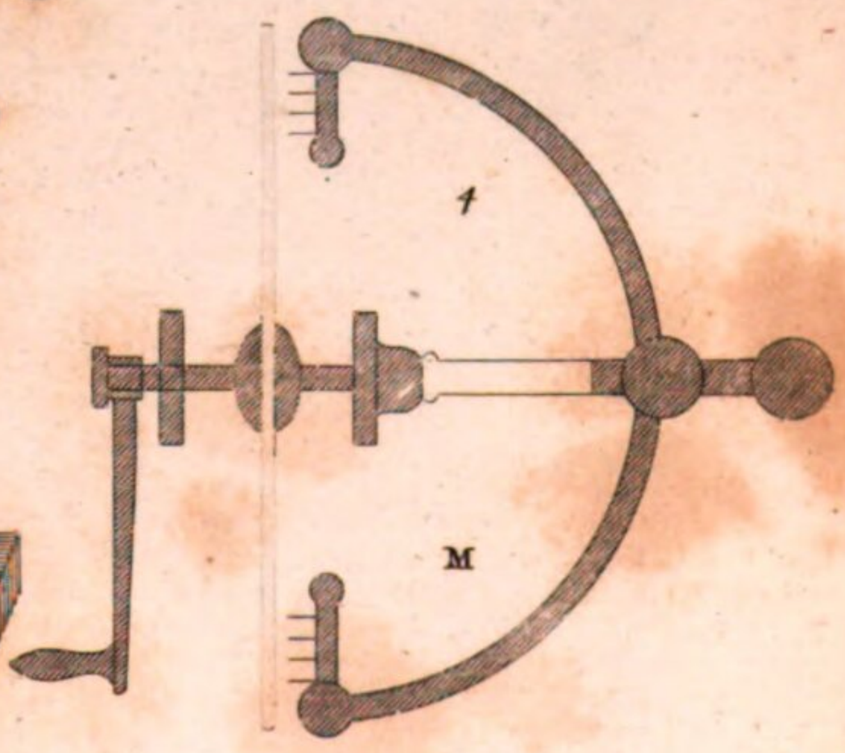
10
Leyden Jar



Electrical Plate Machine







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and after a variety of trials and alterations the instrument was in the year 1777 brought to the state which is represented in fig. 19. The three parts of the figure represent the instrument in its case, the same out of the case, and a section of its brass cap and neck.

"CDMN is an open glass vessel narrower at top than at bottom, and cemented into the wooden piece A B, by which part the instrument is held when it is to be presented to the atmosphere, or it may be rested upon a table for other experiments. This wooden piece also serves to screw the instrument into its wooden case O. The upper part of CDMN is tapering like the neck of a phial; and a short glass tube is cemented into it, so as to project a little above and a little within the neck of the former: then the upper part of the instrument from C D to L, is covered with sealing-wax, by means of heat, which gives it the appearance of one continuate body. The inner part G of the small glass tube is also covered with sealing-wax. Into this tube a brass wire is cemented, the lower part H of which is flattened, and is perforated with two holes; the upper part L is formed into a screw, upon which the brass cap E F is screwed. The office of this cap is to defend the upper part of the instrument from the rain. The conical, or oval, or globular, corks P of this electrometer, are as small as can be made, and are suspended by exceedingly fine silver wires, the upper parts of which are formed in rings, which pass through the holes at H, and are thereby so loosely suspended, that they are caused to diverge when the brass cap E is exposed to a very slightly electrified atmosphere. I M and K N are two narrow slips of tin-foil stuck to the inside of the glass, and communicating with the wooden bottom A B; they serve to carry off that electricity, which, when the corks touch the glass, is communicated to it, and if accumulated would disturb the free motion of the corks."

VI. It is remarkable, that in certain cases bodies electrified will retain their electric power for almost any length of time, and on this principle a very ingenious instrument has been constructed, called an electrophorus.

This simple species of electrical machine consists of two plates (fig. 20.) A and B, made of a circular form, from eight to eighteen inches in diameter, or upwards. The upper plate is generally made of brass; but a tin plate, with a wire turned in upon its edge, will answer exceedingly well. At the centre of this plate there is a socket O, in which a glass handle I, nine or ten inches long, is fixed. A thin board, covered with tin-foil, and suspended by silken strings, will answer well, when the electrophorus is wanted of a large diameter.

The under plate may be made of glass, sealing-wax, or the following composition, viz. four parts rosin, three parts pitch, three parts shell-lac, two parts Venice turpentine, melted together over a gentle fire. It may be poured and spread upon a thin linen cloth, to about one-fourth of an inch thick. The linen cloth must be stretched upon a hoop, and made as tight as possible. If the surface is a little rough, it will be no worse.

The manner of using this machine is as follows: Rub the coated side of the under plate A with fine new flannel, or a hare's or cat's skin; and when it is excited as much as possible, set it on a table, and place the upper plate upon it, and put your finger on the upper plate; then remove your finger, and take hold of the top of the glass handle I, and apply it to the knob of a coated jar. Repeat this operation for 30 or 40 times, and the jar will become charged.

Cavallo mentions one of the above kind made by him, with which he charged a coated phial several times, by once exciting, so strong as to pierce a hole through a card at every discharge.

When a glass is covered with sealing-wax, after it is excited and laid with the waxed side downward, and the glass uppermost, then on making the usual experiment of putting the metal plate on it, and taking the spark, &c. it will be attended with contrary electricity to what it had before.

To explain these phenomena it will be again necessary to recur to what has been said concerning negative and positive electricity; it will be necessary also to recollect, that the negative electricity was originally termed the resinous, because it was first thought to be peculiar to those substances. In the electrophorus, therefore, the lower part or resinous mass, being negatively electrified, the matter is taken from the metal plate, and this becoming also negatively electrified, the fluid is attracted from any body which is presented to it.

Electrical phenomena.—The various phenomena of electricity may, for the sake of perspicuity, be divided into four classes; in the first of which may be included all those experiments which serve to illustrate the electrical attraction and repulsion; in the second, those produced by the stream of electricity; in the third class may be ranged all those phenomena which are accompanied with the luminous appearances; and lastly, we may enumerate those more formidable effects arising from the concentrated electricity, in the experiments with the Leyden phial and the electrical battery.

1. That light bodies are attracted and repelled by the electrical influence, is evident from many common experiments. If a feather of a downy kind is affixed by linen threads to a small wire, and the wire is inserted into the prime conductor, upon turning the cylinder, the plumage will be found to expand every way, and the threads will also recede as far as possible from each other. If a finger approaches the feather, the plumage will bend towards it, and if the finger is moved, the feather will seem to follow it. If a spark is taken from the conductor, the plumage immediately collapses: and, if the cylinder is again excited, the threads will diverge, and the plumage expand as before.

There is another very entertaining experiment illustrative of the electric attraction. If a small plate of metal is suspended from the prime conductor, and another plate is placed at a small distance under it; if then on the lower plate a piece of leaf gold is laid, when the cylinder is turned the gold will be lifted up, and expand itself with one corner opposite the upper and the other opposite the under plate. If the room is darkened, the leaf gold will appear to be supported by pillars of fire.

If instead of the leaf gold small figures or images (which may be easily made of thick paper or thin pasteboard, see fig. 21.) are placed on the under plate, after turning the cylinder the images will successively rise up in an erect position, and will seem to dance between the two plates, sometimes leaping upon each other, and exhibiting themselves in a variety of entertaining positions. If the head of the image is held before the fire and dried, the image will ascend to the upper plate and remain there; and if the experiment is reversed, and the feet of the image are dried, and the head a little moistened at the same time, the image will continue to stand immoveable on the lower plate. The experiment will not succeed, if instead of metal, the images are placed upon glass, because glass is an electric, and does not transmit the electrical matter, and consequently the images will not move backwards and forwards; but if the finger or any conducting body is held under the glass plate, they will then move as before.

There is another very pretty experiment illustrative of the same principle, the apparatus of which is to be found in the shops of most of the instrument-makers, and which has been already described. It consists of three small bells, with clappers between them, (see fig. 8.) If the machine is turned the clappers fly from one bell to the other, and ring a kind of peal by the effect of electricity. To explain this, it is only necessary to notice that the two outer bells are suspended by metal chains, and the middle bell and clappers by silk, but from the middle bell a chain is suspended, which goes to the table. The fluid is then conveyed from the conductor down the chains to the two exterior bells, and the clappers which are light are attracted by them. The clappers then become charged and are repelled by the outer bells, but attracted by that in the middle, to which they give the electricity they had received, and it is conveyed to the earth by the chain which communicates with the table. Being thus disburthened, they are again attracted and strike the outer bells as before, and this is continued as long as the machine is in action.

The electrical porcupine, as it has been called, is formed nearly in the shape of the animal, the name of which it bears. It is covered with ermine, or some other fur, in which are inserted some pieces of cotton pulled out to a considerable length, to resemble the porcupine's quills. On turning the machine the hairs of the fur or ermine diverge, and the pieces of cotton are discharged, and by a powerful conductor are driven to some feet distance. This effect, it is obvious, depends upon the principle which has been just explained, and is illustrative of the electric repulsion.

A very common mode of demonstrating the same effect, is to put a pointed wire into one of the holes of the conductor, and while the machine is in action, to hold a glass tumbler over the point till its interior surface becomes charged. If then a few pith-balls are laid on the table, and covered with the tumbler, the balls will presently move about as if by magical power. See fig. 22.

Electrified bodies in certain circumstances adhere so closely together, that the fact has given occasion to a new term in philosophy,

and it has been called the electrical cohesion. This was pleasantly illustrated by some experiments on silk stockings, communicated to the Royal Society by Mr. Robert Symner a few years ago. Two silk stockings, the one black and the other white, had been for some time upon one leg, and were then rubbed with the hand, and both pulled off together; it appears that in this case the two stockings will adhere together in such a manner as to require a considerable force to separate them. M. Brisson, who repeated the experiment, observes, that after he had separated the white from the black stocking another phenomenon occurred; for while he held them one in each hand, suspended in the air, they swelled and puffed up as wide as if the leg had remained in them! When they were brought within ten or twelve inches of each other, they rushed upon one another, and adhered forcibly together; but this adhesion was not so great as that which took place while the stockings were one within the other. Mr. Symner supposed, that the success of this experiment depended upon the contrast between the black and white colour; but M. Brisson proves this hypothesis to be without foundation, having made the experiment by substituting for the black stocking another of a different colour, and even a white one; but he confesses, that when the experiment was made with two white silk stockings the effects were weak in comparison. The same effects have been produced, when the stockings were one of black silk, and the other of light-coloured Angola wool.

Electrical attraction appears, however, not to be so strong in vacuo as in the open air. From several experiments of Beccaria's we learn, that if the air is thoroughly exhausted out of a glass receiver, the attraction and repulsion of electrified light bodies within the receiver become languid, and soon cease altogether.

2. That the stream of electricity is capable of producing motion in almost a similar manner to a stream of common air, will be manifest from several pleasing experiments. If a brass cross or fly, such as that in fig. 14. is placed on the conductor, when the machine is turned it will go rapidly round. If it is taken off, and held under the conductor, it will move in the same manner. If the cross, or fly, as it is called, is insulated, it will not move, because no electricity can be drawn through it either way. If a pin or any other conductor approaches it, it will however move as usual.

By means of the stream of electricity issuing from a point, many other amusing experiments have been contrived: such is the electrical orrery, shewing the motion of the sun, earth, and moon.

The sun and earth go round the common centre of gravity between them in a solar year; and the earth and moon go round the common centre of gravity between them in a lunar month. These motions are represented by an electrical experiment as follows:

The ball S (fig. 23) represents the sun, E the earth, and M the moon, connected by wires a c and b d: b is the centre of gravity between the earth and moon. These three balls and their connecting wires are hung and supported on the sharp point of a wire A, which is stuck upright in the prime conductor B of the electrical machine; the earth and moon hanging upon the sharp point of the wire c a e, in which wire is a pointed short pin, sticking out horizontally at c; and there is just such another pin at d, sticking out in the same manner, in the wire that connects the earth and the moon.

When the cylinder of the electrical machine is turned, these balls and wires are electrified; and the electrical fire, flying off horizontally from the points c and d, causes S and E to move round their common centre of gravity a, and E and M to move round their common centre of gravity b. And as E and M are light when compared with S and E, there is much less friction on the point b, than S and E make about the point a. The weights of the balls may be adjusted so, that E and M may go twelve times round b, in the time that S and E go once round a. This affords an amusing experiment in electricity; but it is so far from proving that the motions of the planets in the heavens are owing to a like cause, that it plainly proves they are not; for the real sun and planets are not connected by wires or bars of metal, and consequently there can be no such metallic points as c and d between them. And without such points, the electric fluid would never cause them to move; for, take away these points in the above-mentioned experiment, and the balls will continue at rest, let them be ever so strongly electrified.

Fig. 24 represents a water-mill for grinding corn, turned by a stream of electricity. A is the water-wheel, B the cog-wheel on its axis, C the trundle turned by that wheel, and D the running mill-stone on the top of the axis of the trundle. It may easily be contrived and turned also by electricity, if instead of the round plate D for the mill-stone, there is a horizontal wheel on the trundle C, with spur-cogs, which will turn two trundles placed on its opposite sides; and on the top of each of these trundles' axis, may be a round plate representing a mill-stone; so that this model has all the working parts of a double water-mill, turning two mill-stones.

Set the mill near the prime conductor, and place the crooked wire so that its point may be directed towards the uppermost side of the great wheel A. Then turn the glass globe by the winch, and the stream of fire that issues from the point of the wire will turn the wheel, and consequently all the other working parts of the mill.

Small boats or swans are sometimes made of light wood or cork, and they may be attracted and made to swim in any direction, by applying a finger towards them; or they may have the addition of sails, and will then be made to sail briskly before an electrical gale from a wire held in the hand of the operator.

3. Every person knows that with his knuckle or finger, he can draw sparks from a conductor; the further he removes his knuckle from the conductor, the longer will be the spark, and it will even resemble lightning in the curves it forms, and its zig-zag appearance.

There is even a mode of imitating the course of lightning by some conducting substance, such as pieces of tin-foil stuck at different distances on a plate of glass, and sending a strong spark through them from a powerful conductor. In fig. 25 is a glass tube with pieces of tin-foil pasted on at different distances in a spiral direction, and hence called the spiral tube. It is inclosed in a larger tube, fitted with brass caps at each end, which connect with the tin-foil. When the electric spark is made to pass through this tube, a beautifully illuminated spot will be seen at each separation of the tin-foil; and from the course in which the electric light is attracted, will serve to give some idea, on a very diminutive scale, of the manner in which the lightning is attracted from one cloud to another. A similar effect will be produced by the jar, fig. 26.

A very pleasing effect is also produced from the electrical light, which has been called the diadem of beatification. The person who wishes to exhibit this experiment, binds his head with a band of silvered leather; and while he stands upon an insulated stool is connected with the conductor by a metal chain. If then, while the machine is turned, another person passes his knuckle or finger near the band of leather, it will appear beautifully illuminated, and vivid flashes of light will play about the person's head who wears the magic diadem.

It has been mentioned before that spirit of wine may be set on fire by the electric spark. The experiment is easily made either by placing the ladle or spoon which contains the fluid upon the conductor, and taking the spark through the spirit; or by a person holding the spoon or ladle in one hand, while he stands on the insulated stool, having the other hand on the conductor. If then another person approaches the spoon, either with his finger or an iron poker, or other metal instrument, the spark will pass through the spirit of wine, and set it immediately in a flame. The experiment will succeed better if the spirit is a little warm, or even if the spoon in which it is contained has been previously a little heated.

4. Whatever may be the effects, however, of a spark drawn from the conductor, they are greatly augmented by what may be termed concentrated electricity, when the fluid is accumulated by means of a Leyden phial, or a glass plate properly prepared. If a card is held close to the coating of a charged jar near the bottom, and one knob of the discharging rod is applied to the card, and the other to the ball of the jar, the electric fluid in passing through the card, will perforate it. The edges of the hole on each side will be a little raised, and the discharge will be attended with a sulphureous smell. With a moderate battery a quire of the thickest paper may be perforated in the same manner.

If a small chain is laid upon a piece of white paper, and a shock from a Leyden phial is made to pass through it, the paper will be stained with a blackish tinge at every joint of the chain; and if the experiment is made in the dark, the chain will appear illuminated, with a kind of radiation at every juncture.

By a strong shock of electricity, metals are melted, and gold itself may be incorporated with glass, so as to give the latter the colour and appearance of that metal. The experiment is not difficult. All that is re-

quired is, to take two narrow slips of common window-glass, each about an inch broad, and three or four inches long. Let a narrow slip of gold leaf then be placed between the glasses, with about an inch at each end hanging beyond the glasses, which by some means should be pressed closely together. One end of the slip of gold leaf should communicate with the outer coating of the phial; and when it is charged, one knob of the discharging rod must be applied to the other end of the leaf, so as to send the charge through it. When the glasses are taken asunder, it will be found that the gold has been melted, and the substance of it actually incorporated with the glass, which consequently must have undergone a partial fusion itself.

By a smart shock of electricity from a charged phial, or a battery, a plant may be killed, and the experiment will best succeed with the common balsam or impatiens. The smaller animals may also be deprived of life; but human art has not yet been able to construct a battery large enough to kill an animal above the size of a sheep or a dog. The immediate or proximate cause of the death of animals by electricity, or by lightning, which is natural electricity, has not yet been ascertained. It was once supposed that the living principle was extinguished by the bursting of some blood vessel, from the violence of the shock; but a dog which was killed by lightning, was carefully dissected, and none of the vessels found in the least injured. Beccaria recovered some persons apparently struck dead by lightning; and when questioned with respect to the pain or suffering which they endured, they only complained of an unusual numbness or weariness in their limbs. The flesh of animals killed by electricity is rendered extremely tender, and is recommended by Dr. Franklin as an article of luxury. It will also putrify in a much shorter time than the flesh of those which are killed in any ordinary way.

Electricity augments the natural evaporation of fluids, and especially of those fluids which are most subject to evaporation of themselves; and it has a greater effect on fluids, when the vessels containing them are non-electrics. If a humid body, a sponge for instance, is placed upon a conductor positively electrified, the evaporation will proceed much more rapidly, and it will be much sooner dry, than a similar body differently circumstanced.

Dr. Priestley also supposes that plants, when electrified, vegetate earlier and more vigorously, than those which have not been subjected to this influence.

That electricity increases the insensible perspiration of animals, may be inferred from the circumstance that electrified animals are always lighter than those which are not.

The stream of electrical fluid has no sensible heat, but even appears cold to the touch; yet we have seen that the more inflammable bodies, and particularly spirit of wine, may be ignited by it; in this respect it remarkably differs from fire or caloric.

The luminous effects of electricity are not the same in vacuo as in the air, and the reason of this is, that dry air is a non-conductor. Thus if a wire with a round end is included in an exhausted receiver, and presented to a conductor of an electrical machine, every spark will pass through the vacuum in a broad stream of light, visible the whole length of the receiver, moving with regularity (unless it is turned back by some non-electric); and then dividing itself into a number of beautiful rivulets, which are continually separating and uniting in a pleasing manner. When the vessel is grasped by the hand, a pulsation is perceived like that of an artery, and the fire inclines towards the hand. A small quantity of air is, however, necessary to occasion the most brilliant luminous effect.

Of thunder and lightning, meteors, waterspouts, &c.—It no longer remains a doubt among philosophers, that the cause of thunder is the same with that which produces the ordinary phenomena of electricity; the resemblance between them is indeed so great, that we cannot believe thunder itself to be any other than a grander species of electricity, naturally excited without the feeble efforts of human art. This fluid, probably, is diffused through the whole atmosphere at all times, either in a smaller or greater degree; and is occasionally perceptible to our senses, according to the concurrence of natural circumstances.

The cloud which produces the thunder and lightning may be considered as a great electrified body; but how has the cloud acquired its electric virtue? is the reasonable demand of an inquisitive mind: and to satisfy this inquiry it will be necessary to refer to what has been before observed, that this power is produced in two modes, by friction, and by communication. Bodies electrified by friction communicate their virtue to other bodies which are susceptible of it, provided they are insulated, and at a convenient distance. As air, therefore, is an idio-electric body, it is not unphilosophical to suppose, that in stormy weather, especially when it is common to observe the clouds and the wind take contrary courses, a part of the atmosphere, rushing by the other, may cause the air to be electrified by the friction of its own particles, or by rubbing against terrestrial objects which it meets in its passage, or perhaps against the clouds themselves. It is probable also, that the inflammable substances, which arise and accumulate in the cloudy regions, contribute to increase the effects, not only of themselves, but perhaps still more by the electric matter which they carry along with them. Another circumstance, which favours this inference, is, that thunder-storms are more frequent and tremendous in those times and places, when and where we have reason to conclude that these exhalations are in the greatest abundance in the atmosphere, as in warm seasons and climates, as well as in those places where the earth is filled with substances capable of furnishing a large quantity of these exhalations, and in particular in the neighbourhood of volcanoes.

A cloud in a thunder-storm may be considered as a great conductor, actually insulated and electrified; and it may be supposed to have the same effect upon those non-electrics which it meets with in its course, as our common conductors have upon those which are presented to them. If a cloud of this kind meets with another which is not electrified, or less so than itself, the electric matter flies off from all parts towards this cloud; hence proceed flashes of lightning, and the formidable report of thunder.

"Thunder-storms," says Beccaria, "generally happen when there is little or no wind; and their first appearance is marked by one dense cloud, or more, increasing very fast in size, and rising into the higher regions of the air; the lower surface black, and nearly level, but the upper finely arched, and well defined. Many of these clouds seem frequently piled one upon another, all arched in the same manner; but they keep continually uniting, swelling, and extending their arches.

"At the time of the rising of this cloud, the atmosphere is generally full of a great number of separate clouds, motionless, and of odd and whimsical shapes. All these, upon the appearance of the thunder cloud, draw towards it, and become more uniform in their shapes as they approach, till coming very near the thunder cloud, their limbs mutually stretch towards one another; they immediately coalesce, and together make one uniform mass. But sometimes the thunder cloud will swell, and increase very fast, without the conjunction of these adscitious clouds, the vapours of the atmosphere forming themselves into clouds wherever it passes. Some of the adscitious clouds appear like white fringes at the skirts of the thunder cloud, but these keep continually growing darker and darker as they approach or unite with it.

"When the thunder cloud is grown to a great size, its lower surface is often ragged, particular parts being detached towards the earth, but still connected with the rest. Sometimes the lower surface swells into various large protuberances, bending uniformly towards the earth. When the eye is under the thunder cloud, after it is grown larger, and well formed, it is seen to sink lower, and to darken prodigiously; at the same time that a number of adscititious clouds (the origin of which can never be perceived) are seen in a rapid motion, driving about in very uncertain directions under it. While these clouds are agitated with the most rapid motions, the rain generally falls in the greatest plenty; and if the agitation is exceedingly great, it commonly hails.

"While the thunder cloud is swelling, and extending its branches over a large tract of country, the lightning is seen to dart from one part of it to another, and often to illuminate its whole mass. When the cloud has acquired a sufficient extent, the lightning strikes, between the cloud and the earth, in two opposite places, the path of the lightning lying through the whole body of the cloud and its branches. The longer this lightning continues, the rarer the cloud grows, and the less dark is its appearance, till at length it breaks in different places, and displays a clear sky."

It is the opinion of the same author, that the clouds serve as conductors to convey the electric fluid from those parts of the earth which are overloaded with it, to those which are exhausted of it.

To prove that the earth is often positively charged with respect to the clouds in one

part while it is negative in another, he adverts to the fall of great quantities of sand, and other light substances, which are often carried into the air, and scattered uniformly over a large tract of country, when there is no wind to effect this phenomenon; and even when there was, they have been carried against the wind; he therefore supposes, that these light bodies are raised by a large quantity of electrical matter issuing from the earth.

This comparatively rare phenomenon, he thinks, exhibits both a perfect image and demonstration of the manner in which the vapours of the atmosphere are raised to form thunder clouds. The same electric matter, wherever it issues, attracts to it, and carries into the higher regions of the air, the watery particles dispersed in the atmosphere. The electric matter ascends, being solicited by the less resistance it finds there than in the common mass of the earth, which at those times is generally very dry, and consequently highly electric. The uniformity with which thunder clouds spread themselves, and swell into arches, must be owing to their being affected by some cause which, like the electric matter, diffuses itself uniformly wherever it acts, and to the resistance they meet with in ascending through the air.

The same cause which first raised a cloud from vapours dispersed in the atmosphere, draws it to those already formed, and continues to form new ones, till the whole collected mass extends so far as to reach a part of the earth where there is a deficiency of electric fluid; thither also they will be attracted, and thus the mass serves as a conductor. When the clouds are attracted in their passage by those parts of the earth, where there is a deficiency of the fluid, those detached fragments are formed, and also those uniform depending protuberances, which are probably the cause of waterspouts.

A wind always blows from the place whence a thunder cloud proceeds; and the wind is more or less violent in proportion to the sudden appearance of the thunder cloud, the rapidity of its expansion, and the velocity with which the adscititious clouds join it. The sudden condensation of such a prodigious quantity of vapour must displace the air, and agitate it on all sides.

In three states of the air, says the author above quoted, I could find no electricity in it. 1st. In windy weather. 2d. When the sky was covered with distinct and black clouds, which had a slow motion. 3d. In moist weather, not actually raining.

In rainy weather, without lightning, his apparatus was always electrified a little time before the rain fell, and during the time of rain, but ceased a little before the rain was over.

The higher his rods reached, or his kites flew, the stronger signs they gave of being electrified.

It has been intimated that the clouds are sometimes positively, and sometimes negatively electrified. In the latter case, the lightning is supposed, upon the Franklinean theory, to proceed from the earth to the cloud. The general effects of lightning are precisely the same with those of the electric shock, only greatly magnified. It may not be improper in this place to notice an old error, namely, the melting of metals by what has been called the cold fusion. The error is found to rest upon certain ill-attested relations of swords being melted in the scabbard, by lightning, and money in a bag, without injuring the scabbard or the bag. A variety of experiments have been accurately made to determine the fact; the results of which have been, that the thin edge of the sword, or of the money, might have been instantaneously melted, and yet so instantaneously cooled, as neither to affect the scabbard nor the bag. A very small wire will instantly melt and instantly cool in the flame of a common candle.

Mr. Kinnesley inclosed a small wire in a goose quill filled with loose grains of gunpowder, which took fire as readily as if they had been touched by a red-hot poker; tinder was kindled when tied to a piece of the same wire; but no such effects could be produced with a wire twice as large. Hence it appears, as Mr. Kinnesley remarks, that though the electrical matter has no sensible heat when in a state of rest, it will, in passing through bodies, produce heat in them, provided they are proportionably small. Thus, in passing through the small wire, the particles are confined to a narrower passage, and, crowding close together, act with a more condensed force, and produce sensible heat.

The discovery of Dr. Franklin, which established the identity of lightning with the electrical fluid, suggested an invention, for which we are indebted to the same philosopher, for securing buildings from this most formidable enemy. The reader will perceive that we allude to that of metallic conductors.

The effects of the electric matter, when it strikes a building, and the method of preventing it, are exemplified by an instrument called the thunder-house, representing the side of a house, either furnished with a metallic conductor, or not. A (figure 27) is a board about three quarters of an inch thick, and shaped like the gable-end of a house. This board is fixed perpendicularly upon the bottom board B, upon which the perpendicular glass pillar C is also fixed, in a hole about eight inches distant from the basis of A. A small hole ILMK, about a quarter of an inch deep, and nearly one inch wide, is made in the board A, and is filled with a square piece of wood, nearly of the same dimensions. It should be nearly of the same dimensions, because it must go so easily into the hole that it may drop off by the least shaking of the instrument. A wire I K, is fastened diagonally to this square piece of wood. Another wire L H, of the same thickness, having a brass ball H screwed on its pointed extremity, is fastened on the board A; so also the wire M N, which is shaped in a ring at N. From the upper extremity of the glass pillar C, a crooked wire proceeds, having a spring socket F, through which a double-knobbed wire slips perpendicularly, the lower knob G of which falls just above the knob H. The glass pillar C must not be made very fast in the bottom board; but it must be fixed so that it may be easily moved round its own axis, by which means the brass ball G may be brought either nearer or farther from the ball H, without touching the part E F G. Now, when a square piece of wood L M I K (which may represent the shutter of a window or the like) is fixed into the hole, so that the wire I K stands in the direction L M, then the metallic communication from H to N is complete, and the instrument represents a house furnished with a proper metallic conductor; but if the square piece of wood L M I K is fixed so that the wire I K stands in the direction I K as represented in the figure, then the metallic conductor H N from the top of the house to its bottom, is interrupted at L M: in which case the house is not properly secured.

Fix the piece of wood L M I K, so that its wire may be as represented in the figure, in which case the metallic conductor H N is discontinued. Let the ball G be fixed at about half an inch perpendicular distance from the ball H: then, by turning the glass pillar C, remove the former ball from the latter; by a wire or chain, connect the wire E F with the wire Q of the jar P, and let another wire or chain, fastened to the hook N, touch the outside coating of the jar. Connect the wire Q with the prime conductor, and charge the jar: then, by turning the glass pillar C, let the ball G come gradually near the ball H, and when they are arrived sufficiently near one another, you will observe that the jar explodes, and the piece of wood L M I K is pushed out of the hole to a considerable distance from the thunder-house. Now the ball G in this experiment, represents an electrified cloud, which, when it is arrived sufficiently near the top of the house A, the electricity strikes; and as the house is not secured with a proper conductor, the explosion breaks part of it, *i. e.* knocks off the piece of wood I M.

Repeat the experiment with only this variation, viz. that this piece of wood I M is situated so that the wire I K may stand in the situation L M, in which case the conductor H N is not discontinued; and you will observe, that the explosion will have no effect upon the piece of wood L M, this remaining in the hole unmoved; which shews the usefulness of the metallic conductor.

Further, unscrew the brass ball H from the wire H L, so that this may remain pointed, and with only this difference in the apparatus, repeat both the above experiments; and you will find the piece of wood L M is in neither case moved from its place, nor will any explosion be heard.

The conductor E F G in this experiment is supposed to represent a thunder cloud discharging its contents on a weathercock, or any other metal, at the top of a building; and it may be inferred from this experiment, that if there is a connection of metal to conduct the electric fluid down to the earth, the building will receive no damage; but where the connection is imperfect, it will strike from one part to another, and thus endanger the whole building.

Elevated conductors, applied to buildings to secure them from lightning, will in this manner discharge the electricity from a cloud that passes over them, and a greater quantity of the discharge will pass through a pointed conductor than through one which terminates with a ball; but whether the discharge will be made by a gradual current, or by explosion, will depend upon the suddenness of the discharge, on the nearness and

motion of the cloud, and the quantity of the electricity contained in it. If a small cloud hangs suspended under a large one loaded with electric matter, pointed conductors on a building underneath will receive the discharge by explosion, in preference to those terminated by balls; the small cloud forming an interruption, which allows only an instant of time for the discharge.

Earl Stanhope has communicated to the public, in a treatise on this subject, some essentials to be observed in the erection of conductors to buildings: he advises, that the upper fifteen or twenty inches of the rod should be composed of copper and not of iron, as the latter being exposed to the weather will rust, and rust does not conduct electricity; that the iron part of the rod should be painted, but not the upper part of it, because paint is no conductor. He further advises, that the upper extremity of a conducting rod should not only be accurately pointed and finely tapered, but that it should be extremely prominent, about ten or fifteen feet above all the parts of the building which are the nearest it. It may be added, that a conductor should always be carried in the earth some feet beyond the foundation of the building, and should, if possible, terminate in water.

The safest situation during a thunder storm is the cellar; for when a person is below the surface of the earth, the lightning must strike it before it can reach him, and will of course, in all probability, be expended on it. Dr. Franklin advises persons apprehensive of lightning to sit in the middle of a room, not under a metal lustre or any other conductor, and to lay their feet up upon another chair. It will be still safer, he adds, to lay two or three beds or matrasses in the middle of the room, and folding them double, to place the chairs upon them. A hammock suspended by silk cords would be an improvement upon this apparatus. Persons in fields should prefer the open parts to the vicinity of trees, &c. The distance of a thunder storm, and consequently the danger, are not difficult to be estimated. As light travels at the rate of 72,420 leagues in a second of time, its effects may be considered as instantaneous within any moderate distance. Sound, on the contrary, is transmitted only at the rate of 1,142 feet, or about 380 yards in a second. By accurately observing therefore the time which intervenes between the flash and the noise of thunder which follows it, a very near calculation may be made of its distance, and we know no better means of removing unnecessary apprehensions.

The success of Dr. Franklin, in ascertaining the cause of thunder and lightning, induced succeeding philosophers to apply the same theory to the explanation of the other atmospherical phenomena. From a number of observations, the indefatigable Beccaria endeavours to account for the rising of vapours and the fall of rain, upon electrical principles; and it must be confessed, that if it is not a primary agent in these effects, it would be rashness entirely to deny its influence. This philosopher supposes, that previously to rain a quantity of electric matter escapes from the earth, and in its ascent to the higher regions of the air collects and conducts into its path a great quantity of vapours. The same cause that collects will condense them more and more, till in the places of the nearest intervals they come almost into contact, so as to form small drops, which, uniting with others as they fall, come down in rain. The rain he supposes to fall heavier in proportion as the electricity is more vigorous.

Hail he supposes to be formed in the higher regions of air, where the cold is intense, and where the electric matter is very copious. In these circumstances, a great number of particles of water are brought near together, where they are frozen, and in their descent collect other particles; so that the density of the substance of the hailstone grows less and less from the centre, this being formed first in the higher regions, and the surface being collected in the lower. Agreeably to this, it is observed, that on mountains, hailstones as well as drops of rain are very small, there being but a small space through which they can fall.

Clouds of snow differ in nothing from clouds of rain, but in the circumstance of the cold which freezes them. Both the regular diffusion of snow, and the regularity of the parts of which it consists, shew the clouds of snow to be actuated by some uniform cause like electricity.

Consistent with this theory is the fact, that vapours never rise to a great height without producing meteors. Almost all volcanic eruptions are accompanied with lightning. The column of vapour, which proceeds from the bowels of a volcano, is continually transversed by lightning, which sometimes seems to proceed from the higher regions, sometimes from the column itself. These lightnings were observed by the younger Pliny, in the eruption which killed his uncle; and sir William Hamilton has observed them several times. The aurora borealis is also generally supposed to be electrical; its light seems to be produced by the electric fluid, while it is condensed in passing in the columns of elevated vapour.

Mr. Adams's description of this meteor, in his Lectures, is as follows: The appearances of the aurora come under four different descriptions. 1st, A horizontal light, like the morning aurora, or break of day. 2dly, Fine, slender, luminous beams, well defined, and of dense light. These often continue a quarter, a half, or a whole minute, apparently at rest, but oftener with a quick lateral motion. 3dly, Flashes pointing upward, or in the same direction with the beams, which they always succeed. These are only momentary, and have no lateral motion; but they are generally repeated many times in a minute. They appear much broader, more diffuse, and of a weaker light, than the beams: they grow gradually fainter till they disappear; and sometimes continue for hours, flashing at intervals. 4thly, Arches, nearly in the form of a rainbow: these, when complete, go quite across the heavens, from one point of the horizon to the opposite point.

When an aurora happens, these appearances seem to succeed each other in the following order: 1, the faint rainbow-like arches; 2, the beams; and, 3, the flashes. As for the northern horizontal light, it appears to consist of an abundance of flashes or beams blended together by the situation of the observer.

The beams of the aurora borealis appear at all places to be arches of great circles of the sphere, with the eye in the centre; and these arches, if prolonged upwards, would all meet at one point.

The rainbow-like arches all cross the magnetic meridian at right angles. When two or more appear at once, they are concentric, and tend to the east and west; also the broad arch of the horizontal light tends to the magnetic east and west, and is bisected by the magnetic meridian; and when the aurora extends over any part of the hemisphere, whether great or small, the line separating the illuminated part of the hemisphere from the clear part, is half the circumference of a great circle crossing the magnetic meridian at right angles, and terminating in the east and west: moreover, the beams perpendicular to the horizon, are only those on the magnetic meridian.

That point in the heavens to which the beams of the aurora appear to converge, at any place, is the same as that to which the south pole of the dipping-needle points at that place.

The beams appear to rise above each other in succession; so that of any two beams, that which has the higher base has also the higher summit.

Every beam appears broadest at or near the base, and to grow narrower as it ascends; so that the continuation of the bounding lines would meet in the common centre to which the beam tends.

The height of the rainbow-like arches of the aurora is estimated by Mr. Dalton to be above the earth's surface about 150 English miles.

A very beautiful experiment will illustrate this appearance in the heavens: Fig. 28 is called the luminous conductor. A is a glass tube about two feet long, capped at both ends with brass, having one of the ends furnished with a stop-cock, and a screw to fit into the plate of the air-pump. This tube is exhausted of air, and when it is placed in the circuit of the electric fluid, by fixing a chain to each end, which is connected with the positive and negative parts of the machine, the electricity in passing through it, exhibits a beautiful luminous appearance, very much resembling the aurora borealis. See AURORA BOREALIS.

It was intimated that water-spouts are among the phenomena which some philosophers have attempted to explain on electrical principles. A water-spout is a most formidable phenomenon, and is indeed capable of causing great ravages. It commonly begins by a cloud, which appears very small, and which mariners call the squall; which augments in a little time into an enormous cloud of a cylindrical form, or that of a reversed cone, and produces a noise like an agitated sea; sometimes emitting thunder and lightning, and also pouring down large quantities of rain or hail, sufficient to inundate large vessels, overset trees and houses, and every thing which opposes its violent impetuosity.

These water-spouts are more frequent at sea than by land; and sailors are so convinced of their dangerous consequences, that

when they perceive their approach, they frequently endeavour to break them by firing a cannon before they approach too near the ship. They have also been known to have committed great devastations by land: though, where there is no water near, they generally assume the harmless form of a whirlwind. See WATERSPOUT, and METEOROLOGY.

In accounting for these phenomena upon electrical principles, it is observed, that the effluent matter proceeds from a body actually electrified, towards one which is not so; and the affluent matter proceeds from a body not electrified, towards one which is actually so. These two currents occasion two motions analogous to the electrical attraction and repulsion. If the current of the effluent matter is more powerful than of the affluent matter, which in this case is composed of particles exhaled from the earth, the particles of vapours, which compose the cloud, are attracted by this effluent matter, and form the cylindrical column called the descending water-spout; if, on the contrary, the affluent matter is the strongest, it attracts a sufficient quantity of aqueous particles to form gradually into a cloud, and this is commonly termed the ascending water-spout.

Of the electricity which is produced by means of melting, heating, cooling, and evaporation.—If sulphur is melted in an earthen vessel, and the whole is left to cool upon conductors; and if afterwards the sulphur, when cold, is taken out of the vessel, it will be found strongly electrical; but not at all so if it is left to cool upon electrics.

If sulphur is melted in a glass vessel, and is left to cool, both the glass and the sulphur will acquire a strong electricity, the former positive and the latter negative; and that will be the case whether they are left to cool upon electrics or upon conductors.

If melted sulphur is poured into a vessel of baked wood, it will acquire the negative, and the wood the positive, electricity; but if it is poured into sulphur, or rough glass, it will acquire no sensible degree of electricity.

Melted sulphur poured into a metal cup, and there left to cool, shews no signs of electricity whilst standing in the cup; but if they are separated, then they will both appear strongly electrified, the sulphur positive, and the cup negative. If the sulphur is replaced in the cup, every sign of electricity will vanish; but if, whilst separate, the electricity either of the cup or sulphur is taken off, then on being replaced they both will appear possessed of that electricity which has not been taken off.

Melted wax, being poured into glass or wood, acquires the negative electricity, and the glass or wood becomes positive. But sealing-wax, poured into a sulphur vessel, acquires the positive electricity, and leaves the sulphur negative.

Chocolate fresh from the mill, as it cools in the tin pans in which it is received, becomes strongly electrical. When turned out of the pans, it retains this property during a certain time, but loses it presently by handling. By melting it again in an iron ladle, and pouring it into the tin pans as at first, you may renew its power once or twice; but when the mass becomes very dry and powdery in the ladle, the electricity is no longer revived by simple melting; but if then a little olive oil is added, and is mixed well with the chocolate in the ladle, and is afterwards poured into the tin pans as at first, it will be found to have completely recovered its electrical power, which continues a considerable time.

The property of becoming electrified merely by heating or cooling, was first observed in, and is eminently possessed by, a hard pellucid stone called the tourmalin, which is generally of a deep red, or purple, or brown colour; which seldom, if ever, exceeds the size of a small walnut; and which is found in several parts of the East Indies, especially in the island of Ceylon; but on farther examination it has been found that several other precious stones, and especially the Brasilian emerald, possess the like properties more or less; hence the following particulars, which have been principally observed of the tourmalin, must be understood to belong likewise to most other precious stones.

1. The tourmalin, while kept in the same temperature, shews no signs of electricity; but it will become electrical by increasing or diminishing its heat, and stronger in the latter circumstance than in the former. A very trifling alteration of temperature is often sufficient to produce the effect.

2. Its electricity does not appear all over its surface, but only on two opposite sides of it, which may be called its poles, and which always are in one right line with the centre of the stone, and in the direction of its strata; in which direction the stone is absolutely opaque, though in the other it is semitransparent.

3. Whilst the tourmalin is heating, one of its sides (call it A) is electrified plus, or positive, and the other B minus; but when cooling, A is minus, and B is plus. Hence, if one side of the stone is heating, whilst the other is cooling, then both sides will acquire the same electricity; or if one side only changes its temperature, then that side only will appear electrified.

4. If this stone is heated, and suffered to cool without either of its sides being touched, then A will appear positive, and B negative, all the time of its heating and cooling.

5. This stone may be excited by means of friction like any other electric; and either of its sides, or both, may be rendered positive.

6. If the tourmalin is heated or cooled upon some other insulated body, that body will be found electrified as well as the stone; but it will be found possessed of the electricity contrary to that of the contiguous side of the stone.

7. The electricity of either side, or of both, may be reversed by heating or cooling the tourmalin in contact with various substances, such as the palm of the hand, a piece of metal, &c.

8. These properties of the tourmalin are also observable in vacuo, but not so strong as in the open air.

9. If a tourmalin is cut into several parts, each piece will have its positive and negative poles, corresponding to the positive and negative sides of the original stone.

10. If this stone is covered all over with some electric substance, such as sealing-wax, oil, &c. it will in general shew the same properties as without it.

11. A vivid light appears upon the tourmalin, whilst heating in the dark, and by a little attention one may be easily enabled by this light to distinguish which side of the stone is positive, and which negative. Sometimes when the stone is strongly excited, pretty strong flashes may be seen in the dark, to go from the positive to the negative side of it.

12. Lastly, it has been found that with respect to the electric properties, the tourmalin is sometimes injured by the action of a strong fire, at other times is improved, and sometimes is not at all altered by it.

The evaporation of water, as also of some other fluids, produces electricity, viz. those bodies from which the water has departed, will remain in a negative state of electricity, indicating that the water by its conversion into vapour has its capacity for the electric fluid increased, as it has its capacity increased for containing heat. But though the effect is in general such as has been mentioned above, yet there are two exceptions which involve the subject in some difficulty, and which will require farther experiments and consideration.

The exceptions are, 1st, that if water is evaporated by being put in contact with a red-hot piece or pieces of very rusty iron, it will leave the iron electrified positively; whereas, if the iron is not rusty, the evaporation of the water from its surface will leave it electrified negatively. 2dly. If water is evaporated by throwing into it impure red-hot glass (such as the green glass of common bottles), the vessel, or the remaining water, will be electrified positively.

This curious production of electricity by evaporation, as also the production of electricity by the condensation of vapour, may be easily observed in the following manner:

Place a metallic cup, or a pewter plate, upon an insulating stand, and connect a sensible electrometer (fig. 18) with it. Also place one or two lighted coals in the cup or plate; then pour a little water at once upon the coal or coals, which will produce a quick evaporation accompanied with a great hissing noise, and at the same time the electrometer will diverge with negative electricity.

If the steam which issues copiously from water quickly boiling, is received under a pretty large and insulated metallic plate, that plate, by the condensation of the steam upon it, will be electrified positively, as may be ascertained merely by connecting a sensible electrometer with it.

On throwing a variety of other substances upon actually burning, or only hot and insulated coals, the coals, &c. either shewed negative electricity, or no electricity at all. Either spirit of wine, or ether, when thus treated, left the coals negative; but if (the coals being sufficiently hot) the spirit of wine or the ether took fire, and burned in their usual way, then no electricity was produced.

Of animal electricity.—Under this title we shall take notice of that electricity only which is produced from the animal itself, in consequence of its particular organization, and not that which is produced by the ap-

ELECTRICITY.

Fig. 14

Fig. 13

Electrometer

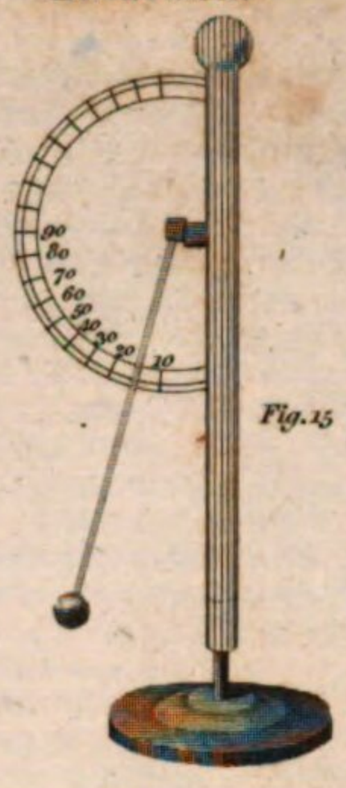


Fig. 15

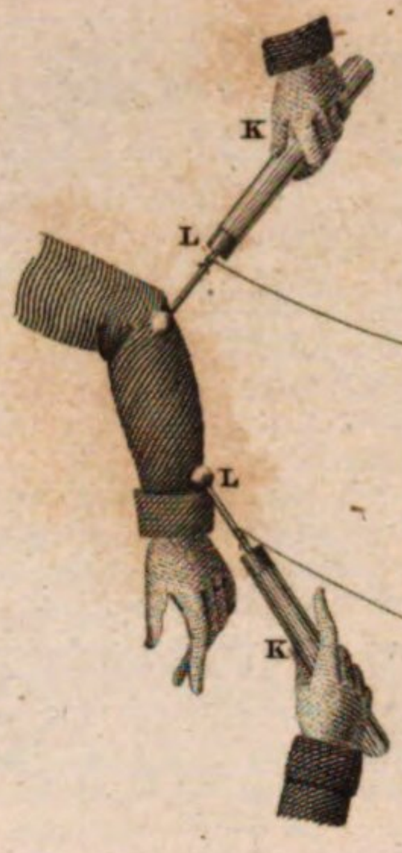
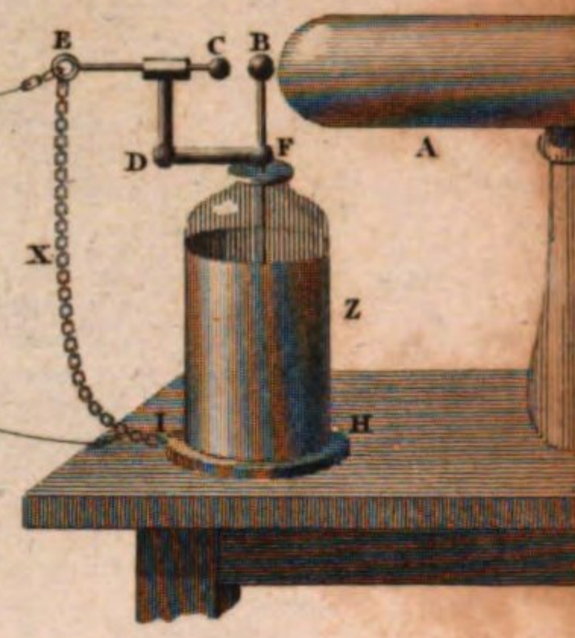


Fig. 16

Medical Electricity



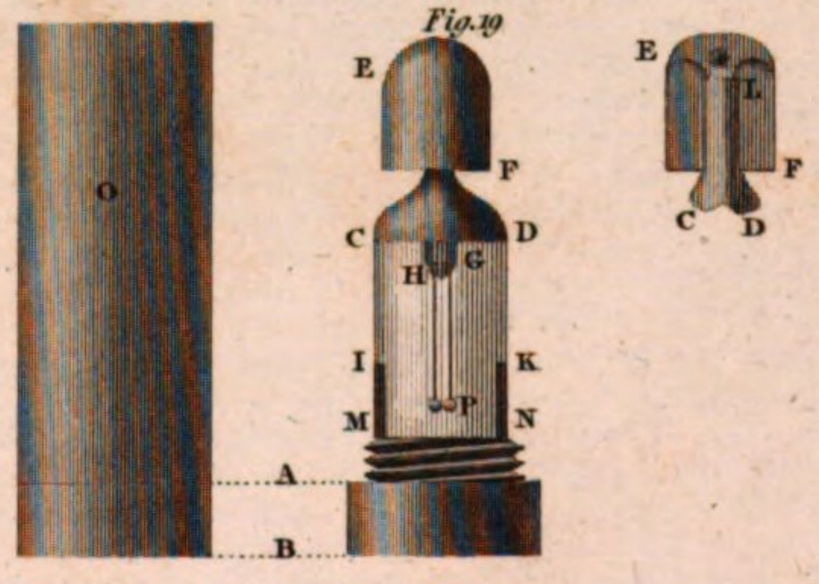
Bennets Electrometer

Fig. 18

Fig. 17

Cavallo's Electrometer

Fig. 19



Electrophorus

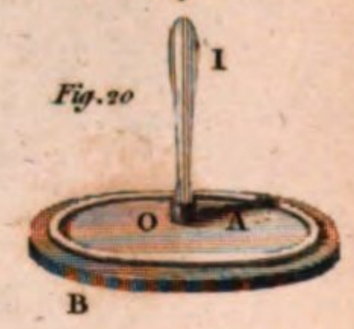


Fig. 20

Electrical Attraction

Fig. 21

Fig. 22

Electrical Orrery

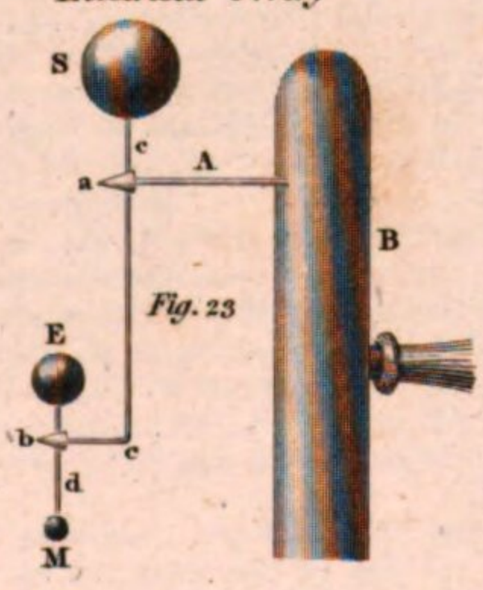


Fig. 23

Electrical Mill

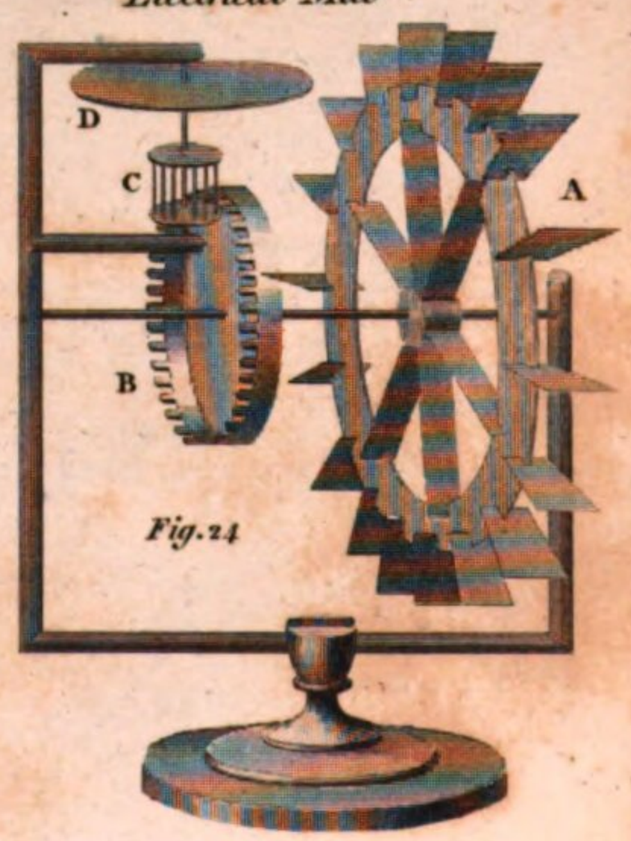


Fig. 24

Spiral Tube

Fig. 25

Electrical Jar

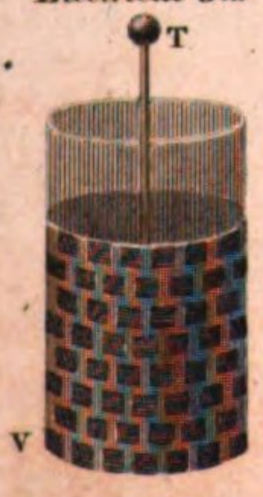


Fig. 26

Thunder House

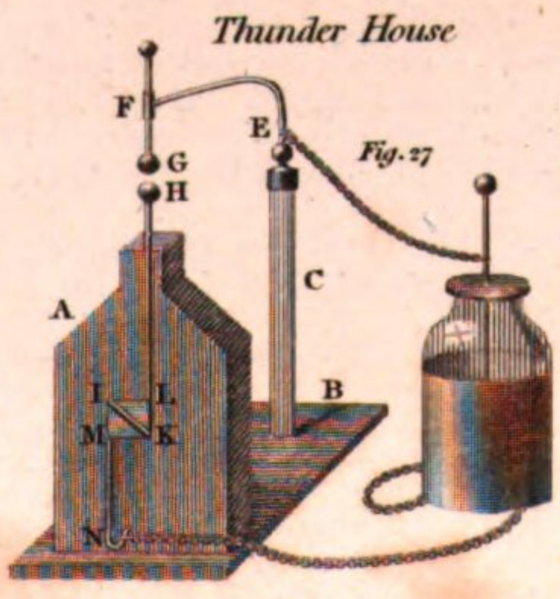


Fig. 27

Luminous Conductor

Fig. 28

Porter sculp.

plication of metallic substances to animals.

Three fishes have hitherto been discovered to have, whilst living, the singular property of giving shocks analogous to those of artificial electricity; namely, the torpedo, the gymnotus electricus, and the silurus electricus. Those animals belong to three different orders of fish; and the few particulars which they seem to have in common are the power of giving the shock; an organ in their bodies, called the electric organ, which is in all probability employed by those animals for the exertion of that power; a smooth skin without scales; and some spots here and there on the surface of their bodies.

The torpedo, which belongs to the genus of rays (raja electrica), is a flat fish, very seldom 20 inches long, weighing not above a few pounds when full-grown, and is pretty common in various parts of the sea-coast of Europe. The electric organs of this animal are two in number, and are placed on each side of the cranium and gills, reaching from that place as far as the semicircular cartilages of each great fin, and extending longitudinally from the anterior extremity of the animal to the transverse cartilage which divides the thorax from the abdomen. In those places they fill up the whole thickness of the animal from the lower to the upper surface, and are covered by the common skin of the body, under which, however, are two thin membranes or fasciæ. The length of each organ is less than one-third part of the whole length of the animal. Each organ consists of perpendicular columns, reaching from the under to the upper surface of the body, and varying in length according to the various thickness of the fish in various parts. The number of those columns is not constant, differing in different torpedos, and likewise in different ages of the animal. In a very large torpedo, one electric organ was found to consist of 1182 columns. The greatest number of those columns are either irregular hexagons, or irregular pentagons, but their figure is by no means constant. Their diameters are generally equal to one-fifth part of an inch.

The above-mentioned electric organs seem to be the only parts employed to produce the shock; the rest of the animal appearing to be merely the conductor of that shock, as parts adjacent to the electric organs; and, in fact, the animal has been found to be a conductor of artificial electricity. The two great lateral fins, which bound the electric organs laterally, are the best conductors.

If the torpedo, while standing in water, or out of the water, but not insulated, is touched with one hand, it generally communicates a trembling motion, or slight shock, to the hand; but this sensation is felt in the fingers of that hand only. If the torpedo is touched with both hands at the same time, one hand being applied to its under, and the other to its upper surface, a shock in that case will be received, which is exactly like that which is occasioned by the Leyden phial. When the hand touches the fish on its opposite surfaces, and just over the electric organs, then the shock is the strongest; but if the hands are placed upon other parts of the opposite surfaces, the shocks are somewhat weaker; and no shock at all is felt when the hands are both placed upon the electric organs of the same surface; which shews that the upper and lower surfaces of the electric organs are in opposite states of electricity, answering to the plus and minus sides of a Leyden phial. When the fish is touched by both hands on the same surface, and the hands are not placed exactly on the electric organs, a shock, though weak, is still received; but in this case the opposite power of the other surface of the animal seems to be conducted over the skin.

The shock which is given by the torpedo, when standing in air, is about four times as strong as when standing in water; and when the animal is touched on both surfaces by the same hand, the thumb being applied to one surface, and the middle finger to the opposite surface, the shock is felt much stronger than when the circuit is formed by the application of both hands. Sometimes the torpedo gives the shocks so quickly one after the other, that scarcely two seconds elapse between them; and when, instead of a strong determinate shock, it communicates only a torpor, that sensation is naturally attributed to the successive and quick discharge of a great many consecutive shocks.

This power of the torpedo is conducted by the same substances which conduct artificial electricity, and is intercepted by the same substances which are non-conductors of electricity; hence, if the animal, instead of being touched immediately by the hands, is touched by non-electrics, as wires, wet cords, &c. held in the hands of the experimenter, the shock will be communicated through them. The circuit may also be formed by several persons joining hands, and the shock will be felt by them all at the same time. If, when the animal is in water, the hands are put in the same water, a shock will also be felt, which will be stronger if one of the hands touches the fish, whilst the other is kept in the water at a distance from it. In short, the shock of this animal is conducted by the same conductors as that of the Leyden phial; thus it may pass through more than one circuit at the same time, or the circuit may be much extended, &c. but in those cases the shock is much weakened.

The shock of the torpedo cannot pass through the least interruption of continuity; thus it will not be conducted by a chain, nor will it pass through the air from one conductor to the other, when the distance is even less than the 200th part of an inch; consequently no spark was ever observed to accompany it.

No electric attraction or repulsion was ever observed to be produced by the torpedo, nor indeed by any of the electric fishes, though several experiments have been instituted expressly for that purpose.

These shocks of the torpedo seem to depend on the will of the animal; for each effort is accompanied with a depression of its eyes, by which even his attempts to give it to non-conductors may be observed. It is not known whether both electric organs must always act together, or one of them only may be occasionally put in action by the will of the animal.

Almost all these effects of the torpedo may be imitated by means of a large electrical battery weakly charged.

The gymnotus electricus has been frequently called electrical-eel, on account of its bearing some resemblance to the common eel. The gymnotus electricus is found pretty frequently in the great rivers of South America. Its usual length is about three feet, but some of them have been said to be so large as to be able to strike a man dead with their electric shock. A few of these animals, about three feet long, were brought alive to England thirty or forty years ago, and a great many experiments were made with them.

A gymnotus of three feet in length generally is between 10 and 14 inches in circumference at the thickest part of its body. The electric power of this animal being much greater than that of the torpedo, its electric organs are accordingly a great deal larger; and indeed that part of its body which contains most of the animal parts that are common to the same order of fishes, is considerably smaller than that which is subservient to the electric power, though the latter must naturally derive nourishment and action from the former. The head of the animal is large, broad, flat, smooth, and impressed with various small holes. The mouth is rather large, but the jaws have no teeth, so that the animal lives by suction, or by swallowing the food entire. The eyes are small, flattish, and of a bluish colour, placed a little way behind the nostrils. The body is large, thick, and roundish, for a considerable distance from the head, and then diminishes gradually. The whole body, from a few inches below the head, is distinguished into four longitudinal parts, clearly divided from each other by lines. The carina begins a few inches below the head, and widening as it proceeds, reaches as far as the tail, where it is thinnest. It has two pectoral fins; and the anus is situated on the under part, more forward than those fins, and of course not far distant from the rostrum.

This animal has two pairs of electric organs, one pair being larger than the other, and occupying most of the longitudinal parts of the body. They are divided from each other by peculiar membranes.

The nerves which go to the electric organs of the gymnotus, as well as of the torpedo, are much larger than those which supply any other part of the body. The electric organs of the gymnotus are supplied with nerves from the spinal marrow, and they come out in pairs between the vertebræ of the spine.

The gymnotus possesses all the electric properties of the torpedo, but in a superior degree. His shock is conducted by conductors of electricity; it is communicated through water, &c. The strongest shock is received when, the animal standing out of the water, you apply one hand towards the tail, and the other towards the head of the animal. In this manner shocks may be received from one of those animals, which are felt not only in the arms, but very forcibly even in the chest. If the animal is touched with one hand only, then a kind of tremor is felt in that single hand; which, though stronger, is however perfectly analogous to that which is given by the torpedo when touched in the like manner.

This power of the gymnotus is likewise depending on the will of the animal, so that sometimes he gives strong shocks, and at other times very weak ones. He gives the

strongest shocks when provoked by being frequently and roughly touched.

When small fishes are put into the water where the gymnotus is, they are commonly stunned, and are either effectually or apparently killed.

The strongest shocks of the gymnoti which were exhibited in London, would pass through a very short interruption of continuity in the circuit. They could be conveyed by a short chain when stretched, so as to bring the links into a more perfect contact. When the interruption was formed by an incision made with a pen-knife on a slip of tin-foil that was pasted upon glass, the shock in passing through that interruption, shewed a small but vivid spark, plainly visible in a dark room.

This animal shewed a peculiar property, namely, that of knowing when he could, and when he could not, give the shock; for if non-conductors or interrupted circuits were placed in the water, he would not approach them; but as soon as the circuit was completed, he would approach the extremities of that circuit, and immediately give the shock.

The third fish which is known to have the power of giving the shock, is found in the rivers of Africa; but we have a very imperfect account of its properties.

This animal belongs to the genus which the naturalists call siluris; hence its name is siluris electricus. The length of some of these fishes has been found to exceed 20 inches.

The body of the siluris electricus is oblong, smooth, and without scales; being rather large, and flattened towards its anterior part. The eyes are of a middle size, and are covered by the skin, which envelopes the whole head. Each jaw is armed with a great number of small teeth. About the mouth it has six filamentous appendices, viz. four from the under lip, and two from the upper; the two external ones, or farthermost from the mouth on the upper lip, are the longest. The colour of the body is greyish, and towards the tail it has some blackish spots.

The electric organ seems to be towards the tail, where the skin is thicker than on the rest of the body; and a whitish fibrous substance, which is probably the electric organ, has been distinguished under it.

It is said that the siluris electricus has the property of giving a shock or benumbing sensation, like the torpedo, and that this shock is communicated through substances that are conductors of electricity. No other particular seems to be known concerning it.

Nature seems to have given these fishes the singular power of giving the shock for the purpose of securing their prey, by which they must subsist; and perhaps likewise for the purpose of repelling larger animals, which might otherwise annoy them. The power with which they are endued seems more to correspond with Galvanism (which is doubtless a species of electricity) than with common electricity. See GALVANISM.

The antients considered the shocks of the torpedo as capable of curing various disorders; and a modern philosopher will hardly hesitate to credit their assertions, since electricity has been found to be an useful remedy in several cases.

A fourth fish, said to give shocks like the above-mentioned, was found on the coast of Johanna, one of the Comoro islands, in lat. 12° 13′ south, by lieutenant now col. William Paterson, and an imperfect account of it is given in the 76th volume of the Philosophical Transactions.

"The fish is described to be seven inches long, two and a half broad, has a long projecting mouth, and seems of the genus tetrodon. The back of the fish is a dark-brown colour, the belly part of a sea-green, the sides yellow, and the fins and tail of a sandy-green. The body is interspersed with red, green, and white spots, the white ones particularly bright; the eyes large, the iris red, its outer edge tinged with yellow."

Whilst this fish is living, strong shocks, like electrical shocks, are felt by a person who attempts to hold it between his hands. Three persons only are mentioned in the account as having experienced this property of one of those fishes; but the want of opportunity prevented the trial of farther experiments.

ELECTUARY, in pharmacy, a form in which both officinal and extemporaneous medicines are frequently made. See PHARMACY.

ELEGIAC, in antient poetry, any thing belonging to elegy.

Elegiac verses are alternately hexameter and pentameter, as in the following verses of Ovid:

Flebilis indignos, elegeia, solve capillos:
Ah! nimis ex vero nunc tibi nomen erit.

Sometimes, though very rarely, the pentameter preceded the hexameter, as in the following verses of Athenæus:

Ευδαιμων Χαριτων και, Μελανιππ☉ εφυ
Θειας αγισηρες εφεμεριοις φιλοτητ☉.

Who was the inventor of elegiac poetry, is not known. Horace professes himself quite ignorant of it. The principal writers of elegia everse, among the Latins, were Propertius, Ovid, and Tibullus, the latter of whom Quinctilian esteems the best elegiac poet, but Pliny the younger gives the preference to the first: the chief writers of elegy among the Greeks were Callimachus, Parthenius, and Euphorion.

ELEGIA, a genus of the dioecia triandria class and order. There is one species, a native of the Cape, which has the habit of a rush.

ELEGIT, in law, a writ of execution, which lies for a person who has recovered debt or damages; or upon a recognizance in any court, against a defendant that is not able to satisfy the same in his goods. It is directed to the sheriff, commanding him to make delivery of a moiety of the party's lands, and all his goods, beasts of the plough excepted; this is done by a jury, summoned to enquire what land the defendant had at the time of the judgment obtained; and the creditor, by virtue thereof, shall hold the said moiety of land delivered to him, until his whole debt and damages are paid and satisfied: and during that time he is tenant by elegit. This writ ought to be sued out within a year and a day after the judgment. All other writs of execution may be good, though not returned, except an elegit; but that must be returned when executed, because an execution is taken upon it, and that the court may judge of the sufficiency of it.

ELEGY, a mournful and plaintive kind of poem. See POETRY.

ELEMENT, in physiology, a term used by philosophers to denote the original component parts of bodies, or those into which they are ultimately resolvable.

It seems to have been an opinion established among philosophers in the remotest ages, that there are only four simple bodies; namely, fire, air, water, and earth. To these they gave the name of elements, because they believed that all substances are composed of these four. This opinion, variously modified indeed, was maintained by all the ancient philosophers. We now know that all these supposed elements are compounds: fire is composed of caloric and light; air of caloric, oxygen, and azotic gases; water of oxygen and hydrogen; and the earth includes nine different substances.

The doctrine of the four elements seems to have continued undisputed till the time of the alchemists. These men having made themselves much better acquainted with the analysis of bodies than the antient philosophers had been, soon perceived that the common doctrine was inadequate to explain all the appearances that were familiar to them. They substituted a theory of their own in its place. According to them, there are three elements, of which all bodies are composed; namely, salt, sulphur, and mercury, which they distinguish by the appellation of the tria prima. These principles were adopted by succeeding writers, particularly by Paracelsus, who added two more to their number; namely, phlegm and caput mortuum.

It is not easy to say what the alchemists meant by salt, sulphur, and mercury; probably they had affixed no precise meaning to the words. Every thing which is fixed in the fire they seem to have called salt, every inflammable substance they called sulphur, and every substance which flies off without burning was mercury. Accordingly they tell us, that all bodies may by fire be decomposed into these three principles; the salt remains behind fixed, the sulphur takes fire, and the mercury flies off in the form of smoke. The phlegm and caput mortuum of Paracelsus were the water and earth of the ancient philosophers.

Mr. Boyle attacked this hypothesis in his Sceptical Chemist, and in several of his other publications; proving that the chemists comprehended under each of the terms salt, sulphur, mercury, phlegm, and earth, substances of very different properties; that there is no proof that all bodies are composed of these principles; and that these principles themselves are not elements but compounds. The refutation of Mr. Boyle was so complete, that the hypothesis of the tria prima seems to have been almost immediately abandoned by all parties.

Meanwhile a very different hypothesis was proposed by Beccher in his Physica Subterranea; an hypothesis to which we are indebted for the present state of the science, because he first pointed out chemical analysis as the true method of ascertaining the elements of bodies. According to him, all terrestrial bodies are composed of water, air, and three earths; namely, the fusible, the inflammable or sulphureous, and the mercurial. The three earths, when they are com-

bined in nearly equal proportions, compose the metals; when the proportion of mercurial earth is very small, they compose stones; when the fusible predominates, the resulting compounds are the precious stones; when the sulphureous predominates, and the fusible is deficient, the compounds are the calorific earths: fusible earth and water compose a universal acid, very much resembling sulphuric acid, from which all other acids derive their acidity; water, fusible earth, and mercurial earth, constitute common salt; sulphureous earth, and the universal acid, form sulphur.

Stahl modified the theory of Beccher considerably. He seems to have admitted the universal acid as an element; the mercurial earth he at last discarded altogether; and to the sulphureous earth he sometimes gave the name of phlogiston, sometimes of ether. Earths he considered as of different kinds, but containing all a certain element called earth. So that, according to him, there are five elements; air, water, phlogiston, earth, and the universal acid. He speaks too of heat and light, but it is not clear what his opinion was respecting them.

Stahl's theory was gradually modified by succeeding chemists. The universal acid was tacitly discarded, and the different known acids were considered as distinct undecomposed or simple substances: the different earths were distinguished from each other, and all the metallic calces were considered as distinct substances. For these changes chemistry was chiefly indebted to Bergman. While the French and German chemists were occupied with theories about the universal acid, that illustrious philosopher, and his immortal friend and fellow-labourer Scheele, loudly proclaimed the necessity of considering every undecomposed body as simple till it has been decomposed, and of distinguishing all those substances from each other which possess distinct properties. These cautions, and the consequent arrangement of chemical bodies into distinct classes by Bergman, soon attracted attention, and were at last tacitly acceded to.

Thus the elements of Stahl were in fact banished from the science of chemistry, and in place of them were substituted a great number of bodies which were considered as simple, because they had not been analysed. These were phlogiston, acids, alkalies, earths, metallic calces, water, and oxygen. The rules established by Bergman and Scheele are still followed: but subsequent discoveries have shewn that most of the bodies which they considered as simple are compounds; while several of their compounds are now placed among simple bodies, because the belief in the existence of phlogiston, which they considered as a component part of these bodies, is now discarded.

As the term simple substance in chemistry means nothing more than a body whose component parts are unknown, it cannot be doubted that, as the science advances towards perfection, many of those bodies which we consider at present as elementary will be decomposed, and most probably a new set of elementary bodies will come into view, of which we are at present ignorant. These may be decomposed in their turn, and new simple bodies discovered; till at last, when the science reaches the highest point of perfection, those really simple and elementary bodies will come into view of which all substances are ultimately composed. When this happens, (if it is not above the reach of the human intellect) the number of simple substances will probably be much smaller than at present. Indeed it has been the opinion of many distinguished philosophers in all ages, that there is only one kind of matter; and that the difference which we perceive between bodies depends upon varieties in the figure, size, and density of the primary atoms when grouped together. This opinion was adopted by Newton, and Boscovich has built upon it an exceedingly ingenious and instructive theory.

We must observe, however, that this opinion is mere hypothesis, wholly unsupported by fact and experiment; and indeed all experiment may be said hitherto to be directly against it. In the present state of science, the following may be regarded as simple or elementary substances, and we have little doubt that many of them will ultimately prove such.

Dr. Thomson makes out the number of simple substances at present known to be about 33, and these he divides into two classes. The bodies belonging to the first class can be confined in proper vessels, and exhibited in a separate state; these he calls confinable bodies. Those which belong to the second class are of too subtile a nature to be confined by any vessels that we possess: they cannot therefore be exhibited in a separate state, and their existence is inferred merely from certain phenomena, which the first class of bodies and their compounds exhibit in particular circumstances; these he denominates unconfinable bodies. It is evident that a person must be acquainted with the properties of the first set of bodies before he can investigate the second.

Table of simple substances.

I. Confinable bodies.

1.	Oxygen
2. Simple combustibles	Sulphur
	Phosphorus
	Carbon or Diamond
	Hydrogen
3. Sim. incombustibles	Azote or Nitrogen
	Muriatic acid
4. Metals	Gold
	Platinum
	Silver
	Mercury
	Copper
	Iron
	Tin
	Lead
	Nickel
	Zinc
	Bismuth
	Antimony
	Tellurium
	Arsenic
	Cobalt
	Manganese
	Tungsten
	Molybdenum
	Uranium
	Titanium
	Chromium
	Columbium
	Tantalum
5. Alkalies	Potass (or vegetable and
6. Earths	Soda (mineral alkalies.

The vegetable and mineral alkalies, and some of the earths, are supposed to be compounds, though they have not yet been analyzed: these of course, belong to the 1st classs, viz. confinable bodies.

- Barytes
- Strontian
- Lime
- Magnesia
- Alumina
- Yttria
- Glucina
- Zirconia
- Silica.

II. Unconfinable bodies.

- Light
- Caloric
- Electricity
- Magnetism.

ELENCHUS, in logic, a sophism, or fallacious argument, which deceives the hearer under the appearance of truth.

ELEPHAS, the ELEPHANT, a genus of the mammalia class, of the order bruta. The generic character is, cutting-teeth none in either jaw; tusks in the upper jaw; proboscis very long, prehensile; body nearly naked.

1. The elephas maximus, the great elephant. The stupendous size, strength, and sagacity of the elephant, have, in all ages, rendered it the admiration of mankind. Though possessed of power superior to every other quadruped, it is guiltless of unprovoked violence, and wanders about the woods of Asia and Africa in a state of majestic mildness. Elephants are naturally gregarious. Large troops assemble together, and live in a kind of society. They feed only on vegetables. The elephant is generally of a deep ash-coloured brown, or nearly blackish; but in some parts of India it is said to be found, though very rarely, of a white colour. In the young animals the tusks are not visible: in the more advanced state of growth they are extremely conspicuous: and in the full-grown animal they advance several feet from the mouths of their sockets: it is but rarely that the tusks are seen in the females; and when they appear, they are but small, and their direction is rather downwards than upwards: this is also the case in some specimens of the male elephant, so that there appears to be some variation in this respect in different individuals. Tusks have sometimes been seen upwards of ten feet long; particularly from the Mosambique and Cochinchina.

The teeth which are imported into Europe are generally from Africa, where they are frequently found in the woods. Instances have sometimes occurred, in which, on sawing a tooth, a brass bullet has been found completely imbedded in the central part of the tooth; the ivory having gradually grown over it, and inclosed it.

The elephant is undoubtedly the largest of all terrestrial animals, arriving at the height of twelve feet, though the more general height seems to be from nine to ten feet. Elephants are commonly found in the midst of shady woods, being equally averse to extreme heat as to cold: they delight in cool spots, near rivers, and frequently bathe themselves in the water, and even roll in the mud. They are also capable of swimming with great ease. Their general food consists of

the tender branches of various trees, as well as of grains and fruits. It is for this reason that their incursions are so much dreaded in plantations of various kinds, where they are said occasionally to commit the most violent depredations; at the same time, injuring the crops by trampling the ground with their vast feet. The trunk of the elephant may justly be considered as one of the miracles of nature; being at once the organ of respiration, and the instrument by which the animal supplies itself with food; conveying whatever it eats into the mouth by its assistance. By this instrument also it drinks; first sucking up the water by the trunk, and then pouring it into the mouth. This wonderful organ is composed of a vast number of flexible rings; and consists of a double tube, with a somewhat flattened circular tip, furnished with a projecting point, or fleshy moveable hook, of extreme sensibility, and with which it can pick up the smallest object at pleasure. The trunk, being flexible in all directions, performs the office of a hand and arm. On its under surface it is somewhat flattened, and is circularly formed on the upper. At the end of the trunk are situated the nostrils. The teats of the female elephant are two in number, and are situated at a small distance behind the fore-legs. The eyes are extremely small; the ears very large, somewhat irregularly waved on the edges, and pendulous. In each jaw are four large and flat grinding teeth, with the upper surfaces flat, and scored or striated with numerous transverse furrows. In the upper jaw are the two tusks before described. The form of the whole animal is extremely awkward; the head very large, the body very thick, the back greatly arched; the legs extremely thick, very short; and the feet slightly divided into, or rather edged with, five rounded hoofs; the tail is of a moderate length, and is terminated by a few scattered hairs, of great thickness, and of a black colour: the skin has a few thinly scattered hairs or bristles dispersed over it, and which are somewhat more numerous about the head.

The tales related of the sagacity of the elephant are, in all probability, somewhat exaggerated, and must consequently be received with a degree of limitation: but there is no reason to doubt that they are possessed of a greater degree of intelligence than most other quadrupeds (the dog excepted); and that, when in a state of domestication, they may be taught to perform many operations, requiring not only strength, but skill in their execution. It appears, from the most authentic information, that they are highly attached to those who have them under their care: that they are grateful for attentions shewn them, and mindful of any injury received; which they generally find some means of retaliating. Some elegant anecdotes of this kind are related by Pliny; and the laborious Aldrovandus has collected many others. The celebrated story of the taylor of Delhi is a remarkable example of the elephant's sagacity. In that city an elephant, passing along the streets, put his trunk into a taylor's shop, where several people were at work: one of them pricked the end of the trunk with his needle: the elephant passed on; but, in the first dirty puddle, filled his trunk with the water, and returning, squirted every drop among the people who had offended him, and spoiled the rich garments they were at work upon.

It is said that elephants have been taught to lade vessels with goods, which they have stowed in proper order, and with much address.

The Indian elephants, but more especially those of the island of Ceylon, excel the African elephants in size and strength. Those of India are said to carry with ease three or four thousand-weight. In a state of nature they use the tusks for tearing up trees, and the trunk for breaking the branches. It has been affirmed that they run as swift as a horse can gallop; but Mr. Pennant assures us, that what has been said on this subject is a mistake; and that a nimble Indian can easily outstrip them.

The contrivances for taking elephants are various. The Ceylonese sometimes surround the woods in bands, and drive with lighted torches, and all manner of noises, the elephants which inhabit them, till they are at length entrapped into a particular spot surrounded with palisades, so as to prevent all escape. At other times a kind of decoy, or female elephant, is sent out in order to induce some of the males to pursue her, who are by this means secured. When a wild elephant is taken, it still remains to reduce it to a quiet state; and to tame it, in order to be made useful: this is effected by throwing ropes round the legs and body, which are well secured; and two tame elephants, properly instructed, are placed on each side. The captive animal finds himself gradually so fatigued by his ineffectual struggles, and so much soothed by the caresses occasionally given by the trunks of the tame elephants, by the food from time to time presented to him, and the water with which he is refreshed by pouring it over him, that in the space of some days he becomes completely tame, and is placed with the rest of the domesticated troop. Sometimes, in order to subdue them the more effectually, they are deprived of sleep for a considerable time.

Great care is taken by the grandees of India in the management and decoration of their elephants; which, after their daily feeding, bathing, oiling, and rubbing, are often painted about the head and ears with various colours, and their tusks are surrounded with rings of gold or silver: and when employed in processions, &c. they are clothed in the most sumptuous trappings.

By the ancient Indians they were much used in war; and we are told that Porus, the Indian monarch, opposed the passage of Alexander over the Hydaspes with eighty-five elephants. Buffon also imagines that some of the elephants which were taken by Alexander, and sent into Greece, were employed by Pyrrhus against the Romans. The Romans received their elephants from Africa, and that in great numbers; since it appears that Pompey entertained the people with a show of eighteen in the space of five days, which were all destroyed in conflicts with armed men. Fifty lions were also exhibited in the same space. The crying and distress of the wounded elephants are said to have excited much commiseration among the Roman people. It is highly remarkable, if true, that the young elephants do not attach themselves to their dams in particular, but suck indiscriminately the females of the whole herd. Mr. Bruce, however, in his Travels, gives a particular description of the more than common attachment of a young elephant to its dam, which it endeavoured to defend, when wounded, and with much fierceness assaulted the invaders. The young elephants do not suck by the trunk, but by the mouth.

The elephant brings only one young at a time; very rarely two: the young are about three feet high when they are first born, and continue growing till they are sixteen or twenty years old; they are said to live a hundred, or a hundred and twenty years.

In the Philosophical Transactions for the year 1799, we find some curious particulars relative to the natural history of the elephant, by Mr. Corse, whose residence in India afforded him opportunities of investigating the subject with exactness.

From these observations it appears that something must be subtracted from that elevated character with which this animal has been so frequently honoured; and that neither its docility nor its memory can be allowed a very high rank, when compared with those of some other animals; and that the scrupulous delicacy, which, as it was pretended, forbade all public demonstrations of its passions, is a mere fable. A female elephant has also been known to forget her young one, after having been separated from it for the short space of only two days, and to repel its advances. An elephant, also, which had escaped from its confinement, has again suffered itself to be trepanned, and reconducted to its state of captivity.

Both male and female elephants, Mr. Corse informs us, are divided by the natives of Bengal into two casts, viz. the koomareah, and the merghee. The first consists of the large or full-bodied kind; the second of the more slender, with longer legs and thinner trunk in proportion; it is also a taller animal, but not so strong as the former. A large trunk is always considered as a great beauty in an elephant, so that the koomareah is preferred not only on this account, but for his superior strength in carrying burthens, &c. Many indistinct varieties are again produced from the intermixture of these two breeds. The torrid zone seems to be the natural clime of the elephant, and the most favourable for the production of the largest and hardiest race; and when this animal migrates beyond the tropics, the species degenerates. On the coast of Malabar elephants are taken as far north as the territories of Coorgah Rajah; but these, according to Mr. Corse, are much inferior to the Ceylonese elephant.

The tusks in some female elephants are so small as not to appear beyond the lip; whilst in others they are large and long, as in one variety of the male, called mooknah. The grinders are so much alike in both sexes, that one description may serve for both. The largest tusks, and from which the best ivory is supplied, are taken from that kind of male elephant, called daumtelah, from this circumstance, in opposition to the mooknah, whose tusks are not larger than those of some females. An elephant is said to be perfect when his ears are large and rounded, not ragged or indented at the margin: his eyes of a dark hazel-colour, free from specks: the roof of his mouth and his tongue without dark or blackish spots of any considerable size: his trunk large: his tail long, with a tuft of hair

reaching nearly to the ground. There must be five nails on each of his fore-feet, and four on each of the hind ones: his head well set on, and carried rather high: the arch or curve of his back rising gradually from the shoulder to the middle, and thence descending to the insertion of the tail; and all his joints firm and strong. In one variety of the elephant the tusks point downwards, projecting only a little way beyond the trunk. The tusks in elephants are fixed very deep in the upper jaw; and the root, or upper part, which is hollow, and filled with a core, goes as high as the insertion of the trunk, round the margin of the nasal opening of the throat; which opening is just below the protuberance of the forehead. Through this opening the elephant breathes, and by its means he sucks up water into his trunk; between it and the roots of the tusks there is only a thin bony plate. The first or milk-tusks of an elephant never grow to any considerable size, but are shed between the first and second year, when not two inches in length. The time at which the tusks cut the gum varies considerably; sometimes a young elephant has his tusks at five months old, and sometimes not till seven. Even in a fetus which has arrived at its full time, these deciduous tusks are formed. A young elephant shed one of his milk-tusks the 6th of November, 1790; when about thirteen weeks old; and the other on the 7th of December, when above four months old. Two months afterwards the permanent ones cut the gums, and on the 19th of April, 1791, they were an inch long. Another young elephant did not shed his milk-tusks till he was sixteen months old, which proves that the time of this process varies considerably. The permanent tusks of the female are very small, compared with those of the male: and do not take their rise so deep in the jaw. The largest elephant-tusks Mr. Corse ever saw in Bengal, did not exceed the weight of seventy-two pounds avoirdupois: at Tiperah they seldom exceed fifty-two pounds each. Both these weights are very inferior to that of the tusks brought from other parts to the India-house, where some have weighed 150 pounds each. These, Mr. Corse suspects, were from Pegu. The African elephant is said to be smaller than the Asiatic: yet the ivory-dealers in London affirm that the largest tusks come from Africa, and are of a better texture, and less liable to turn yellow, than the Indian ones. The increase of the tusks arises from circular layers of ivory, applied internally, from the core on which they are formed; similar to what happens in the horns of some animals. See plate Nat. Hist. fig. 176.

2. The sukotyro. That we may not seem to neglect so remarkable an animal, though hitherto so very imperfectly known, we shall here introduce the sukotyro. This, according to Niewhoff, its only describer, and who has figured it in his Travels to the East Indies, is a quadruped of a very singular shape. Its size is that of a large ox; the snout like that of a hog; the ears round and rough; and the tail thick and bushy. The eyes are placed upright in the head, quite differently from those of other quadrupeds. On each side the head, next to the eyes, stand the horns, or rather teeth, not quite so thick as those of an elephant. This animal feeds upon herbage, and is but seldom taken. It is a native of Java, and is called by the Chinese sukotyro. This is all the description given by Niewhoff. The figure is repeated in Churchill's Collection of Voyages and Travels, vol. ii. p. 360. Niewhoff was a Dutch traveller, who visited the East Indies about the middle of the 16th century, viz. about the year 1563, and continued his peregrinations for several years. It must be confessed, that some of the figures introduced into his works are not remarkable for their accuracy.

ELEPHANT, *knights of the*, an order of knighthood in Denmark, conferred upon none but persons of the first quality and merit. It is also called the order of St. Mary. Its institution is said to have been owing to a gentleman among the Danish croisees having killed an elephant, in an expedition against the Saracens, in 1184; in memory of which king Canutus instituted this order, the badge of which is a towered elephant, with an image of the Holy Virgin encircled with rays, and hung on a watered sky-coloured ribbon, like the George in England.

ELEPHANTIASIS, called also the lepra of the Arabians, in medicine, a chronical disease, one of the two species of leprosy, which affects the whole body, where even the bones as well as the skin are covered with spots and tumours, which being red, at last turn black. See MEDICINE.

ELEPHANTINE, in Roman antiquity, an appellation given to the books in which were registered the transactions of the senate and magistrates of Rome, of the emperors or generals of armies, and even of the provincial magistrates; the births and classes of the people, and other things relating to the census. They are supposed to have been so called as being made of ivory, though some will have them to have been written on the intestines of elephants.

ELEPHANTOPUS, BASTARD-SCABIOUS, in botany, a genus of the syngenesia polygamia segregata class of plants, the compound flower of which is tubulose, consisting of four or five hermaphrodite and ligulated corollulæ, with a narrow limb, divided into five nearly equal segments: the stamina are five very short filaments: the seeds are solitary, and contained in the cup, being of a compressed figure, and crowned with bristly hairs. There are four species, herbaceous plants of the East and West Indies.

ELEVATION, *angle of*, in gunnery, that comprehended between the horizon and the line of direction of a cannon or mortar; or it is that which the chase of a piece, or the axis of its hollow cylinder, makes with the plane of the horizon.

ELEVATION, in architecture, the same with an orthographic or upright draught of a building.

ELEVATION *of the host*, in the church of Rome, that part of the mass where the priest raises the host above his head for the people to adore.

ELEVATOR, the name of several muscles. See ANATOMY.

ELEVATORY, *elevatorium*, in surgery, an instrument for raising depressed or fractured parts of the scull, to be applied after the integuments and periosteum are removed. See SURGERY.

ELEUSINIA, in Grecian antiquity, a festival kept in honour of Ceres, every fourth by some states, but by others every fifth year. The Athenians celebrated it at Eleusis, a town of Attica, whence the name. It was celebrated with much ceremony, and persons of both sexes were initiated in it: it being deemed impious to neglect doing so. The mysteries were of two sorts, the lesser and the greater; of which the former were sacred to Proserpine, Ceres's daughter, and the latter to Ceres herself.

ELEUTHERIA, another festival celebrated at Platæa, by delegates from almost all the cities of Greece, in honour of Jupiter Eleutherius, or the assertor of liberty. It was instituted in memory of the victory obtained by the Grecians, in the territories of Platæa, over Mardonius, the Persian general left by Xerxes with a mighty army to subdue Greece.

ELIGIBILITY, in the Romish canon law, a bull granted by the pope to certain persons, to qualify them to be chosen to an office, or dignity, whereof they were before incapable by want of age, birth, or the like.

ELISION, in grammar, the cutting off or suppressing a vowel at the end of a word for the sake of sound or measure, the next word beginning with a vowel. Elisions are pretty frequently met with in English poetry, but more frequently in Latin, French, &c. They chiefly consist in suppressions of the *a*, *e*, and *i*, though elision suppresses any of the other vowels: in the following example from Virgil there are three elisions:

Phillida amo ante alias.

ELIXIR, in medicine, a compound tincture extracted from many efficacious ingredients. Hence the difference between a tincture and an elixir seems to be this, that a tincture is drawn from one ingredient, sometimes with an addition of another to open it, and to dispose it to yield to the menstruum; whereas an elixir is a tincture extracted from several ingredients at the same time. See PHARMACY.

ELL, a measure of length, different in different countries; but the English ell is chiefly used in this country, which is equal to five quarters, or to a yard and a quarter. In Scotland the ell contains 37 $\frac{2}{10}$ English inches.

ELLIPSIS, in geometry, a curve line returning into itself, and produced from the section of a cone by a plane cutting both its sides, but not parallel to the base. See CONIC SECTIONS, and MENSURATION.

ELLIPSIS, in grammar, a figure in syntax, in which one or more words are not expressed; and from this deficiency it has got the name ellipsis. To this figure, besides the ellipsis properly so called, belong apposition, synecdoche, asyndeton, zeugma, syllepsis, and prolepsis. The ellipsis is when the deficient word or words must be supplied from elsewhere; as Hectoris Andromache, where uxor is understood; that is, Andromache Hector's wife.

ELLIPSIS, in rhetoric, a figure nearly allied to preterition, when the orator, through transport of passion, passes over many things, which, had he been cool, ought to have been mentioned.

ELLIPTIC, or ELLIPTICAL, something belonging to an ellipsis. Thus we meet with elliptical compasses, elliptic conoid, elliptic space, elliptic stairs, &c. The elliptic space is the area contained within the curve of the ellipsis, which is to that of a circle described on the transverse axis, as the conjugate diame-

ter is to the transverse axis; or it is a mean proportional between two circles, described on the conjugate and transverse axes.

ELLIPTOIDES, in geometry, a name used by some to denote infinite ellipses, defined by the equation $ay^{m+n}=bx^m(a-x)^n$. Of these there are several sorts: thus, if $cy^3=bx^2(a-x)$ it is a cubical elliptoid: and if $ay^4=bx^2(a-x)^2$, it denotes a biquadratic elliptoid, which is an ellipsis of the third order in respect of the Apollonian ellipsis.

ELLISIA, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 28th order, luridæ. The corolla is monopetalous and funnel-shaped; the berry carnous and bilocular; there are two seeds muricated or set with small raised points, the one higher than the other. There is one species, an annual plant of Virginia.

ELOGY, or EULOGY, *elogium*, a praise or panegyric bestowed on any person or thing, in consideration of its merit. The beauty of elogy consists in an expressive brevity. Elogiums should not have so much as one epithet properly so called, nor two words synonymous. They should strictly adhere to truth; for extravagant and improbable elogies rather lessen the character of the person or thing they would extol. See RHETORIC.

ELOINED, in law, signifies restrained or hindered from doing something; thus it is said, that if those within age are eloined, so that they cannot sue personally, their next friends shall sue for them.

ELONGATION, in astronomy, the digression or recess of a planet from the sun, with respect to an eye placed on our earth. The term is chiefly used in speaking of Venus and Mercury, the arch of a great circle intercepted between either of these planets and the sun, being called the elongation of that planet from the sun. But here it is to be observed, that it is only a circle which has the sun for its centre; that the greatest elongation is in a line touching the planet's orbit. For in an elliptic orbit it may be, that the elongation from the sun may grow still greater, even after it has left the place where the line joining the earth and planet touches its orbit. For after that, the true distance of the planet from the sun may increase, whilst the distance of the sun and planet from the earth does not increase, but rather decrease. But because the orbits of the planets are nearly circular, such small differences may be neglected in astronomy. The greatest elongation of Venus is found by observation to be about forty-eight degrees, and the greatest elongation of Mercury about twenty-eight degrees, upon which account this planet is rarely seen with the naked eye. See ASTRONOMY.

ELONGATION is also used for the difference in motion between the swiftest and the slowest of two planets, or the quantity of space the one has passed beyond the other.

ELONGATION, *angle of*, is an angle contained under lines drawn from the centres of the sun and planet to the centre of the earth.

ELONGATION, in surgery, is an imperfect luxation, occasioned by the stretching or lengthening of the ligaments of any joint. See SURGERY.

ELOPEMENT, is when a married woman of her own accord departs from her husband, and dwells with an adulterer; for which without voluntary reconciliation to the husband she shall lose her dower by the statute of Westminster ii. c. 34. If a wife willingly leaves her husband, and goes away and continues with her avouterer, she shall be barred for ever of action to demand her dower that she ought to have of her husband's lands, if she is convicted thereof; except that her husband willingly and without coercion of the church, reconciles her, and suffers her to dwell with him; in which case, she shall be restored to her action. 13 Ed. I. st. i. c. 34. See ADULTERY.

ELOPS, a genus of fishes of the order of abdominales, of which there is but a single species, viz. the saurus, or scar-fish, which inhabits the coast of Carolina. The generic character is, tail armed above and beneath; body long, and differing from the salmon in wanting the fleshy back-fin. Head large, smooth, shining, compressed, and flattened; eyes half-covered with the skin of the head; body slender, covered with large angular scales; tail deeply cleft, with a bony scale or spine above and beneath before it.

ELYMUS, a genus of the digynia order, in the triandria class of plants; and in the natural method ranking under the fourth order, *gramina*. The calyx is lateral, bivalved, aggregate, and multiflorous. There are eleven species, known in general by the name of lyme grass; one or other of which may be found in most parts of the world.

ELYSIUM, or ELYSIAN FIELDS, in heathen mythology, certain plains abounding with woods, fountains, verdure, and every delightful object; supposed to be the habitation of heroes and good men after death. According to some, the fable of Elysium is of Phœnician extraction, or rather founded upon the account of Paradise delivered in the scriptures.

EMANCIPATION, in the Roman law, the setting free a son from the subjection of his father; so that whatever moveables he acquires, belong in propriety to him, and not to his father, as before emancipation. Emancipation puts the son in capacity of managing his own affairs, and of marrying without his father's consent, though a minor. Emancipation differs from manumission, as the latter was the act of a master in favour of a slave, whereas the former was that of a father in favour of his son. There were two kinds of emancipation: the one tacit, which was by the son's being promoted to some dignity, by his coming of age, or by his marrying, in all which cases he became his own master of course; the other express, where the father declared before a judge, that he emancipated his son. In performing this, the father was first to sell his son imaginarily to another, whom they called pater fiduciarius, father in trust, of whom being bought back again by the natural father, he manumitted him before the judge, by a verbal declaration.

EMBALMING, is the opening of a dead body, taking out the intestines, and filling the place with odoriferous and desiccative drugs and spices, to prevent its putrifying. The Egyptians excelled all other nations in the art of preserving bodies from corruption; for some that they have embalmed upwards of 2000 years ago, remain whole to this day, and are often brought into other countries as great curiosities. Their manner of embalming was thus: They scooped the brains with an iron scoop out at the nostrils, and threw in medicaments to fill up the vacuum: they also took out the entrails, and having filled the body with myrrh, cassia, and other spices, except frankincense, proper to dry up the humours, they pickled it in nitre, where it lay soaking for 70 days. The body was then wrapped up in bandages of fine linen and gums, to make it stick like glue, and so was delivered to the kindred of the deceased, entire in all its features, the very hairs of the eye-lids being preserved. They used to keep the bodies of their ancestors, thus embalmed, in small houses, magnificently adorned, and took great pleasure in beholding them, without any change in their size, features, or complexion. The Egyptians also embalmed birds, &c. The prices for embalming were different: the highest was a talent, the next 20 minæ, and so decreasing to a very small matter; but those who had not wherewithal to answer this expence, contented themselves with infusing, by means of a syringe, through the fundament, a certain liquor extracted from the cedar, and leaving it there, wrapped up the body in salt of nitre; the oil thus preyed upon the intestines, so that when they took it out, the intestines came away with it, dried, and not in the least putrified; the body being inclosed in nitre, grew dry, and nothing remained besides the skin glued upon the bones.

The method of embalming used by the modern Egyptians, according to Maillet, is to wash the body several times with rose-water, which, he elsewhere observes, is more fragrant in that country than with us; they afterwards perfume it with incense, aloes, and a quantity of other odours, of which they are by no means sparing; and then they bury the body in a winding-sheet, made partly of silk and partly of cotton, and soaked, as is supposed, with some sweet-scented water or liquid perfume, though Maillet uses only the term moistened; this they cover with another cloth of unmixed cotton, to which they add one of the richest suits of clothes of the deceased. The expence, he says, on these occasions, is very great, though nothing like what the genuine embalming cost in former times.

The principle of embalming depends either on the absorption of the fluids of the body, or the impregnation of them with some substance which will preserve the solids from putrefaction. Hence, absorbing-powders have been used, and also nitre, which powerfully acts on the flesh, though, like all other saline matter, it tends to prevent the body from drying. Dr. Hunter recommended the injecting of oil of turpentine impregnated with camphor and other aromatic gums into the blood-vessels, which is a very rational method.

EMBARGO, in commerce, an arrest on ships, or merchandize, by public authority; or a prohibition of the state, commonly on foreign ships, in time of war, to prevent their going out of port, sometimes to prevent their coming in, and sometimes both, for a limited time. The king may lay embargoes on ships, or employ those of his subjects, in time of danger, for service and defence of the nation; but they must not be for the private advantage of a particular trader or company, and

therefore a warrant to stay a single ship is no legal embargo. No inference can be made from embargoes which are only in war-time, and are a prohibition by advice of council, and not at prosecution of parties. If goods are laden on board, and after an embargo, or restraint from the prince or state, comes forth, and then the master of the ship breaks ground, or endeavours to sail, if any damage accrues, he must be responsible for the same; the reason is, because his freight is due, and must be paid, nay though the goods be seized as contraband. Embargo differs from quarantine, as this last is always for the term of forty days, in which persons from foreign parts infected with the plague, are not permitted to come on shore.

EMBASSADOR, or AMBASSADOR, a public minister sent from one sovereign prince, as a representative of his person, to another. Embassadors are either ordinary or extraordinary. Embassador in ordinary, is he who constantly resides in the court of another prince, to maintain a good understanding, and attend to the interest of his master. Till about 200 years ago, embassadors in ordinary were not heard of: all, till then, were embassadors extraordinary, that is, such as are sent on some particular occasion, and who retire as soon as the affair is dispatched. By the law of nations, none under the quality of a sovereign prince can send or receive an embassador. At Athens, embassadors mounted the pulpit of the public orators, and there opened their commission, acquainting the people with their errand. At Rome they were introduced to the senate, and delivered their commissions to them.

Embassadors should never attend any public solemnities, as marriages, funerals, &c. unless their masters have some interest in it; nor must they go into mourning on any occasions of their own, because they represent the person of their prince. By the civil law, the moveable goods of an embassador, which are accounted an accession to his person, cannot be seized on, neither as a pledge, nor for payment of a debt, nor by order or execution of judgment, nor by the king's or state's leave where he resides, as some conceive; for all actions ought to be far from an embassador, as well that which touch his necessaries as his person; if, therefore, he has contracted any debt, he is to be called upon kindly, and if he refuses, then letters of request are to go to his master. Nor can any of the embassador's domestic servants, that are registered in the secretaries of state's office, be arrested in person or goods; if they are, the process shall be void, and the parties suing out and executing it, shall suffer and be liable to such penalties and corporal punishment as the lord chancellor, or either of the chief justices, shall think fit to inflict. Yet embassadors cannot be defended when they commit any crime against that state, or the person of the prince, with whom they reside; and if they are guilty of treason, felony, &c. or any other crime against the law of nations, they lose the privilege of an embassador, and may be subject to punishment as private aliens.

EMBER-WEEKS, are those wherein the ember or embring days fall. In the laws of king Alfred, and those of Canute, those days are called ymbren, that is, circular days, whence the word was probably corrupted into ember-days; by the canonists they are called quatuor anni tempora, the four cardinal seasons, on which the circle of the year turns: and hence Henshaw takes the word to have been formed, viz. by corruption from temper or tempora. The ember days are, the Wednesday, Friday, and Saturday, after Quadragesima Sunday, after Whitsunday, after Holy-rood day in September, and after St. Lucia's day in December; which four times answer well enough to the four quarters of the year, spring, summer, autumn, and winter. Mr. Somner thinks they were originally fasts, instituted to beg God's blessing on the fruits of the earth. Agreeably to which, Skinner supposes the word ember taken from the ashes, embers, then strewed on the head. These ember-weeks are now chiefly taken notice of, on account of the ordination of priests and deacons; because the canon appoints the Sundays next succeeding the ember-weeks, for the solemn times of ordination; though the bishops, if they please, may ordain on any Sunday or holiday.

EMBERIZA, in ornithology, a genus of birds belonging to the order of passeres. The bill is conical, and the mandibles recede from each other towards the base; the inferior mandible has the sides narrowed inwards, but the upper one is still narrower. There are 24 species, of which the most remarkable are,

1. The nivalis, or great pyed mountain-finch of Ray, and the snow-bird of Edwards, it has white wings, but the outer edges of the prime feathers are black; the tail is black, with three white feathers on each side. These birds are called in Scotland snow-flakes, from their appearance in hard weather and in deep snows. They arrive in that season among the Cheviot-hills and in the Highlands in amazing flocks. A few breed in the Highlands, on the summit of the highest hills, in the same places with the ptarmigans; but the greatest numbers migrate from the extreme north. They appear in the Shetland islands, then in the Orkneys; and multitudes of them often fall, wearied with their flight, on vessels in the Pentland-frith. Their appearance is a certain forerunner of hard weather, and storms of snow, being driven by the cold from their common retreats. Their progress southward is probably thus; Spitzbergen and Greenland, Hudson's-bay, the Lapland Alps, Scandinavia, Iceland, the Ferroe Isles, Shetland, Orkneys, Scotland, and the Cheviot-hills. They visit at that season all parts of the northern hemisphere, Prussia, Austria, and Siberia. They arrive lean, and return fat. In Austria they are caught and fed with millet, and, like the ortolan, grow excessively fat. In their flights they keep very close to each other, mingle most confusedly together, and fling themselves collectively into the form of a ball; at which instant the fowler makes great havock among them. See Plate Nat. Hist. fig. 179.

2. The miliaris, or grey emberiza, is of a greyish colour, spotted with black in the belly, and the orbits are reddish. It is the bunting of English authors, and a bird of Europe.

3. The hortulana, or ortolan, has black wings; the first three feathers on the tail are white on the edges, only the two lateral are black outwardly. The orbits of the eyes are naked and yellow; the head is greenish, and yellow towards the inferior mandible. It feeds principally upon the millet, grows very fat, and is reckoned a delicate morsel by certain epicures, especially when fattened artificially. These birds are found in several parts of Europe, but are not met with in Britain; are common in France and Italy, and some parts of Germany and Sweden, migrating from one to the other in spring and autumn; and in their passage are caught in numbers, in order to fatten for the table. This species will sometimes sing very prettily, and has been kept for that purpose. The song is not unlike that of the yellow-hammer, but finer and sweeter. In some parts it makes the nest in a low hedge, in others on the ground. It is carelessly constructed, not unlike that of the lark. The female lays four or five greyish eggs, and in general has two broods in a year. These birds receive both their Greek and Latin name from their food, the millet. Aristotle calls them cynchromi, and the Latins miliariæ. The latter kept and fattened them in their ornithones, or fowl-yards, as the Italians do at present.

4. The citrinella, or yellow-hammer, has a blackish tail, only the two outward side-feathers are marked on the inner edge with sharp white spots. It is a bird of Europe, and comes about houses in winter; it builds its nest in banks or on low fences.

5. The schœniclas, or reed-sparrow, has a black head, a blackish-grey body, and a white spot on the quill-feathers. It inhabits marshy places, most commonly among reeds, from which it takes its name. Its nest is worthy of notice for the artful contrivance of it, being fastened to four reeds, and suspended by them like a hammock, about three feet above the water; the cavity of the nest is deep, but narrow; and the materials are bushes, fine bents, and hairs. It lays four or five eggs of a blueish white, marked with irregular purplish veins, especially on the larger end. It is a bird much admired for its song, and like the nightingale sings in the night.

6. The oryzivora, or rice-bunting, with the head and whole under-side of the body black; hind part of the neck in some pale yellow, and in others white; coverts of the wings and primaries, black, the last edged with white; part of the scapulars, lesser coverts of the wings, and rump, white; back black, edged with dull yellow; tail of the same colours, and each feather sharply pointed; the legs are red.

7. The cirlus is brown; breast spotted; eye-brows pale yellow; the two outmost tail-feathers with a white wedged spot. It inhabits France and Italy, and feeds on seeds, worms, and insects. See Plate Nat. Hist. fig. 177.

8. The ciris; the head blue; belly orange; back green; the feathers green-brown. Inhabits South America; varies in colour by age, sex, or climate; builds in orange groves. See Plate Nat. Hist. fig. 178.

These birds inhabit, in vast numbers, the island of Cuba, where they commit great ravages among the early crops of rice, which precede those of Carolina. They arrive very lean; but soon grow so fat, as to fly with difficulty, and when shot, often burst with the fall. They continue in Carolina not much above three weeks, and retire by the time the rice begins to harden; going on to

other parts, and staying in each only so long as the rice continues green. They come into Rhode-island and New York at the end of April, or the second week in May, frequenting the borders of fields, and live on insects, &c. till the maize is fit for their palates, when they begin by pecking holes in the sides of the husk, and after satiating themselves go on to another, which leaves room for the rain to get in, and effectually spoils the plants. They continue there during the summer, and breed, returning as autumn approaches to the southward. The males and females do not arrive together; the females come first. They are esteemed to be the most delicate birds of those parts; and the male is said to have a fine note.

EMBEZZLEMENT. By stat. 39. G. III. c. 85, for protecting masters against embezzlements by their clerks and servants; servants or clerks, or persons employed for the purpose or in the capacity of servants or clerks, who shall, by virtue of such employment, receive or take into their possession any money, goods, bond, bill, note, banker's draft, or other valuable security or effects, for, or in the name, or on the account of, their master or employer; and who shall fraudulently embezzle, secrete, or make away with the same, or any part thereof; every such offender shall be deemed to have feloniously stolen the same from his master or employer, for whose use, or on whose account, the same was delivered to, or taken into the possession of such servant, clerk, or other person so employed, although such money, goods, bond, bill, note, banker's draft, or other valuable security, was or were no otherwise received into the possession of his or their servants, clerk, or other person so employed; and every such offender, his adviser, procurer, aider, or abettor, being thereof lawfully convicted or attainted, shall be liable to be transported to such part beyond the seas as his majesty, by and with the advice of his privy council, shall appoint, for any term not exceeding fourteen years, in the discretion of the court before whom such offender shall be convicted or adjudged.

EMBLEM, a kind of painted enigma, or certain figures painted or cut metaphorically, expressing some action with reflections underneath, which in a measure explain the sense of the device, and at the same time instruct us in some moral truth, or other matter of knowledge. The emblem is somewhat plainer than the enigma, and the invention is more modern, it being entirely unknown to the antients.

EMBLEMENTS, signify the profits of land sown; but the word is sometimes used more largely, for any profits that arise and grow naturally from the ground, as grass, fruit, hemp, flax, &c. Cowel.

EMBRACERY, is an attempt to corrupt or influence a jury, or any way incline them to be more favourable to the one side than the other, by money, promises, letters, threats, or persuasions; whether the juror on whom such attempt is made, gives verdict or not, or whether the verdict given be true or false. 1 Haw. 259. The punishment of an embracer, or embraceor, is by fine and imprisonment; and for the juror so embraced, if it is by taking money, the punishment is (by divers statutes) perpetual infamy, imprisonment for a year, and forfeiture of tenfold the value. 4 Black. 140.

EMBOLISMIC, or INTERCALARY, a term used by chronologists in speaking of the additional months and years, which they insert to bring the lunar to the solar year. Since the common lunar year consists of 12 synodic months, or 354 days nearly, and the solar consists of 365 days (omitting the odd hours and minutes), it is plain that the solar year will exceed the lunar by about 11 days; and consequently in the space of about 33 years the beginning of the lunar year will be carried through all the seasons, and hence it is called the moveable lunar year. This form of the year is used at this time by the Turks and Arabians; and because in three years time, the solar year exceeds the lunar by 33 days, therefore, to keep the lunar months in the same seasons and times of the solar year, or near it, chronologists added a whole month to the lunar year every third year, and so made it consist of 13 months; this year they called the embolismic year, and the additional month the embolismic, or embolimean, or intercalary month. This form of the year is called the fixed lunar year, and it was used by the Greeks and Romans till the time of Julius Cæsar.

EMBOSSING, or IMBOSSING, in architecture and sculpture, the forming or fashioning works in relievo, whether cut with a chisel or otherwise. Embossing is a kind of sculpture, in which the figures stick out from the plane; and according as the figures are more or less prominent, they are said to be in alto, mezzo, or basso relievo; or high, mean, or low relief.

EMBOTHRUM, a genus of the class and order tetrandria monogynia. The corolla is four-petalled; anthers sessile, sitting on the tips of the petals; follicle round. There are four species, handsome shrubs of New Holland and South America.

EMBRASURE. See ARCHITECTURE.

EMBRASURE, in fortification, a hole or aperture in a parapet, through which the cannon are pointed to fire into the moat or field. See FORTIFICATION.

EMBROCATION, in surgery and pharmacy, an external kind of remedy, which consists in an irrigation of the part affected, with some proper liquor, as oils, spirits, &c. by means of a woollen or linen cloth, or a spunge, dipped in the same. See SURGERY.

EMBROIDERY, a work in gold or silver, or silk thread, wrought by the needle upon cloth, stuffs, or muslin, into various figures. In embroidering stuffs, the work is performed in a kind of loom, because the more the piece is stretched, the easier it is worked. As to muslin, they spread it upon a pattern ready designed; and sometimes, before it is stretched upon the pattern, it is starched, to make it more easy to handle. Embroidery on the loom is less tedious than the other, in which, while they work flowers, all the threads of the muslin, both lengthwise and breadthwise, must be continually counted; but on the other hand this last is much richer in points, and susceptible of greater variety. Cloths too much milled are scarcely susceptible of this ornament, and in effect we seldom see them embroidered. The thinnest muslins are the best for this purpose, and they are embroidered to the greatest perfection in Saxony. In other parts of Europe, however, they embroider very prettily, and especially in France.

There are several kinds of embroidery, as, 1. Embroidery on the stamp, where the figures are raised and rounded, having cotton or parchment put under them to support them. 2. Low embroidery, where the gold and silver lie low upon the sketch, and are stitched with silk of the same colour. 3. Guimped embroidery: this is performed either in gold or silver; they first make a sketch upon the cloth, then put on cut vellum, and afterwards sow on the gold and silver with silk-thread. In this kind of embroidery they often put gold and silver cord, tinsel, and spangles. 4. Embroidery on both sides; that which appears on both sides of the stuff. 5. Plain embroidery; where the figures are flat and even, without cords, spangles, or other ornaments.

No foreign embroidery, or gold or silver brocade, is permitted to be imported into this kingdom on pain of being seized and burned, and a penalty of 100*l.* for each piece. No person is allowed to sell any foreign embroidery, gold or silver thread, lace, fringe, or brocade, or make up the same into any garment, upon pain of having it burned, and penalty of 100*l.*

EMBRYULCUS. See MIDWIFERY.

EMERALD, in natural history, a precious stone, of a green colour, and next in hardness to the ruby.

This stone has hitherto been found almost always crystallized. The primitive form of the crystals is a regular six-sided prism; and the form of its particles is a triangular prism, whose sides are square, and bases equilateral triangles. The most common variety of its crystals is the regular six-sided prism, sometimes with the edges of the prism, or of the bases, or the solid angles, or both wanting, and small faces in their place. The sides of the prism are generally channelled.

Its texture is foliated. Its fracture conchoidal. Causes a double refraction. Hardness 12. Specific gravity 2.65 to 2.775. Colour green. Becomes electric by friction, but not by heat. Its powder does not phosphoresce when thrown on a hot iron. At 150° Wedgewood it melts into an opaque coloured mass. According to Dolomieu, it is fusible per se by the blowpipe.

This mineral was formerly subdivided into two distinct species; the emerald, and beryl or aqua marina. Hauy demonstrated, that the emerald and beryl correspond exactly in their structure and properties; and Vauquelin found that they were composed of the same ingredients: henceforth, therefore, they must be considered as varieties of the same species.

The variety called emerald varies in colour from the pale to the perfect green. It comes chiefly from Peru; some specimens have been brought from Egypt. Dolomieu found it in the granite of Elba. When heated to 120° Wedgewood, it becomes blue, but recovers its colour when cold. A specimen, analysed by Vauquelin, was composed of

64.60	silica
14.00	alumina
13.00	glucina
3.50	oxide of chromium
2.56	lime
2.00	moisture, or other volatile ingredient
99.66	

See BERYL.

169

Didus ineptus
Hooded dodo

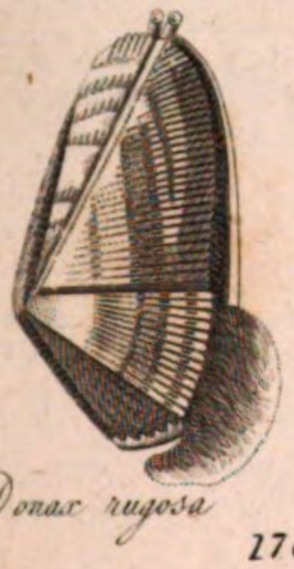
170

Dionæa muscipula
Venus' Flytrap

171

Diospyros Virginiensis

172



Donax rugosa

173

Dorstenia contrayerva

174

Draco volans
Flying Dragon

175

Dytiscus marginalis

176

Elephas maximus

177

Emberiza cirlus
Cirl Bunting

178

Emberiza ciris
Painted Bunting

179

Emberiza nivalis
Snow Bunting

The beryl is of a mountain-green colour, and sometimes blue, yellow, and even white; sometimes different colours appear in the same stone. It is found in Ceylon, different parts of India, Brazil, and especially in Siberia and Tartary, where its crystals are sometimes a foot long. A specimen of beryl, analysed by Vauquelin, contained

69 silica
13 alumina
1 oxide of iron
0.5 lime

83.5

It was by analysing this stone that Vauquelin discovered the earth which he called glucina.

Our jewellers distinguish emeralds into two kinds, the oriental and occidental: the emeralds of the East Indies are evidently finer than those of any other part of the world; but our jewellers, seldom meeting with these, call the American emeralds the oriental, and usually sell crystals accidentally tinged with green, under the name of occidental emeralds: these being also the most common, there has grown an opinion among the lapidaries, that the emerald is no harder than the crystal; because what they take to be the emeralds, are in general only crystals. The genuine emerald, in its most perfect state, is perhaps the most beautiful of all the gems; it is found of various sizes, but usually small; a great number of them are met with of about the sixteenth part of an inch in diameter, and they are found from this size to that of a walnut.

EMERSION, in astronomy, is when any planet that is eclipsed begins to emerge or get out of the shadow of the eclipsing body. It is also used when a star, before hidden by the sun as being too near him, begins to re-appear or emerge out of his rays. See ASTRONOMY.

EMERY, in natural history, a rich iron-ore found in large masses, of no determinate shape or size, extremely hard and very heavy. It is usually of a dusky brownish-red on the surface, but when broken, is of a fine, bright, iron-grey, but not without some tinge of redness, and is spangled all over with shining specks, which are small flakes of a foliaceous talc, highly impregnated with iron. It is also sometimes very red, and then usually contains veins of gold. It is imported from the island of Naxos, where it exists in great abundance. It is opaque and brittle; its specific gravity is about four. From the analysis of Mr. Tennant, it appears that emery, when freed as much as possible from iron, is composed of

80 alumina
3 silica
4 iron

87.

This analysis corresponds very nearly with that of the imperfect corundum.

Emery is prepared for the manufacturers by grinding in mills, and the powder is separated into parcels of different degrees of fineness by washing; these are called the first, second, and third sort; the first being that which remains longest suspended in water, the others, such as sink sooner from the same liquor, and from which it is poured, while yet turbid, to settle for the finer kind. These several sorts are of great use to various artificers in polishing and burnishing iron and steel works, marble, cutting and scalloping glass, &c. The lapidaries cut the ordinary gems on their wheels, by sprinkling the wetted powder over them, the wheels they use being usually of lead, with a small admixture of pewter, that their softness may admit the emery the better. It will not cut diamonds.

EMETIC, a medicine which induces vomiting. See PHARMACY.

EMINENCE, in the military art, a high or rising ground, which overlooks and commands the low places about it; such places within cannon-shot of a fort are a great disadvantage; for if the besiegers become masters of them, they can thence fire into the fort.

EMIR, a title of dignity among the Turks, signifying a prince, which was first given to the caliphs, but when they assumed the title of sultans, that of emir remained to their children, as that of Cæsar among the Romans. At length the title became attributed to all who were judged to descend from Mahomet by his daughter Fatimah, and who wear the green turban instead of the white. The Turks also call the viziers, bashaws, or governors of provinces, by this name.

EMOLLIENTS, in medicine and pharmacy, are such remedies as sheath and soften the asperity of the humours, and relax and supple the solids at the same time. See MATERIA MEDICA.

EMPEROR, *imperator*, a title of honour among the antient Romans, conferred on a general who had been victorious, and now used to signify a sovereign prince, or supreme ruler of an empire.

The title of emperor adds nothing to the rights of sovereignty; it only gives pre-eminence above other sovereigns. The emperors, therefore, pretend, that the imperial dignity is more eminent than the regal. It is disputed whether emperors have the power of disposing of the regal title; however this may be, they have sometimes taken upon them to erect kingdoms: thus it is that Bohemia, Prussia, and Poland, are said to have been raised to that dignity. In the East the title of emperor is more frequent than with us; thus the sovereign princes of China, the Mogul empire, &c. are called emperors. In the West, the title has been for a long time restrained to the emperors of Germany. The first who bore it was Charlemagne, who was crowned by pope Leo III. in 800; and it is to be observed, that there was not a foot of land or territory annexed to the emperor's title. In the year 1723, the czar of Muscovy assumed the title of emperor of all the Russias. The kings of France were also called emperors when they reigned with their sons, whom they associated in the crown; thus Hugh Capet was called emperor, and his son Robert, king. The kings of England were antiently stiled emperors, as appears from a charter of king Edgar. The emperor of Germany is a limited monarch in regard to the empire, though he is an absolute sovereign in most of his hereditary dominions. We do not think it necessary under this article to give any account of the present French usurper, who has lately assumed this title, because it is to be hoped and expected that his unjust domination will not be long endured

EMPETRUM, *berry-bearing heath*, a genus of the triandria order, in the monœcia class of plants. In the natural method this genus is ranked by Linnæus under the 54th order, miscellaneæ; and likewise among those of which the order is doubtful. The male calyx is tripartite; the corolla tripetalous; the stamina long; the female calyx is tripartite; the corolla tripetalous; the styles nine; the berry nine-seeded. There are two species; one of which, viz. the nigrum, bears the crow-crake berries, and is a native of Britain. It grows wild on boggy heaths and mountains. Children sometimes eat the berries; but when taken in too great quantity, they are apt to occasion a head-ache. Grouse feed upon them. When boiled with alum, they afford a dark purple dye. Goats are not fond of the plant; cows, sheep, and horses, refuse it. The album is a native of Portugal, and bears white berries.

EMPHYSEMA, in surgery, a windy tumour, generally occasioned in a fracture of the ribs, and formed by the air insinuating itself, by a small wound, between the skin and muscles, into the substance of the cellular or adipose membrane, spreading itself afterwards up to the neck, head, belly, and other parts, much after the manner in which butchers blow up their veal. See SURGERY.

EMPHYTEUSIS, in the civil and canon law, the letting out of poor barren lands for ever, or at least for a long term of years, on condition of the tenant's cultivating, meliorating, or mending them, and paying a certain yearly consideration. Emphyteuses are a kind of alienations, differing from sale, in that they only transfer the dominium utile, the benefits of the ground, not the property, or simple fee. Among the Romans they were at first temporary, afterwards perpetual.

EMPIRE, in political geography, a large extent of land, under the jurisdiction or government of an emperor. See EMPEROR.

The most antient empire we read of is that of the Assyrian, which was subverted through the effeminacy of Sardanapalus; the Persian empire was destroyed through the bad conduct of Darius Codomannus; the Grecian empire, by its being dismembered among the captains of Alexander the Great; and the Roman empire, through the ill management of the last emperors of Rome. Empire, or the empire, used absolutely, and without any addition, signifies the empire of Germany, called also in juridical acts and laws, the holy Roman empire. Authors are at a loss under what form of government to range this empire. Some consider it as a monarchical state, as all the members are forced to ask the investitute of their states of the emperor, and to take an oath of fidelity to him. Others will have it an aristocratic state, because the emperor cannot determine any thing without the concurrence of the princes: and, lastly, others regard the empire as a monarcho-aristocratic state.

EMPIS, in zoology, a genus of insects belonging to the order diptera, of which the characters are these: the proboscis is of an horny substance, bivalve, reflected under the head and breast, and longer than the thorax. There are five species. These minute insects live by sucking out the blood and fluids of other animals.

EMPLEURUM, a genus of the monoecia tetrandria class and order. The male calyx is four-cleft; corolla none; fem. calyx, four-cleft inferior; corolla none; stigma cylindric; caps. opening at the side; seed one, arilled. There is one species, a shrub of the Cape.

EMPYEMA, in medicine, a disorder in which purulent matter is contained in the thorax or breast, after an inflammation and suppuration of the lungs and pleura, which, if it is not timely discharged, not only obstructs respiration, but also returning into the blood occasions a continual hectic, with a consumption of the whole body, and other bad symptoms. See MEDICINE.

EMPYREUMA, among chemists and physicians, the fiery taste or offensive smell which brandies, and some other bodies prepared by fire, are impregnated with.

EMULGENT or RENAL ARTERIES, those which supply the kidneys with blood; being sometimes single, sometimes double on each side.

EMULSION, in pharmacy, a soft liquid substance, of a colour and consistence resembling milk. See PHARMACY.

EMUNCTORY, in anatomy, a general term for all those parts which serve to carry off the excrementitious parts of the blood and other humours of the body. Such more especially are the kidneys, bladder, &c.

ENALLAGE, in grammar, is when one word is substituted for another of the same part of speech; a substantive for an adjective, as exercitus victor for victoriosus, scelus for scelestus; a primitive for a derivative, as Dardana arma for Dardania, laticem lyæum for lyæeium; an active for a passive, as nox humida cœlo præcipitat, for præcipitatur, &c.

ENALLAGE, in rhetoric, is a figure by which the discourse is changed and reversed contrary to all the rules of the language; but this is not done altogether at pleasure, or without reason.

ENALURON, according to Guillim, is a bordure charged with birds; though others will have it to signify, in orle, or form of a bordure.

ENAMEL, a kind of coloured glass, used in enamelling and painting in enamel. Enamels have for their basis a pure crystal-glass or frit, ground up with a fine calx of lead and tin prepared for the purpose, with the addition usually of white salt of tartar. These ingredients baked together are the matter of all enamels, which are made by adding colours of different kinds in powder to this matter, and melting or incorporating them together in a furnace.

For white enamel, Neri De Arte Vitriar. directs only manganese to be added to the matter which constitutes the basis; for azure, zaffer mixed with calx of brass; for green, calx of brass with scales of iron, or with crocus martis; for black, zaffer with manganese, or with crocus martis; or manganese with tartar; for red, manganese or calx of copper and red tartar; for purple, manganese with calx of brass; for yellow, tartar and manganese; and for violet-coloured enamel, manganese with thrice-calcined brass.

In making these enamels, the following general cautions are necessary to be observed. 1. That the pots must be glazed with white glass, and must be such as will bear the fire. 2. That the matter of enamels must be very nicely mixed with the colours. 3. When the enamel is good, and the colour well incorporated, it must be taken from the fire with a pair of tongs. 4. The general way of making the coloured enamels is this; powder, sift, and grind all the colours very nicely, and first mix them with one another, and then with the common matter of enamels; then set them in pots in a furnace, and when they are well mixed and incorporated, cast them into water, and when dry, set them in a furnace again to melt, and when melted take a proof of it. If too deep-coloured, add more of the common matter of enamels, and if too pale, add more of the colours.

Enamels are used either in counterfeiting or imitating precious stones, in painting in enamel, or by enamellers, jewellers, and goldsmiths, in gold, silver, and other metals. The first two kinds are usually prepared by the workmen themselves, who are employed in these arts. That used by jewellers, &c. is brought to us chiefly from Venice or Holland, in little cakes of different sizes, commonly about four inches diameter, having the mark of the maker struck upon them with a puncheon.

ENAMELLING, the art of laying enamel upon metals, as gold, silver, copper, &c. and of melting it at the fire, or of making divers curious works in it at a lamp. It signifies also to paint in enamel.

The method of painting in enamel.—This is performed on plates of gold or silver, or most commonly of copper, enamelled with the white enamel, which they paint with colours melted in the fire, where they take a brightness and lustre like that of glass. This painting is the most prized of all for its peculiar brightness and vivacity, which is very permanent, the force of its colours not being effaced or sullied with time, as in other painting, and continuing always as fresh as when it came out of the workman's hands. It is usual in miniature, it being the more difficult the larger it is, by reason of certain accidents it is liable to in the operation. Fine enamelling should only be practised on plates of gold, the other metals being less pure: copper, for instance, scales with the application, and yields fumes; and silver turns the yellows white. Nor must the plate be made flat; for in such case, the enamel cracks; to avoid which, they usually forge them a little round or oval, and not too thick. The plate being well and evenly forged, they usually begin the operation by laying on a couch of white enamel, on both sides, which prevents the metal from swelling and blistering; and this first lay serves for the ground of all the other colours. The plate being thus prepared, they begin at first by drawing out exactly the subject to be painted with red vitriol, mixed with oil of spike, marking all parts of the design very lightly with a small pencil. After this, the colours (which are to be previously ground with water in a mortar of agate extremely fine, and mixed with oil of spike somewhat thick) are to be laid on, observing the mixtures and colours that agree to the different parts of the subject; for which it is necessary to understand painting in miniature. But here the workman must be very cautious of the good or bad qualities of the oil he employs to mix his colours with, for it is very subject to adulterations. Great care must likewise be taken that the least dust imaginable come not to your colours while you are either painting or grinding them; for the least speck, when it is worked up with it, and when the work comes to be put into the reverberatory to be red-hot, will leave a hole, and so deface the work. When the colours are all laid, the painting must be gently dried over a slow fire to evaporate the oil, and the colours afterwards melted to incorporate them with the enamel, making the plate red-hot in a fire such as the enamellers use. Afterwards that part of the painting must be passed over again which the fire has any way effaced, strengthening the shades and colours, and committing it again to the fire, observing the same method as before, which is to be repeated till the work is finished.

The white enamel of which the glazing of fine earthernware vessels consists, is made of 100 parts of lead melted with from 15 to 40 parts of tin, and the mixture is oxydized completely, by exposing it to heat in an open vessel. One hundred parts of this oxide are mixed with an equal quantity of white sand, three parts of silica, one of talc, and 25 of common salt. This mixiure is melted, then reduced to powder, and formed into a kind of paste, which is spread over the porcelain vessel before it is baked. The excellence of good enamel is, that it easily fuses into a kind of paste at the heat which is necessary for baking porcelain, and spreads equally on the vessel, forming a smooth glassy surface, without losing its opacity, or flowing completely into a glass. Its whiteness depends on the proportion of tin, and its fusibility on the lead.

Mr. Anness has just obtained a patent for enamels, of which the following are among his principal directions.

To prepare the flux or principal matter for enamelling on glass vessels.—Take one pound of saturnus glorificatus (to prepare glorificatus thus: take litharge of white lead, put it in a pan, pour on distilled vinegar, stirring it well over a gentle fire till the vinegar becomes impregnated with the salt of the lead; evaporate half the vinegar, put it in a cool place to crystallize, and keep the crystals dry for use); half a pound of natural crystal calcined to a whiteness; one pound of salt of polverine, or other fit alkali; mix them together, and bake in a slow heat for about 12 hours, then melt the mass, and pulverize the same in an agate mortar, or any other proper vessel which is not capable of communicating any metallic or other impurity.

To make green.—Take one ounce of copper-dust, two ounces of sand, one ounce of litharge, half an ounce of nitre; or two of copper, one of sand, two of litharge, one and a half of nitre; mix them with equal parts of flux, or vary the proportions of them, as may be found necessary, according to the tint of colour required.

To make black.—Take calcined iron one ounce, cobalt, crude or prepared, one ounce, or zaffer two ounces, and manganese one ounce; mixed with equal parts of flux, by melting or grinding together.

To make yellow.—Take of lead and tin ashes one ounce, litharge one ounce, antimony one ounce, sand one ounce, nitre four ounces; calcine or melt them together; pulverize and mix them with a due proportion of flux, as the nature of the glass may re-

quire; or take more or less of any or all the above, according to the depth of colour desired.

To make blue.—Take prepared cobalt one ounce, sand one ounce, red lead one ounce, nitre one ounce, flint-glass two ounces; melted together by fire, pulverized and fluxed according to the degree of softness or strength of colour required.

To make olive.—Take one ounce of the blue as prepared above, half an ounce of black, half an ounce of yellow; grind them for use; if necessary, add flux to make it softer.

To make white.—Take tin prepared by aqua-fortis one ounce, red lead one ounce, of white pebble-stone or natural crystal two ounces, nitre one ounce, arsenic one drachm, with equal parts of flux, or more or less, as the softness or opacity may require; melted, calcined, or used raw.

To make purple.—Take the finest gold; dissolve it in aqua-regia, regulated with sal ammoniac; put it in a sand-heat for about 48 hours to digest the gold, collect the powder, grind it with six times its weight of sulphur, put it into a crucible on the fire till the sulphur is evaporated, then amalgamate the powder with twice its weight of mercury, put it into a mortar or other vessel, and rub it together for about six hours, with a small quantity of water in the mortar, which change frequently; evaporate the remaining mercury in a crucible, and add to the powder ten times its weight of flux, or more or less, as the hardness or softness of the colour may require.

To make rose-colour.—Take purple as prepared above, mix it with thirty times its weight of flux, and one hundredth part of its weight of silver leaf, or any preparation of silver, or vary the proportion of the flux and silver as the quality of the colour may require; or any of the other preparations for purple will do, varying the proportion of the flux and silver as above; or any materials, from which purple can be produced, will, with the addition of silver and flux, answer.

To make brown.—Take red lead one ounce, calcined iron one ounce, antimony two ounces, litharge two ounces, zaffer one ounce, sand two ounces, calcined, or melted together, or used raw, as may be most expedient; or vary the proportions of any or all the above, as tint or quality may require.

Method of application.—The aforesaid colours may be applied to vessels of glass in the following manner, viz. by painting, printing, or transferring, dipping, floating, and grounding.

To paint.—Mix the colours (when reduced by grinding to a fine powder) with spirits of turpentine, temper them with thick oil of turpentine, and apply them with camel-hair pencils, or any other proper instrument, or mix them with nut or spike oil, or any other essential or volatile oil, or with water, in which case use gum arabic, or any other gum that will dissolve in water, or with spirits, varnishes, gums of any kind, waxes, or resins; but the first is conceived to be the best.

To print.—Take a glue bat, full size, for the subject, charge the copper-plate with the oil or colour, and take the impression with the bat from the plate, which impression transfer on the glass: if the impression is not strong enough, shake some dry colour on it, which will adhere to the moist colour; or take any engraving or etching, or stamp, or cast, and having charged it with the oil or colour, transfer it on the glass by means of prepared paper, vellum, leather, or any other substance that will answer; but the first is the best. Any of the aforesaid engravings, etchings, stamps, casts, or devices, may be charged with waters, oils, varnishes, or glutinous matters of any kind, reduced to a proper state, as is necessary in printing in general; any or all of these may be used alone, or mixed with the colours. When used alone, the colour is to be applied in powder as before mentioned.

To dip.—Mix the colour to about the consistency of a cream with any of the ingredients used for printing, in which dip the glass vessel, and keep it in motion till smooth.

To ground.—First charge the glass vessel with oil of turpentine, with a camel-hair pencil, and while moist apply the colour in a dry powder, which will adhere to the oil, or, instead of oil of turpentine, use any of the materials used for printing: but the first is the best.

To float.—Mix the colour with any of the ingredients used for printing, to a consistency according to the strength of ground required, float it through a tube, or any other vessel, moving or shaking the piece of glass till the colour is spread over the part required.

ENARGEA, a genus of the hexandria monogynia class and order. There is no calyx; the petals are six; berry three-celled; four or five globular seeds. There is one species, a native of Terra del Fuego.

ENCÆNIA, the name of three several feasts celebrated by the Jews in memory of the dedication, or rather purification, of the temple, by Judas Maccabeus, Solomon, and Zorababel. This term is likewise used in church-history for the dedication of christian churches.

ENCAMPMENT, the pitching of a camp. In the regulations published by authority, are particularly enjoined the following

Attentions relative to encampments.—On the arrival of a brigade, or a battalion, on the ground destined for its camp, the quarter and rear guards of the respective regiments will immediately mount; and when circumstances require them, the advanced picquets will be posted. The grand guards of cavalry will be formed, and the horses picketed. The men's tents will then be pitched, and till this duty is completed, the officers are on no account to quit their troops or companies, or to employ any soldier for their own accommodation. Necessaries are to be made in the most convenient situations, and the utmost attention is required in this, and every other particular, to the cleanliness of the camp.

If circumstances will allow the ground on which a regiment is to encamp to be previously ascertained, the pioneers should make these, and other essential conveniences, before the corps arrives at its encampment.

Whenever a regiment remains more than one night in a camp, regular kitchens are to be constructed. No tents, or huts, are to be allowed in front, or between the intervals of the battalions. A spot of ground for this purpose should be marked by the quarter master, with the approbation of the commanding officer.

On arriving in a camp which is intersected by hedges, ditches, unequal or boggy ground, regiments will immediately make openings of communication, of 60 feet in width. The ground in front of the encampment is to be cleared, and every obstacle to the movement of the artillery and troops is to be removed. Commanding officers of regiments must take care that their communication with the nearest grand route is open and free from impediments.

ENCANTHIS, in surgery, a tubercle arising either from the caruncula lachrymalis, or from the adjacent red skin; sometimes so large, as to obstruct not only the puncta lachrymalia, but also part of the sight or pupil itself. See SURGERY.

ENCAUSTIC, and ENCAUSTUM, the same with enamelling and enamel. See ENAMELLING, and ENAMEL.

ENCAUSTIC *painting*, a method of painting made use of by the antients, in which wax was employed to give a gloss to their colours, and to preserve them from the injuries of the air.

This antient art, after having been long lost, was restored by count Caylus, a member of the Academy of Inscriptions in France; and the method of painting in wax was announced to the Academy of Painting and Belles Lettres, in the year 1753; though M. Bachelier, the author of a treatise De l'Histoire et du Secret de la Peinture en Cire, had actually painted a picture in wax in 1749; and he was the first who communicated to the public the method of performing the operation of inustion, which is the principal characteristic of the encaustic paintings. The count kept his method a secret for some time, contenting himself with exhibiting a picture at the Louvre in 1754, representing the head of Minerva, painted in the manner of the antients, which excited the curiosity of the public, and was very much admired. In the interval of suspense, several attempts were made to recover the antient method of painting. The first scheme adopted was that of melting wax and oil of turpentine together, and using this composition as a vehicle for mixing and laying on the colours. But this method did not explain Pliny's meaning, as the wax is not burnt in this way of managing it. In another attempt, which was much more agreeable to the historian's description of encaustic painting, the wax was melted with strong lixivium of salt of tartar, and with this the colours were ground. When the picture was finished, it was gradually presented to the fire, so as to melt the wax, which was thus diffused through all the particles of the colours, so that they were fixed to the ground, and secured from the access of air or moisture. But the method of count Caylus is much more simple: the cloth or wood, which he designed for the basis of his picture, is waxed over, by rubbing it simply with a piece of bee's-wax; the wood or cloth, stretched on a frame, being held horizontally over, or perpendicularly before a fire, at such a distance, that the wax might gradually melt whilst it is rubbed on, diffuse itself, penetrate the body, and fill the interstices of the texture of the cloth, which, when cool, is fit to paint upon; but as water-colours, or

those that are mixed up with common water, will not adhere to the wax, the whole picture is to be first rubbed over with Spanish chalk or white, and then colours are applied to it; when the picture is dry, it is put near the fire, whereby the wax melts, and absorbs all the colours.

Mr. J. H. Muntz, in a treatise on this subject, has proposed several improvements in the art of encaustic. When the painting is on cloth, he directs it to be prepared by stretching it on a frame, and rubbing one side several times over with a piece of bee's-wax, or virgin-wax, till it is covered with a coat of wax of considerable thickness. In fine linen, this is the only operation necessary previous to painting; but coarse cloth must be rubbed gently on the unwaxed side with a pumice stone, to take off all those knots which would prevent the free and accurate working of the pencil. Then the subject is to be painted on the unwaxed side with colours prepared and tempered with water; and when the picture is finished, it must be brought near the fire, that the wax may melt and mix and fix the colours. This method, however, can only be applied to cloth or paper, through the substance of which the wax may pass; but in wood, stone, metals, or plaister, the former method of count Caylus must be observed.

Mr. Muntz has also discovered a method of forming grounds for painting with crayons, and fixing these, as well as water-colours, employed with the pencil. On the unwaxed side of a linen cloth, stretched and waxed as before, lay an even and thick coat of the colour proper for the ground; having prepared this colour by mixing some proper pigment with an equal quantity of chalk, and tempering them with water. When the colour is dry, bring the picture to the fire that the wax may melt, pass through the cloth, and fix the ground. An additional quantity of wax may be applied to the back of the picture, if that which was first rubbed on should not be sufficient for the body of colour; but as this must be laid on without heat, the wax should be dissolved in oil of turpentine, and applied with a brush, and the canvas be again exposed to the fire, that the fresh supply of wax may pass through the cloth, and be absorbed by the colour; and thus a firm and good body will be formed for working on with the crayons. If cloth and paper are joined together, the cloth must be first fixed to the straining frame, and then the paper must be pasted to it with a composition of paste made with wheaten flour, or starch and water, and about a twelfth part of its weight of common turpentine. The turpentine must be added to the paste when it is almost sufficiently boiled, and the composition well stirred, and left to simmer over the fire for five or six minutes; let wax be dissolved in oil of turpentine to the consistence of a thin paste; and when the cloth and paper are dry, let them be held near a fire, and with a brush lay a coat of the wax and turpentine on both sides the joined cloth and paper, to such a degree of thickness, that both surfaces may shine throughout without any appearance of dull spots. Then expose the cloth to the fire or to the sun, by which means the oil will evaporate, and the wax become solid, and be fit to receive any composition of colour proper for a ground, which is to be laid on as above directed in the case of cloth without paper.

Almost all the colours that are used in oil-painting may be also applied in the encaustic method. Mr. Muntz objects, indeed, to brown, light pink, and unburnt terra di Sienna; because these, on account of their gummy or stony texture, will not admit such a cohesion with the wax as will properly fix them; but other colours which cannot be admitted in oil-painting, as red lead, red orpiment, crystals of verdegris, and red precipitate of mercury, may be used here. The crayons used in encaustic painting are the same with those used in the common way of crayon-painting, excepting those that in their composition are too tenacious; and the method of using them is the same in both cases.

The encaustic painting has many peculiar advantages; though the colours have not the natural varnish or shining which they acquire with oil, they have all the strength of paintings in oil, and all the airiness of water-colours, without partaking of the apparent character or defects of either; they may be looked at in any light and in any situation, without any false glare: the colours are firm, and will bear washing; and a picture, after having been smoked, and then exposed to the dew, becomes as clean as if it had been but just painted. It may also be retouched at pleasure, without any detriment to the colours; for the new colours will unite with the old ones, without spots, as is the case in common size-painting; nor is it necessary to rub the places to be retouched with oil as in oil pictures; it is not liable to crack, and easily repaired if it should chance to suffer any injury. The duration of this painting is also a very material advantage; the colours are not liable to fade and change; no damp can affect them, nor any corrosive substance injure them; nor can the colour fall off in shivers from the canvas. However, notwithstanding all these and other advantages enumerated by the abbé Mazeas and Mr. Muntz, this art has not yet been much practised. Many of these properties belong to a much higher species of encaustic painting afterwards discovered in England, the colours of which are fixed by a very intense heat; nor are the colours or grounds on which they are laid liable to be dissolved or corroded by any chemical menstruum; nor, like the glassy colours of enamel, to run out of the drawing on the fire. This method is described in the second part of the xlixth volume of the Philosophical Transactions, No. 100. Yet, notwithstanding the ingenuity of this communication, we find the antient or some similar method of painting in wax remained a desideratum upwards of 25 years; and till a method was communicated to the Society of Arts by miss Greenland, in 1787. The ground of her information she received at Florence, through the acquaintance of an amateur of painting, who procured her the satisfaction of seeing some paintings in the antient Grecian style, executed by signora Parenti, a professor at that place, who had been instructed by a Jesuit at Pavia, the person who made the farthest discoveries in that art. Miss Greenland's friends, knowing she was fond of painting, informed her what were the materials used, but could not tell her the proportions of the composition; however, from her anxiety to succeed in such an acquisition, she made various experiments, and at last obtained such a sufficient knowledge of the quantities of the different ingredients, as to begin and finish a picture, which she afterwards presented to the society for their inspection.

Her method is as follows: "Take an ounce of white wax, and the same weight of gum mastich powdered. Put the wax in a glazed earthern vessel over a very slow fire; and when it is quite dissolved, strew in the mastich, a little at a time, stirring the wax continually until the whole quantity of gum is perfectly melted and incorporated; then throw the paste into cold water, and when it is hard, take it out of the water, wipe it dry, and beat it in one of Mr. Wedgewood's mortars, observing to pound it at first in a linen cloth to absorb some drops of water that will remain in the paste, and would prevent the possibility of reducing it to a powder, which must be so fine as to pass through a thick gauze. It should be pounded in a cold place, and but a little while at a time, as after long beating the friction will in a degree soften the wax and gum, and instead of their becoming a powder they will return to a paste.

"Make some strong gum arabic water, and when you paint, take a little of the powder, some colour, and mix them together with the gum water. Light colours require but a small quantity of the powder, but more of it must be put in proportion to the body and darkness of the colours; and to black there should be almost as much of the powder as colour.

"Having mixed the colours, and no more than can be used before they grow dry, paint with fair water, as is practised in painting with water-colours, a ground on the wood being first painted of some proper colour prepared in the same manner as is described for the picture; walnut-tree and oak are the sorts of wood commonly made use of in Italy for this purpose. The painting should be very highly finished; otherwise, when varnished, the tints will not appear united.

"When the painting is quite dry, with rather a hard brush, passing it one way, varnish it with white wax, which is put into an earthen vessel, and kept melted over a very slow fire till the picture is varnished, taking great care that the wax does not boil. Afterwards hold the picture before a fire, near enough to melt the wax, but not to make it run; and when the varnish is entirely cold and hard, rub it gently with a linen cloth. Should the varnish blister, warm the picture again very slowly, and the bubbles will subside. When the picture is dirty, it need only be washed with cold water."

The opinion given by the society upon the above is, "the method made use of by miss Greenland provides against all inconveniences; and the brilliancy of the colours in the picture painted by her, and exhibited to the society, fully justifies the opinion, that the art of painting in wax, as above described, highly merited the reward of a gold pallet voted to her on this occasion."

ENCEINTE, in fortification, is the wall or rampart which surrounds a place, sometimes composed of bastions or curtins, either faced or lined with brick or stone, or only made of earth. The enceinte is sometimes only flanked by round or square towers, which is called a Roman wall.

ENCEPHALI, in medicine, worms generated in the head, where they cause so great a pain, as sometimes to occasion distraction. See MEDICINE.

ENCHASING, INCHASING, or CHASING, the art of enriching and beautifying gold, silver, and other metal work, by some design or figures represented thereon in low relievo.

Enchasing is practised only on hollow thin works, as watch-cases, cane-heads, tweezer-cases, &c. It is performed by punching or driving out the metal to form the figure from withinside, so as to stand out prominent from the plane or surface of the metal. In order to this they provide a number of fine steel blocks or puncheons, of different sizes; and the design being drawn on the surface of the metal, they apply the inside upon the heads or tops of these blocks, directly under the lines or parts of the figures; then, with a fine hammer, striking on the metal, sustained by the block, the metal yields, and the block makes an indenture or cavity on the inside, corresponding to which there is a prominence on the outside, which is to stand for that part of the figure. Thus the workman proceeds to chase and finish all the parts by successive application of the block and hammer to the several parts of the design. And it is wonderful to observe with what beauty and justness, by this simple piece of mechanism, the artists in this line will represent foliages, grotesques, animals, histories, &c.

ENCHELIS, a genus of vermes infusoria. It is invisible to the naked eye, very simple, and cylindrical. There are eleven species, most of which have been described in Mr. Adams's Treatise on the Microscope.

ENCLAVE, in heraldry, denotes a thing's being let into another, especially when the piece so let in is square.

ENCLITICA, in grammar, particles which are so closely united with other words as to seem part of them, as *virumque*, &c. There are three enclitic particles in Latin, viz. *que*, *ne*, *ve*: but there are great many in the Greek, as τε, με, μοι, σε, τοι, &c.

ENCRATITES, in church history, a sect of Christians who appeared towards the end of the second century. They were called encratites or continentes, because they gloried in abstaining from marriage, and the use of wine and animal food.

END FOR END, in the sea language, is said of a rope that has run quite out of the block wherein it was reeved.

ENDEMIC or ENDEMICAL DISEASES, those to which the inhabitants of particular countries are subject more than others, on account of the air, water, situation, and manner of living. See MEDICINE.

ENDORSE, in heraldry, an ordinary, containing the eighth part of a pale, which Leigh says is only used when a pale is between two of them.

ENDORSED, in heraldry, is said of things borne back to back, more usually called adossé.

ENDOWMENT, in law, denotes the settling a dower on a woman: though sometimes it is used figuratively for settling a provision upon a parson, on the building of a church; or the severing a sufficient portion of tithes for a vicar, when the benefice is appropriated.

ENEMA, in medicine, the same with clyster. See MEDICINE.

ENEMY, is properly an alien or foreigner who, in a public capacity, and in a hostile manner, invades any kingdom or country. If a prisoner is rescued by enemies, the gaoler is not guilty of an escape, as he would have been if subjects had made the rescue, when he might have a legal remedy against them. 2 Haw. 130.

ENERGUMENS, in church history, persons supposed to be possessed by the devil, concerning whom there were many regulations among the primitive Christians. They were denied baptism and the eucharist; at least this was the practice of some churches: and though they were under the care of exorcists, yet it was thought a becoming act of charity to let them have the public prayers of the church, at which they were permitted to be present.

ENFILADE, in the art of war, is used in speaking of trenches or other places which may be scoured by the enemy's shot, along their whole length. In conducting the approaches at a siege, care must be taken that the trenches be not enfiladed from any work of the place.

ENFRANCHISEMENT, the incorporating a person into any society or body politic; such is the enfranchisement of one made a citizen of London, or other city, or burgess of any town corporate, because he is made partaker of the liberties which appertain to the corporation wherein he is enfranchised.

ENGASTRIMYTHI, in Pagan theology, the Pythias or priestesses of Apollo, who delivered oracles from within, without any action of the mouth or lips.

ENGENDERING, a term sometimes used for the act of producing or forming any thing: thus worms in the abdomen are said to be engendered.

ENGINE, in mechanics, is a compound machine, consisting of one or more mechanical powers, as levers, pulleys, screws, &c. in order to raise, cast, or sustain any weight, or produce any effect which could not be easily effected otherwise. See MECHANICS.

Engines are extremely numerous; some used in war, as the battering-ram, balista, waggons, chariots, &c.; others in trade and manufactures, as cranes, mills, presses, &c.; others to measure time, as clocks, watches, &c.; and others for the illustration of some branch of science, as the orrery, cometarium, and the like.

ENGINE, *fire*, the name now commonly given to a machine by which water is thrown upon fires in order to extinguish them.

The fire-engine is properly a forcing-pump (see HYDRAULICS); and its usual construction, after the great improvements were made in it by Mr. R. Newsham, was nearly that which is exhibited in fig. 1. Plate Engines, where we have represented a vertical section of the engine. The motion of the water in this machine is effected by the pressure of the atmosphere, the force of men acting upon the extremities H, H, of a lever, and thence giving motion to the pistons, and by the elasticity of condensed air, in the following manner: When the piston R is raised, a vacuum would be made in the barrel TU, if the water did not follow it from the inferior canal EM (through the valve O), which rises through the tube EF, immersed in the water of a vessel by the pressure o the atmosphere on its surface. The water of the barrel TU, by the succeeding depression of the piston R, shuts the valve O, and is forced, through the superior canal ON, to enter by the valve I into the air-vessel *abcd*; and the like being done alternately with respect to the other barrel WX, and its piston S, the air-vessel is by these means continually filling with water, which greatly compresses the air above the surface of the water in that vessel, and thereby proportionally augments its spring; which at length is so far increased as to react with great force on the surface YZ of the subjacent water, and compel it to ascend through the small tube *ef* to the stop-cock *eg*, where upon turning the cock the water is suffered to pass through a pipe *h* fixed to a ball and socket; from the orifice of which it issues in a continued stream with a great velocity, to a considerable height or distance; and it is usually kept from diverging too soon in its progress by means of a long series of flexible leather pipes, properly joined together, and known among the firemen by the name of the hose.

The greatest artifice in the engine, according to the construction just described, is the contrivance to produce a continual stream, which is done by the compression and proportional elasticity of air in the barrel *abcd*, called the air-vessel. For the air, being an elastic fluid, will be susceptible of compression in any degree by the water forced in through the valves at IK; and since the force of the air's spring will always be inversely as the space it possesses, it follows, that when the air-vessel is half full of water, the air will be compressed into half the space it possessed at first, and therefore its spring will be twice as great as at first.

But this spring at first was equal to the pressure of the atmosphere on the same surface: for if it was not, it could not have sustained or resisted the pressure of the atmosphere which stood over it, and consequently could not have filled the vessel before the water was driven in; which yet we find it did, and maintained an equilibrium with the common air. The vessel then being half-filled with water, or the air compressed into half the first space, its spring will in this case be equal to twice the pressure of the atmosphere; and therefore when the stop-cock at *p* is turned, the air within, pressing on the subjacent water with twice the force it meets with from the external air in the pipe *ef*, will cause the water to spout out of the engine to the height of 32 or 33 feet, if the friction is not too great.

When the air-vessel is two-thirds full of water, the air takes up one-third part; whence its spring will be three times as great as that of the common air, and it will project the water with twice the common atmospheric pressure; consequently it will rise to the height of 62 or 64 feet. When the air-vessel is three-fourths full of water, the air will be compressed into its one-fourth part, and so will protrude the water with three times the atmospheric pressure, and carry it to the height of 96 or 99 feet. Hence it will be easy to state the law by which the spring of the air will act on the surface of the water below it, as in the following table:

Height of water in air-bar.	*Of the air compressed.*	*Proportion of air's elasticity.*	*Height of the spout.*
$\frac{1}{2}$	$\frac{1}{2}$	2	33
$\frac{2}{3}$	$\frac{1}{3}$	3	66
$\frac{3}{4}$	$\frac{1}{4}$	4	99
$\frac{4}{5}$	$\frac{1}{5}$	5	132
$\frac{5}{6}$	$\frac{1}{6}$	6	165
$\frac{6}{7}$	$\frac{1}{7}$	7	198
$\frac{7}{8}$	$\frac{1}{8}$	8	231
$\frac{8}{9}$	$\frac{1}{9}$	9	264
$\frac{9}{10}$	$\frac{1}{10}$	10	297
$\frac{n-1}{n}$	$\frac{1}{n}$	n	$(n-1)$ 33

Various alterations and improvements have been made from time to time in the construction of fire-engines. The contrivers of some of these improvements, as Messrs. Bramah, Dickenson, Simpkin, Rowntree, and Philips, have secured their inventions from infringement by patents, the specifications of most of which may be seen in the Repertory of Arts and Manufactures. In the year 1785, the silver medal and 20 guineas were conferred by the Society for the Encouragement of Arts, &c. on Mr. Furst, as a reward for his contrivance to increase the effect of engines in extinguishing fires; of which the following is a short description: From a platform rises an upright pole or mast, of such height as may be judged necessary; a gaft slides upon it in an ascending direction, and along both is conveyed the leather hose from the engine. The branch or nose-pipe of the engine projects at the extremity of the gaft; towards which an iron frame is fixed, whence two chains are suspended; and from these hang ropes, which serve to give an horizontal direction to the branch; while other ropes that run through proper pulleys, and are thus conveyed down the mast, serve likewise to communicate a vertical motion to it. By these means the branch or nose-pipe of the engine is conducted into the window of any room where the fire more immediately rages; and the effect of the water discharged is applied in the most efficacious manner to the extinguishing of the flames.

A very cheap and simple fire-engine is that invented in America by Mr. Benjamin Dearborn, who communicated it to the American academy of arts and sciences, from whose Memoirs for 1794 we extract the following particulars:

Fig. 2. AB and CD are the edges of two planks, confined by four bolts; *ab* and *cd* are two cylindrical barrels, in each of which a piston, with a valve, is fastened to the spear *e*, and is moved up and down alternately by the motion of the arms EE. Beneath each barrel a hole is made through the plank AB, which is covered with a valve. The arms EE are suspended on the common centre *f*: there are also arms parallel to these on the opposite side: *gg* are the ends of handles which are fastened across the ends of the arms. At *h* a bolt goes across from arm to arm, to which the piece *ik* is affixed, and on which it plays; the lower end of this piece is fastened to the spear *e*. G *lf* is a standard for the purpose of supporting the arms, to which there is a correspondent one on the opposite side: both are notched into the edges of the planks, where they are secured by a bolt, which passes through them at *l*, and has a nut or fore-lock on the opposite side. HI, HI, are square braces, answering the purpose of ducts, through which the water ascends from the barrels, passing through the plank at *m*. KL, KL, are irons in the form of a staple, in order to confine the braces: the lower ends of these irons meet, and are secured by a bolt passing through them, and MN *uv*, which is a piece that goes up through a mortice in the centre of the planks. This piece is square from the lower end till it reaches the top of the braces; whence they become cylindrical to the top, the upper end being perforated sufficiently low down in order to communicate with the braces. OP is an iron ring that surrounds the tube, and has two shanks which ascend through the head, which screws on the top at *pq*.

Fig. 3. is the same engine; the arms and standards being taken off, in order to delineate more clearly the mode of securing the braces; an object which is completely effected by a wedge driven into the mortice *a*: beneath the upper plank *b* is a hole for admitting a passage to the bolt, which secures the standards. In this figure a side view of the head is given, with the pipe in a perpendicular direction.

The machine is confined within a box, set on wheels, as in the common fire-engines. The whole is made of wood, excepting the spears of the pumps, and a few bolts, &c. The advantages of this machine are, that it can be made in any place where common pumps are manufactured; the interior work will not exceed one-fourth of the price of those which are constructed on the usual plan; and they are incomparably more easy to work than the common ones: circumstances which strongly recommend the American fire-engine to the attention of the public.

Since the construction of engines for the extinguishing of fires has long been considered of very great importance, it is no wonder that many persons have devoted much of their time and talents to this subject.

ENGINE, *pile*, a machine by which piles are driven into the earth for the foundations of piers and other structures.

In pile-engines the contrivance consists in drawing up a great weight, called a ram or hammer, to a moderate height, and then letting it fall freely with a considerable momentum upon the head of the pile. In the most simple pile-engines the ram is drawn up by men pulling at a cord running over a fixed pulley, and suffering the cord to slip from their hands when the weight is sufficiently elevated. Among the more complex engines, the best are those invented by Mr. Vauloue and by Mr. S. Bunce.

Description of Vauloue's pile-engine. (See Plate Engines, fig. 4.)—A is a great upright shaft or axle, on which are the great wheel B and the drum C, turned by horses joined to the bars S,S. The wheel B turns the trundle X, on the top of whose axis is the fly O, which serves to regulate the motion, as well as to act against the horses, and to keep them from falling when the heavy ram Q is discharged to drive the pile P down into the mud in the bottom of the river. The drum C is loose upon the shaft A, but is locked to the wheel B by the bolt Y. On this drum the great rope HH is wound; one end of the rope being fixed to the drum, and the other to the follower G, to which it is conveyed by the pulleys I and K. In the follower G are contained the tongs F, that take hold of the ram Q by the staple R for drawing it up. D is a spiral or fusee fixed to the drum, on which is wound the small rope T that goes over the pulley U, under the pulley V, and is fastened to the top of the frame at 7. To the pulley-block V is hung the counterpoise W, which hinders the follower G from accelerating as it goes down to take hold of the ram; for, as the follower tends to acquire velocity in its descent, the line T winds downwards upon the fusee in a larger and larger radius, by which means the counterpoise W acts stronger and stronger against it; and so allows it to come down with only a moderate and uniform velocity. The bolt Y locks the drum to the great wheel, being pushed upward by the small lever 2, which goes through a mortice in the shaft A, turns upon a pin in the bar 3, fixed to the great wheel B, and has a weight 4, which always tends to push up the bolt Y through the wheel into the drum. L is the great lever turning on the axis *m*, and resting upon the forcing-bar 5,5, which goes through a hollow in the shaft A, and bears up the little lever 2.

By the horses going round, the great rope H is wound about the drum C, and the ram Q is drawn up by the tongs F in the follower G, until the tongs come between the inclined planes E; which, by shutting the tongs at the top, opens them at the foot, and discharges the ram, which falls down between the guides *bb* upon the pile P, and drives it by a few strokes as far into the mud as it will go; after which the top part is sawed off close to the mud by an engine for that purpose. Immediately after the ram is discharged, the piece 6 upon the follower G takes hold of the ropes *aa*, which raise the end of the lever L, and cause its end N to descend and press down the forcing-bar 5 upon the little lever 2, which, by pulling down the bolt Y, unlocks the drum C from the great wheel B; and then the follower, being at liberty, comes down by its own weight to the ram; and the lower ends of the tongs slip over the staple R, and the weight of their heads causes them to fall outward and shut upon it. Then the weight 4 pushes up the bolt Y into the drum, which locks it to the great wheel, and so the ram is drawn up as before.

As the follower comes down, it causes the drum to turn backward, and unwinds the rope from it, whilst the horses, great wheel, trundle, and fly, go on with an uninterrupted motion; and as the drum is turning backward, the counterpoise W is drawn up, and its rope T wound upon the spiral fusee D.

There are several holes in the under side of the drum, and the bolt Y always takes the first of them that it finds, when the drum stops by the falling of the follower upon the ram, until which stoppage the bolt has not time to slip into any of the holes.

The peculiar advantages of this engine are, the weight, called the ram or hammer, may be raised with the least force; that when it is raised to a proper height, it readily disengages itself and falls with the utmost freedom; that the forceps or tongs are lowered down speedily, and instantly of themselves again lay hold of the ram and lift it up.

This engine was placed upon a barge on the water, and so was easily conveyed to any place desired. The ram was a ton weight; and the guides *bb*, by which it was let fall, were 30 feet high.

Description of Bunce's pile-engine.—Figs. 5 and 6 represent a side and front section of the machine. The chief parts are, A B fig. 5. which are two endless ropes or chains, connected by cross pieces of iron, B (fig. 6.), corresponding with two cross grooves cut diametrically opposite in the wheel C (fig. 5.), into which they are received, and by which means the rope or chain A is carried round. D is a wheel, over which the chain passes and turns within at the top of the frame. It moves occasionally from F to G upon the centre H, and is kept in the position F by the weight I fixed to the end K. In fig. 7, L is the iron ram, which is connected with the cross pieces by the hook M. N is a cylindrical piece of wood suspended at the hook at O, which, by sliding freely up the bar that connects the hook to the ram, always brings the hook upright upon the chain when at the bottom of the machine.

When the man at S turns the usual crane-work, the ram, being connected to the chain and passing between the guides, is drawn up in a perpendicular direction; and when it is near the top of the machine, the projecting bar Q of the hook strikes against a cross piece of wood at R (fig. 5.), and consequently discharges the ram; while the weight I of the moveable frame instantly draws the upper wheel into the position shewn at F, and keeps the chain free of the ram in its descent. The hook, while descending, is prevented from catching the chain by the wooden piece N: for that piece being specifically lighter than the iron weight below, and moving with a less degree of velocity, cannot come into contact with the iron till it is at the bottom and the ram stops. It then falls, and again connects the hook with the chain, which draws up the ram as before.

In this machine, as well as Vauloue's, the motion of the first wheel is uninterrupted, so that very little time is lost in the operation: with a slight alteration it might be made to work with horses. It has the advantage over Vauloue's engine in point of simplicity: it may be originally constructed at less expence, and is not so liable to be deranged. Both, however, are ingenious performances, and part of their construction might be advantageously introduced into other machines.

ENGINES for raising water by the pressure and descent of a column inclosed in a pipe, have been lately erected in different parts of this country. The principle now adverted to was adopted in some machinery executed in France about 1731, and was likewise adopted in Cornwall more than forty years ago. But the pressure-engine of which we are about to give a particular description, is the invention of Mr. R. Trevithick, who probably was not aware that any thing at all similar had been attempted before. This engine, a section of which, on a scale of a quarter of an inch to a foot, is shewn in Plate Engines, fig. 8, was erected about eight years ago at the Druid copper-mine, in the parish of Illogan, near Truro. AB represents a pipe six inches in diameter, through which water descends from the head to the place of its delivery to run off by an adit at S, through a fall of 34 fathom in the whole; that is to say, in a close pipe down the slope of a hill 200 fathoms long, with 26 fathoms fall; then perpendicularly six fathoms, till it arrives at B; and thence through the engine from B to S two fathoms. At the turn B the water enters into a chamber C, the lower part of which terminates in two brass cylinders four inches in diameter; in which two plugs or pistons of lead, D and E, are capable of moving up and down by their piston rods, which pass through a close packing above, and are attached to the extremities of a chain leading over and properly attached to the wheel Q, so that it cannot slip.

The leaden pieces D and E are cast in their places, and have no packing whatever. They move very easily; and if at any time they should become loose, they may be spread out by a few blows with a proper instrument, without taking them out of their place. On the sides of the two brass cylinders, in which D and E move, there are square holes communicating towards G, which is an horizontal trunk or square pipe, four inches wide, and three inches deep. All the other pipes G, G, and R, are six inches in diameter, except the principal cylinder wherein the piston H moves; and this cylinder is ten inches in diameter, and admits a nine-foot stroke, though it is here delineated as if the stroke were only three-foot.

The piston-rod works through a stuffing-box above, and is attached to MN, which is the pit-rod, or a perpendicular piece divided into two, so as to allow its alternate motion up and down, and leave a space between, without touching the fixed apparatus or great cylinder. The pit-rod is prolonged down into the mine, where it is employed to work the pumps; or if the engine was applied to mill-work, or any other use, this rod would be the communication of the first mover.

KL is a tumbler or tumbling-bob, capable of being moved on the gudgeons V, from its present position to another, in which the weight L shall hang over with the same inclination on the opposite side of the perpendicular, and consequently the end K will then be as much elevated as it is now depressed.

The pipe RS has its lower end immersed in a cistern, by which means it delivers its water without the possibility of the external air introducing itself; so that it constitutes a Torricellian column or water-barometer, and renders the whole column from A to S effectual, as we shall see in our view of the operation.

The operation.—Let us suppose the lower bar KV of the tumbler to be horizontal, and the rod PO so situated as that the plugs or leaden pistons D and E shall lie opposite to each other, and stop the water-ways G and F. In this state of the engine, though each of these pistons is pressed by a force equivalent to more than a thousand pounds, they will remain motionless, because these actions being contrary to each other, they are constantly in equilibrio. The great piston H being here shewn as at the bottom of its cylinder, the tumbler is to be thrown by hand into the position here delineated. Its action upon OP, and consequently upon the wheel Q, draws up the plug D, and depresses E, so that the water-way G becomes open from AB, and that of F to the pipe R: the water consequently descends from A to C, thence to GGG, until it acts beneath the piston H. This pressure raises the piston; and if there be any water above the piston, it causes it to rise and pass through F into R. During the rise of the piston (which carries the pit-rod MN along with it), a sliding block of wood I, fixed to this rod, is brought into contact with the tail K of the tumbler, and raises it to the horizontal position, beyond which it oversets by the acquired motion of the weight L.

The mere rise of the piston, if there was no additional motion in the tumbler, would only bring the two plugs D and E to the position of rest, namely to close G and F, and then the engine would stop; but the fall of the tumbler carries the plug D downwards quite clear of the hole F, and the other plug E upwards quite clear of the hole G. These motions require no consumption of power, because the plugs are in equilibrio, as was just observed.

In this new situation the column AB no longer communicates with G, but acts through F upon the upper part of the piston H, and depresses it; while the contents of the great cylinder beneath that piston are driven out through GGG, and pass through the opening at E into R. It may be observed, that the column which acts against the piston is assisted by the pressure of the atmosphere, rendered active by the column of water hanging in R, to which that assisting pressure is equivalent, as has already been noticed.

When the piston has descended through a certain length, the slide or block at T, upon the pit-rod, applies against the tail K of the tumbler, which it depresses, and again oversets; producing once more the position of the plugs DE, here delineated, and the consequent ascent of the great piston H, as before described. The ascent produces its former effect on the tumbler and plugs; and in this manner it is evident that the alternations will go on without limit, or until the manager shall think fit to place the tumbler and plugs DE in the positions of rest, namely, so as to stop the passages F and G.

The length of the stroke may be varied by altering the positions of the pieces T and I, which will shorten the stroke the nearer they are together; as in that case they will sooner alternate upon the tail K.

As the sudden stoppage of the descent of the column AB, at the instant when the two plugs were both in the water-way, might jar and shake the apparatus, those plugs are made half an inch shorter than the depth of the side holes, so that in that case the water can escape directly through both the small cylinders to R. This gives a moment of time for the generation of the contrary motion in the piston and the water in GGG, and greatly deadens the concussion which might else be produced.

Some former attempts to make pressure-engines upon the principle of the steam-engine have failed; because water, not being elastic, could not be made to carry the piston onwards a little, so as completely to shut one set of valves and open another. In the present judicious construction, the tumbler performs the office of the expansive force of steam at the end of the stroke.

Mr. Boswell suggests, as a considerable improvement, that the action of this engine should be made elastic by the addition of an air-chamber, on the same principle as that used in fire-engines: this, he thinks, might be best effected by making the piston hollow, with a small orifice in the bottom, and of a larger size, to serve for this purpose, as the spring of the air would then act both on the upward and downward pressure of the water.

ENGINE, *steam*. The steam-engine is one of the noblest monuments of human ingenuity. It was originally invented by the marquis of Worcester, in the reign of Charles II. This nobleman, who appears to have been possessed of much knowledge, with a fertile imagination, published in 1663, a small book, called "A Century of Inventions," giving an account of a hundred discoveries or contrivances of his own; but the descriptions of many of them are altogether unintelligible.

Among them is an account of his invention of raising water by the force of steam, which, now that we are possessed of the engine, appears to agree very well with its construction. But as there is no plate to accompany his description, we are entirely unacquainted with the particular mode in which he applied the power of steam. It does not appear, however, that he met with sufficient encouragement; and this useful discovery was long neglected.

Towards the end of the century, captain Savary, a person of great ingenuity, having probably seen the account of the marquis of Worcester's invention, was convinced of its practicability, and succeeded in constructing a machine of this kind. He obtained a patent for the invention, and erected several steam-engines, which he described in a book entitled "The Miner's Friend," published in 1696.

The following is the description of his machine, as improved by himself:

A (Plate fig. 1) is a strong boiler, built in a furnace for generating steam. From the top of this boiler there proceeds a pipe, b, which conveys the steam into another strong vessel, r, called the receiver. This pipe has a cock at c, called the steam-cock. In the bottom of the receiver is a pipe S, which communicates with the rising-pipe H n k, the lower end of which is immersed in the well from which the water is to be raised. Immediately below the place where the pipe S enters the rising-pipe, there is a valve, n, opening upwards. A similar valve is also placed at i, above the pipe S. Lastly, there is a pipe e, which branching off from the rising-pipe, enters the top of the receiver. This pipe has also a cock, d, called the injection-cock. The mouth of the pipe e, has on the end f a nozzle, pierced full of holes, pointing from a centre in every direction. The keys of the two cocks c and d, are united by the handle h, called the regulator.

The mode of operation is as follows: Let the regulator be so placed, that the steam-cock c be open, and the injection-cock d shut: put water into the boiler A, and make it boil. The steam from it will enter the pipe b, and fill the receiver, first driving out the air which it before contained; a considerable quantity of steam will be at first condensed by the cold sides of the receiver: but it being at length warmed, the steam will proceed into the rising-pipe, lifting up the valve i. When this is perceived to be the case, by the rising-pipe feeling warm, and hearing the valve i rattle, the communication is now to be cut from the boiler, by shutting the steam-cock c, the injection cock d being also shut. The receiver now gradually cools, and the steam included in it condenses into water. When this is the case, as the air was at first driven out by the steam, and cannot return again, all the cocks being shut, a vacuum is formed in the receiver; consequently, there is nothing to counterbalance the pressure of the atmosphere, which acting upon the water in the well, forces it up the rising-pipe, and fills the receiver. The steam-cock is now opened; and the steam from the boiler rushing in with great violence, presses upon the surface of the water in the receiver, and forcing it through the pipe s, into the rising-pipe, causes it to shut the valve n, and open the other valve i; and, provided the steam be sufficiently strong, will force it up the rising-pipe to the top k, where it is delivered. The cock c is kept open until all the water be driven out of the receiver, and it is again filled with steam. The regulator is now applied, which shuts the steam-cock, whilst at the same time it opens the injection-cock. The rising-pipe being still full of water, a stream of cold water proceeds through the pipe e, and enters the receiver in a shower. This instantly condenses the steam in the receiver, and produces a vacuum as before; in consequence of which, the water from the well is again forced up by the external pressure of the atmosphere, and the receiver is again filled with water. The regulator is then turned, which shuts the injection-cock and opens the steam-cock, which permits the steam from the boiler to press upon the water, and again force it up the rising-pipe. This operation filling the receiver with water by means of a vacuum produced in it, and forcing it up the rising-pipe by the pressure of the steam from the boiler, is constantly repeated, by merely turning the regulator, which shuts and opens the steam-cocks and injection-cocks alternately.

This construction of the steam-engine is extremely simple, and might perhaps be successfully applied for some purposes. But it has several considerable defects. It may readily be apprehended, that the action of the direct steam on any definite surface (such, for example, as a square inch) will be accurately equal to the re-action of the water which is forced up; and consequently, that Savary's engine will require steam more elastic than the air of the atmosphere, in every case except where the water is raised no higher than it can be by the vacuum that is produced, and the pressure of the atmosphere. When the water is forced up through the rising-pipe, every square inch of the boiler must sustain a pressure equal to a column of water an inch square, and of the height of the pipe above the boiler. This, therefore, requires very strong vessels, and several accidents happen by their bursting when the safety valve is loaded too much.

But the greatest defect of this machine is the great waste of steam, and consequently of fuel. For when the steam is admitted to the top of the cold water in the receiver, it is condensed with great rapidity; and the water does not begin to yield to its pressure, until its surface is so hot, as not to condense any more steam: it now descends; but as by that, a new part of the side of the receiver is exposed to the steam, more is condensed, so that a condensation of the steam is going on all the while the water is descending. This too must necessarily be repeated every stroke, as the receiver is cooled every time it is filled with water.

Mr. Savary succeeded in raising water to small heights, and erected several engines in different parts of England; but he could make nothing of deep mines. Many attempts have been made to correct these defects, but hitherto without much success.

In the beginning of the eighteenth century, Newcomen, an ironmonger or smith, and Crauly, a glazier at Dartmouth, in Devonshire, first conceived the project of applying a piston with a lever, and other machinery. They were contented to share the profits of the invention with Savary, who procured a patent for it in 1705, in which they were all three joined.

Fig. 2, exhibits a section of Newcomen's engine: a is the boiler, built in brick-work. In the top of the boiler is a steam-pipe, c, communicating with the cylinder, b, which is of metal, and is bored very truly. The lower aperture of this pipe is shut by the plate n, which is ground very flat, so as to apply very accurately to the whole circumference of the orifice. This plate is called the regulator, or steam-cock, and it turns horizontally round an axis o, which passes through the top of the boiler, and is fitted by grinding to the socket, so as to be steam-tight. It is opened and shut by a handle fixed to its axis.

In the cylinder b is a solid piston, p, well fitted into it, and made air-tight by a packing of leather or soft rope, well filled with tallow; and for greater security, a small quantity of water is kept above the piston.

The piston-rod d is suspended by a chain, which is fixed to the upper extremity of the arched head e of the great lever, or working-beam, e f g, which turns on the gudgeon f. There is a similar arched head g, at the other end of the beam; to the upper extremity of which is fixed a chain, carrying the pump-rod h, which raises the water from the mine.

The load on this end of the beam is made to exceed considerably the weight of the piston at the other extremity.

At a small height above the top of the cylinder, is a cistern called the injection-cistern, i. From this descends the injection-pipe, k, which enters the bottom of the cylinder, and terminates in a nozzle pierced with holes. This pipe has a cock, l, called the injection-cock.

At the opposite side of the cylinder, a little above its bottom, there is a lateral pipe m, turning upwards at the extremity; and there covered by a clack-valve, called the snifting-valve, which has a little dish round it, to hold water for keeping it air-tight.

There proceeds also from the bottom of the cylinder, a pipe g, of which the lower end is turned upwards, and is covered with a valve r. This part is immersed in a cistern of water, called the hot-well, and the pipe itself is called the eduction-pipe.

Lastly, the boiler is furnished with a safety valve, called the puppet-clack, in the same

Pressure Engine.

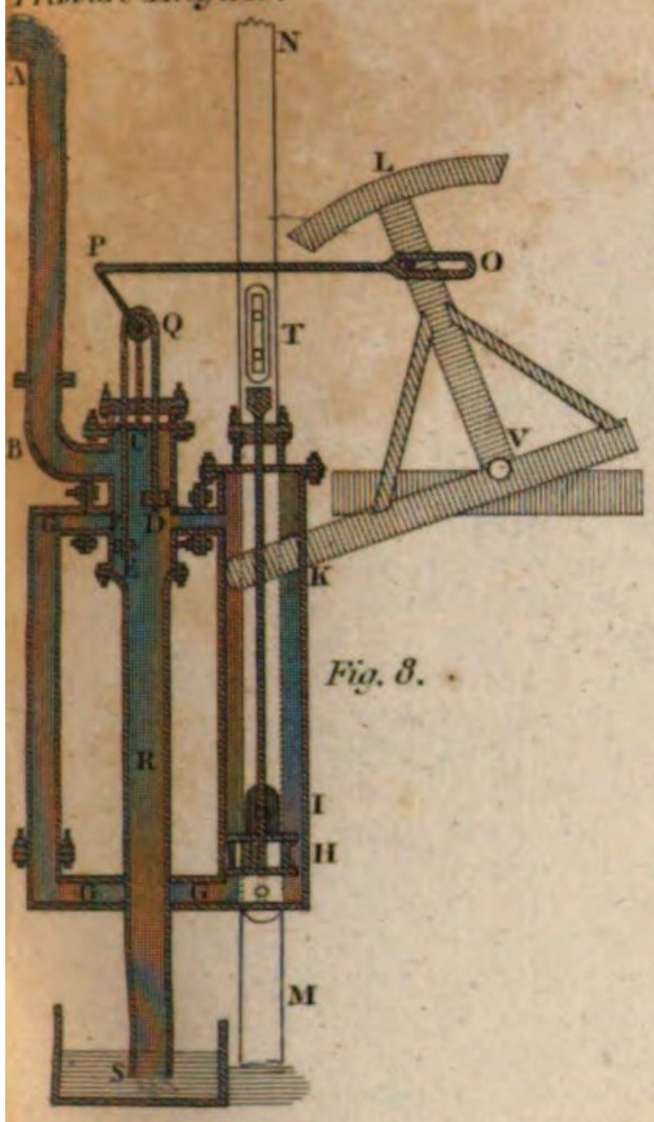


Fig. 8.

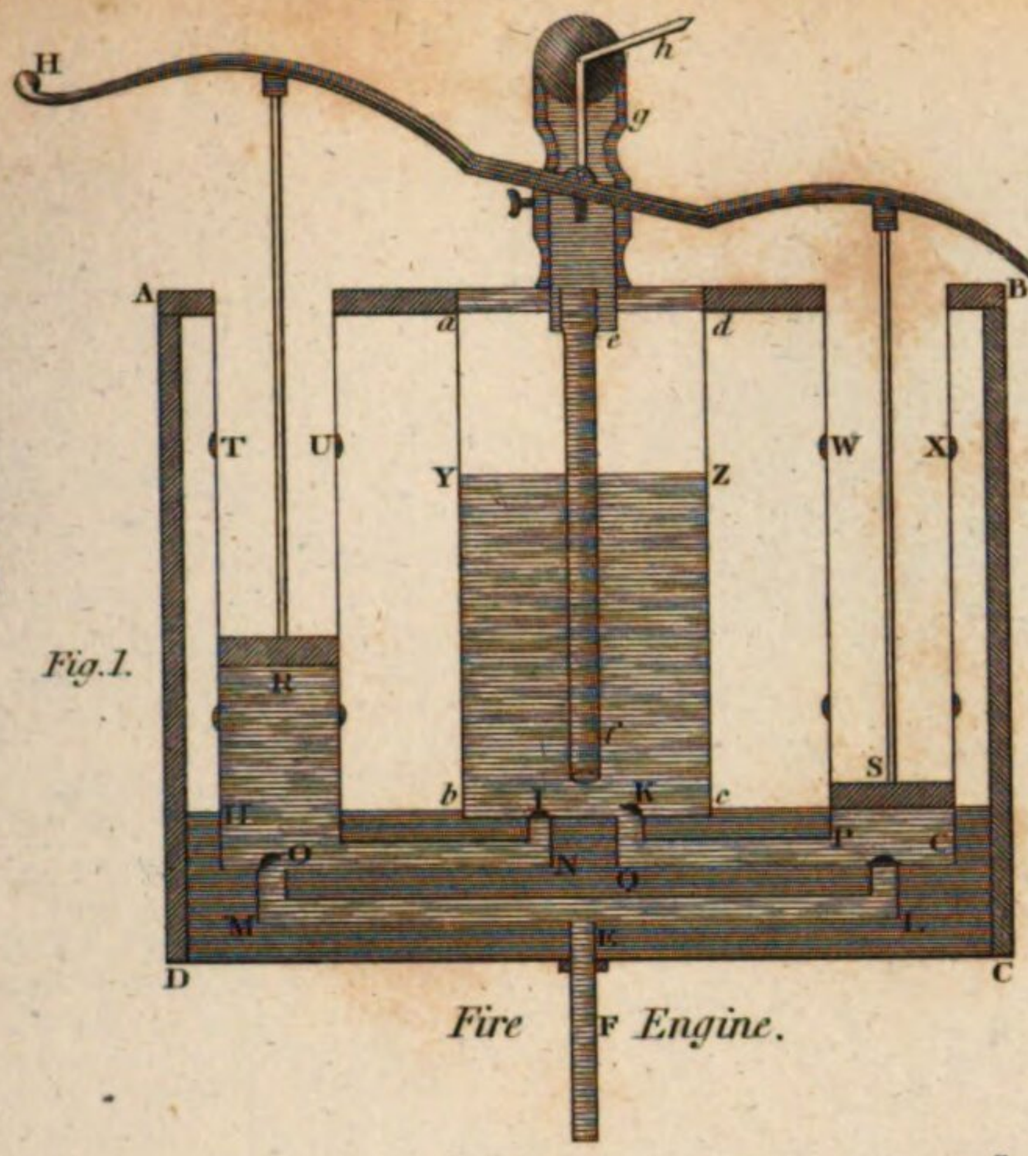


Fig. 1.

Fire Engine.

Engine to lower Weights.

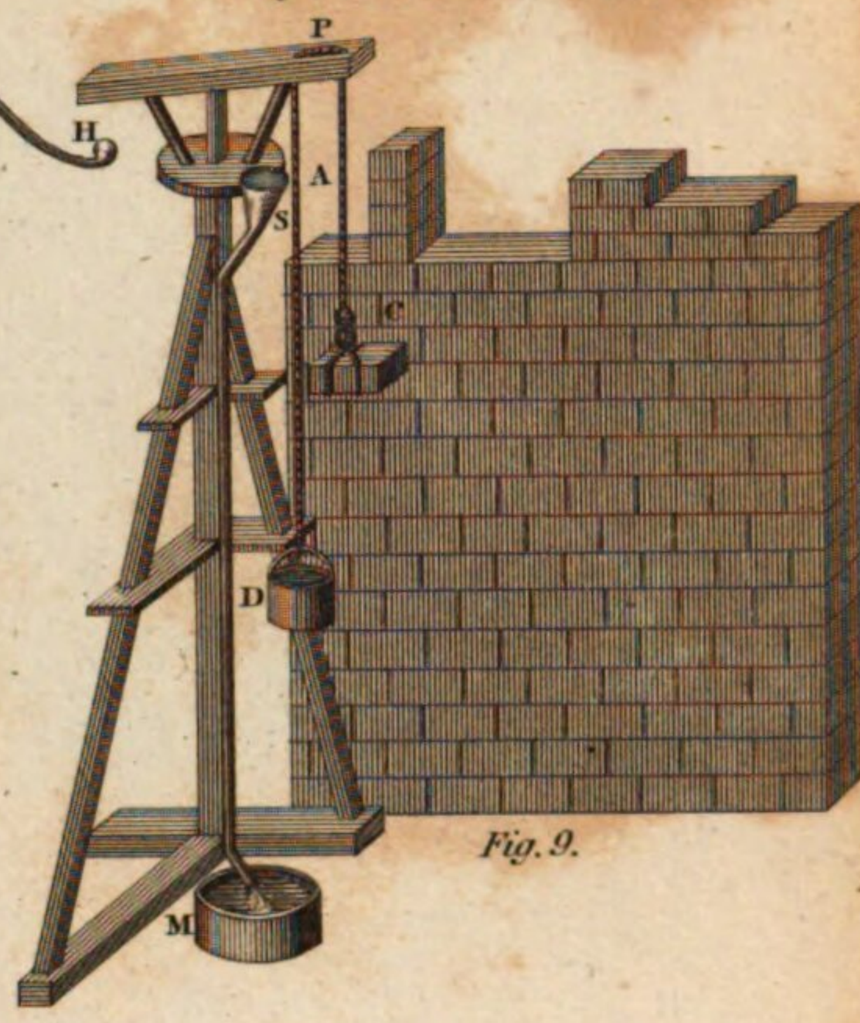


Fig. 9.

Dearborn's Fire Engine.

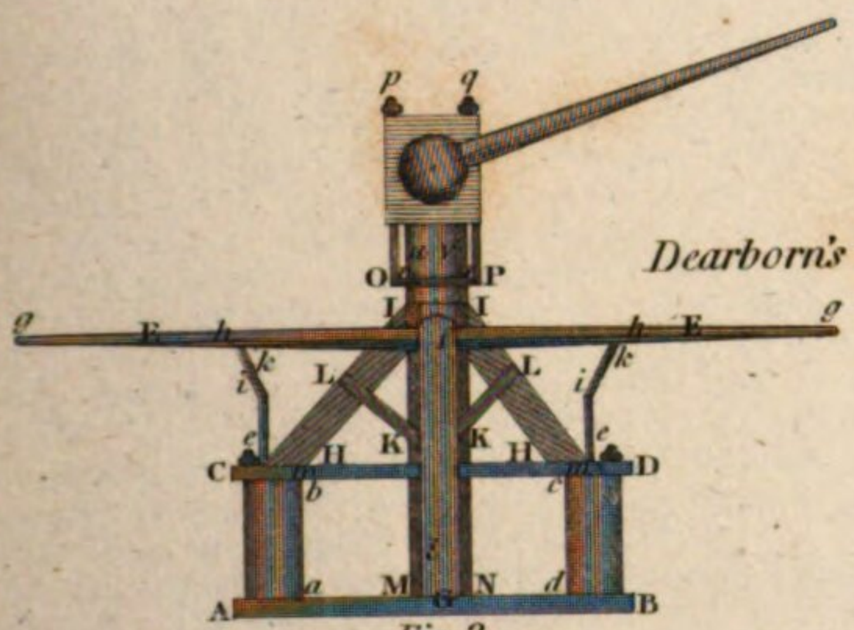


Fig. 2.

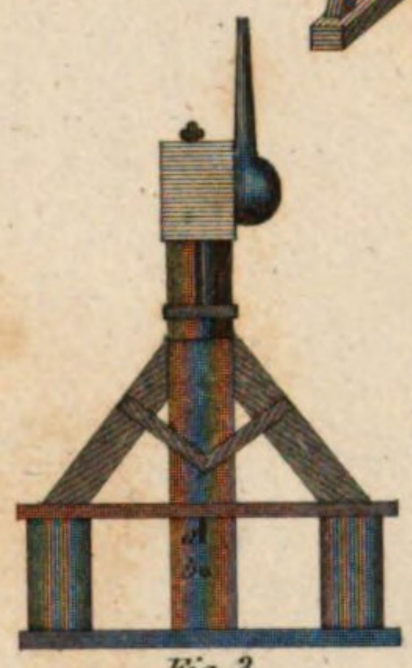
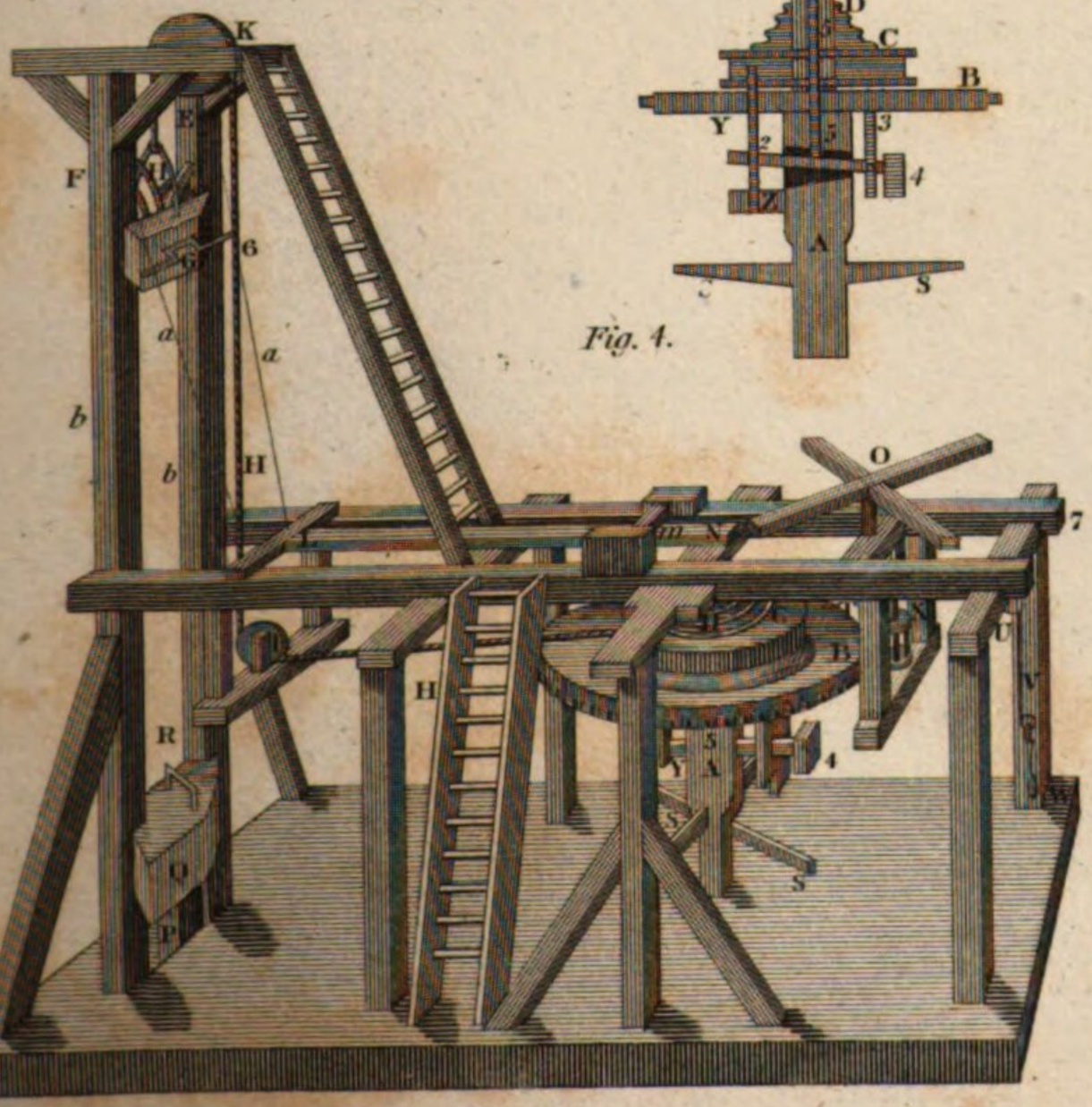


Fig. 3.

Vauloue's Pile Engine.



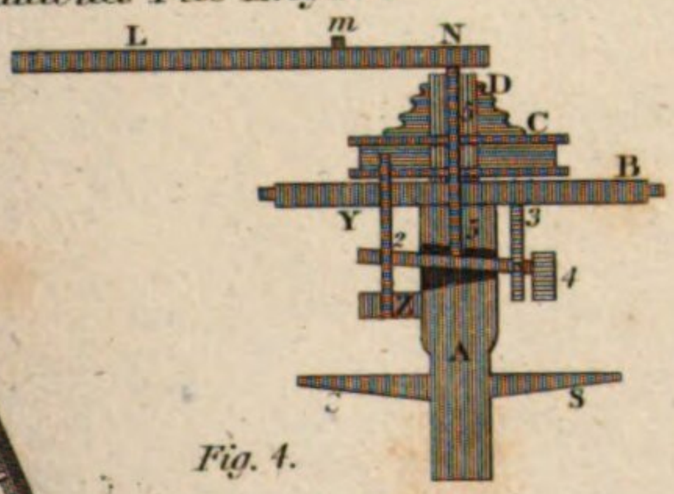


Fig. 4.

Bunce's Pile Engine.

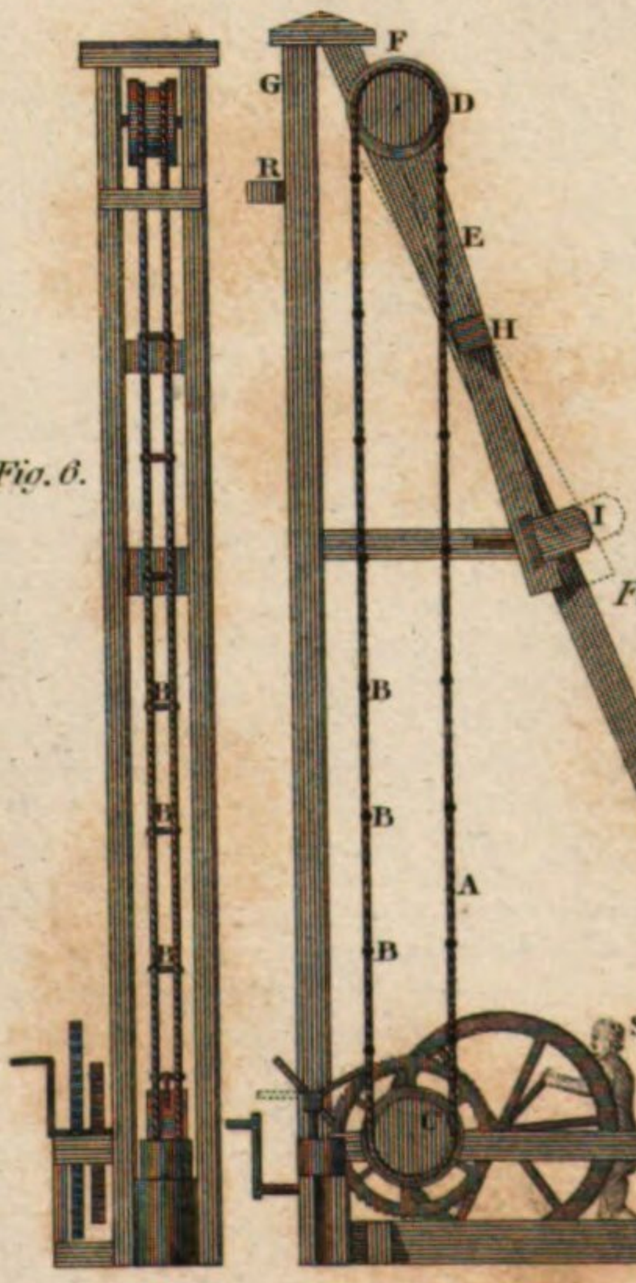


Fig. 6.

Fig. 5.

Fig. 7.

manner as in Savary's engine. This valve is generally loaded with one or two pounds in the square inch, so that it allows the steam to escape when its elasticity is one-tenth greater than that of the atmosphere. Thus all risk of bursting the boiler is avoided, the pressure outwards being very moderate.

When the cistern for the injection-water i, cannot be supplied by pipes from some more elevated source, water is raised by the machine itself. A small lifting-pump, s, is worked by a rod v, suspended from a small arch upon the great beam; this forces water through the pipe t into the injection-cistern.

The parts of the engine being now described, the operation is as follows:

Suppose the piston and lever in the position represented in the plate, and the water in the boiler in a state of ebullition, the steam and injection-cocks being shut. Having opened the steam-cock, n, the steam from the boiler will immediately rush in, and flying all over the cylinder, will mix with the air.

Much of it will be condensed by the cold surface of the cylinder and piston, and the water produced from it will trickle down the sides, and run off by the eduction-pipe. This condensation and waste of steam will go on until the whole cylinder and piston be be made as hot as boiling-water.

When this happens, the steam will begin to issue through the snifting-valve, slowly at first, and cloudy, being mixed with much air; but, by degrees, it will become more transparent, having carried off the greatest part of the air which filled the cylinder.

When the attendant perceives that the blast at the snifting-valve is strong and steady, and the boiler is supplied with a steam of proper strength, appearing by the renewal of its discharge at the safety-valve, which had stopped while the cylinder was filling, he shuts the steam-cock, n, and opens the injection-cock, l. The pressure of water in the injection-pipe forces some out into the cylinder, which condenses the steam and forms a partial vacuum, as explained above.

The upper side of the piston is now exposed to the whole pressure of the atmosphere, which, not being counterbalanced on the under side, will act with its whole force on the piston, and, provided there be not too much weight on the other end, will raise it, the piston going to the bottom of the cylinder.

When the piston has gone down as low as necessary, the injection-cock is shut, and the steam-cock opened. The steam, which has been accumulating above the water in the boiler, during the time of the descent of the piston, and is now issuing through the puppet-clack, as soon as the steam-cock is opened, rushes violently into the cylinder, having a greater elasticity than that of the air. It therefore immediately blows open the snifting-valve, through which it drives out the air that had been disengaged from the injection-water.

At the same time, the water which had been injected before, and the condensed steam, run out through the eduction-pipe, g, and lifting up the valve, r, flow into the hot-well.

By the admission of the steam under the piston, the pressure of the atmosphere on the top is counterbalanced, and the piston is free to move upwards or downwards.

But the other end of the beam being broader, so as to be heavier than the piston, now raises it to the top of the cylinder, whence it is again forced downwards by the pressure of the atmosphere, as soon as a vacuum is formed under it by the admission of the injection-water. In this manner the operation is repeated; the piston being forced down by the weight of the atmosphere, raises the other end of the beam, with whatever is attached to it; and, on the other hand, when the pressure of the atmosphere is counterbalanced by the steam under the piston, the superior weight of the pump-end of the beam brings the piston up again.

We now see the difference between Savary's and Newcomen's engine, in respect to principle. Savary's was an engine that raised water by the force of steam; but Newcomen's raises water entirely by the pressure of the atmosphere; and the steam is employed merely as the most expeditious mode of producing a vacuum, into which the atmospherical pressure may impel the first mover of his machine.

We see also the great superiority of this new machine. We have no need of steam of great and dangerous elasticity; and we operate by means of very moderate heats, and consequently with a much smaller quantity of fuel; and there are no bounds to the power of this machine. How deep soever a mine may be, a cylinder may be employed of such dimensions, that the pressure of the air may exceed, in any degree, the weight of the column of water to be raised. And lastly, this form of the machine renders it applicable to almost every mechanical purpose; because a skilful mechanic can readily find a method of converting the reciprocating motion of the working-beam into a motion of any kind which may suit his purpose. Savary's engine could hardly admit of such a general application, and seems almost restricted to raising water.

Newcomen's engine was first offered to the public in 1705. But many difficulties occurred in the execution of it, which were removed one by one; and it was not till 1712, that the engine seemed to give confidence in its efficacy.

The most exact and unremitting attention was required, to open and shut the cocks precisely at the proper time; for neglect might be ruinous to the machine, by the confined steam beating out the bottom of the cylinder, or allowing the piston to be wholly drawn out of it. Stops were contrived to prevent these accidents; then strings were used to connect the handles of the cocks with the beam, so that they should be turned whenever it was in certain positions. These were gradually changed, and improved into detents and catches of different shapes; at last, Mr. Beighton, a very ingenious and well-informed artist, simplified the whole of these subordinate movements, and otherwise very much improved the machine.

The greatest improvement that has since been made on Newcomen's engine, has been in the manner of placing the boiler. Instead of placing it underneath the cylinder, it is built at some distance from it, and sometimes in a separate building.

About 1762, Mr. Watt began to turn his attention to this machine, which he has since brought to so great a degree of perfection.

But before we explain Mr. Watt's engines, it is necessary to premise a short account of the imperfections of the old steam-engines, and their causes.

The steam or vapour which arises from water confined in a close vessel, and heated a few degrees above the point at which it boils in the open air, becomes an elastic fluid, uniform, and transparent, about half the gravity of atmospheric air, very much greater in bulk than the water of which it is composed, and capable of being again reduced to water when brought into contact with matter of a less degree of heat than itself.

The pressure of the atmosphere, or any equivalent resistance, prevents the production of steam, until the water is heated to 212 degrees of Fahrenheit's thermometer; but when that pressure is removed, or the water is placed in a vessel exhausted of air, steam is produced from it when it is colder than the human blood. On the contrary, if water is pressed upon by air or steam, which are more compressed than the atmosphere, a degree of heat above 212 degrees is necessary for the production of steam; and the difference of heats at which water boils under different pressures, increases in a less proportion than the pressures themselves; so that a double pressure requires less than a double increase of sensible heat.

The experiments which have been published concerning the bulk of water when converted into steam, are erroneous; and the conclusions drawn from them make that bulk greater than it really is. It has been known for some time, that water would boil in an exhausted receiver at a low degree of heat.

If we consider the common steam-engine, we shall find it defective; first, because the vacuum is produced by throwing cold water into the cylinder to condense the steam: that water becomes hot, and, being in a vessel partially exhausted, produces a steam, which in part resists the pressure of the atmosphere upon the piston, and lessens the power of the engine. The second defect is the destruction of steam, which unavoidably happens upon attempting to fill a cold cylinder with that fluid; for the injection-water, at the same time that it condenses the steam, not only cools the cylinder, but remains there until it is extruded at the eduction-pipe by the steam which is let in to fill the cylinder for the next stroke; and that steam will be condensed into water as fast as it enters, until all the matter it comes in contact with is nearly as hot as itself.

Every attempt to make the vacuum more perfect by the addition of injection-water, will cool the cylinder more effectually, and cause a greater destruction of steam in the next filling; and if the engine has already a proper load, the destruction of steam will proceed in a greater ratio than the increase of power by the amendment of the vacuum.

Though it appears that the constructors of steam-engines have never investigated these causes, yet they have been so sensible of the effects, that a judicious engineer does not attempt to load his engine with a column of water heavier than seven pounds for each square inch of the area of the piston.

Mr. Watt's improvements are founded upon these, and some other collateral observations. He preserves an uniform heat in the cylinder of his engines, by suffering no

cold water to touch it; and by protecting it from the air or other cold bodies, by a surrounding case filled with the steam, or with hot air or water, and by coating it over with substances that transmit heat slowly. He makes his vacuum to approach nearly to that of the barometer, by condensing the steam in a separate vessel, called the condenser; which may be cooled at pleasure without cooling the cylinder, either by injection of cold water, or by surrounding the condenser with it; and generally by both. He extracts the injection-water and detached air from the cylinder or condenser, by pumps, which are wrought by the engine itself; or he blows it out by the steam.

As the inside of the cylinder was in the old engine exposed to the air at every stroke when the piston descended, and was considerably cooled thereby, he incloses the top of the cylinder by a metal plate, having a hole in it, through which the piston-rod works in a collar of leathers; and instead of employing the pressure of the atmosphere to force down the piston, he introduces the steam above the piston, when the vacuum is formed underneath, and employs it to produce this effect: thus making the direct pressure of the steam the moving power, as in the original construction of the engine.

The last great improvement made by Mr. Watt, was his giving an impulse to the piston by the steam, both in descending and ascending, instead of being impelled, as in the old engine, during the descent of the piston only.

Having thus briefly mentioned the principal improvements made in the steam-engine by Mr. Watt, we shall proceed to describe one of his engines on the latest construction.

A is the boiler, to which Mr. Watt has paid very great attention. It is generally of an oblong form; and the flame, after striking on its concave bottom, circulates round the sides, and sometimes returns in a pipe through the body of the water before it is suffered to go up into the chimney. In his engines there are commonly two of these boilers, so that one of them may work while the other is repairing. B (Plate fig. 3) is the steam-pipe which conveys the steam to the cylinder C, which is cased, and closed at top by a plate, having a collar of leathers, through which the piston-rod D works. a and c are the steam-valves, through which the steam enters into the cylinder: it is admitted through a, when it is to press the piston downwards, and through c when it presses it upwards. b and d are the eduction-valves, through which the steam passes from the cylinder into the condenser e, which is a separate vessel placed in a cistern of cold water, and which has a jet of cold water continually playing up in the inside of it. f is the air-pump, which extracts the air and water from the condenser: it is worked by the great beam or lever; and the water brought by it from the condenser, after being brought into the hot-well g, is pumped up again by the pump h, and is brought back again into the boiler by the pipe i. k is another pump, also worked by the engine itself, which supplies the cistern in which the condenser is placed, with cold water.

In the old engines, where the working-stroke was only downwards, the piston-rod was attached to the beam by chains, which bent round an arch on the end of the beam, in order to make the piston-rod move always in a perpendicular direction. This may be seen in the plate of Newcomen's engine. But in Mr. Watt's engines, where the working-stroke is doubled, that is, both upwards and downwards, chains could not answer this purpose, as, when the piston was forced upwards, they would slacken, and would not communicate the motion to the beam. It was necessary, therefore, that the piston-rod should be fastened to the beam by inflexible bars; but that the stroke might be perpendicular, a particular contrivance was invented by Mr. Watt, which is exhibited in the plate, and which answers the intended purpose admirably. It is usually called the parallel joint, and its nature and construction will be easily understood from the figure. In order to make the engine itself open and shut the steam and eduction-valves, long levers are attached to them, which are moved by the piston-rod of the air-pump E F. This part of the apparatus is called the working-geer, and is so contrived, that the valves may be worked either by hand or by the perpendicular rod. By shutting these valves, the engine may be stopped in an instant.

In order to communicate a rotatory motion to any machinery by the motion of the beam of the steam-engine, Mr. Watt makes use of a very large fly-wheel G; on the axis of which is a small concentric toothed wheel, H. A similar toothed wheel, I, is fastened by straps to a rod coming from the end of the beam, so that it cannot turn round on its axis, but must rise and fall with the motion of the great beam.

A bar of iron connects the centres of these two small toothed wheels, so that they cannot quit each other. When, therefore, the beam raises the wheel I, it must move round the circumference of the wheel H, and turn it together with the fly; and it will be evident, upon consideration, that the fly, driven in this manner, will make two revolutions for every one of the wheel I. This mode of moving the fly, is preferable to a crank; as it goes with twice the velocity. This contrivance is called the sun and planet wheel, from the resemblance of the motion to that of those luminaries.

The valves of this steam-engine are all puppet-valves, as these are found least liable to be out of order.

The mode of operation in Mr. Watt's engine, is as follows:

Suppose the piston at the top of the cylinder, in the situation represented in the plate, and the lower part of the cylinder filled with steam. By means of the handle E, open the steam-valve a, and the eduction-valve d, the levers of which are connected together; there being now a communication between the cylinder and the condenser, the steam instantly rushes into the condenser, leaving the cylinder empty; whilst at the same time the steam from the boiler, entering by the steam-valve a, presses upon the piston, and forces it down. As soon as the piston has arrived at the bottom, the steam-valve c, and the eduction-valve b, are opened, whilst the valves a and d are shut; the steam therefore immediately rushes through the eduction-valve b, into the condenser, whilst the piston is forced up again by the steam, which is now admitted by the steam-valve c.

Fig. 4, which is a section of the steam-pipes, taken at right angles to that in fig. 3, shews this more distinctly; s is the pipe which conveys the steam from the boiler; a and c are the steam-valves, and b and d the eduction-valves. By attending to the operation in both the sections, the reader will easily understand it. It appears at first a little confused, by there seeming to be only one steam-pipe for communicating between the cylinder and the condenser; but the difficulty is cleared up, by representing both the pipes, as in fig. 4.

Fig. 5, is a longitudinal section of the boiler, representing the mode of supplying it with water, and the safety-valve and cocks. f is a small cistern, which is supplied with water from the hot-well, as represented in fig. 3; from the bottom of this cistern, a pipe goes down almost to the bottom of the boiler, where it turns up a little, to prevent the entrance of the steam which rises from the bottom. From the side of this cistern, is supported a small lever, to one end of which is fastened a wire, that carries a stone which hangs in the water of the boiler; the other end of the lever supporting also by a wire, a valve that shuts the top of the pipe that goes down from the cistern. Now, supposing the stone just at the surface of the water, and balanced by a weight at the opposite end of the lever; it is evident, that by the laws of hydrostatics, already explained, a certain part of the weight of the stone will be supported by the water, so long as it continues immersed in it; but if a part of the water evaporate by boiling, a proportional part of the stone will be above the water, consequently the stone will bear more upon the lever, and raise the weight at the other end; but in raising that weight, it also opens the valve in the small cistern, and admits water until it stand at the same height in the boiler as before, and then the valve and the stone being again in equilibrio, the valve remains shut until a new quantity is evaporated. By this means the supply of water is very gradual, however, and not by fits and starts, as here described for the sake of illustration.

It is found by experience, to be a much better method than a ball-cock, and the regular supplying of the boiler with water is of the first importance. As a check upon this, and to know perfectly the height of the water in the boiler, there are two cocks, g and h, one of which reaches nearly to the surface of the water when at its proper height, and the other enters a little below the surface.

It is evident, that if the water be at the just height, and you open g, steam will issue; and if h be opened, water will be driven out by the pressure of the steam. But if water come out from g, then the water must be too high in the boiler; and if steam issue from h, then the water is too low. By this means, it is easy to know at all times the exact height of the water in the boiler.

i is a safety-valve, to prevent the bursting of the boiler by the steam growing too strong; k is the pipe which conveys the steam to the engine.

Fig. 6 is Mr. Cartwright's steam-engine, the construction of which evinces much inge-

nuity. a is the cylinder, which is supplied with steam from the boiler through the pipe b; c is the piston in the act of going up; d is the pipe that conducts the steam into the condenser e, which consists of two cylinders, one within the other, leaving a small space between them, into which the steam is admitted; while the inner cylinder is filled with cold water, and also the external cylinder surrounded by the same; so that, by this means, a very large surface of steam is exposed, though no water is suffered to come into actual contact with it.

To the bottom of the piston, c, is attached a rod, with another piston, e, working in the pipe d. When the piston e arrives at the bottom of the cylinder, a valve which is in the piston, is opened by its pressing against the bottom, and opens a communication with the condenser, whilst the spring k, fixed to the rod of the piston, shuts the valve which admits the steam from the boiler. The steam, therefore, being thus condensed, runs into the lower pipe f. The piston e, arriving at the bottom of the pipe in which it works at the same time with c, presses upon the condensed water, shuts the valve f, and forces the water up the pipe g, into the box h. The air which is disengaged from the water, rises to the top of the box, and, by its elasticity, forces the water through the pipe i, which carries it back again into the boiler. When the air accumulates in the box to such a degree as to depress the water, the ball-cock falls with it, and opens a valve in the top of the box, which suffers some of the air to escape.

When all the steam is condensed, the motion of the fly attached to the machine brings the piston up again, its valve now remaining shut by its weight. On arriving at the top, it presses up the steam-valve, which admits the steam from the boiler to force it down as before.

l and m are two cranks, upon whose axis are two equal wheels working in each other, for the purpose of converting the perpendicular motion of the piston-rod into a rotatory motion, for working the machinery attached to it.

But the most valuable part of this engine is in the construction of the piston, which Mr. Cartwright made wholly of metal, and so as, by means of springs, to fit the cylinder very exactly. This not only saves the expence and trouble of packing, which they are obliged frequently to renew in all other engines, but also saves a great deal of steam, on account of the more accurate fitting of the piston.

As it is evident, from its construction, that the whole of the steam is brought back again into the boiler, it affords the means of employing ardent spirit instead of water, and thus saving a great deal of fuel.

This machine seems to be peculiarly applicable to purposes requiring only a small power, as it is not expensive, and occupies little room.

It would far exceed the limits of this work, to enter into an examination of all the steam-engines invented by different persons. It is sufficient to mention, that no engine of this kind has been found, upon careful trial, to be superior to those of Mr. Watt.

From this brief description of the steam-engine, the reader will be enabled to perceive the nature, and appreciate the value, of Mr. Watt's improvements. It had hitherto been the practice to condense the steam in the cylinder itself, by the injection of cold water; but the water which is injected acquires a considerable degree of heat from the cylinder, and being placed in air highly rarefied, part of it is converted into steam, which resists the piston, and diminishes the power of the engine. When the steam is next admitted, part of it is converted into water by coming in contact with the cylinder, which is of a lower temperature than the steam, in consequence of the destruction of its heat by the injection-water. By condensing the steam, therefore, in the cylinder itself, the resistance to the piston is increased by a partial reproduction of this elastic vapour, and the impelling power is diminished by a partial destruction of the steam which is next admitted. Both these inconveniences Mr. Watt has in a great measure avoided, by using a condenser separate from the cylinder, and encircled with cold water; and by surrounding the cylinder with a wooden case, and interposing light wood-ashes, in order to prevent its heat from being abstracted by the ambient air.

The greatest of Mr. Watt's improvements consists in his employing the steam both to elevate and depress the piston. In the engines of Newcomen and Beighton, the steam was not the impelling power it: was used merely for producing a vacuum below the piston, which was forced down by the pressure of the atmosphere, and elevated by the counterweight at the farther extremity of the great beam. The cylinder, therefore, was exposed to the external air at every descent of the piston, and a considerable portion of its heat being thus abstracted, a corresponding quantity of steam was of consequence destroyed. In Mr. Watt's engines, however, the external air is excluded by a metal plate at the top of the cylinder, which has a hole in it for admitting the piston-rod; and the piston itself is raised and depressed merely by the force of steam.

When these improvements are adopted, and the engine is constructed in the most perfect manner, there is not above $\frac{1}{4}$ part of the steam consumed in heating the apparatus; and, therefore, it is impossible that the engine can be rendered $\frac{1}{4}$ more powerful than it is at present. It would be very desirable, however, that the force of the piston could be properly communicated to the machinery without the intervention of the great beam. This, indeed, has been attempted by Mr. Watt, who has employed the piston-rod itself to drive the machinery; and Mr. Cartwright has, in his engine, converted the perpendicular motion of the piston into a rotatory motion, by means of two cranks fixed to the axis of two equal wheels which work in each other. Notwithstanding the simplicity of these methods, none of them have come into general use; and Mr. Watt still prefers the intervention of the great beam, which is generally made of hard oak, with its heart taken out, in order to prevent it from warping. A considerable quantity of power, however, is wasted by dragging, at every stroke of the piston, such a mass of matter from a state of rest to a state of motion, and then from a state of motion to a state of rest. To prevent this loss of power, a light frame of carpentry has been employed by several engineers, instead of the solid beam; but after being used for some time, the wood was generally cut by the iron bolts, and the frame itself was often instantaneously destroyed. In some of the engines lately constructed by Mr. Watt, he has formed the great beam of cast iron, and while he has thus added to its durability, he has at the same time diminished its weight and increased the power of his engine.

Encouraged by Mr. Watt's success, several improvements upon the steam-engine have been attempted by Hornblower, Trevethick, and many other engineers of this country. But it does not appear that they have either increased the power of the engine, or diminished its expence. It appears, on the contrary, that many of these pretended improvements, excepting those of Hornblower, consist merely in having adopted Mr. Watt's discoveries, in such a manner as not to infringe upon his patent.

Some time since, Mr. Arthur Woolf announced to the public a discovery respecting the expansibility of steam, which promises to be of very essential utility. Mr. Watt had formerly ascertained, that steam which acts with the expansive force of four pounds per square inch, against a safety valve exposed to the weight of the atmosphere, after expanding itself to four times the volume it thus occupies, is still equal to the pressure of the atmosphere. But Mr. Woolf has gone much farther, and has proved, that quantities of steam, having the force of 5, 6, 7, 8, 9, 10, &c. pounds on every square inch, may be allowed to expand 5, 6, 7, 8, 9, 10, &c. times its volume, and will still be equal to the atmosphere's weight, provided that the cylinder in which the expansion takes place, has the same temperature as the steam before it began to expand. It is evident, however, that an increase of temperature is necessary both to produce and to maintain this augmentation of the steam's expansive force above the pressure of the atmosphere. At the temperature of 212° of Fahrenheit, the force of steam is equal only to the pressure of the atmosphere: and in order to give it an additional elastic force of five pounds per square inch, the temperature must be increased to about 227½°; when it will have acquired a power to expand itself to five times its volume, and still be equal in pressure to the atmosphere, and capable of being applied as such in the working of steam-engines, according to his invention. The ratio of other pressures, temperatures, and expansive forces of steam, is shewn in the following table; which gives the relative pressure per square inch, temperatures, and expansibility of steam, at degrees of heat above the boiling point of water; beginning with a temperature of steam of an elastic force equal to five pounds per square inch, and extending to steam able to sustain forty pounds on the square inch.

Table of the pressures, temperatures, and expansibility of steam, equal to the force of the atmosphere.

Elastic force of steam predominating over the pressure of the atmosphere, and acting upon a safety-valve.	Degrees of temperature requisite for bringing the steam to the different expansive forces in the preceding column.	No. of times its volume that steam of the preceding force and temperature will expand, and still continue equal to the pressure of the atmosphere.
Pounds per square inch.	Degrees of heat.	Expansibility.
5	227½	5
6	230½	6
7	232½	7
8	235½	8
9	237½	9
10	239½	10
15	250½	15
20	259½	20
25	267	25
30	273	30
35	271	35
40	282	40

In this manner, by small additions of temperature, an expansive power may be given to steam, which will enable it to expand 50, 100, 200, 300, &c. times its volume, and still have the same force as the atmosphere.

Upon this principle Mr. Woolf has taken out a patent for various improvements on the steam-engine, a short account of which we shall subjoin in the words of the specification.

"If the engine be constructed originally with the intention of adopting the preceding improvement, it ought to have two steam-vessels of different dimensions, according to the expansive force to be communicated to the beam, for the smaller steam-cylinder must be a measure for the larger. For example, if steam of 40 pounds the square inch is fixed on, then the smaller steam-vessel should be at least one-fortieth part the contents of the larger one. Each steam-vessel should be furnished with a piston, and the smaller cylinder should have a communication both at its top and bottom, with the boiler which supplies the steam, which communications, by means of cocks or valves, are to be alternately opened and shut during the working of the engine. The top of the small cylinder should have a communication with the bottom of the larger cylinder, and the bottom of the smaller one with the top of the larger, with proper means to open and shut these alternately by cocks, valves, or any other contrivance. And both the top and bottom of the larger cylinder should, while the engine is at work, communicate alternately with a condensing vessel, into which a jet of water is admitted to hasten the condensation. Things being thus arranged, when the engine is at work, steam of a high temperature is admitted from the boiler to act by its elastic force on one side of the smaller piston, while the steam which had last moved it has a communication with the larger cylinder, where it follows the larger piston now moving towards that end of its cylinder which is open to the condensing vessel. Let both pistons end their stroke at one time, and let us now suppose them both at the top of their respective cylinders ready to descend; then the steam of 40 pounds the square inch, entering above the smaller piston, will carry it downwards, while the steam below it, instead of being allowed to escape into the atmosphere, or applied to any other purpose, will pass into the larger cylinder above its piston, which will take its downward stroke at the same time that the piston of the smaller cylinder is doing the same thing; and, while this goes on, the steam which last filled the larger cylinder, in the upward stroke of the engine, will be passing into the condenser, to be condensed in the downward stroke. When the pistons in the smaller and larger cylinder have thus been made to descend to the bottom of their cylinders, then the steam from the boiler is to be shut off from the top, and admitted to the bottom of the smaller cylinder, and the communication between the bottom of the smaller, and the top of the larger cylinder, is also to be cut off, and the communication to be opened between the top of the smaller and the bottom of the larger cylinder; the steam which, in the downward stroke of the engine, filled the larger cylinder, being now opened to the condenser, and the communication between the bottom of the larger cylinder and the condenser cut off; and so on alternately, admitting the steam to the different sides of the smaller piston, while the steam last admitted into the smaller cylinder passes alternately to the different sides of the larger piston in the larger cylinder, the top and bottom of which are made to communicate alternately with the condenser.

"In an engine where these improvements are adopted, that waste of steam which arises in other engines from steam passing the piston, is totally prevented, for the steam which passes the piston in the smaller cylinder is received into the larger."

Mr. Woolf has also shewn how the preceding arrangement may be altered, and has pointed out various other modifications of his invention, and the method of applying his improvements to steam-engines which are already constructed.

On the power of steam-engines, and the method of computing it.—From the account which has been given of the steam-engine, and the mode of its operation, it must be evident that its power depends upon the breadth and height of the cylinder, or, in other words, on the area of the piston and the length of its stroke. If we suppose that no force is lost in overcoming the inertia of the great beam, and that the lever by which the power acts is equal to the lever of resistance; then, if steam of a certain elastic force is admitted above the piston, so as to press it downwards with a force of a little more than 100 pounds, it will be able to raise a weight of 100 pounds hanging at the end of the great beam. When the piston has descended to the bottom of the cylinder, through the space of four feet, the weight will have risen through the same space; and 100 pounds raised through the height of four feet, during one descent of the piston, will express the mechanical power of the engine. But if the area of the piston, and the length of the cylinder, are doubled, while the expansive force of the steam, and the time of the piston's descent, remain the same, the mechanical energy of the engine will be quadruple, and will be represented by 200 pounds raised through the space of eight feet during the time of the piston's descent. The power of steam-engines therefore is, cæteris paribus, in the compound ratio of the area of the piston, and the length of the stroke. These observations being premised, it will be easy to compute the power of steam-engines of any size.

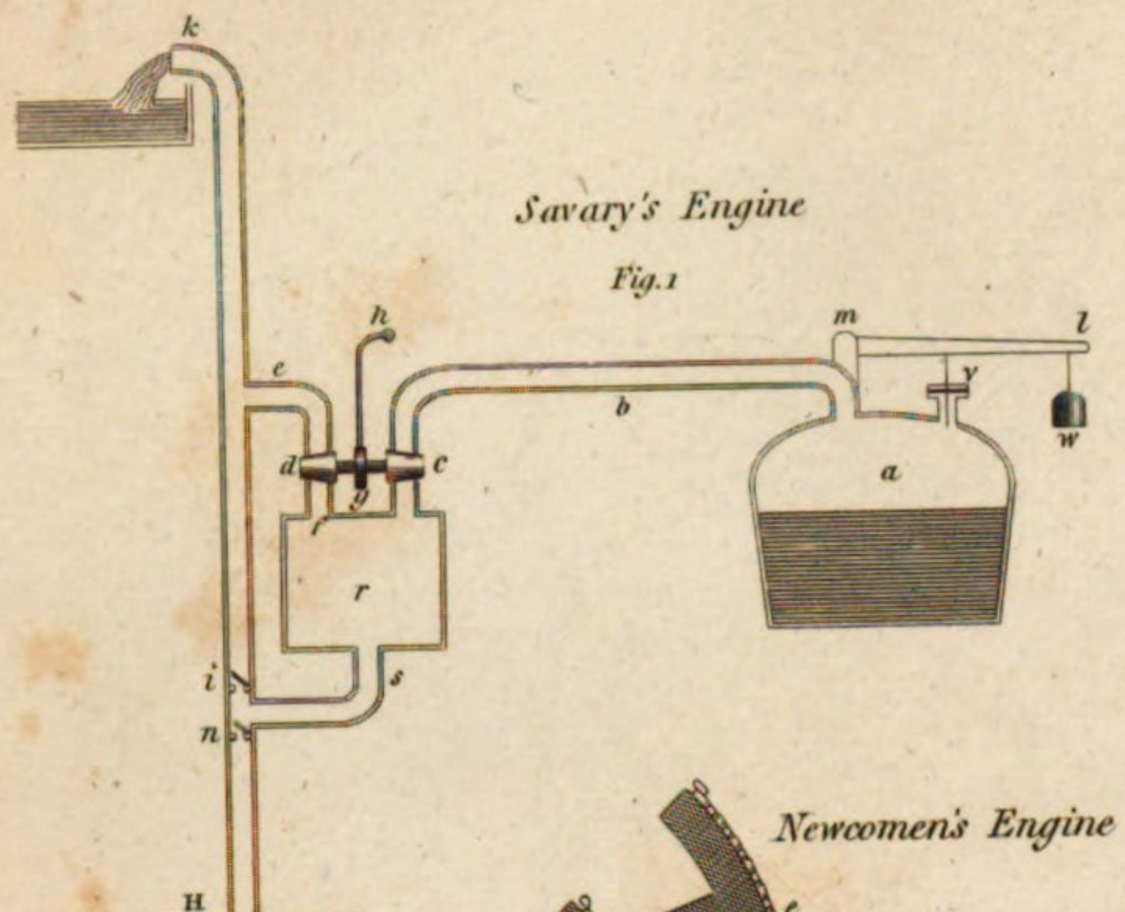
Thus, let it be required to determine the power of steam-engines, whose cylinder is twenty-four inches diameter, and which make twenty-two double strokes in a minute, each stroke being five feet long, and the force of the steam being equal to a pressure of twelve pounds avoirdupois upon every square inch. The diameter of the piston being multiplied by its circumference, and divided by four, will give its area in square inches; thus $\frac{24 \times 3.1416 \times 24}{4} = 452.4$ the number of square inches exposed to the pressure of the steam. Now if we multiply this area by twelve pounds, the pressure upon every square inch, we shall have $452.4 \times 12 = 5428.8$ pounds, the whole pressure upon the piston, or the weight which the engine is capable of raising But since the engine performs 22 double strokes, five feet long, in a minute, the piston must move through $22 \times 5 \times 2 = 220$ feet in the same time; and therefore the power of the engine will be represented by 5428.8 pounds avoirdupois, raised through 220 feet in a minute; or by 10.4 hogsheads of water, ale measure, raised through the same height in the same time. Now this is equivalent to $5428.8 \times 220 = 1194336$ pounds, or $10.4 \times 220 = 2288$ hogsheads, raised through the height of one foot in a minute. This is the most unequivocal expression of the mechanical power of any machine whatever, that can possibly be obtained. But as steam-engines were substituted in the room of horses, it has been customary to calculate their mechanical energy in horse-powers, or to find the number of horses which could perform the same work. This indeed is a very vague expression of power, on account of the different degrees of strength which different horses possess. But still, when we are told that a steam-engine is equal to 16 horses, we have a more distinct conception of its power, than when we are informed that it is capable of raising a number of pounds through a certain space in a certain time.

Messrs. Watt and Boulton suppose a horse capable of raising 32,000 pounds avoirdupois, one foot high in a minute, while Dr. Desaguliers makes it 27,500 pounds, and Mr. Smeaton only 22,916. If we divide, therefore, the number of pounds which any steam-engine can raise one foot high in a minute, by these three numbers, each quotient will represent the number of horses to which the engine is equivalent. Thus in the

STEAM ENGINES.

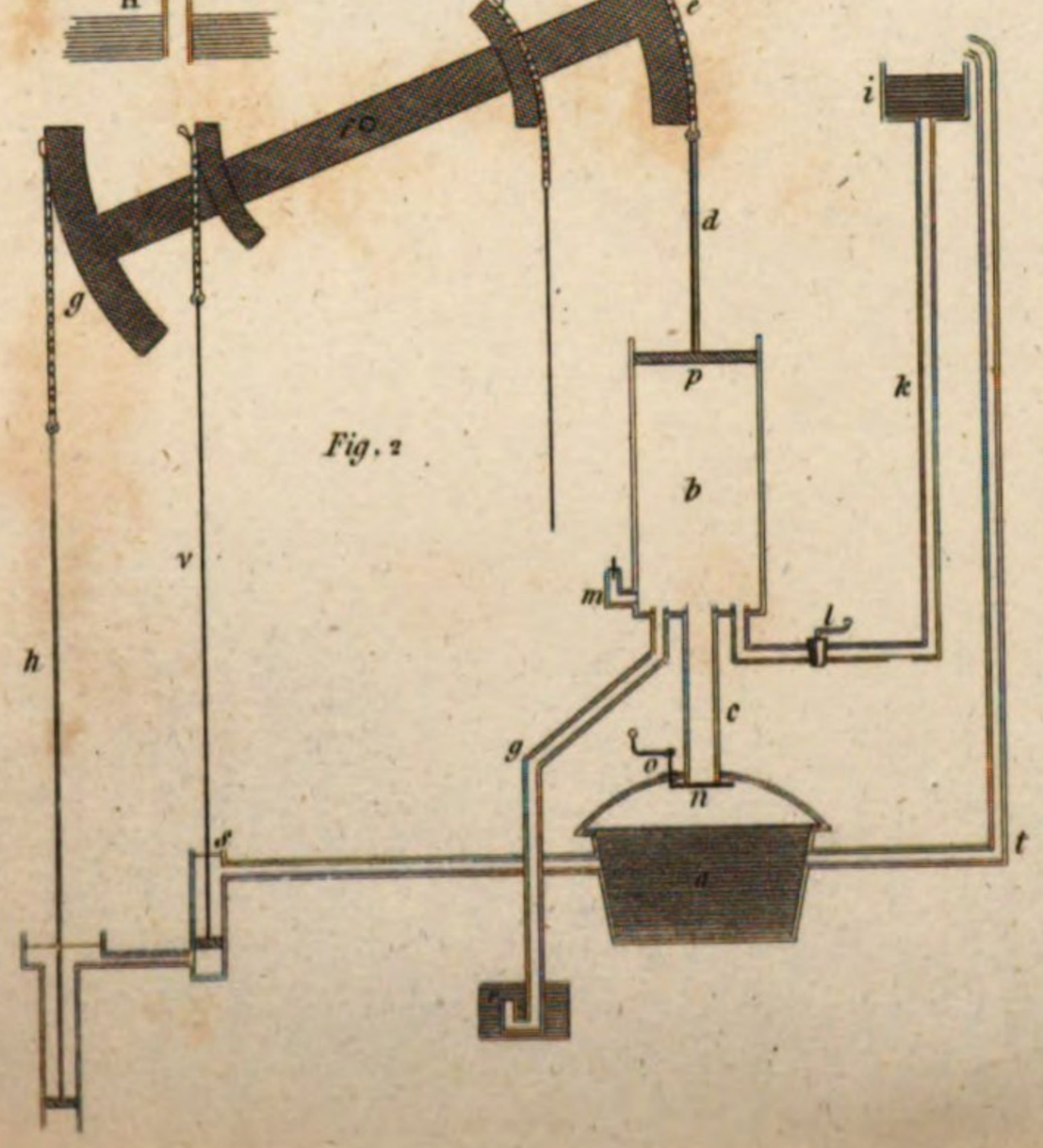
Savary's Engine

Fig. 1



Newcomen's Engine

Fig. 2



Watt's Engine

Fig. 3

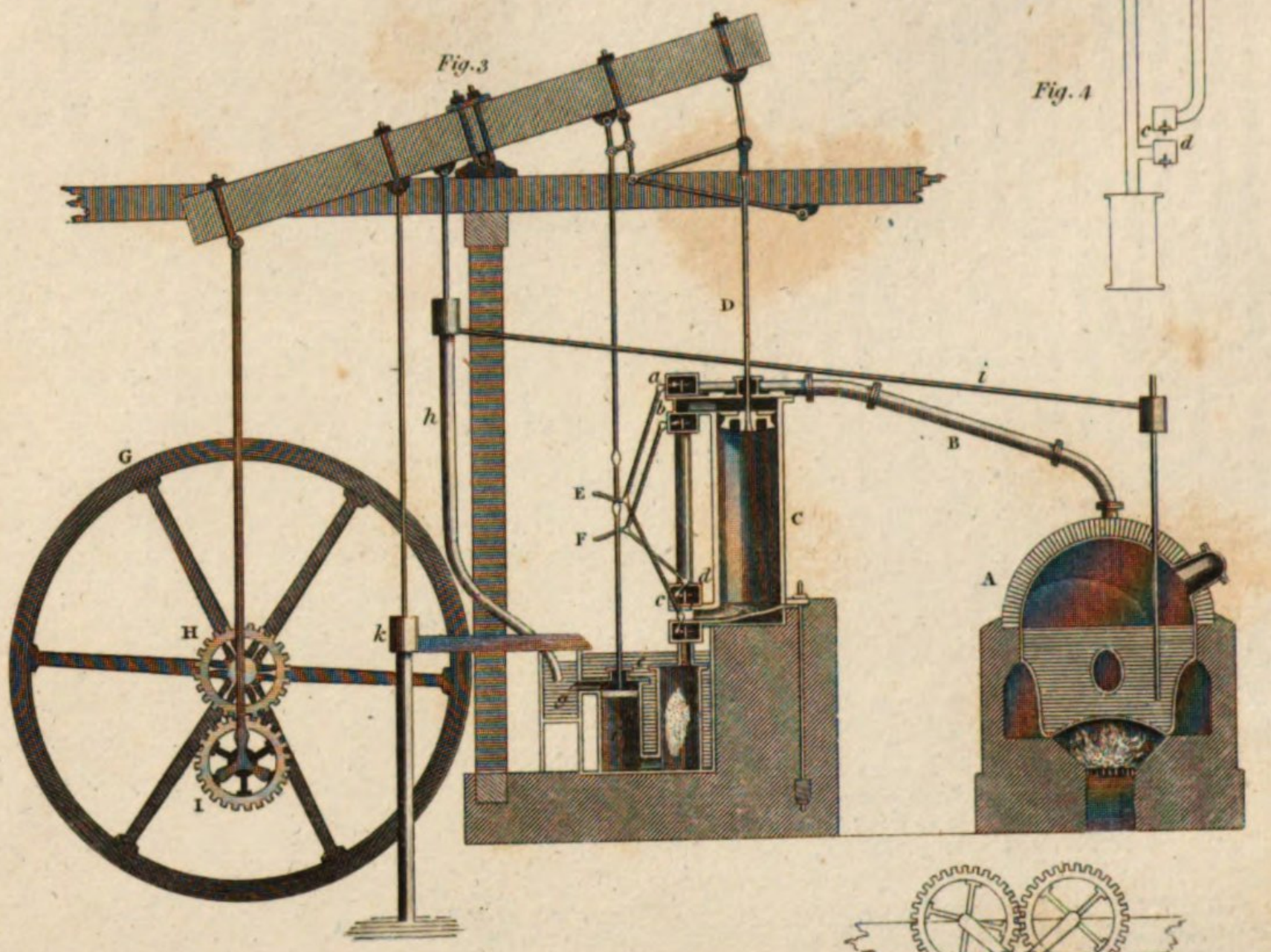


Fig. 4

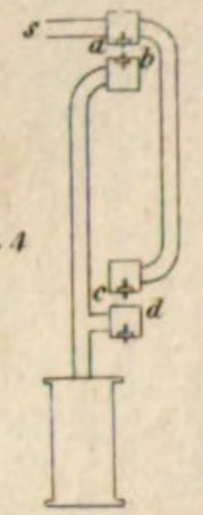
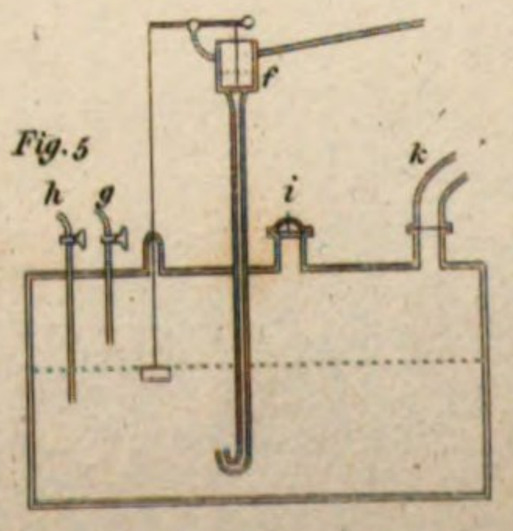
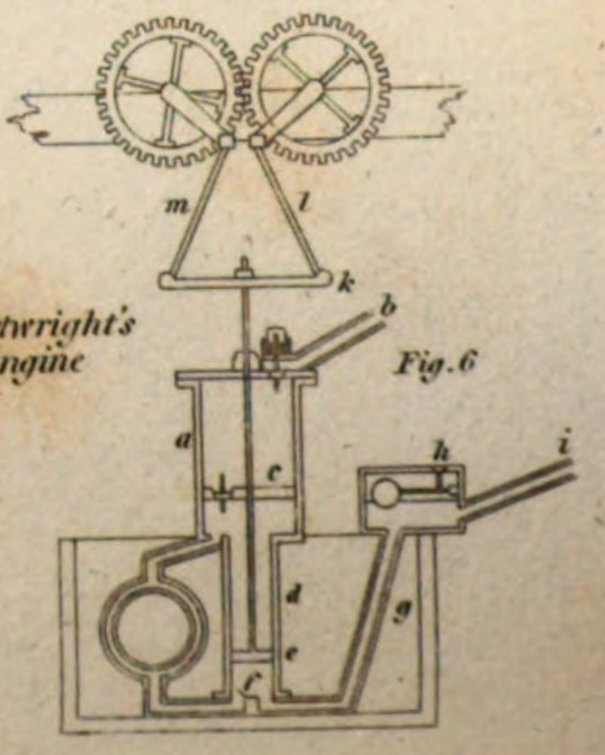


Fig. 5



Cartwright's Engine

Fig. 6



Printed for Richard Phillips, New Bridge Street, Blackfriars.

present example, $\frac{1194336}{32000} = 37\frac{1}{3}$ horses according to Watt and Boulton; $\frac{1194336}{27500} = 43\frac{1}{3}$ horses, according to Desaguliers; and $\frac{1194336}{22916} = 52\frac{1}{7}$ horses, according to Smeaton. In this calculation it is supposed that the engine works only eight hours a day; so that if it wrought during the whole 24 hours, it would be equivalent to thrice the number of horses found by the preceding rule. We cannot help observing, and it is with sincere pleasure that we pay that tribute of respect to the honour and integrity of Messrs. Watt and Boulton which has every where been paid to their talents and genius,—that in estimating the power of a horse, they have assigned a value the most unfavourable to their own interests. While Mr. Smeaton and Dr. Desaguliers would have made the engine in the preceding example equivalent to 52 or 43 horses, the patentees themselves state that it will perform the work only of 37. How unlike is this conduct to some of our modern inventors, who ascribe powers to their machines which cannot possibly belong to them, and employ the meanest arts for ensnaring the public!

Before we conclude this article, we shall state the performance of some of these engines, as determined by experiment. An engine whose cylinder is 31 inches in diameter, and which makes 17 double strokes per minute, is equivalent to 40 horses, working day and night, and burns 11,000 pounds of Staffordshire coal per day. When the cylinder is nineteen inches, and the engine makes 25 strokes of 4 feet each per minute, its power is equal to that of 12 horses working constantly, and it burns 3,700 pounds of coals per day. And a cylinder of 24 inches which makes 22 strokes of 5 feet each, performs the work of 20 horses, working constantly, and burns 5,500 pounds of coals. Mr. Boulton has estimated their performance in a different manner. He states, that one bushel of Newcastle coals, containing 84 pounds, will raise 30 million pounds one foot high; that it will grind and dress eleven bushels of wheat; that it will slit and draw into nails 5 cwt. of iron; that it will drive 1,000 cotton spindles, with all the preparation machinery, with the proper velocity; and that these effects are equivalent to the work of 10 horses.

ENGINE *to lower heavy weights.* This method was described nearly a century ago, and is as follows: Suppose it was required to lower large stones from a building; erect a frame A, set up a gin close by the side of the wall, and let the pulley (Plate Engines, fig. 9.) be firmly attached to this frame. Over this pulley must pass a cord, one end of which C has a hook to which the stone or other weight can be fastened: the other end D carries a vessel, which may be filled with water from the reservoir M on the ground at the bottom of the wall. Then, while one man is fixing the stone to the hook at the top of the wall, let another put water into the vessel D at the bottom till it nearly equals the weight of the stone; after which the stone will gradually descend to the ground, while the vessel D will be carried up to the funnel S, into which the water may be poured, and thence conveyed by a wooden or leathern pipe to M. Then the vessel D may be suffered to descend, and the hook C will be raised to be fixed to another stone, and thus the operation may be repeated.

The same method may be adopted in lowering sacks from a granary, &c. The velocity of the descending weight may be so regulated as to have any proportion to that which gravity imparts to bodies falling freely: thus if W = weight to be lowered, V that of the vessel of water, then $\frac{W-V}{W+V}$ expresses the ratio of the velocity, to that freely imparted by gravity when denoted by unity: thus if $V = \frac{W}{2}$, the weight will fall through $\frac{1}{3}$ of $16\frac{1}{12}$, or about $5\frac{1}{3}$ feet in the first second: if $V = \frac{2W}{3}$, the weight will fall through $\frac{1}{5}$ of $16\frac{1}{12}$, or $3\frac{1}{2}$ feet, the friction not being taken into consideration.

ENGINES, in military mechanics, are compound machines, made of one or more mechanical powers, as levers, pulleys, screws, &c. in order to raise, project, or sustain, any weight, or produce any effect which could not be easily effected otherwise.

ENGINE *to drive fuses*, consists of a wheel with a handle to it, to raise a certain weight, and to let it fall upon the driver, by which the strokes become more equal.

ENGINE *to draw fuses*, has a screw fixed upon a three-legged stand, the bottom of which has a ring to place it upon the shell; and at the end of the screw is fixed a hand-screw by means of a collar, which being screwed on the fuse, by turning the upper screw, draws out or raises the fuse.

ENGINEER, is commonly applied to an officer who is appointed to inspect and contrive any attacks, defences, &c. of a fortified place, or to build or repair them, &c.

The art of fortification is an art which stands in need of so many others, and whose object is so extensive, and its operations accompanied with so many various circumstances, that it is almost impossible for a man to make himself master of it by experience alone, even supposing him born with all the advantages of genius and disposition possible for the knowledge and practice of that important art. We do not pretend to deny that experience is of greater efficacy than all the precepts in the world; but it has likewise its inconveniences as well as its advantages: its fruits are of slow growth; and whoever is content with pursuing only that method of instruction, seldom knows how to act upon emergencies of all kinds, before old age incapacitates him from exercising his employment. Experience teaches us through the means of the errors we commit ourselves, what theory teaches us at the expence of others. The life of man being short, and opportunities of practice seldom happening, it is certain nothing less than a happy genius, a great share of theory, and intent application joined to experience, can make an engineer expect to shine in his profession. Whence it follows, that less than the three first of those four qualities should not be a recommendation for the reception of a young gentleman into the corps of engineers.

The fundamental sciences, or those absolutely necessary, are arithmetic, geometry, mechanics, hydraulics, and drawing. Without arithmetic, it is impossible to make a calculation of the extent, and to keep an account of the disbursements made or to be made; nor without it can an exact computation be made upon any occasion whatsoever. Without geometry, it is impossible to lay down a plan or map with truth and exactness, or settle a draught of a fortification, or calculate the lines and angles, so as to make a just estimation, in order to trace them on the ground, and to measure the surface and solidity of their parts. Mechanics teach us the proportions of the machines in use, and how to increase or diminish their powers as occasion may require; and likewise to judge whether those which our own imagination suggests to us will answer in practice. Hydraulics teach us how to conduct waters from one place to another, to keep them at a certain height, or to raise them higher. How fluently soever we may express ourselves in speaking or writing, we can never give so perfect an idea as by an exact drawing; and often in fortification both are wanted, for which reason the art of drawing is indispensably necessary for engineers.

To the qualities above mentioned must be added activity and vigilance; both which are absolutely necessary in all operations of war, but especially in the attack of such places as are in expectation of succours. The besieged must have no time allowed them for consideration; one hour lost at such a juncture often proves irreparable. It is by their activity and vigilance, that engineers often bring the besieged to capitulate much sooner than they would have done if those engineers had not pushed on the attack with firmness and resolution. Want of vigilance and activity often proceed from irresolution, and that from weakness of capacity.

As the office of an engineer requires great natural qualifications, much knowledge, study, and application, it is but reasonable that the pay should be proportioned to that merit which is to be the qualification of the person employed: he must be at an extraordinary expence in his education, and afterwards for books and instruments for his instruction and improvement, as well as for many other things; and that he may be at liberty to pursue his studies with application, he must not be put to shifts for necessaries. It should likewise be considered, that if an engineer does his duty, be his station what it will, his fatigue must be very great; and to dedicate himself wholly to that duty, he should be divested of all other cares.

The word engineer is of modern date, and was first used about the year 1650, when captain Thomas Rudd had the title of chief engineer to the king. In 1600, the title given to engineers was trench-master; and in 1622, sir William Pelham, and after him sir Francis Vere, acted as trench-masters in Flanders. In the year 1634, an engineer was called camp-master general, and sometimes engine-master, being always subordinate to the master of the ordnance.

At present the corp of royal engineers in England consists of one colonel in chief, one colonel en second, one chief engineer, five colonels, six lieutenant-colonels, 18 captains, 15 captain-lieutenants and captains, 31 lieutenants, and 16 second lieutenants. The esta-

blishment of the corps of invalid engineers, comprises a colonel, lieutenant-colonel, captain, captain-lieutenant and captain, first lieutenant, and second lieutenant.

The corps of royal engineers in Ireland consists of a director, colonel, lieutenant-colonel, major, captain, captain-lieutenant and captain, and two first lieutenants.

ENGRAILED, or INGRAILED, in heraldry, a term derived from the French *grèle*, hail; and signifying a thing the hail has fallen upon and broke off the edges, leaving them ragged, or with half-rounds or semicircles struck out of their edges.

ENGRAVING, the art of cutting wood, metals, and precious stones, and representing thereon figures, letters, or whatever device or design the artist fancies.

Engraving, properly a branch of sculpture, is divided into several other branches, according to the matter whereon it is employed, and the manner of performing it.

ENGRAVING, or *graving* as it is generally called, is the cutting lines upon a copper-plate, by means of a steel instrument, called a graver, without the use of aqua fortis.

This was the first mode of producing copper-plate prints that was practised; and is still much used in historical subjects, portraits, and in finishing landscapes.

The tools necessary for this art are, gravers, a scraper, a burnisher, an oil-stone, a sand-bag or cushion, an oil-rubber, and some good charcoal.

The gravers are instruments of tempered steel, fitted into a short wooden handle. They are of two sorts, square and lozenge: the first is used in cutting very broad strokes, the other for fainter and more delicate lines.

The scraper is a three-edged tool, for scraping off the burr raised by the graver. Burnishers are for rubbing down any lines that are too deep, or burnishing out any scratches or holes in the copper: they are of very hard steel, well rounded and polished.

The oil-stone is for whetting the gravers, etching-points, &c.

The sand-bag, or cushion, is for laying the plate upon, for the convenience of turning it round in any direction.

The oil-rubber and charcoal, are for polishing the plate when necessary.

As great care is required to whet the graver nicely, particularly the belly of it, care must be taken to lay the two angles of the graver, which are to be held next the plate, flat upon the stone, and rub them steadily, till the belly rises gradually above the plate; so that, when you lay the graver flat upon it, you may just perceive the light under the point; otherwise it will dig into the copper, and then it will be impossible to keep a point, or execute the work with freedom. In order to this, keep your right arm close to your side, and place the fore-finger of your left hand upon that part of the graver which lies uppermost on the stone. When this is done, in order to whet the face, place the flat part of the handle in the hollow of your hand, with the belly of the graver upwards, upon a moderate slope; and rub the extremity, or face, upon the stone, till it has an exceedingly sharp point, which you may try upon your thumb-nail.

When the graver is too hard, as is usually the case when first bought, and may be known by the frequent breaking of the point, the method of *tempering* it is as follows: Heat a poker red-hot, and hold the graver upon it, within half an inch of the point, till the steel changes to a light straw-colour; then put the point into oil, to cool: or, hold the graver close to the flame of a candle, till it be of the same colour, and cool it in the tallow; but be careful either way, not to hold it too long, for then it will be too soft; and in this case the point, which will then turn blue, must be tempered again. Be not too hasty in tempering; for sometimes a little whetting will bring it to a good condition, when it is but a little too hard.

To hold the graver, cut off that part of the handle which is upon the same line with the belly, or sharp edge of the graver; making that side flat, that it may be no obstruction.

Hold the handle in the hollow of your hand; and, extending your fore-finger towards the point, let it rest on the back of the graver, that you may guide it flat and parallel with the plate. Take care that your fingers do not interpose between the plate and the graver; for they will hinder you from carrying the graver level with the plate, and from cutting your strokes so clean as they ought to be.

To lay the design upon the plate, after you have polished it fine and smooth, heat it so that it will melt virgin-wax, with which rub it thinly and equally over, and let it cool. Then the design which you lay on, must be drawn on paper, with a black-lead pencil, and laid upon the plate, with its pencilled side upon the wax: then press it to, and with a burnisher go over every part of the design; and when you take off the paper, you will find every line which you drew with the black-lead pencil upon the waxed plate, as if it had been drawn: then, with a sharp-pointed tool, trace all your design through the wax upon the plate, and you may then take off the wax, and proceed to work.

Let the table, or board you work at, be firm and steady; upon which place your sand-bag with the plate upon it; and, holding the graver as above directed, proceed in the following manner.

For straight strokes, hold your plate firm upon the sand-bag with your left hand, moving your right hand forwards; leaning lighter where the stroke should be fine, and harder where you would have it broader.

For circular or crooked strokes, hold the graver stedfast; moving your hand, or the plate, as you see convenient.

Learn to carry your hand with such dexterity, that you may end your stroke as finely as you began it; and if you have occasion to make one part deeper or blacker than another, do it by degrees; and that you may do it with greater exactness, take care that your strokes be not too close, nor too wide.

In the course of your work, scrape off the roughness which arises, with your scraper; but be careful, in doing this, not to scratch the plate; and that you may see your work properly as you go on, rub it with the oil-rubber, and wipe the plates clean; which will take off the glare of the copper, and shew what you have done to the best advantage.

Any mistakes or scratches in the plate may be rubbed out with the burnisher, and the part levelled with the scraper, polishing it again afterwards lightly with the burnisher, or charcoal.

Having thus attained the use of the graver, according to the foregoing rules, you will be able to finish any piece previously etched, by graving up the several parts to the colour required: beginning, as in the etching, with the fainter parts, and advancing gradually with the stronger, till the whole is completed. See ETCHING.

The dry point, or needle, (so called because not used till the ground is taken off the plate) is principally employed in the extremely light parts of water, sky, drapery, architecture, &c.

To prevent any obstruction from too great a degree of light, the use of a sash, made of transparent or fan paper, pasted on a frame, and placed sloping at a convenient distance between your work and the light, will preserve the sight; and when the sun shines, it cannot possibly be dispensed with.

Of mezzotinto engraving or scraping.—This art, which is of late date, is recommended by the amazng ease with which it is executed, especially by those who understand drawing.

Mezzotinto prints are those which have no patching, or strokes of the graver, but whose lights and shades are blended together, and appear like a drawing in Indian ink. They are different from aqua tinta; but as both resemble Indian ink, the difference is not easily described. Mezzotinto is applied to portraits and historical subjects, and aqua tinta is used only for landscape and architecture.

The tools necessary for mezzotinto scraping are the grounding-tool, burnishers, and scrapers.

To lay the mezzotinto ground, lay your plate, with a piece of flannel under it, upon your table: hold the grounding-tool in your hand perpendicularly; lean upon it moderately hard, continually rocking your hand in a right line from end to end, till you have wholly covered the plate in one direction: next cross the strokes from side to side, afterwards from corner to corner, working the tool each time all over the plate, in every direction, almost like the points of a compass; taking all possible care not to let the tool cut (in one direction) twice in a place. This done, the plate will be full, or, in other words, all over rough alike; and would, if it was printed, appear completely black.

Having laid the ground, take the scrapings of black chalk, and with a piece of rag rub it over the plate; or you may smoke it with candles, as before directed for etching.

Now take your drawing, and having rubbed the back with red-chalk dust, mixed with flake-white, proceed to trace it on the plate.

To form the lights and shadows, take a blunt needle, and mark out the outlines only: then with a scraper scrape off the lights in every part of the plate, as clean and smooth as possible, in proportion to the strength of the lights in your drawing, taking care not to hurt your outlines.

The use of the burnisher is to soften or rub down the extreme light parts, after the scraper is done with; such as the tip of the nose, forehead, linen, &c. which might otherwise, when proved, appear rather misty than clear.

Another method used by mezzotinto-scrapers is, to etch the outlines of the original, as also the folds in drapery, making the

breadth of the shadows by dots; which having bit to a proper depth with aqua fortis, they take off the ground used in etching, and having laid the mezzotinto-ground, proceed to scrape as above.

When your plate is ready for taking a proof, or impression, send it to the copper-plate printer, and get it proved. When the proof is dry, touch it with white chalk where it should be lighter, and with black chalk where it should be darker: and when the print is retouched, proceed as before for the lights; and for the shades use a small grounding-tool, as much as you judge necessary, to bring it to a proper colour; and when you have done as much as you think expedient, prove it again; and so proceed to prove and touch till it is entirely to your mind.

Engraving in aqua tinta.—Aqua tinta is a method of producing prints very much resembling drawings in Indian ink.

The principle of the process consists in corroding the copper with aqua fortis, in such a manner, that an impression from it has the appearance of a tint laid on the paper. This is effected by covering the copper with a powder, or some substance which takes a granulated form, so as to prevent the aqua fortis from acting where the particles adhere; and by this means cause it to corrode the copper partially, and in the interstices only. When these particles are extremely minute and near to each other, the impression from the plate appears to the naked eye exactly like a wash of Indian ink; but when they are larger, the granulation is more distinct: and as this may be varied at pleasure, it is capable of being adapted with great success, to a variety of purposes and subjects.

This powder, or granulation, is called the aqua-tinta grain, and there are two general modes of producing it.

We shall first describe what is called the powder-grain, because it was the first that was used.

Having etched the outline on a copper-plate, prepared in the usual way by the coppersmith, (for which see the article ETCHING) some substance must be finely powdered and sifted, which will melt with heat, and when cold will adhere to the plate, and resist the action of aqua fortis. The substances which have been used for this purpose, either separately or mixed, are asphaltum, Burgundy pitch, rosin, gum-copal, gum-mastich; and, in a greater or less degree, all the resins and gum-resins will answer the purpose. Common rosin has been most generally used, and answers tolerably well; though gum-copal makes a grain that resists the aqua fortis better.

The substance intended to be used for the grain, must now be distributed over the plate as equally as possible; and different methods of performing this essential part of the operation have been used by different engravers, and at different times.

The most usual way is, to tie up some of the powder in a piece of muslin, and strike it against a piece of stick, held at a considerable height above the plate; by this, the powder that issues falls gently, and settles equally over the plate. Every one must have observed how uniformly hair-powder settles upon the furniture after the operations of the hair-dresser. This may afford a hint towards the best mode of performing this part of the process. The powder must fall upon it from a considerable height, and there must be a sufficiently large cloud of the dust formed. The plate being covered equally over with the dust, or powder, the operator is next to proceed to fix it upon the plate, by heating it gently, so as to melt the particles. This may be effected by holding under the plate lighted pieces of brown paper rolled up, and moving them about till every part of the powder is melted; this will be known by its change of colour, which will turn brownish. It must now be suffered to cool, when it may be examined with a magnifier, and if the grains or particles appear to be uniformly distributed, it is ready for the next part of the process.

The design or drawing to be engraved must now be examined, and such parts of it as are perfectly white are to be remarked. Those corresponding parts of the plates must be covered, or stopped out as it is called, with turpentine-varnish, diluted with turpentine to a proper consistence to work freely with the pencil, and mixed with lamp-black to give it colour; for if transparent, the touches of the pencil would not be so distinctly seen. The margin of the plate must also be covered with varnish. When the stopping out is sufficiently dry, a border of wax must be raised round the plate, in the same manner as in etching, and the aqua fortis properly diluted with water poured on. This is called biting in, and is the part of the process which is most uncertain, and which requires the greatest degree of experience. When the aqua fortis has lain on so long that the plate, when printed, would produce the lightest tint in the drawing, it is poured off, and the plate washed with water and dried. When it is quite dry, the lightest tints in the drawing are stopped out, and the aqua fortis poured on as before, and the same process is repeated as often as there are tints to be produced in the plate.

Although many plates are etched entirely by this method of stopping out and biting in alternately, yet it may easily be conceived, that in general, it would be very difficult to stop round, and leave out all the finishing touches; as also the leaves of trees, and many other objects, which it would be impossible to execute with the necessary degree of freedom in this manner.

To overcome this difficulty, another very ingenious process has been invented, by which these touches are laid on the plate with the same ease and expedition as they are in a drawing in Indian ink. Fine washed whiting is mixed with a little treacle or sugar, and diluted with water in the pencil, so as to work freely; and this is laid on the plate covered with the aquatint ground, in the same manner and on the same parts as ink on the drawing. When this is dry, the whole plate is varnished over with a weak and thin varnish of turpentine, asphaltum, or mastich, and then suffered to dry, when the aqua fortis is poured on. The varnish will immediately break up in the parts where the treacle mixture was laid, and expose all those places to the action of the acid, while the rest of the plate remains secure. The effect of this will be, that all the touches or places where the treacle was used, will be bit in deeper than the rest, and will have all the precision and firmness of touches in Indian ink.

After the plate is completely bit in, the bordering-wax is taken off, by heating the plate a little with a lighted piece of paper; and it is then cleared from the ground and varnish by oil of turpentine, and wiped clean with a rag and a little fine whiting, when it is ready for the printer.

The principal disadvantages of this method of aqua-tinting are, that it is extremely difficult to produce the required degree of coarseness or fineness in the grain, and that plates so engraved do not print many impressions before they are worn out. It is therefore now very seldom used, though it is occasionally of service.

We next proceed to describe the second method of producing the aquatint ground, which is generally practised. Some resinous substance is dissolved in spirit of wine, as common resin, Burgundy pitch, or mastich, and this solution is poured all over the plate, which is then held in a slanting direction till the superfluous fluid drains off; and it is laid down to dry, which it does in a few minutes. If the plate is then examined with the magnifier, it will be found that the spirit, in evaporating, has left the resin in a granulated state; or rather, that the latter has cracked in every direction, still adhering firmly to the copper.

A grain is thus produced with the greatest ease, which is extremely regular and beautiful, and much superior for most purposes to that produced by the former method. After the grain is formed, every part of the process is conducted in the same manner as above described.

Having thus given a general idea of the art, we shall mention some particulars necessary to be attended to, in order to ensure success in the operation. The spirit of wine used for the solution, must be highly rectified, and of the best quality. What is sold in the shops, generally contains camphor, which would entirely spoil the grain. Resin, Burgundy pitch, and gum mastich, when dissolved in spirit of wine, produce grains of a different appearance and figure; and are sometimes used separately, and sometimes mixed in different proportions, according to the taste of the artist, some using one substance and some another. In order to produce a coarser or finer grain, it is necessary to use a greater or smaller quantity of resin; and to ascertain the proper proportions, several spare pieces of copper must be provided, on which the liquid may be poured, and the grain examined, before it is applied to the plate to be engraved. After the solution is made, it must stand still and undisturbed for a day or two, till all the impurities of the resin have settled to the bottom, and the fluid is quite pellucid. No other method of freeing it from those impurities has been found to answer; straining it through linen or muslin, only fills it with hairs, which are ruinous to the grain. The room in which the liquid is poured on the plate, must be perfectly still and free from dust; which, whenever it falls on the plate while wet, causes a white spot, which it is impossible to remove without laying the grain afresh. The plate must also be previously cleaned, with the greatest possible care, with a rag and whiting, as the smallest stain or particle of grease produces a

streak or blemish in the grain. All these attentions are absolutely necessary to produce a tolerably regular grain; and, after every thing that can be done by the most experienced artists, still there is much uncertainty in the process. They are sometimes obliged to lay on the grains several times, before they procure one sufficiently regular. The same proportions of materials do not always produce the same effect, as it depends in some degree on their qualities; and it is even materially altered by the weather. These difficulties are not to be surmounted but by a great deal of experience; and those who are daily in the habit of practising the art, are frequently liable to the most unaccountable accidents. Indeed it is much to be lamented, that so elegant and useful a process should be so extremely delicate and uncertain.

It being necessary to hold the plate in a slanting direction, in order to drain off the superfluous fluid, there will naturally be a greater body of the liquid at the bottom than at the top of the plate. On this account, a grain laid in this way is always coarser at the side of the plate that was held lowermost. The most usual way is, to keep the coarsest side for the fore-ground, that being generally the part which has the deepest shadows. In large landscapes, sometimes various parts are laid with different grains, according to the nature of the subject.

The finer the grain is, the more nearly does the impression resemble Indian ink, and the fitter it is for imitating drawings: but very fine grains have several disadvantages; for they are apt to come off before the aqua fortis has lain on long enough to produce the desired depth; and as the plate is not corroded so deep, it sooner wears out in printing; whereas coarser grains are firmer, the acid goes deeper, and the plate will throw off a great many more impressions. The reason of all this is evident, when it is considered, that in the fine grains the particles are small and near each other, and consequently the aqua fortis, which acts laterally as well as downwards, soon undermines the particles, and causes them to come off. If left too long on the plate, the acid would eat away the grain entirely.

On these accounts, therefore, the moderately coarse grains are more sought after, and answer better the purpose of the publisher, than the fine grains which were formerly in use.

Although there are considerable difficulties in laying properly the aquatint grain, yet the corroding of the copper, or biting in, so as to produce exactly the tint required, is still more precarious and uncertain. All engravers allow that no positive rules can be laid down, by which the success of this process can be secured; nothing but a great deal of experience and attentive observation can enable the artist to do it with any degree of certainty.

There are some hints, however, which may be of considerable importance to the person who wishes to attain the practice of this art. It is evident, that the longer the acid remains on the copper, the deeper it bites, and consequently the darker will be the shade in the impression. It may be of some use, therefore, to have several bits of copper laid with aquatint grounds, of the same kind to be used in the plate, and to let the aqua fortis remain for different lengths of time on each; and then to examine the tints produced in one, two, three, four minutes, or longer. Observations of this kind, frequently repeated, and with different degrees of strength of the acid, will at length assist the judgment, in guessing at the tint which is produced in the plate. A magnifier is also useful to examine the grain, and to observe the depth to which it is bitten. It must be observed, that no proof of the plate can be obtained till the whole process is finished. If any part appears to have been bitten too dark, it must be burnished down with a steel burnisher; but this requires great delicacy and good management not to make the shade streaky; and as the beauty and durability of the grain are always somewhat injured by it, it should be avoided as much as possble.

Those parts which are not dark enough, must have a fresh grain laid over them, and be stopped round with varnish, and subjected again to the aqua fortis. This is called rebiting, and requires peculiar care and attention. The plate must be very well cleaned out with turpentine before the grain is laid on, which should be pretty coarse, otherwise it will not lie upon the heights only, as is necessary in order to produce the same grain. If the new grain is different from the former, it will not be so clear nor so firm, but rotten.

We have now given a general account of the process of engraving in aqua tinta, and we believe that no material circumstance has been omitted that can be communicated without seeing the operation: but after all it must be confessed, that no printed directions whatever can enable a person to practise it perfectly. Its success depends upon so many niceties, and attention to circumstances apparently trifling, that the person who attempts it must not be surprised if he does not succeed at first. It is a species of engraving simple and expeditious, if every thing goes on well; but it is very precarious, and the errors which are made are rectified with great difficulty.

It seems to be adapted chiefly for imitation of sketches, washed drawings, and slight subjects; but does not appear to be at all calculated to produce prints from finished pictures, as it is not susceptible of that accuracy in the balance of tints necessary for this purpose. Nor does it appear to be suitable for book-plates, as it does not print a sufficient number of impressions. It is therefore not to be put in competition with the other modes of engraving. If confined to those subjects for which it is calculated, it must be allowed to be extremely useful, as it is expeditious, and may be attained with much less trouble than any other mode of engraving. But even this circumstance is a source of mischief, as it occasions the production of a multitude of prints, that have no other effect than that of vitiating the public taste. See ETCHING.

Engraving on wood.—Engraving on wood is a process exactly the reverse to engraving on copper. In the latter, the strokes to be printed are sunk, or cut into the copper, and a rolling-press is used for printing it; but in engraving on wood, all the wood is cut away, except the lines to be printed, which are left standing up like types, and the mode of printing is the same as that used in letter-press.

The wood used for this purpose is box-wood, which is planed quite smooth. The design is then drawn upon the wood itself with black lead; and all the wood is cut away with gravers and other proper tools, except the lines that are drawn. Or sometimes the design is drawn upon paper, and pasted upon the wood, which is cut as before. The art is of considerable difficulty, and there are very few who practise it. It is, however, useful for books, as the printing of it is cheaper than that of copper-plates. It cannot be applied equally well to all the purposes to which copper-plate engraving is applicable.

In *engraving on precious stones*, they use either the diamond, or emery. The diamond, which is the hardest of all stones, is only cut by itself, or with its own matter. The first thing to be done in this branch of engraving, is to cement two rough diamonds to the ends of two sticks large enough to hold them steady in the hand, and to rub or grind them against each other till they are brought to the desired form. The dust, or powder, that is rubbed off, serves afterwards to polish them, which is performed with a kind of mill that turns a wheel of soft iron. The diamond is fixed in a brass dish, and thus applied to the wheel, is covered with diamond-dust, mixed up with oil of olives; and when the diamond is to be cut facet-wise, they apply first one face, then another, to the wheel. Rubies, sapphires, and topazes, are cut and formed the same way on a copper wheel, and polished with tripoli diluted in water. As to agates, amethysts, emeralds, hyacinths, granites, rubies, and others of the softer stones, they are cut on a leaden wheel, moistened with emery and water, and polished with tripoli, on a pewter wheel. Lapis-lazuli, opal, &c. are polished on a wooden wheel. To fashion and engrave vases of agate, crystal, lapis-lazuli, or the like, they make use of a kind of lathe, like that used by pewterers to hold the vessels, which are to be wrought with proper tools: that of the engraver generally holds the tools, which are turned by a wheel; and the vessel is held to them to be cut and engraved, either in relievo or otherwise; the tools being moistened, from time to time, with diamond-dust and oil, or at least emery and water. To engrave figures or devices on any of these stones, when polished, such as medals, seals, &c. they use a little iron wheel, the ends of whose axis are received within two pieces of iron, placed upright, as in the turner's lathe; and to be brought closer, or set further apart, at pleasure: at one end of the axis are fitted the proper tools, being kept tight by a screw. Lastly, the wheel is turned by the foot, and the stone applied by the hand to the tool, and is shifted and conducted as occasion requires.

The tools are generally of iron, and sometimes of brass: their form is various; but it generally bears some resemblance to chisels, gouges, &c. Some have small round heads, like buttons; others like ferules, to take the pieces out; and others flat, &c. When the stone has been engraved, it is polished on wheels of hair-brushes and tripoli.

Engraving on steel is chiefly employed in cutting seals, punches, matrices, and dyes proper for striking coins, medals, and counters. The method of engraving with the instruments, &c. is the same for coins as for

medals and counters. All the difference consists in their greater or less relievo, the relievo of coins being much less considerable than that of medals, and that of counters still less than that of coins.

Engravers in steel commonly begin with punches, which are in relievo, and serve for making the creux, or cavities, of the matrices and dyes: though sometimes they begin with the creux, or hollowness, but then it is only when the intended work is to be cut very shallow. The first thing done, is that of designing the figures; the next is the moulding them in wax, of the size and depth they are to lie, and from this wax the punch is engraved. When the punch is finished, they give it a very high temper, that it may the better bear the blows of the hammer with which it is struck, to give the impression to the matrix.

The steel is made hot to soften it, that it may the more readily take the impression of the punch; and after striking the punch on it, in this state, they proceed to touch up or finish the strokes and lines, where, by reason of their fineness, or the too great relievo, they are any thing defective, with steel gravers of different kinds, chisels, flatters, &c. being the principal instruments used in graving on steel.

The figure being thus finished, they proceed to engrave the rest of the medal, as the mouldings of the border, the engrailed ring, letters, &c. with little steel punches, well tempered, and very sharp.

ENMANCHE', in heraldry, is when lines are drawn from the centre of the upper edge of the chief to the sides, to about half the breadth of the chief; signifying sleeved, or resembling a sleeve, from the French manche.

ENNEANDRIA, in botany, the ninth class of plants with hermaphrodite flowers, and nine stamina or male parts in each. See BOTANY. To this class belong the laurus, rheum, spondias, butomus, &c.

ENSIFORM, in general, something resembling a sword, ensis: thus we find mention of ensiform leaves, ensiform cartilage, &c.

ENSIGN, in the military art, a banner under which the soldiers are ranged according to the different companies or parties they belong to.

ENSIGN is also the officer that carries the colours, being the lowest commissioned officer in a company of foot, subordinate to the captain and lieutenant.

ENTABLATURE, or *entablement*, in architecture, is that part of an order of a column which is over the capital, and comprehends the architrave, frieze, and corniche.

ENTABLATURE, in masonry, is used sometimes to denote the last row of stones on the top of the wall of a building, on which the timber and covering rest. This is often made to project beyond the naked of the wall, to carry off the rain.

ENTAIL, in law, is a fee-estate entailed; that is, abridged and limited to certain conditions prescribed by the donor or grantor. See ESTATE.

ENTE', in heraldry, a method of marshalling, more frequent abroad than with us, and signifying grafted or engrafted.

ENTEROCELE. See SURGERY.

ENTERPLEADER, in law, signifies the discussing or trial of a point, incidentally falling out, before the principal cause can be determined.

ENTHYMEME, among logicians, denotes a syllogism, perfect in the mind, but imperfect in the expression, because one of the propositions is suppressed, as being easily supplied by the understanding of those with whom we discourse: *e. g.* "In every right-lined triangle the three angles are just equal to two right ones; therefore, those of an isosceles are so:" where the proposition, "every isosceles is a right-lined triangle," is omitted, as being sufficiently known.

ENTOMOLOGY, that part of the science of zoology which treats exclusively of insects.

Some natural historians consider this class of animals the most imperfect of any, while others prefer them to the larger animals. One mark of their imperfections is said to be, that many of them can live a long time, though deprived of those organs which are necessary to life in the higher ranks of nature. Many of them are furnished with lungs and a heart, like the nobler animals; yet the caterpillar continues to live, though its heart and lungs, which is often the case, are entirely eaten away. It is not however from their conformation alone that insects are inferior to other animals, but from instincts also. It is true, that the ant and bee present us with striking instances of assiduity; yet even these are inferior in the marks of sagacity displayed by the larger animals. A bee taken from the swarm is totally helpless and inactive, incapable of giving the smallest variations to its instincts. It has but one single method of operating; and if put from that, it can turn to no other. In the pursuits of the hound, there is something like choice; but in the labours of the bee, the whole appears like necessity and compulsion. All other animals are capable of some degree of education; their instincts may be suppressed or altered; the dog may be taught to fetch and carry, the bird to whistle a tune, and the serpent to dance: but the insect has only one invariable method of operating; no arts can turn it from its instincts; and indeed its life is too short for instruction, as a single season often terminates its existence. Their amazing number is also an imperfection. It is a rule that obtains through all nature, that the nobler animals are slowly produced, and that nature acts with a kind of dignified economy; but the meaner births are lavished in profusion, and thousands are brought forth merely to supply the necessities of the more favourite part of the creation. Of all productions in nature, insects are by far the most numerous. The vegetables which cover the surface of the earth bear no proportion to the multitudes of insects; and though, at first sight, herbs of the field seem to be the parts of organized nature produced in the greatest abundance, yet, upon more minute inspection, we find every plant supporting a mixture of scarcely perceptible creatures, that fill up the compass of youth, vigour, and age, in the space of a few days existence. In Lapland and some parts of America, the insects are so numerous, that if a candle is lighted they swarm about it in such multitudes, that it is instantly extinguished by them; and in those parts of the world, the miserable inhabitants are forced to smear their bodies and faces with tar, or some other unctuous composition, to protect them from the stings of their minute opponents.

Swammerdam however argues for the perfection of insects in the following manner. "After an attentive examination (says he) of the nature and anatomy of the smallest as well as the largest animals, I cannot help allowing the least an equal, or perhaps a superior, degree of dignity. If, while we dissect with care the larger animals, we are filled with wonder at the elegant disposition of their parts, to what a height is our astonishment raised, when we discover all these parts arranged, in the least, in the same regular manner! Notwithstanding the smallness of ants, nothing hinders our preferring them to the largest animals, if we consider either their unwearied diligence, their wonderful powers, or their inimitable propensity to labour. Their amazing love to their young is still more unparalleled among the larger classes. They not only daily carry them to such places as may afford them food, but if by accident they are killed, and even cut into pieces, they will with the utmost tenderness carry them away piecemeal in their arms. Who can show such an example among the larger animals which are dignified with the title of perfect? Who can find an instance in any other creature that can come in competition with this?"

On this dispute it is only necessary to observe, that the wisdom of the Creator is so conspicuous in all his works, and such surprising art is discovered in the mechanism of the body of every creature, that is very difficult, if not impossible, to say where it is most, and where it is least, to be perceived.

Those who are desirous of attaining a systematic knowledge of insects, ought primarily to be solicitous about acquiring the terms made use of in the science, that so they may be able rightly to denominate every part of an insect. The student is first to know what an insect is, lest he mistake the hippocampi, and other amphibious animals, for them, as was formerly done: or confound them with the vermes, which Linnæus first distinguished from insects, and which differ as essentially from them as the class mammalia do from birds. Every insect is furnished with a head, antennæ, and feet, of all which the vermes are destitute. All insects have six or more feet; they respire through pores placed on the sides of their bodies, and which are termed spiracula: their skin is extremely hard, and serves them instead of bones, of which they have internally none. From this definition, the acus marina is evidently no insect. But the antennæ placed on the fore-part of the head constitute the principal distinction. These are jointed and moveable in every part, in which they differ from the horns of other animals: they are organs conveying some kind of sense; but we have no more idea of what this kind of sense is, than a man has, who, without eyes, attempts to determine the particular action of the rays of light on the retina of the eye, or to explain the changes which thence take place in the human mind. That they are the organs of some kind of sense, is apparent from their perpe-

tually moving them forward; yet the hard crust with which they are invested, and their shortness in flies and other insects, would induce one to believe them not to be the organs of touch: Mr. Barbut supposes them to constitute or to contain the organs of hearing, because they are tubular, and filled with air and some kind of humour, as appears from the antennæ of butterflies immersed in water. To come now to the terms of the art. A knowledge of the external parts of the body is first to be established; which, after the method of anatomists, we may divide into head, trunk, abdomen, and extremities.

Of the external parts of the body.

I. Caput, the head. It is asserted in the Fundamenta Entomologiæ, that this part in insects is without brain. The difference between the brain and spinal marrow consists in the former being a medullary part organized. We do not deny the existence of a medullary thread in the heads of insects, but we never could discover it to be organized; hence the hippobosca equina, or horse-fly, will live, run, nay even copulate, after being deprived of its head: to say nothing of many others which are capable of living a long while under the same circumstances.

Insects not being apparently furnished with ears, they have been apprehended incapable of hearing; as we can no more conceive that sense to exist without ears, than vision without eyes. That they are nevertheless susceptible of any shrill or loud noise, as well as fishes, is indisputable; but it has been supposed to be in a manner different from that of hearing. Mr. Barbut, however, supposes them to possess this sense in a very distinct manner. Many insects, he observes, are well known to be endowed with the power of uttering sounds, such as large beetles, the bee, wasp, common fly, gnat, &c. The sphinx atropos squeaks, when hurt, nearly as loud as a mouse. Now, if insects are endowed with the power of uttering sounds, it certainly must be for some purpose. As they vary their cry occasionally, it must be certainly designed either to give notice of pleasure or pain, or some affection in the creature who possesses it. "The knowledge of their sounds (says our author) is undoubtedly confined to their tribe, and is a language intelligible to them only; saving when violence obliges the animal to exert the voice of nature in distress craving compassion; then all the animals understand the doleful cry. For instance: attack a bee or wasp near the hive or a few of them: the consequence of that assault will be, the animal or animals, by a different tone of voice, will express his or their disapprobation or pain; that sound is known to the hive to be plaintive, and that their brother or brethren require their assistance; and the offending party seldom escapes with impunity. Now, if they had not the sense of hearing, they could not have known the danger their brother or brethren were in by the alteration of their tone."

A still more decisive proof occurred to his observation in a large spider in St. James's park. This creature had made a very large web on a wooden railing; and was at the time of observation, on one of the rails at a considerable distance from the place where a large fly had entangled itself. Nevertheless, the moment the fly was entangled, the spider became sensible of it; though from the situation of the rail, he could not possibly have seen it. In this, however, Mr. Barbut might possibly be deceived; because the spider was perhaps alarmed by the tremulous motion of the threads, occasioned by the fluttering of the fly; which he might well know how to distinguish from their vibration by the wind. The organ of hearing, in our author's opinion, is situated in the antennæ; both from their situation in the part of the head most favourable to such organs, and their inward structure being moveable; the ears of the most inferior animals being so. He has never considered the antennæ as either offensive or defensive, but has observed them to have been endowed with an exquisite sense of feeling; that the animal appeared to be in agony when its antennæ were pinched; and that it takes care to avoid the touching any hard substance with them roughly. "This tenderness in the organ of hearing (says he) is common to all animals; and insects seem to be particularly tender in these parts, by quickly withdrawing them from the touch."

This writer further observes, that the antennæ of all insects are composed of joints varying in size, form, and number. Those who are chiefly confined to live under water, have their antennæ in general shorter than those who live on land. Some who roam at large in the air, have them long and slender. They are all hollow, and are rendered flexible by the joints, which are very visible in the horns of the crab and lobster. This hollowness, in our author's opinion, is to receive the sound communicated to the extremities of the antennæ by the repercussion of the air affected by any noise; and conveys it, by means of the joints, from one to another, till it arrives in that lessened degree of tone best suited to the timid nature of the animal. In this circumstance there may be many variations in point of perfection in those organs; the strength, utility, and degree of power in receiving sound, being proportioned to the necessities of the animals, different in their nature and requisites. In most animals, the entrance to the auricular organ is patulous: but in this case the animal would suffer great inconvenience from such an organization, as the orifice would be subject to impediments from dirt, &c.

Most naturalists are in doubt whether insects have the sense of smell, no organs being found in them adapted to that purpose: and although it was evident they had a perception of agreeable and fetid effluvia, it was thought to be in a manner altogether unknown to us. Mr. Barbut is of opinion that the organs of smell reside in the palpi or feelers. Many insects have four, and some six, two of which are in general chiliform, in order to assist the insect in conveying its food to its mouth. It may be likewise observed, that the palpi are in a continual motion; the animal thrusting them into every kind of putrid or other matter, as a hog would his nose, smelling and searching after food. Insects which apparently do not possess palpi or spiral tongues, have undoubtedly some organ concealed within the mouth, analogous to them in function and utility; the fleshy proboscis of the fly is thrust into every substance in which the animal expects to find food; and when it is extended, nearly in the middle are situated, in our author's opinion, two upright palpi, which, no doubt, perform in their turn some office, and perhaps that of smell.

Many insects are without the tongue, nor do they make any sound with their mouths; but for this purpose some use their feet, others their wings, and others some elastic instrument with which they are naturally furnished.

Eyes. Most insects have two eyes; but the gyrinius has four, the scorpion six, the spider eight, and the scolopendra three. They have no eyebrows, but the external tunic of the eye is hard and transparent like a watch-glass; their eyes have no external motion, unless it be in the crab. They consist for the most part of one lens only; but in those of the butterfly, diptera, and many of the beetles, they are more numerous. Pugett discovered 17,325 lenses in the cornea of a butterfly, and Lieuwenhoek 800 in that of a fly.

Antennæ. The number of these is generally two (unless four are allowed to some crabs), and placed on the fore part of head: they are peculiar to insects; and are plainly distinguishable from the tentacula of the vermes, in being crustaceous; and from the palpi of insects, which are more numerous, placed near the mouth, and are sometimes wanting. As the antennæ are of great moment in distinguishing the various kinds of insects, we shall enumerate and explain the several different forms of them.

Setaceæ, are those which grow gradually taper towards the extremity.

Filiformes, such as are of the same thickness throughout.

Moniliformes, are filiformes, like the preceding, but consist of a series of round knobs, like a necklace of beads.

Clavatæ, such as gradually increase in size toward the extremity.

Capitatæ are clavatæ, but have the extremity somewhat round.

Fissiles are capitatæ; but have the capitulum, or knob, divided longitudinally into three or four parts, or laminæ, as in scarabæi.

Perfoliatæ are also capitatæ; but have the capitulum horizontally divided, as in the dermestes.

Pectinatæ, so called from their similitude to a comb, though they more properly resemble a feather, as in the moths and elateres: this is most obvious in the male,

Aristatæ, such as have a lateral hair, which is either naked, or furnished with lesser hairs, as in the fly.

Breviores, those which are shorter than the body.

Longiores, those which are longer than the body.

Mediocres, those which are of the same length with the body; all three of which varieties are distinguishable in the cerambyces.

Palpi, or feelers, resemble filiform, articulated, moveable antennæ. They are most commonly four in number, sometimes six; they are sufficiently distinguished from antennæ, in being naked, short, and always placed at the mouth.

Os, the mouth, is generally placed in the anterior part of the head, extending somewhat downwards. In some insects, it is placed under the breast; as in the chermes, coccus, cancer (crab), and curculio.

Rostrum or proboscis, is a mouth drawn out to a rigid point: in many of the hemiptera class it is bent downward toward the breast and belly, as in the cicada, nepa, notonecta, cimex (bug), aphis, and remarkably so in some curculiones.

Maxillæ, the jaws, are two in number, sometimes four, and at other times more; they are placed horizontally; the inner edge of them in some insects is serrated, or furnished with little teeth.

Lingua, the tongue, in some insects is taper and spiral, as in the butterfly; in others it is fleshy, resembling a proboscis, and tubular, as in the fly.

Labium superius, the upper lip, is situated above the jaws; as in the scarabæus and gryllus.

Stemmata, or crown, are three smooth hemispheric dots, placed generally on the top of the head; as in most of the hymenoptera, and others.

II. Truncus, the trunk, is that part which comprehends the breast or thorax: it is situated between the head and abdomen; and has the legs inserted into it, that its parts may be distinctly determined. It is divided into thorax, scutellum, and sternum.

Thorax, the chest, is the back part of the breast; and is very various in its shape. It is called dentatus, when its sides are armed with points.

Spinosus, when its back is furnished with them, as in the cerambyx; and marginatus, when its margin is lateral'y dilated, as in the silpha and cassida.

Scutellum, or escutcheon is the posterior part of the thorax; it is frequently triangular, and appears to be divided from the thorax by an intervening suture, as in most of the coleoptera.

The sternum, or breast-bone, is situated on the inferior part of the thorax; it is pointed behind in the elateres, and bifid in some of the dytisci.

III. The abdomen is in most insects distinct from the thorax; it is the posterior part of the body of the insect; and is composed of a number of annular segments which serve occasionally to lengthen or shorten it, and to contain the organs of chylification, &c.

Spiracula, are little holes or pores, placed singly on each side of every segment of the abdomen: through these the insect breathes; and if oil is applied so as to stop them up, it proves fatal to most of them.

Tergum, the back, is the superior part of the abdomen.

Venter, the belly, is the inferior part.

Anus, is the posterior part of the abdomen, perforated for the evacuation of the excrement. This part also frequently contains the organs of generation.

IV. Artus, the limbs, or extremities, are the various instruments of motion.

Pedes, the legs, are generally six. There is an exception to this, however, in the class aptera, many of which have eight: as acari (mites), phalangii, most of the aranei (spiders), scorpiones (scorpions), and cancri (crabs). The oniscus has 14, and the iuli and scolopendri still more.

The first joint of the leg, which is generally thickest, is called femur; the second, which is generally of the same size throughout, tibia: the third, which is jointed, is distinguished by the name of tarsius; and the last, which in most insects is double, by that of unguis. The legs of insects, in general, are named from the various motions they produce: as

Cursorii, from that of running, which are most numerous.

Saltatorii, from that of leaping.

Natatorii, from that of swimming, &c. In the saltatorii, the thighs are remarkably large, by which means they are able to leap to a considerable distance, as in the gryllus, grasshopper, &c. In those of the natatorii, the feet are flat, and edged with hairs, which answer the same purpose as oars in assisting them to swim, as in the dytiscus.

Mutici, are such feet as have no claws.

Chelæ, or claws, are the fore-feet enlarged towards their extremities, each of which is furnished with two lesser claws, which act like a thumb and finger; as in the crab.

Alæ, wings, the instruments which enable the insect to fly. These are membranous and undivided, except in the instance of the phalænæ alucitæ, in which they are in part divided. Most insects have four; the diptera class, and the coccus, however, have only two.

The wing is divided into its superior and inferior surfaces: its anterior part in a butterfly, is that towards the anterior margin, or next to the head; its posterior part, that towards the anus; its exterior part, that towards the outer edge; and the interior, that next the abdomen.

They are called plicatiles, when they are folded at the time the insect is at rest, as in the wasp: opposite to these are the planæ, which are incapable of being folded.

Erectæ, such as have their superior surfaces brought in contact when the insect is at rest; as in the ephemera, puella and virgo, and papiliones (butterflies).

Patentes, which remain horizontally extended when the insect is at rest; as in the phalænæ geometræ, and most of the libellulæ.

Incumbentes, such as cover horizontally the superior part of the abdomen when the insect is at rest.

Deflexæ, are incumbentes, but not horizontally, the outer edges declining toward the sides.

Reversæ, are deflexæ, with this addition, that the edge of the inferior wings projects from under the anterior part of the superior ones.

Dentatæ, in which the edge is serrated, or scalloped.

Caudatæ, in which one or more projections in the hinder wings are extended into processes.

Reticulatæ, when the vessels of the wings put on the appearance of net-work, as in the hemerobius perla; the two anterior wings generally become superior, and the posterior ones inferior, in moths, when their wings are closed; but the anterior wings are called primary, and the inferior ones secondary, in butterflies, as they cannot with propriety be called inferior when the wings are erect.

Colores, the colours; these are various and apparent; but according to their several shapes, they take the different names of punctæ, dots; and maculæ, spots.

Fasciæ, bands, which frequently run across and sometimes surround the edge of the wings.

Striæ, streaks, which are very slender fasciæ, and lineæ, lines, which are longitudinally extended.

Ocellus, is a round spot containing a lesser spot of a different colour in its centre.

Stigma, another term lately introduced by Linnæus, signifies the spot, or anastomis, in the middle of the wing near the anterior margin; it is conspicuous in most of the hymenoptera and neuroptera, and even in the coleoptera. The single or double kidney-shaped spot, situated in the same part of the anterior wings, and frequently occurring in the phalænæ paganæ, is distinguished likewise by the name of stigma.

Elytra (in the singular number elytron). The upper wings, or case, which are of a hard substance, in some degree resembling leather, and which in most insects are of a very hard texture, but in others flexible, are called elytra: their superior surface is generally convex, their inferior concave. When the insect flies, they are extended; and shut when it rests, closing together, and forming a longitudinal suture down the middle of the back, as in the coleoptera. They are of various shapes:

Abbreviata, when shorter than the abdomen.

Truncata, when shorter than the abdomen, and terminating in a transverse line.

Fastigata, when of equal or greater length than the abdomen, and terminating in a transverse line.

Serrata, when the exterior margin towards the apex is notched or serrated, as in some of the buprestes.

Spinosa, when the surface is covered with sharp points or prickles.

Scabra, when their surface is so uneven as to grate against the fingers.

Striata, when marked with slender longitudinal furrows.

Porcata, when with elevated longitudinal sulci or ridges.

Sulcata, when the ridges are concave.

Hemelytra, when the superior wings are of a middle substance between leather and membrane; either totally so, as in the grylli; or partially so, as in the cimices, nepæ, and notonectæ: these are commonly distinguished by the name liemiptera.

Halteres, poisers (a term also introduced by Linnæus), are little heads placed on a stalk or peduncle, most frequently under a little arched scale. They are found only in the class diptera, and appear to be nothing more than the rudiments of the hinder wings.

Cauda, the tail, in most insects is,

Simplex, simple, capable of being extended, and again drawn back at pleasure. In the crab and scorpion, however, it is

Elongata, elongated or lengthened.

Setacea, brittle shaped, or taper; as in the raphidea.

Triseta, consisting of three bristles; as in the ephemera.

Furcata, being forked, as in the podura.

Forcipata, resembling a pair of forceps; as in the forsicula.

Foliosa, resembling a leaf; as in the blatta, grylli, and some species of cancri.

Telifera, such as are armed wih a dart or stng; as in the scorpion or panorpa.

Aculeus, the sting, an instrument with which they wound, and at the same time instil a poison: with such the bee, wasp, scorpion, &c. are furnished.

Explanation of the figures that accompany this article.

Fig. 62. Antennæ pectinatæ, or feathered; as in the phalænæ, moths.

63. ——— perfoliatæ, or perfoliated; as in the dermestes and dytiscus.

64. ——— fissiles, or fissile, divided into laminæ at the extremity; as in the scarabæi, beetles.

65. ——— clavatæ, or club-shaped; as in the papilio, butterfly.

66. Moniliformes, like a necklace of beads; as in the chrysomela.

67. ——— setaceæ, setaceous, or bristle-shaped; as in many of the phalænæ.

68. ——— aristatæ, furnished with a lateral hair; as in the fly.

Fig. 69, and 70. *a*, caput, the head. *b*, palpi, or feelers. *c*, antennæ, or horns. *d*, oculi, the eyes. *e*, thorax. *f*, scutellum, or escutcheon. *g*, pectus, or breast. *h*, sternum, or breast-bone. *i*, abdomen, and its segments. *k*, anus. *l*, elytra, or shells. *m*, membranous wings. *n*, pedes, or feet, which are natatorii.

71. *o*, femur, or thigh. *p*, tibia, or leg. *q*, tarsus, or foot. *r*, unguis, or claw.

72. *a*, the anterior part of the wing. *b*, the posterior part. *c*, the exterior part. *d*, the interior part. *e*, the margin. *f*, the disk, or middle. *g*, oculus, or eye.

73, 74, 75, and 76, represent the insect in its egg, caterpillar, pupa, and perfect state.

Of the sexes of insects.

In insects the same difference exists as in other animals, and they even appear more disposed to increase their species than other animals; many of them, when become perfect, seeming to be created for no other purpose but to propagate their species. Thus the silkworm, when it arrives at its perfect or moth state, is incapable of eating, and can hardly fly: it endeavours only to propagate its species; after which the male immediately dies, and, as soon as she has deposited her eggs, the female also expires.

The males and females of many insects are with difficulty distinguished; whilst in some they differ so widely, that an unskilful person might easily take the male and female of the same insect for different species: as for instance, in the phalæna humuli, piniari, russula: each sex of which differs in colour. This dissimilarity is still more apparent in some insects, in which the male has wings and the female none; as in the coccus, lampyris, phalæna antiqua, brumata, lichenella. And as most insects remain a long while in copulation, as we may see in the tipula and silkworm, the winged males fly with the wingless females, and carry them about from one place to another; as in the phalæna antiqua. It is, however, no certain rule, that when one insect of the same species is found to have wings, and the other to be without, the former must necessarily be the male, and the latter the female. The aphides, for instance, are an exception; and besides these, individuals of both sexes, and of the same species, are found without wings, as the carabi majores, tenebriones, meloes, cimices. The gryllus pedestris is likewise destitute of wings; and might have passed for a gryllus in its pupa state, had it not been seen in copulation; for it is well known that no insect can propagate its species till it arrives at its last or perfect state.

"Pleraque insectorum genitalia sua intra anum habent abscondita, et penes solitarios, sed nonnulla penem habent bifidum: cancri autem et aranei geminos, quemadmodum nonnulla amphibia, et quod mirandum in loco alieno, ut cancer, sub basi caudæ. *Araneus mas* palpos habet clavatos, qui penes sunt, juxta os utrinque unicum, quæ clavæ sexum nec speciem distinguunt; et fœmina vulvas suas habet in abdomine juxta pectus. Huic vero si unquam vere dixeris, *Res plena timoris amor:* si enim procus in auspicato accesserit, fœmina ipsum devorat; quod etiam sit, si non statim se retraxerit. Libellula fœmina genitale suum sub apice geret caudæ, et mas sub pectore; adeo ut cum mas collum fœminæ forcipe caudæ arripit, illa caudam sub pectore ejus adplicet, sicque peculiari ratione connexæ volitent."

Besides those of male and female, a third sex exists in some insects which we call neuter: as these have not the distinguishing parts of either sex, they may be considered as eunuchs, or infertile. We know of no instance of this kind in any other class of animals, nor in vegetables, except in the class syngenesia, and in the opulus. This kind of sex is only found among those insects which form themselves into societies, as bees, wasps, and ants: and here these kind of eunuchs are real slaves, as on them lies the whole business of the economy; while those of the other sex are idle, only employing themselves in the increase of the family. See Apis. Among ants, the neuters form a hill in the shape of a cone, that the water may run off it, and place those which are in the pupa state on that side of it which is least exposed to the heat of the sun. At a considerable distance from these are found the habitations of the males and females, to whom the most ready obedience is yielded by the neuters, till a new offspring succeeds, and then they oblige them to quit their habitations. But those ants which live entirely under ground provide better for themselves in this respect; for a little before their nuptials they quit their habitation of their own accord, and, after swarming in the manner of bees, copulate in the air; and each retiring to some new habitation founds a new race.

No hermaphrodites have as yet been discovered among insects. There is something very singular, however, in the propagation of the aphides. A female aphis once impregnated can produce young, which will continue to produce others without any fresh impregnation, even to the tenth progeny; afterwards a new impregnation must take place.

The male insects, like male hawks, are always smaller than the females.

In the propagation of their species they are remarkably careful; so that it is with the greatest difficulty the flies are kept from depositing their eggs on fresh meat, the cabbage-butterfly from laying them on cabbage, and other insects from depositing them in the several places peculiar to each. The scarabæus pilularius and carnifex are deserving of our attention, as they afford a mutual assistance to each other: for when the female has laid her eggs in a little ball of dung, the males with their feet, which are axiform, assist the female to roll it to some suitable place; as Aristotle and Pliny formerly, and Loefling has since remarked.

A fact not a little wonderful is, that in the coccus and oniscus the female has no sooner brought forth her young than she is devoured by it; and that the sphex should be able so readily to kill the caterpillar of a moth, then bury it in the earth, and there deposit her eggs in it. Nor can we without admiration behold the same species of aphis, which was viviparous in the summer, become oviparous in the autumn.

Almost innumerable examples might be brought of the singularities in the eggs of insects: we shall, however, only mention those of the hemerobius, which are deposited on a footstalk; those of the phalæna neustria, which are placed regularly in a ring round the branch of some tree; and the compound eggs of the blatta, or cockroach.

Of the metamorphoses of insects.

Except those of the aptera class, there are no insects but what are continually undergoing some transformation. They change first from the (ovum) egg, into the (larva) caterpillar, or maggot; then into the (pupa) chrysalis; and, lastly, into the (imago) fly, or perfect state. During each of those changes their appearance differs most essentially. The insect, as soon as it came out of the egg, was by former entomologists called eruca; but as this is synonymous with the botanic name sisymbrium, it was changed by Linnæus for the term

Larva; a name expressive of the insect's being, in this state, as it were masked, having its true appearance concealed. Under this mask or skin the entire insect, such as it afterwards appears when perfect, lies concealed, enveloped only in its tender wings, and putting on a soft and pulpy appearance; insomuch that Swammerdam was able to demonstrate the butterfly with its wings to exist in a caterpillar, though it bore but a faint resemblance to its future perfection. The insect, therefore, in this state, undergoes no other alteration but the change of its skin. The larvæ are, for the most part, larger than the insect when perfect, and are very voracious. The caterpillar of the cabbage-butterfly eats double what it would seem to require from its size; its growth, however, is not adequate to its voracity.

Pupa. The insect in this state was formerly called chrysalis, or aurelia; but as the appearance of gilding is confined to a few butterflies only, the term of pupa has been adopted in its stead; because the lepidoptera, especially, resemble an infant in swaddling-clothes; and in this state none, except those of the hemiptera class, take any nourishment.

Imago is the third state. This name is given by Linnæus to the third change, in which the insect appears in its proper shape and colours; and as it undergoes no more transformations, it is called perfect. In this state it flies, is capable of propagating its species, and receives its true antennæ; which before, in most insects, were scarcely apparent.

As the shape of the pupa is different in different classes of insects, it assumes different names; thus it is called

Coarctata, when it is round, and as it were turned, without the least resemblance to the structure of the insect; as in the diptera.

Obtecta, when it consists as it were of two parts, one of which surrounds the head and thorax, and the other the abdomen.

Incompleta, when they have wings and feet, but are not capable of moving them: as in most of the hymenoptera.

Semi-completa, in which they walk or run, but have only the rudiments of wings.

Completa, in which they immediately obtain the perfect form of the insect, without undergoing any more change: as in those of the aptera class, except only the flea. The bed-bug also belongs to this class.

The spider undergoes frequent transformations, though only in the colour of its skin. The crustaceous insects, as crabs, lobsters, &c. yearly cast their shells, or their growth would otherwise be impeded. The scolopendri, when young, have fewer feet than when they are full-grown. All insects, as soon as they undergo the third change, are arrived at their full growth; nor do we find any difference in the size of the same species of insect in the same countries, unless, during its caterpillar state, it has not had a sufficiency of proper food.

Of the classification of insects.

The insect tribe being endowed with the various powers of creeping, flying, and swimming, there is scarcely any place, however remote and obscure, in which they are not to be found. The great confusion which appeared to the antients to arise from their number, made them never dream of reducing them to any system. Swammerdam, that indefatigable enquirer into nature, observed, that their metamorphoses were divided by nature into several states or orders. Their external appearance also carried with it some mark of distinction: so that entomologists called all those of the coleoptera class scarabæi (beetles); those of the lepidoptera papiliones; and those of the gymnoptera class that had two wings only, muscæ (flies); those of the same class that had four wings, were called apes (bees). No farther progress was made in the systematic part of this science till the time of Linnæus. He was the first that undertook to determine the genera, and assign them their proper characters, in the Systema Naturæ; and thus reduced this science to a systematic form. This system, in subsequent editions, was considerably enriched and amended by him, insomuch that the science of insects now shines forth in its full lustre. He it was who first instituted natural orders, and reduced them into genera by expressive names; determined an infinite number of species in the Fauna Suecica and Museum Reginæ; collected with incredible pains the synonymous names of the various authors who had written on them; and, lastly, added their descriptions, and the places in which they were to be found: so that the system of this illustrious author will lead any person, without the assistance of a master, for the most part, easily to ascertain the name of any insect he may meet with. Before his time scarcely any more than 200 insects were known; whereas, in the last edition of his system, he has determined the names of nearly 3000 distinct species; though this is not the sixth part of the number that is now known.

Orders.—The class of insects is divided by Linnæus into seven orders. 1. The coleoptera (from κωλεος, a sheath, and πτερον, a wing), are such insects as have crustaceous elytra or shells, which shut together, and form a longitudinal suture down the back of the insect; as the beetle (buprestis ignita), fig. 77. 2. Hemiptera (from ημισυ, half, and πτερον, a wing), have their upper wings usually half crustaceous and half membranaceous, not divided by a longitudinal suture, but incumbent on each other; as the cimex, fig. 78. 3. Lepidoptera (from λεπις, a scale, and πτερον, a wing), are insects having four wings, covered with fine scales in the form of powder or meal; as in the butterfly (papilio antiopa), fig. 79. 4. Neuroptera (from νευρον, a nerve, and πτερον, a wing), have four membranous transparent naked wings, generally like network; as in the panorpa coa, fig. 80. 5. Hymenoptera (from υμην, a membrane, and πτερον, a wing), are insects with four membranous wings; tail furnished with a sting, as in the tenthredo, fig. 81. 6. Diptera (from δυω, two, and πτερον, a wing), are such as have only two wings and poisers; as in the fly (musca), fig. 82. 7. Aptera (from α, without, and πτερον, a wing), insects having no wings. The last division contains scorpions, spiders, crabs, lobsters, &c. See ARANEA, CANCER, &c.

Genera.—It is not necessary to insert here the characters of all the different genera which may be found in Linnæus's Syst. Nat. It will be sufficient to enumerate some new genera mentioned by subsequent systematic writers; so that by being acquainted with the subtile distinctions on which they are built, the student may avoid running into confusion. It is among the moderns only that genera of this kind are to be met with, and new names given them. To remove this difficulty, we shall first enumerate those names adopted by authors, which are synonymous with those of Linnæus.

New genera of authors synonymous with those of Linnæus.

In this account we shall distinguish the names which other authors have given by Italics. Thus, lucanus has been named *platyceros*. Hister, *attelabus*. Byrrhus, *anthrenus cistela*. Mylabris, *laria* scop. Attelabus, *clerus*. Silpha, *peltis*. Bruchus, *mylabris*. Ptinus, *byrrhus*. Chrysomela, *galericula*. Hispa, *crioseris*. Cantharis, *cincindela*. Buprestis, *cucujus*. Carabus, *buprestis*. Myrmeleon, *formica-leo*. Sirex, *urocerus*.

New genera of authors.

Copris, scarabæus absque scutello. *Bostricius*, dermestes capecinus. *Cistela*, byrrhus pilula. *Rhinomancer*, attelabus rostro producto fere curculionis. *Anthribus*, silpha. *Bruchus*, ptinus fur ob spinas thoracis. *Melolontha*, chrysomela cylindrica. *Altica*, chrysomela saltatoria. *Diaperis*, chrysomela fungorum. *Pyrochora*, cantharis. *Telephorus*, cantharis. *Cantharis*, meloë alata. *Cerocoma*, meloë shafferi. *Notaxis*, meloë monoceros. *Prionus*, cerambyx thoracis margine denticulato. *Stenocoris*, leptura thorace spinosa. *Hydrophilus*, dytiscus antennis clavatis. *Mylabris*, necydalis minor. *Acridium*, gryllus muticus. *Locusta*, gryllus tettigonia. *Tettigonia*, cicada. *Corixa*, notonecta. *Naucoceris*, nepa. *Perla*, hemerobius cauda bisecta. *Libelluloides*, myrmeleon antennis capitatis. *Crabro*, tenthredo antennis clavatis. *Pterophorus*, phalæna alucita. *Bibio*, tipula thorace spinoso. *Stomoxoides*, asilus bucca inflata. *Strationymus*, musca. *Nemotelus*, musca. *Volucella*, musca.

These genera appear to be in a great measure like those which were introduced into botany by the followers of Rivinus. Paying too little regard to nature, they disunited natural genera, on account of the most trifling distinctions. This made their continuance in the science of very short duration. Our business here is not to suppose, but to examine, what nature will allow of, and what she will not. Knowledge of this kind, built on opinion only, will not stand. We are therefore to look into the science with great accuracy; and the larva of the insect, its manner of changing, and other things of moment, are to be known, before we presume to form a new genus.

Coining of new names, and changing of one old one for another, has been the source of the greatest confusion. Thus, in order to reduce the cicindela and carabus to the same genus, buprestis has been adopted for the generic name; but as that genus had long ago received a very different application, it was changed for that of cucujus. Again, that the officinal cantharides might be ranged among the cerambyces, the cantharides have been removed from the genus of meloë (to which they naturally belong), and referred to the genus of cicindela, obtaining thus a new name: and so of many others. Thus also, to mention no more, how needless and rash was it to separate the acridium and locusta from the genus of gryllus, the crabro from the tenthredines, and the mylabris from the necydalis!

Trivial names.—The trivial names placed under their respective genera will occasion little or no controversy; they are current like money, and of the same utility as the proper names of men, Peter or Paul, &c. Insects living on vegetables should receive their names from the particular plants on which they mostly feed, as that method is preferable to all others. Thus the names of the phalæna mori, &c. are excellent; and when we are able to give such to insects, the old ones are to be discarded. But we are to be cautious and not too hasty in our judgment in this respect; as insects, when they cannot get their favourite food, will often eat other plants. Thus the silkworm, for want of mulberry-leaves, will eat those of lettuce, though it will not be so well nourished by them.

Various other instances of the invention of trivial names will be met with in the Systema

Naturæ, particularly among the butterflies and moths. To prevent confusion from the great number of species which constitute the genus of phalæna, they are distributed into sections, and distinguished by the terms of bombyces, noctuæ, geometræ, tortrices, pyralides, tineæ, and alucitæ. The bombyces and noctuæ, which are so much alike, that the females of the bombyces are with great difficulty distinguished from the noctuæ, are named in a promiscuous manner.

All those of the geometræ have their names terminating in aria and ata, according as their antennæ are setaceous or pectinated. The tortrices, in aria; the pyralides, in alis; the tineæ, in ella; and the alucitæ, in dactyla: so that it is evident from the termination itself to what section the insect is to be referred. It is to be wished that similar institutions could be formed throughout the whole science, as here the name itself serves to distinguish the insect.

Butterflies are divided into sections, by the names of equites, heliconii, danai, nymphales, and plebeii. In such a multitude of butterflies, the greatest part of which are foreign and extra-European, and to whose food and manner of life we are utter strangers, it was impossible to give significant trivial names. Linnæus, therefore, by way of simile, has taken the names of the equites from the Trojan history. These consist of two troops or bodies; of which one contains the sable, and as it were mourning nobles, having red or bloody spots at the basis of their wings. These receive names from the Trojan nobles; and as Priam was king of Troy, the most splendid among these bear his name. The other body, ornamented with a variety of gay colours, are distinguished by the names of the Grecian heroes; and as in both armies there were kings as well as officers of an inferior rank, those elegant butterflies, whose hinder wings resembled tails, were distinguished by some royal name. Thus when Paris is mentioned (knowing from history that he was a Trojan, and of royal blood), we find him among those of the first section; that is, those of a sable colour, spotted in the breast with red, and having their hinder wings resembling tails. When Agamemnon is named, we remember him to be a noble Greek, and find him among those nobles which have variegated and swallow-tailed wings. But when Nereus is spoken of, we readily know him to belong to the last section, having wings but no tails.

The second class, which contains the heliconii, derive their names from the muses, as Urania. The names of the sons and daughters of Danaus are bestowed on the third section. And as these species are subdivided into two other sections, viz. the white and parti-coloured, the metaphor is so conducted, that the white ones preserve the names of the daughters of Danaus, and the parti-coloured ones those of the sons of Egyptus: so that it is evident from the name itself to what section the butterfly is to be referred.

The names of the fourth section, nymphales, are taken from various nymphs of antiquity; and those of the fifth section, plebeii, are selected from different men among the antients whose names are worthy of remembrance: so that by this means a knowledge of the antients may be interspersed, and this agreeable science be made doubly pleasing. Those, therefore, who may find new lepidoptera, and give them new names, will do well to follow this method, unless it should be apparent what food the insect chiefly prefers for its subsistence.

ENTOYER, in heraldry, denotes a bordure charged wholly with things without life: it seems to be a corruption of the French entour, round about.

ENTRING-LADDERS, in a ship, are of two sorts; one used by the vessel's sides, in a harbour, or in fair weather, for persons to go in and out of the ship: the other is made of ropes, with small staves for steps; and is hung out of the gallery to enter into the boat, or to come aboard the ship, when the sea runs so high that they dare not bring the boat to the ship's side for fear of staving it.

ENTRY, writ of, is a writ directed to the sheriff, requiring him to command the tenant of the land, that he render to the demandant the premises in question, or appear in court on such a day, and shew why he has not done it. Of this writ there are four kinds. 1. A writ of entry sur disseisin, that lies for the disseisee against the disseisor, upon a disseisin done by himself; and this is called a writ of entry in the nature of an assise. 2. A writ of entry sur disseisin in the per, for the heir by descent, who is said to be in the per, as he comes in by his ancestor. 3. A writ of entry sur disseisin in the per and cui, where the feoffee of a disseisor makes a feoffment over to another; and then the form of a writ is, that the tenant had no title to enter but by a prior alienee, to whom the intruder demised it. A writ of entry sur disseisin in the post, which lies after a disseisin: the land is removed from hand to hand, in case of a more remote seisin, whereunto the other three degrees do not extend. 1 Inst. 238.

But all these writs are now disused, as the title of lands is now usually tried upon actions of ejectment or trespass.

ENTRY AD COMMUNEM LEGEM. The writ of entry ad communem legem lies where tenant in dower, or tenant by the courtesy, or for life, aliens in fee, or for the life of another, or in tail, the lands which they hold, &c. after their death, he in the reversion who has it in fee, or for life, shall have this writ against whomsoever is in possession of the land.

ENTRY AD TERMINUM QUI PRÆTERIIT: a writ of entry ad terminum qui præteriit, lies where a man leases lands or tenements for term of life, or years, and afterwards the term expires, and he to whom the lease was made, or a stranger, enters upon the land, and occupies the same, and deforces the lessor; the lessor or his heirs shall have the writ. And this writ lies in the per, cui, and post; for if the lessee holds over his term, and afterwards makes a feoffment, the lessor or heirs may have this writ against the feoffee in the per; and if the feoffee makes a feoffment over, he may have it against the second feoffee in the per and cui, and against the third feoffee in the post.

ENTRY IN CASU CONSIMILI. A writ of entry in casu consimili lies where tenant by the courtesy, or for life, or for another's life, aliens in fee, or in tail, or for life; now he in the reversion, who has an estate there for life, or in fee simple, or in tail, shall have that writ during the life of the tenant for life who aliened.

ENTRY IN CASU PROVISO. The writ of entry in casu proviso lies where tenant in dower aliens in fee, for life, or in tail, the land which he holds in dower; he who has the reversion in fee, or in tail, or for life, shall maintain that writ against the alienee, and against him who is the tenant of the freehold of land during the life of the tenant in dower, &c. and the writ may be made in the per, cui, and post.

ENTRY CAUSA MATRIMONII PRÆLOCUTI, lies where lands or tenements are given to a man, on condition that he shall take the donor to his wife within a certain time: and if he does not espouse her within the limited time, or espouses another, or otherwise disables himself, that he cannot take her according to the said condition, then the donor and her heirs shall have the said writ against him, or against whoever else is in the said land.

Bill of ENTRY, in commerce. See BILL. In making entries inwards, it is usual for merchants to include all the goods they have on board the same ship in one bill, though sometimes they may happen to be upwards of twenty several kinds; and in case the goods are short-entered, additional or post-entries are now allowed, though formerly the goods so entered were forfeited. As to bills of entry outwards, or including goods to be exported, upon delivering them, and paying the customs, you shall receive a small piece of parchment called a cocket, which testifies your payment thereof, and all duties for such goods.

If several sorts of goods are exported at once, of which some are free, and others pay customs, the exporter must have two cockets, and therefore must make two entries; one for the goods that pay, and the other for the goods that do not pay custom.

Entries of goods on which a drawback is allowed, must likewise contain the name of the ship in which the goods were imported, the importer's name, and time of entry inwards. The entry being thus made, and an oath taken that the customs for those goods were paid as the law directs, you must carry it to the collector and comptroller, or their deputies; who, after examining their books, will grant a warrant, which must be given to the surveyor, searcher, or land-waiter, for them to certify the quantity of goods; after which the certificate must be brought back to the collector and comptroller, or their deputies, and oath made that the said goods are really shipped, and not landed again in any part of Great Britain.

ENVELOPE, in fortification, a work of earth, sometimes in form of a simple parapet, and at others, like a small rampart with a parapet: it is raised sometimes on the ditch, and sometimes beyond it. See FORTIFICATION.

ENVIRONNÉ, in heraldry, signifies surrounded with other things: thus, they say, a lion environné with so many bezants. See BEZANT.

ENUMERATION, in rhetoric, a part of the peroration, in which the orator, collecting the scattered heads of what has been delivered throughout the whole, makes a brief and artful relation, or recapitulation thereof.

ENVOY, a person deputed to negotiate some affair with any foreign prince or state. Those sent from the courts of France, Britain, Spain, &c. to any petty prince or state, such as the princes of Germany, the republics of Venice, Genoa, &c. go in quality of

envoys, not ambassadors; and such a character only do those persons bear who go from any of the principal courts of Europe to another, when the affair they go upon is not very solemn or important. There are envoys ordinary and extraordinary, as well as embassadors; they are equally under the protection of the law of nations, and enjoy all the privileges of embassadors, only differing from them in this, that the same ceremonies are not performed to them.

EPACRIS, in botany, a genus of the monogynia order, in the pentandria class of plants. The calyx is a five-parted perianthium; the corolla monopetalous and tubular; the stamina five very short filaments; the pericardium a roundish, depressed, quinquelocular, quinquevalvular, gaping capsule; the seeds are numerous and very small. There are four species, natives of New Holland.

EPACT, in chronology, a number arising from the excess of the common solar year above the lunar, by which the age of the moon may be found every year.

The excess of the solar year above the lunar is 11 days; or the epact of any year expresses the number of days from the last new moon of the old year, which was the beginning of the present lunar year, to the 1st of January. On the first year of the cycle of the moon, the epact is 0, because the lunar year begins with the solar. On the second, the lunar year has begun 11 days before the solar year, therefore the epact is 11. On the third, it has begun twice 11 before the solar year, therefore the epact is 22. On the fourth, it begins three times 11 days sooner than the solar year, the epact would therefore be 33: but 30 days being a synodical month, must that year be intercalated; or that year must be reckoned to consist of 13 synodical months, and there remains three, which is the true epact of the year; and so on to the end of the cycle, adding 11 to the epact of the last year, and always rejecting 30, gives the epact of the present year. Thus to adjust the lunar year to the solar, through the whole of 19 years, 12 of them must consist of 12 synodical months each, and 7 of 13, by adding a month of 30 days to every year when the epact would exceed 30, and a month of 29 days to the last year of the cycle, which makes in all 209 days, *i. e.* 19 × 11; so that the intercalary or embolimæan years in this cycle are 4, 7, 10, 12, 15, 18, 19.

If the new moons returned exactly at the same time after the expiration of 19 years, as the council of Nice supposed they would do (when they fixed the rule for the observation of Easter, and marked the new moons in the calendar for each year of the lunar cycle), then the golden number multiplied by 11, would always give the epact. But in a Julian century, the new moons anticipate, or happen earlier than that council imagined they would, by $\frac{8}{25}$ of a day. In a Gregorian common century, which is one day shorter than a Julian century, they happen $\frac{17}{25}$ of a day later ($1 \text{ day} - \frac{8}{25} = \frac{17}{25}$). Now $\frac{17}{25} \times 3 = \frac{51}{25}$ for the three common centuries, but $\frac{8}{25}$ being subtracted, on account of the Gregorian bissextile century, there will remain $\frac{43}{25}$. Therefore in four Gregorian centuries, the new moons will happen later by $\frac{43}{25}$ of a day, and the epacts must be decreased accordingly.

At present the Gregorian epact is 11 days short of the Julian epact; but the quotient of the number of the centuries divided by 4, which at this time is 4, multiplied by $\frac{43}{25}$, with the addition of the remainder 1 multiplied by $\frac{17}{25}$, makes in all but $\frac{18}{25}$, or 7 days + $\frac{14}{25}$, therefore $\frac{86}{25}$, *i. e.* 3 days + $\frac{11}{25}$ must be added to complete the 11 days. Whence we have the following

General rules for finding the Gregorian epact for ever.—Divide the centuries of any year of the christian æra by 4 (rejecting the subsequent numbers); multiply the remainder by 17, and to this product add the quotient multiplied by 43; divide the product + 86 by 25; multiplying the golden number by 11, from which subtract the last quotient; and rejecting the thirties, the remainder will be the epact.

Example for 1806.

$18 \div = 4$ remains 2
$2 \times 17 = 34$
$43 \times 4 + 86 + 34 = 292$
$292 \div 25 = 11$
$11 \times 2 = 22$
$22 - 11 = 11 =$ epact.

A shorter rule for finding the epact until the year 1900. Subtract 1 from the golden number; and multiplying the remainder by 11, reject the thirties, and you have the epact.

A TABLE of golden numbers, and their corresponding epacts, till the year 1900.

G. No.	Epact.	G. No.	Epact.	G. No.	Epact.	G. No.	Epact.
1	0	6	25	11	20	16	15
2	11	7	6	12	1	17	26
3	22	8	17	13	12	18	7
4	3	9	28	14	23	19	18
5	14	10	9	15	4		

EPANORTHOSUS, in rhetoric, a figure by which a person corrects, or ingeniously revokes, what he just before alleged, as being too weakly expressed, in order to add something stronger, and more conformable to the passion with which he is agitated.

EPAULE, in fortification, denotes the shoulder of a bastion, or the place where its face and flank meet, and form the angle called the angle of the shoulder.

EPAULEMENT, in fortification, a work raised to cover sidewise, is either of earth, gabions, or fascines, loaded with earth. The epaulements of the places of arms for the cavalry, at the entrance of the trenches, are generally of fascines mixed with earth.

EPAULEMENT also denotes a mass of earth, called likewise a square orillon from its figure, raised to cover the cannon of a casement, and faced with a wall. It is likewise used for any work, thrown up to defend the flank of a post, or other place.

EPAULETTES, shoulder-knots. Among the French, all the degrees of rank, from a cadet to a general officer, were so minutely marked out by the epaulette, that a common centinel might instantly know what officer approached his station, and could pay the prescribed honours without hesitation or mistake.

This is not the case in our service. Some few alterations have lately been made in those ornaments; but they are so partial, and confined to the upper ranks only, that it is impossible to distinguish the youngest ensign from the oldest captain by his epaulette, or by any other part of his uniform. When Highland or fusileer regiments are mixed with the line, very sentinel is still more perplexed, as all the officers belonging to those corps indiscriminately wear two epaulettes made of fringe and bullion of the same quality.

Epaulettes have been introduceed into the navy during the present war. The following are the gradations of rank as distinguished by epaulettes. Masters and commanders have one epaulette on the left shoulder. Post-captains under three years, one epaulette on the right shoulder. And after having been post three years, two epaulettes. Rear-admirals have one star on the strap of the epaulette, vice-admirals two stars, and admirals three stars.

EPHA, or EPHAH, in Jewish antiquity, a measure for things dry, containing 1.0961 of a bushel.

EPHEDRA, in botany, a genus of the monadelphia order, in the diœcia class of plants, and in the natural method ranking under the 51st order, coniferæ. The male calyx is bifid; there is no corolla, but seven stamina; four antheræ inferior, three superior. The female calyx is bipartite, and fivefold, upon one another; there is no corolla; there are two pistils, and two seeds covered by the calyx, resembling a berry. There are two species, shrubs of Siberia.

EPHEMERA, the *day-fly*, or *May-fly*, in zoology, a genus belonging to the order of neuroptera. It has no teeth or palpæ; there are two large protuberances above the eyes; the wings are erect, the two hind ones being largest; and the tail is bristly. There are 11 species. These flies take their name of May-fly from the shortness of their life, and are distinguished into several species. Some live several days; others do not take flight till the setting of the sun, and live not to see the rising of that luminary. Some exist but one hour, others but half that time; in which short period they comply with the call of nature. With respect to those that live several days, Mr. Barbut observes, there is a peculiarity incident to themselves alone. They have to cast off one slough more, an operation which sometimes takes 24 hours to complete. To bring this about they cling fast to a tree. The ephemeræ, before they flutter in air, have in some manner been fishes. They remain in the states of larva and chrysalis for one, two, or three years. The chrysalis only differs from the larva by there being observable on its back cases for wings. Both have on their sides small fringes of hair, which, when put into motion, serve them as fins. Nothing can be more curious than the plying of those little oars in the water. Their abdomen is terminated, as well as in their state of flies, by three threads. These larvæ scoop themselves out dwellings in the banks of rivers; and they are small tubes made like siphons, the one serving for an en-

trance, the other affording them an outlet. The banks of some rivers are often perforated with them. When the waters decrease, they dig fresh holes lower down, in order to enjoy their element the water. The season and hour when the chrysalids of the different species of the ephemeræ turn into flies, maintain a kind of regularity. The heat, the rise or fall of the waters, accelerate, however, or postpone their final display. The ephemera of the Rhine appear in the air two hours before sunset. These flies are hatched almost all at the same instant in such numbers as to darken the air. The most early of those on the Marne and Seine in France do not begin to fly till two hours after the setting of the sun, towards the middle of August. They are seen fluttering and sporting on the brink of their tomb. The glare of light attracts them, round which they perform a thousand circles with amazing regularity. Their coming together for the purpose of generation can only be surmised, the shortness of their life requiring that all its functions should be proportionable to their duration. Some naturalists have been of opinion, that the males impregnate the eggs after the manner of fishes. The females, by the help of the threads of their tail and the flapping of their wings, support themselves on the surface of the water, and in that almost upright situation drop their eggs in clusters. One single female will lay 700 or 800 eggs, which sink to the bottom. The larvæ that escape from the voraciousness of the fishes, set about the construction of habitations to shelter them from every kind of danger. When the flies have propagated, they are seen to die, and fall by heaps. The land and water are strewed with them to a considerable thickness. The fishermen consider these multitudes of destroyed insects as manna for the fishes. See Plate Nat. Hist. fig. 180.

EPHEMERA, in medicine, the name of a species of fever continuing the space of one day, or sometimes more; for medical writers express themselves by ephemera simplex, vel plurium dierum. See MEDICINE.

EPHEMERA MALIGNA, is also a term by which some authors have called the sudor Anglicanus, or malignant diary fever, which generally destroyed the patient in 24 hours.

EPHEMERIDES, in astronomy, tables calculated by astronomers, shewing the present state of the heavens for every day at noon; that is, the places wherein all the planets are found at that time. It is from these tables that the eclipses, conjunctions, and aspects of the planets, are determined; and horoscopes or celestial schemes constructed.

In England, the Nautical Almanac, or Astronomical Ephemeris, published annually by anticipation, under the direction of the commissioners of longitude, is the most considerable. In France, celestial ephemerides were published by M. Desplaces every ten years, from 1715 to 1745: they were afterwards continued by the abbé Caille, with many additions; of which an account may be seen in the History of the Academy of Sciences for 1748. The Academy of Sciences have likewise published annually, from the beginning of the last century, a kind of ephemeris, under the title of Connoissance des Tems.

EPHIELIS, a genus of the class and order octandria monogynia. The calyx is five-parted; petals five-clawed; nect. ten scales; capsule oblong. There is one species, a tree of Guiana.

EPHOD, in Jewish antiquity, one part of the priestly habit; being a kind of girdle, which, brought from behind the neck over the two shoulders, and hanging down before, was put across the stomach, then carried round the waist, and made use of as a girdle to the tunic.

There were two sorts of ephods, one of plain linen for the priests, and the other embroidered for the high-priest. Of this last Moses gives an ample description. It was composed of gold, blue, purple, crimson, and twisted cotton. Upon part of it, which passed over the shoulders, were two large precious stones, one on each shoulder: upon these were engraved the name of the twelve tribes, six upon each stone.

The ephod was peculiar to the priesthood, and thought essential to their character; it being the opinion of the Jews, that no worship, true or false, could subsist without a priesthood and ephod.

EPHORI, in Grecian antiquity, magistrates established in antient Sparta to balance the regal power. The authority of the ephori was very great. They sometimes expelled and even put to death the kings, and abolished or suspended the power of the other magistrates, calling them to account at pleasure. There were five of them, others say nine. They presided in the public shews and festivals. They were entrusted with the public treasure, made war and peace, and were so absolute, that Aristotle makes their government equal to the prerogative of a monarchy. They were established by Lycurgus.

EPIBATERIUM, a genus of the monœcia hexandria class and order. The calyx is double; petals six; drupes three, subglobular, muconate, &c. There is but one species.

EPIC, or *heroic poem*. See POETRY.

EPICEDIUM, in antient poetry, a poem rehearsed during the funeral solemnity of persons of distinction. We find two beautiful epicediums in Virgil, one of Euryalus, and the other of Pallas.

EPICHIREMA, in logic, a mode of reasoning, which comprehends the proof of one or both the premises of a syllogism, before the conclusion is drawn.

EPICŒNE, in grammar, a term applied to nouns, which, under the same gender and termination, mark indifferently the male and female species.

EPICYCLE, in the antient astronomy, a little circle whose centre is in the circumference of a greater circle; or it is a small orb, or sphere, which being fixed in the deferent of a planet, is carried along with it; and yet, by its own peculiar motion, carries the planet fastened to it round its proper centre. It was by means of epicycles that Ptolemy and his followers solved the various phenomena of the planets, but more especially their stations and retrogradations.

The great circle they called the excentric or deferent, and along its circumference the centre of the epicycle was conceived to move; carrying with it the planet fixed in its circumference, which in its motion downwards proceeded according to the order of the signs, but, in moving upwards, contrary to that order. The highest point of a planet's epicycle they called apogee, and the lowest perigee.

The length of any part of the curve of an epicycloid, which any given point in the revolving circle has described, from the position where it touched the circle upon which it revolved, is to double the versed sine of half the arc which all the time of revolving touched the quiescent circle, as the sum of the diameters of the circles, is to the semidiameter of the quiescent circle in the exterior cycloid; or as the difference of the diameters is to that semidiameter, for the interior one.

Dr. Halley has given a general proposition for the measuring of all cycloids and epicycloids: thus, the area of a cycloid, or epicycloid, either primary, or contracted, or prolate, is to the area of the generating circle; and also the areas of the parts generated in those curves, to the areas of analogous segments of the circle; as the sum of double the velocity of the centre and the velocity of the circular motion, is to this velocity of the circular motion. See Philos. Trans. No. 218.

EPICYCLOIDS, *spherical*, are formed by a point of the revolving circle, when its plane makes a constant angle with the plane of the circle on which it revolves.

If a parabola roll upon another equal to it, its focus will describe a right line perpendicular to the axis of the quiescent parabola; also the vertex of the rolling parabola will describe the cissoid of Diocles; and any other point of it will describe some one of Newton's defective hyperbolas, having a double point in the like point of the quiescent parabola.

In like manner, if an ellipse revolve upon another ellipse, equal and similar to it, its focus will describe a circle, whose centre is in the other focus, and consequently the radius is equal to the axis of the ellipsis; and any other point in the plane of the ellipse will describe a line of the 4th order.

The same may be said also of an hyperbola, revolving upon another, equal and similar to it; for one of the foci will describe a circle, having its centre in the other focus, and the radius will be the principal axis of the hyperbola; and any other point of the hyperbola will describe a line of the 4th order.

Concerning these lines, see Newton's Principia, lib. 1; see also Maclaurin's Geometria Organica.

EPICYCLOID, in geometry, a curve generated by the revolution of the periphery of a circle, ACE (Plate Miscel. fig. 84), along the convex or concave side of the periphery of another circle, DGB.

The length of any part of the curve, that any given point in the revolving circle has described, from the time it touched the circle it revolved upon, shall be to double the versed sine of half the arch, which all that time touched the circle at rest, as the sum of the diameters of the circles, to the semidiameter of the resting circle, if the revolving circle moves upon the convex side of the resting circle; but if upon the concave side, as the difference of the diameters, to the semidiamer of the resting circle.

EPIDEMIC. See MEDICINE.

EPIDENDRUM, a genus of the diandria order, in the gynandria class of plants, and in the natural method ranking under the 7th

order, orchideæ. The nectarium is turbinated, oblique, and reflexed. There are 124 species, one of which is the plant which produces the fruit called vanilla, and which is used in the making of chocolate. It is a native of Mexico, and also of some parts of the East Indies. It is a parasitic plant; the leaves of which greatly resemble the vine, and are about eighteen inches long and three inches broad. The flowers are of a white colour intermixed with stripes of red and yellow. When these fall off they are quickly succeeded by the pods, which at first are green, but afterwards, as they ripen, become yellow, and are gathered for use. The pods of the best vanilla are long, slender, and well filled with seeds. If opened when fresh, the cavity of the pod is found to contain a humid substance that is black, oily, and balsamic, of such a strong smell, that it frequently causes headaches, and even a sort of temporary intoxication. The season for gathering the pods begins about the end of September, and lasts till the end of December. They are dried in the shade; and when dry, and fit for keeping, they are rubbed externally with a little oil of cocoa or calba, to render them supple, or preserve them the better, and to prevent them from becoming too dry or brittle. The use of this fruit is only for perfuming chocolate. In New Spain it is reckoned unwholesome, and therefore never used; but in England, and other countries of Europe, it is a constant ingredient; and perhaps its noxious qualities may be corrected by the sea air. In those countries where they grow, the plants are very easily propagated by cuttings. In this country they require to be kept in a stove, and also to be placed near some American tree, round which they may climb for their support.

EPIDERMIS. See CUTIS.

EPIDIDYMIS, in anatomy, the name by which some call the two bodies more usually known by that of parastatæ.

EPIGASTRIC REGION, a part or subdivision of the abdomen.

EPIGRAM, in poetry, a short poem in verse, treating only of one thing, and ending with some lively, ingenious, and natural thought, or point. See POETRY.

EPIGRAPHE, among antiquarians, denotes the inscription of a building, pointing out the time when, the persons by whom, the uses, &c. for which it was erected.

EPILEPSY, in medicine, the same with what is otherwise called the falling-sickness, from the patient's falling suddenly to the ground. Sometimes this disease comes upon the patient unawares: but it more frequently gives notice of its approach by a lassitude of the whole body, a heavy pain in the head, with some disturbance of the senses, unquiet sleep, unusual dread, dimness of sight, and a noise in the ears: in some there are a violent palpitation of the heart, a puffing or inflation of the breast, difficult respiration, a murmuring noise in the belly, fetid stools, a flux of the urine, and a refrigeration of the joints: in others, there is a sensation as it were of cold air, ascending from the extreme parts towards the brain and heart. At length falling senseless to the ground, the thumbs are shut up close in the palms of the hands, and are with difficulty taken out; the eyes are distorted or inverted, so that nothing but the whites appears; all sensation is suspended, insomuch that no smell, no noise, nor even pinching of the body, is able to bring them to themselves; they froth at the mouth, with a hissing kind of noise: the tongue is lacerated, or torn by the teeth, and there is a shaking or trembling of the joints. However, in different patients the symptoms vary; for sometimes, instead of convulsive motions, the limbs are all stiff, and the patient is as immoveable as a statue. At last there is a remission of the symptoms, and the patients come to themselves after a longer or shorter interval: then they complain of a pain and heaviness of the head, and a lassitude of all their joints. These fits usually return on certain days, or age of the moon, but especially about the new or full moon; in women chiefly about the time of menstruation: and as to the prognostics, they generally leave the patient about the time of puberty. See MEDICINE.

EPILOBIUM, the WILLOW-HERB, in botany; a genus of the monogynia order, in the octandria class of plants; and in the natural method ranking under the 17th order, calycanthemæ. The calyx is quadrifid; the petals four; the capsule oblong, inferior; the seeds pappous or downy. There are fourteen species, several of them natives of Britain. They grow in marshes, or under hedges in moist and shady places; having blossoms generally of a red colour, and sometimes of considerable beauty. The most remarkable is the hirsutum, commonly called codlins-and-cream. The top-shoots of this plant have a very delicate fragrancy; but so transitory, that before they have been gathered five minutes it is no longer perceptible. Horses, sheep, and goats, eat this plant; cows are not fond of it; swine refuse it. An infusion of the leaves of another species, the angustifolium, or rose-bay willow-herb, has an intoxicating quality, as the inhabitants of Kamtschatka have learned. These people also eat the white young shoots which creep under the ground, and have a sort of ale brewed from the dried pith of it. The down of the seeds has been lately manufactured by mixing it with cotton, or beaver's hair.

EPILOGUE, in oratory, the end or conclusion of a discourse, ordinarily containing a recapitulation of the principal matters delivered.

EPILOGUE, in dramatic poetry, a speech addressed to the audience after the play is over, by one of the principal actors, usually containing some reflections on certain incidents in the play, especially those on the part of the person that speaks it. See POETRY.

EPIMEDIUM, BARREN-WORT, in botany; a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 24th order, corydales. There are four nectaria, cup-shaped, and lying on the petals. The corolla is tetrapetalous, the calyx dropping off. The seed-vessel is a pod. There is only one species, viz. the alpinum. It is a low herbaceous plant, with a creeping root, having many stalks about nine inches high, each of which has three flowers, composed of four leaves placed in the form of a cross. They are of a reddish colour, with yellow stripes on the border.

EPIPHANY, a Christian festival, otherwise called the manifestation of Christ to the Gentiles, observed on the sixth of January, in honour of the appearance of our Saviour to the three magi, or wise men, who came to adore him, and bring him presents. The feast of epiphany was not originally a distinct festival, but made a part of that of the nativity of Christ, which being celebrated twelve days, the first and last of which were high or chief days of solemnity, either of these might properly be called epiphany, as that word signifies Christ's appearance in the world. The kings of England and Spain offer gold, frankincense, and myrrh, on epiphany, or twelfth-day, in memory of the offerings of the wise men to the infant Jesus. The festival of epiphany is called by the Greeks the feast of lights, because our Saviour is said to have been baptised on that day, and baptism is by them called illumination.

EPIPHONEMA, in rhetoric, a sententious exclamation containing a lively remark placed at the end of a discourse or narration; such is that of Virgil,

Fas omne abrumpit, Polydorum obtruncat, et auro
Vi potitur. Quid non mortalia pectora cogis,
Auri sacra fames?

This figure closes a narration in a very advantageous manner, deeply impresses the thing related upon the memory of the reader, and leaves him well pleased with the sense and sagacity of the author.

EPIPHYSIS, in anatomy, a bony substance, or as it were a lesser bone, affixed to a larger or principal bone by the intervention of a cartilage. See ANATOMY.

EPISODE, in poetry, a separate incident, story, or action, which a poet invents, and connects with his principal action, that his work may abound with a greater diversity of events: though, in a more limited sense, all the particular incidents of which the action or narration is compounded, are called episodes. The episode, in its original, was only something rehearsed between the parts of the chorus, or ancient tragedy, for the diversion of the audience. Episodes serve to promote the action, to illustrate, embellish, and adorn it, and carry it to its proper period. Episodes are either absolutely necessary, or very requisite. All episodes are incidents, tho' all incidents are not episodes; because some incidents are not adventitious to the action, but make up the very form and series of it. Examples will clear up this distinction: the storm in the first Æneid of Virgil, driving the fleet on the coast of Carthage, is an incident, not an episode, because the hero himself, and the whole body of his forces, are concerned in it; and so it is a direct and not a collateral part of the main action. The adventures of Nisus and Euryalus, in the ninth Æneid, are episodes, not incidents, *i. e.* not direct parts of the main action. See POETRY.

EPISTATES, in the Athenian government, was the president of the proedri. To the custody of this officer was committed the public seal, and the keys of the citadel and the public exchequer; this therefore was an office of so great trust and power, that no man was permitted by the laws to continue in it above one day, nor to be elected into it a second time. The epistates were elected by lot out of the prytanes.

EPISTEMONARCH, in the antient Greek church, an officer of great dignity, who had the care of every thing relating to faith,

in the quality of censor. His office answered pretty nearly to that of master of the sacred palace at Rome.

EPISTROPHE, in rhetoric, a figure wherein that which is supposed of one thing, is strongly affirmed of another: thus, Are they Hebrews? So am I. Are they Israelites? So am I. Are they of the seed of Abraham? So am I, &c.

EPISTYLE, in the antient architecture, a term used by the Greeks for what we call architrave. See ARCHITECTURE.

EPITHALAMIUM, in poetry, a nuptial song, or composition, in praise of the bride and bridegroom, praying for their prosperity, for a happy offspring, &c.

EPITHET, in poetry and rhetoric, an adjective expressing some quality of a substantive to which it is joined; or such an adjective as is annexed to substantives by way of ornament and illustration, not to make up an essential part of the description.

EPITOME, in literary history, an abridgment or summary of any book, particularly of a history. See ABRIDGMENT.

EPITRITUS, in prosody, a foot consisting of three long syllables, and one short. Of these grammarians reckon four kinds; the first consisting of an iambus and spondee, as sălūtāntēs; the second of a trocheus and spondee, as cōncĭtātī: the third of a spondee and an iambus, as cōmmūnĭcāns: and the fourth of a spondee and a trocheus, as īncāntārĕ.

EPITROPUS, among the modern Greeks, a kind of arbitrator chosen by the Greek Christians under the dominion of the Turks, to terminate their differences, and avoid carrying them before the Turkish magistrates.

EPIZEUXIS, in rhetoric, a figure which repeats the same word, without any other intervening; such is that of Virgil, Nunc, nunc, insurgite remis.

EPOCHA, in chronology, a term or fixed point of time, whence the succeeding years are numbered or accounted. The most remarkable epochas are those that follow.

EPOCHA *of the creation of the world.* According to the Vulgate, archbishop Usher places this event 4004 years before the birth of Christ; Scaliger makes it 3950, Petavius 3984, and Ricciolus 4184 years before Christ. According to the Septuagint, Eusebius places the creation 5200 years before the nativity of our Lord; the Alphonsine tables, 6934; and Ricciolus 5634. The creation, therefore, as we follow the archbishop, happened in the year 710 of the Julian period. Sir Isaac Newton, again, makes the creation of the world later by 500 years than all other chronologists; and the proofs by which this illustrious philosopher supports his opinion are of two different kinds. The Egyptians counted 341 generations from Menes to Setho, allowing a hundred years for three generations; and the antient Greeks computed one generation at about forty years. Now, says sir Isaac, it is true, three ordinary generations may be computed at about 120 years; but generations are longer than the reign of kings, because it is evident that mankind in general live longer than kings reign. The duration of a reign, therefore, taking one with another, is according to him about twenty years: whence he concludes, that the antients have erred in their calculation in allowing forty years for every generation. The second kind of proof is taken from the precession of the equinoxes. According to Clemens Alexandrinus, Chiron, who was in the expedition of the Argonauts, fixed the vernal equinox at the fifteenth degree of Aries, and consequently the summer solstice at the fifteenth degree of Cancer. Meto fixed the summer solstice at the eighth degree of Cancer, a year before the Peloponnesian war. Now since one degree answers to the retrograde motion of the equinoctial points in 72 years, there are seven times 72 years from the expedition of the Argonauts to the beginning of the Peloponnesian war: that is, 504 years, and not 507 years, as the Greeks affirm. By combining these two different proofs, sir Isaac concludes, that the expedition of the Argonauts ought to be placed 909 years before Jesus Christ, and not 1400, as is generally believed; and therefore that the creation of the world ought to be placed about 500 years later than chronologists generally place it.

EPOCHA *of the deluge.* According to the Hebrew text, there are 1656 years from the creation to the deluge; 1307 according to the Samaritan; 2242, according to Eusebius and the Septuagint; 2256, according to Josephus and the Septuagint; and 2262 according to Julius Africanus, Petavius, and the Septuagint. In following the Hebrew text this epocha begins in the year 2366 of the Julian period.

EPOCHA *of the olympiads,* used principally by the Greeks, had its origin from the olympic games, which were celebrated at the beginning of every fifth year. This epocha begins 776 years before the incarnation, or in the year 3938 of the Julian period.

EPOCHA, *Varronian, of the building of Rome,* is fixed 753 years before our Saviour's birth, and in the year 3961 of the Julian period.

EPOCHA *of Nabonassar king of Babylon,* made use of by Ptolemy, Censorinus, and several other authors, began 747 years before the incarnation, and in the year 3967 of the Julian period.

EPOCHA, *Julian.* The first year of Julius Cæsar's correcting the calendar stands 45 years before our Saviour's birth, and coincides with the year 4669 of the Julian period.

EPOCHA *of Christ.* The Christian world generally reckoned from the epocha of the creation, the building of Rome, the consuls' register, or the emperor's reign, till about 500 years after Christ, when the epocha of the nativity of our blessed Lord was introduced by Dionysius Exiguus. He began his account from the conception or incarnation, properly called Lady-day. Most countries in Europe, however, at present reckon from the first of January next following, except the court of Rome, where the epocha of the incarnation still obtains for the date of their bulls and briefs. But here we are to observe, that there are different opinions respecting the year of our Saviour's birth. Capellus and Kepler fix it at about the 758th year from the building of Rome. Deckar and Petavius place the incarnation in the 749th of Rome. Scaliger and Vossius make it fall on the 751st of Rome. Dionysius Exiguus, Bede, &c. fix the birth of our Saviour to the year 751 of Rome; the diversity of these opinions proceeding from the difficulty of fixing Herod the Great's death, who, as is evident from the evangelists, was living at our Saviour's birth, the taxation of Cyrenius, and the time of our Saviour's beginning his ministry. But it is generally agreed, that as to computation and use, the common epocha is to be followed which places the birth of Christ in the 4713th of the Julian period, although the true birth rather corresponds with the 4711th of the same period.

EPOCHA, *Dioclesian,* or EPOCHA *of Martyrs,* called also the æra of the Cophti or Egyptians, because the emperor Dioclesian made a great many martyrs in Egypt, begins in the year 283 of our Lord, and the 4997 of the Julian period.

EPOCHA *of the hegira,* or flight of Mahomet, used among the Turks, is the year of the Julian period 5335, answering to the year of Christ 622.

EPOCHA, *Persian,* or *Yezdejerd,* is the year of the Julian period 5345, answering to the year 622. To reduce the years of one epocha to those of another, observe the following rule; add the given year of an epocha to the year of the Julian period corresponding with its rise, and that will give the year of the period. For example, if to 1806, the present year of the Christian epocha, we add 4713, the year of the Julian period corresponding with its rise, the sum, 6529, will be the present year of the Julian period; now if we subtract from the year thus found, the year of the Julian period corresponding with the rise of any epocha, the remainder shews the true method of making a just connection betwixt that epocha and the known year of Christ. Again, if we want to find the year of the Julian period corresponding to a given year before Christ, we subtract the given year from 4714, and the remainder is the year required. See CHRONOLOGY.

EPODE, in lyric poetry, the third or last part of the ode; the antient ode being divided into strophe, antistrophe, and epode. The epode was sung by the priests, standing still before the altar, after all the turns and returns of the strophe and antistrophe, and was not confined to any precise number or kind of verses. The epode is now a general name for all kinds of little verses that follow one or more great ones, of what kind soever they be; and, in this sense, a pentameter is an epode after an hexameter. And as every little verse, which being put after another, closes the period, is called epode, hence the sixth book of Horace's odes is entitled Liber Epodon, Book of Epodes; because the verses are all alternately long and short, and the short ones generally, though not always, close the sense of the long one.

EPOPŒIA, in poetry, the story, fable, or subject treated of, in an epic poem.

EPULONES, in Roman antiquity, ministers who assisted at the sacrifices, and had the care of the sacred banquet committed to them. At first they were only three in number, but afterwards increased to seven. Their office was, to give notice when feasts were to be held in honour of the gods, and to take care that nothing was wanting towards the celebration.

EQUABLE, an appellation given to such motions as always continue the same in degree of velocity, without being either accelerated or retarded. When two or more bodies are uniformly accelerated or retarded, with the same increase or diminution of velocity in each, they are said to be equally accelerated or retarded.

EQUATION, in algebra, the mutual comparing two equal things of different denomi-

nations, or the expression denoting this equality; which is done by setting the one in opposition to the other, with the sign of equality (=) between them: thus $3s.=36d.$, or 3 feet = 1 yard. Hence, if we put a for a foot, and b for a yard, we will have the equation $3a=b$, in algebraic characters. See ALGEBRA.

EQUATION *of a curve*, an equation expressing the nature of a curve, the relation between an abciss and a corresponding ordinate, or the relation of their fluxions. See CURVE.

EQUATION *of time*, in astronomy and chronology, the reduction of the apparent time or motion of the sun, to equable, mean, or true time. See ASTRONOMY.

EQUATOR, in geography, a great circle of the terrestrial globe, equidistant from its poles, and dividing it into two equal hemispheres; one north, and the other south. See GLOBES, *use of*.

EQUATORIAL, *universal*, or PORTABLE OBSERVATORY, is an instrument intended to answer a number of useful purposes in practical astronomy, independant of any particular observatory. It may be employed in any steady room or place, and it performs most of the useful problems in the science of astronomy. See OBSERVATORY.

EQUERRY, in the British customs, an officer of state under the master of the horse. There are five equerries, who ride abroad with his majesty; for which purpose they give their attendance monthly, one at a time, and are allowed a table. As to the equerries of the crown-stable, they have this distinct appellation, as being employed in mounting, managing, and breaking, the saddle-horses for his majesty's use, and holding his stirrup.

EQUES AURATUS, is used for a knight bachelor, called *auratus*, q. d. *gilt*, because antiently none but knights were allowed to beautify their armour, or other habiliments of war, with gold. This term is not used in law, but instead of it *miles* and *chevalier* are made use of.

EQUESTRIAN STATUE, signifies the statue of a person mounted on horseback.

EQUESTRIAN ORDER, among the Romans, signified their knights or equites, as also their troopers or horsemen in the field; the first of which orders stood in contradistinction to the senators, as the last did to the foot, military, or infantry: each of these distinctions was introduced into the state by Romulus.

EQUIANGULAR, in geometry, an epithet given to figures whose angles are all equal: such are a square, an equilateral triangle, &c.

EQUIDIFFERENT NUMBERS, in arithmetic, are of two kinds. 1. Continually equidifferent is when, in a series of three numbers, there is the same difference between the first and second, as there is between the second and third; as 3, 6, 9. And 2. Discretely equidifferent is when, in a series of four numbers or quantities, there is the same difference between the first and second as there is between the third and fourth.: such are 3, 6, 7, 10.

EQUIDISTANT, an appellation given to things placed at an equal distance from some fixed point, or place, to which they are referred.

EQUILATERAL, in general, something that has equal sides, as an equilateral triangle.

EQUILATERAL HYPERBOLA, one whose transverse diameter is equal to its parameter; and so all the other diameters, equal to their parameters; in such an hyperbola, the asymptotes always cut one another at right angles in the centre. Its most simple equation, with regard to the transverse axis, is $y^2=x^2-a^2$; and, with regard to the conjugate, $y^2=x^2\times a^2$, when a is the semitransverse, or semiconjugate. The length of the curve cannot be found by means of the quadrature of any space, of which a conic section is any part of the perimeter.

EQUILIBRIUM, in mechanics, is when the two ends of a lever or balance hang so exactly even and level, as neither to ascend nor descend, but keep in a position parallel to the horizon; which is occasioned by their being both charged with an equal weight.

EQUIMULTIPLES, in arithmetic and geometry, are numbers or quantities multiplied by one and the same number or quantity. Hence, equimultiples are always in the same ratio to each other, as the simple quantities before multiplication: thus if 6 and 8 are multiplied by 4, the equimultiples 24 and 32 will be to each other as 6 to 8.

EQUINOCTIAL, a great circle in the heavens under which the equator moves in its diurnal motion. The poles of this circle are the poles of the world. It divides the sphere into two equal parts, the northern and southern. It cuts the horizon of any place, in the east and west points; and at the meridian its elevation above the horizon is equal to the co-latitude of the place. The equinoctial has also various other properties; as,

1. Whenever the sun comes to this circle, he makes equal days and nights all round the globe; because he then rises due east, and sets due west. Hence it has the name equinoctial. All stars which are under this circle, or have no declination, also rise due east, and set due west.

2. All people living under this circle, or upon the equator or line, have their days and nights at all times equal to each other.

3. From this circle, on the globe, are counted, upon the meridian, the declination in the heavens, and the latitude on the earth.

4. Upon the equinoctial, or equator, is counted the longitude, making in all 360° quite round, or else 180° east and 180° west.

5. And as the time of one whole revolution is divided into 24 hours, therefore 1 hour answers to 15°, or the 24th part of 360°. Hence,

1° of longitude answers to 4 min. of time,
15′ - - - - - - - - to 1 min. of time,
1′ - - - - - - - - to 4 sec. of time, &c.

6. The shadows of those people who live under this circle are cast to the southward of them for one half of the year, and to the northward of them during the other half; and twice a year, viz. at the time of the equinoxes, the sun at noon casts no shadow, being exactly in their zenith.

EQUINOX, the time when the sun enters either of the equinoctial points, where the ecliptic intersects the equinoctial.

It is so called, because when the sun is in these points, the days and nights are of an equal length all the world over. As the sun is in one of them in the spring, viz. about the 20th of March, it is called the vernal equinox; and in the other in autumn, viz. about Sept. 23d, it is called the autumnal equinox.

As the sun's motion is unequal, being sometimes quicker and sometimes slower, it happens that there are about 8 days more from the vernal to the autumnal equinox, or while the sun is on the northern side of the equator, than while he is moving through the southern signs from the autumnal to the vernal equinox. According to Cassini the sun is

186 d. 14 h. 53 m. in the N. signs
178 14 56 in the S. signs.

So that 7 23 57 is the difference of them, or nearly 8 days.

EQUINOXES, *precession of*. Astronomers consider the year under two distinctions; viz. the solar and the astral. The tropical or solar year, upon which the seasons depend, is the exact time in which the sun moves all round from one equinox to the same again, and which period has been found to be equal to 365 days, 5 hours, 48′, 49″. The astral year is the time that the sun employs in going from one fixed part of the heavens, viz. from a given fixed star, all round, and again to the same precise point of the heavens: and this period, or astral year, is a little longer than that of the solar year, viz. it is equal to 365 days, 6 hours, 9′, 12″, which is longer than the solar year by 20′, 23″, of time, or to an arch of 50″. 25 (for in 20′ 23″ of time, the sun runs through an arch of 50″. 25;) so that the sun, as seen from the earth, arrives at the equinoctial point, viz. at the equator, a little before it arrives at that same precise point of the heavens, with which it coincided when it crossed the equator in the preceding year. This difference between the period of the sun's going from one equinox to the same, and the period of its going from a given star, or part of the heavens, to the same again, is called the precession of the equinoxes. This precession in one year is very trifling; but the accumulation of it, after a number of years, produces a considerable difference, which can by no means be passed unnoticed; thus, in a hundred years (which is called the secular precession) it amounts to 1°, 23′ 45″; and the difference which it has produced since the stars were first observed, and their positions were delineated, is very striking.

How can the sun return to the same equinox at the end of every year, without returning to the same spot in the heavens, or to the same fixed star? is the usual difficulty. In order to clear this difficulty, the reader must recollect that the equator is a circle which, being equidistant from the poles, divides the celestial sphere into two equal portions. Now, if the poles were stationary, viz. coincided constantly with the same spots in the heavens, then the equator would likewise pass constantly over the same fixed stars, and would cut the ecliptic constantly at the same points; for the ecliptic is an invariable circle, viz. it passes always over the same stars. But it has been observed, that the poles are subject to a constant, though very small, movement: so that if at one time any of the two points in the heavens, which do not revolve with the daily revolution of the rest of the sphere, and which we for that reason call the poles, be near a certain star, some years after it will be found near some other star; or, in other words, the polar star is not always the same. It appears, from the result of calculations established upon the observations made during several centuries, that the path of either of

the poles is a circle, the poles of which coincide with the poles of the ecliptic, and that the pole will move along that circle so very slowly, as to accomplish the whole revolution in 25791 years nearly. The diameter of this circle is equal to twice the inclination of the ecliptic to the equator, viz. to about 47°.

Now, as the ecliptic is a fixed circle in the heavens; but the equator, which must be equidistant from the poles, moves with the poles; therefore the equator must be constantly changing its intersection with the ecliptic. And from the best observations it appears that the equator cuts the ecliptic every year 50″. 25 more to the westwards, than it did the year before: hence the sun's arrival at the equinoctial point *precedes* its arrival at the same fixed spot of the heavens every year by 20′ 23″ of time, or by an arc of 50″. 25. Thus, by little and little, these equinoctial points will cut the ecliptic more and more to the westward, until, after the long period of 25791 years, they will cut it again at the same point precisely.

The 12 constellations, which, as has been mentioned in the preceding pages, occupy the whole of the zodiac, have given their names to 12 equal portions of the ecliptic, each portion consisting of 30°; and each portion was marked by the sign, mark, or character, peculiar to the constellation to which it belonged, or with which it coincided, when the constellations were first noticed, at which time the vernal equinox took place in the constellation of Aries, the summer solstice in that of Cancer, &c.: but on account of the precession of the equinoxes, the constellations no longer coincide with those points; for instance, the vernal equinox is in the constellation of Pisces, and the constellation of Aries is now considerably removed from it, and is gone nearer to the summer solstice; and so are all the other constellations removed, yet their characters have been left to denote the same parts of the ecliptic; thus the vernal equinox is called the first point of Aries, and is marked ♈; and so of the rest.

From what has been said above, it appears that not only the equinoctial points, but also the solstitial points, must change accordingly.

EQUISETUM, *horse-tail*, a genus of the order of filices, in the cryptogamia class of plants, and in the natural method ranking under the 51st order, coniferæ. There is a spike of peltated or shielded fructifications opening at the base. There are seven species, of which the most remarkable are:

1. The sylvaticum, or wood horse-tail. It grows in woods and moist shady places in many parts of England and Scotland. The stalk rises from 12 to 18 inches high, angular, and rough to the touch; the angles being edged with sharp spiculæ, scarcely visible without a microscope. The leaves grow verticillate, 12 or more in a whorl, and these whorls are about an inch distant from one another. The leaves are very slender, nearly quadrangular, about five inches long, pendent, and beset with several other secondary whorls, so that it resembles a pine-tree in miniature. Horses are very fond of this plant, and in some parts of Sweden it is collected to serve them as winter food.

2. The arvense, common or corn horse-tail, grows in wet meadows and corn-fields. The most remarkable property of this is, that its seeds, when viewed by a microscope, are seen to leap about as if they were animated. It is a troublesome plant in pastures; and disagreeable to cows, being never touched by them unless they are compelled by hunger, and then it brings on an incurable diarrhœa. It does not seem to affect horses or sheep.

3. The palustræ, marsh horse-tail, or pad-dock-pipe, is frequent in marshes and ditches. It is not so rough as the former, but is likewise prejudicial to cattle.

4. The fluviatile, or great river horse-tail, is frequent in shady marshes, and on the brinks of stagnant waters. It is the largest of all the species, growing sometimes to the height of a yard, and near an inch in diameter. Haller tells us, that this kind of equisetum was eaten by the Romans; and Linnæus affirms that oxen and rein-deer are fond of it, but that horses refuse it.

5. The hyemale, rough horse-tail, shave-grass, or Dutch rushes. This is much used by the whitesmiths and cabinet-makers, under the name of Dutch rushes, for polishing their metals and wood. The fact is, that there is a portion of flint, which exists in this plant near the surface, in the form of very fine grains, which enables it to perform this office. All the other species will answer this purpose in some degree, but the last better than any of the rest. In Northumberland the dairy-maids scour and clean their milk-pails with it. Some imagine that if cows are fed with this species their teeth will fall out.

EQUITY, is a construction made by the judges, that cases out of the letter of a statute, yet being within the same mischief or cause of making the same, shall be within the same remedy that the statute provides. And the reason is, that the lawmaker could not possibly set down all cases in express terms: thus, though it may be unlawful to kill a man, yet it is not unlawful for one to kill another assaulting him, in order to preserve his own life. 4 Inst. 24.

EQUITY OF REDEMPTION ON MORTGAGES. If where money is due on a mortgage, the mortgagee is desirous to bar the equity of redemption, he may oblige the mortgagor either to pay the money, or be foreclosed of his equity, which is done by proceedings in the court of chancery.

EQUITY also frequently signifies the court of chancery, where controversies are determined which do not properly come under any express law. See CHANCELLOR.

EQUIVALENT, an appellation given to things which agree in nature, or other circumstances, as force, virtue, &c.

EQUIVOCAL TERMS or WORDS, among logicians, are those which have a doubtful or double meaning.

According to Mr. Locke, the doubtfulness and uncertainty of words has its cause more in the ideas themselves, than in any incapacity of the words to signify them; and might be avoided, would people always use the same term to denote the same idea, or collection of ideas: but, adds he, it is hard to find a discourse on any subject where this is the case; a practice which can only be imputed to folly, or great dishonesty: since a man, in making up his accompts, might with as much fairness use the numeral characters sometimes for one, sometimes for another collection of unities.

EQUIVOCAL GENERATION, the production of animals without the intercourse between the sexes, by the influence of the sun or stars, &c. The equivocal generation of plants, is their production without seed, in the ordinary course of nature. This kind of generation is now quite exploded by the learned. Mr. Ray is clearly of opinion that there is no such thing as spontaneous or equivocal generation, but that all animals are the issue of parents of the same species with themselves; and with him agree Redi, Willughby, and Lister. This last author has fully refuted the vulgar notion, that horse-hairs thrown into water will become animated bodies; by shewing that appearances of this kind are hair-worms bred in the bodies of other insects, and particularly of the common black-beetle.

EQUULEUS, or *ecuuleus*, in antiquity, a kind of rack used for extorting a confession, at first chiefly practised on slaves, but afterwards made use of against the christians. The equuleus was made of wood, having holes at certain distances, with a screw, by which the criminal was stretched to the third, sometimes to the fourth or fifth holes, his arms and legs being fastened on the equuleus with cords; and thus was hoisted aloft, and extended in such a manner that all his bones were dislocated. In this state red-hot plates were applied to his body, and he was goaded in the sides with an instrument called ungula.

EQUULEUS, in astronomy, a constellation of the northern hemisphere, whose stars, according to Ptolemy and Tycho's catalogues, are four, but in Mr. Flamsteed's ten.

EQUUS, the horse, a genus of the mammalia class, of the order of bellua. The generic character is, front teeth in the upper jaw six, parallel; in the lower jaw six, somewhat projecting; canine teeth, one on each side, in both jaws, remote from the rest; feet with undivided hoofs.

1. Equus caballus, or the common horse, the most noble and interesting of quadrupeds, is supposed to be found in a state of nature in several parts of Asia and Africa. In this state it is smaller than the domestic or tame animal, with a larger head, a more arched forehead, and the body thickly covered with pale-brown, or mouse-coloured hair. It has been affirmed by several authors, that wild horses were to be found in the deserts of Arabia; but we must agree with Mons. Sonnini, in thinking it not very probable that this animal should be able to exist in such deserts. We must, therefore, rather suppose that it is occasionally found wild in some parts of the country bordering perhaps on the confines of the desert. It is certain that in Arabia the most beautiful domestic horses are bred; and even those which are kept by the Arabs of the desert are allowed to excel most others in swiftness and elegance of form, and it is from their breed that the European horses have been gradually improved. See Plate Nat. Hist. fig. 182.

Large herds of wild horses are said to be found about the lake Aral, near Kusneck, in lat. 54°; on the river Tom, in the southern parts of Siberia; and in the great Mongalian deserts, and among the Kalkas, north-west of China; and it is affirmed that they will occasionally surround and trepan the horses of the Mongalians and Kalkas, while grazing,

and carry them off among their own herd. They are extremely swift, active, and vigilant; and, like some of the antelopes and other quadrupeds, have always a sentinel, who gives notice to the herd on the approach of danger by a loud neigh; upon which they fly off with amazing rapidity.

Wild horses are found, according to Dr. Pallas, in the deserts on each side the river Don, towards the Palus Mæotis; but these are supposed to be the offspring of the Russian horses, which were employed in the siege of Asoph, in the year 1697, when for want of forage they were turned loose, and their descendants have gradually relapsed into the appearance of natural wildness. Those which are found in some parts of South America, are well known to be the descendants of the horses introduced by the Spaniards on the first discovery of America, and which have so far relapsed into a state of nature as to exhibit the general characters of the wild animal.

The horse, in its domestic or improved state, is found in almost every part of the world, except perhaps within the Arctic circle; and its reduction and conquest may well be considered, as Buffon properly observes, as the greatest acquisition from the animal world ever made by the art and industry of man.

Of the several breeds of horses in common or general use in Europe, it is remarkable that none can come in competition with those of our own island, either for the strength required in laborious services, or for the swiftness and elegance of such as are bred for the course. The annals of Newmarket record instances of horses that have literally outstripped the wind, as is proved from accurate calculations. The celebrated Childers is commemorated, in particular, as the swiftest of his tribe; and the instances of his speed may be found in various publications. He was known to have run near a mile in a minute; and to have cleared the course at Newmarket, which is only 400 yards short of four miles, in six minutes and forty seconds; running at the rate of eighty-two feet and a half in the space of a second. See Plate Nat. Hist. fig. 183.

Of nearly equal fame is the character of Eclipse, whose strength was said to be greater, and his swiftness scarcely inferior. This latter animal forms the subject of Mons. Sainbel's calculations, who, in his work on the veterinary art, has given an elaborate and curious description of his several proportions. It is remarkable that this horse was never esteemed handsome, though the mechanism of his frame, so far as regarded his powers of swiftness, was almost perfect.

As it may be some satisfaction to the reader to be made acquainted with the general proportions of this extraordinary courser, we shall here extract a part of Mons. Sainbel's observations on the subject.

"The horses of different countries are, in general, distinguished from each other by a peculiar and appropriate conformation. The Spanish horse differs materially in his outward appearance from the English racehorse. The difference, in the length and direction of the parts of which each is composed, produces in each a system from whose mechanical arrangement result motions very unequal in their extent. The Spanish horse cadences his steps with dignity, while the English horse drives his mass forward with strength and speed. This difference, which proceeds from the peculiar conformation of each, contradicts, in some particulars, the table of geometrical proportions in the use of the pupils of the veterinary schools of France. It proves that no common measure can be made to apply equally to every species, since nature has even diversified the forms of the individuals which compose it. If each species has its own style of beauty; if even each individual has its peculiar beauty; if it is not possible to find two horses that perfectly resemble each other; we cannot pretend to assign any one form preferably to another as the rule of beauty for the horse. Were persons the best qualified to endeavour to collect together the different beauties dispersed among the different individuals, they might indeed compose a model of each species sufficiently perfect to direct the painter or the statuary, but would deceive any one who would venture to choose a horse by it for his own use. The following observations do not take for their object those forms which please the eye at the first glance; that appearance which vulgarly passes for handsome; but that mechanical construction of the animal, from which result the possibility and extent of those motions by the means of which he is enabled to transport himself from one place to another with greater or less speed; and consequently a horse may appear ugly to a vulgar eye, and be still well proportioned. Eclipse was never esteemed handsome; yet he was swift, and the mechanism of his frame almost perfect. Whoever compares his proportions with those in the table above-mentioned, will discover the following differences:

"1. In that table the horse should measure three heads in height, counting from the foretop to the ground. Eclipse measured upwards of three heads and a half.

"2. The neck should measure but one head in length: that of Eclipse measured a head and a half.

"3. The height of the body should be equal to its length: the height of Eclipse exceeded his length by about one-tenth.

"4. A perpendicular line falling from the stifle should touch the toe: this line in Eclipse touched the ground at the distance of half a head before the toe.

"5. The distance from the elbow to the bend of the knee should be the same as from the bend of the knee to the ground: these two distances were unequal in Eclipse, the former being two parts of a head longer than the latter.

"This summary comparison shews that the beauty of a horse cannot be absolutely determined by general rules, but must ever be in relation to a particular species."

Mons. Sainbel farther informs us, that "on the 25th of February, 1789, Eclipse was seized with a violent cholic. The remedies acknowledged as most proper in that case were administered, but without effect. He expired on the 27th, at seven o'clock in the evening, in the 26th year of his age."

In Mons. Sonnini's edition of Buffon may be found an exact enumeration of all the different colours of which horses are seen, with their several shades and names. On this subject also Gesner and Aldrovandus have given the usual enumerations; in general, however, it seems agreed, that the colour is one of the least important attributes; according to the well-known doctrine, now passed into a proverb, that a good horse is never of a bad colour. The antients appear to have had a predilection for white horses, which were used to draw the cars of emperors and conquerors in public processions. The poets also represent the steeds of many of their heroes as of a snow-white colour. It is remarkable, however, that Virgil, though in the Æneid he represents the horses of Turnus as white, yet in his Georgics condemns that colour. In reality, however, as the learned Dr. Martyn has well observed, this implies no contradiction; since Virgil might be supposed to admire the beauty of a white steed, though he could not commend the colour in a breed or stock. But no country has produced a breed of horses equal in size and strength to the larger kind of our draught-horses. The cavalry of England is, in general, formed of this class of horses. The fens of Lincolnshire generally produce a larger breed than any other part of the kingdom. See Plate Nat. Hist. fig. 184. In our own country there seem to be no breeds of horses naturally of a perfect white; those which are so termed having been first grey, changed through age to whiteness.

The most beautiful general colour seems to be bright bay, which gives an air of peculiar neatness and elegance to the animal. Black horses are commonly of large size, and in this country are chiefly used for the cart and the plough. In some countries horses are not the less esteemed for being variegated or piebald, as it is commonly termed. This is said to be the case in China.

Mr. Bruce informs us, that the horses of Nubia are of unparalleled beauty; far superior, in his opinion, even to those of Arabia. He observes, however, that from the manner in which they are fed they are apt to become too fat or corpulent.

In some parts of India is found a remarkably diminutive race of horses, scarcely exceeding the size of a large dog. Small breeds of horses also occur in some of the northern parts of the world.

2. Equus hemionus, or jicta. This is a species, the knowledge of which seems to have lain dormant almost since the days of Aristotle, till it was revived by the observations of Dr. Pallas, who describes it under the title of equus hemionus, supposing it to be the hemionos of Aristotle. It is a native of the wild or desert regions between the rivers Onon and Argun, in the most southern parts of Siberia; and extends over the vast plains and deserts of Tartary, as well as that of Gobi, which reaches even to India. In Tartary it is said to be most frequent about the salt lake called Taricnoor, which is at times dried up. It shuns wooded and mountainous regions, and is said to live in small herds of about twenty each. Its general manners are those of the common wild horse; but its swiftness is still greater, surpasssing even that of the antelopes, and is proverbial in some of the regions it frequents; and the Thibetians represent Chammo, their god of fire, mounted upon it.

This animal has an appearance much resembling that of a common mule; having a

large head, flat forehead, middle-sized eyes, with ash-coloured irides: the teeth are thirty-eight in all, being two in number fewer than in the common horse: the ears are larger than in that species, erect, and lined with a thick, whitish, curling hair: the neck is slender and compressed: the mane upright, short, soft, and of a greyish colour. In place of the foretop there is a short tuft of downy hair, about two inches in length. The body is rather long, and the back but little elevated; the breast sharp and protuberant; the limbs long and elegant; the thighs thin, as in a mule; within the fore legs is an oval callus, but none in the hind legs: the hoofs are oblong, smooth, and black: the tail like that of a cow, being slender, and naked for half its length; the remainder covered with long ash-coloured hair. The winter coat of this animal is of a brownish ash-colour, with the tips of the hair grey; it is about two inches long, and soft like that of a camel; slightly waved or undulated on the back. In summer it becomes much smoother, and in all parts elegantly marked by small featherings or turnings: the tip of the nose is white; and the remainder of the face of a light tawny cast, which is also diffused over all the upper parts: the hind thighs, insides of the limbs, and belly, are white; and from the mane to the tail extends a chesnut or blackish-brown line, which is broadest on the lines, and gradually lessens as it approaches the tail: there is also a very slight appearance of a transverse band or cross over the shoulders. The length of this species, from nose to tail, is about six feet and a half; that of the trunk of the tail sixteen inches, and of the hairs beyond the tip about four inches: the height about three feet nine inches.

This species is supposed to have been found in Syria, and some other regions, in the days of Aristotle; and is mentioned by Pliny, from the report of Theophrastus, as being found in Cappadocia. Its native name among the Mongalians is dschikketai, and among the Chinese yo-to-tse.

3. Equus asinus, the ass. The ass, having been long condemned to a state of the lowest servitude, and considered as a species of less dignity than the horse, has acquired, in most parts of Europe, a character of contempt. Yet in its natural or wild state it exhibits an appearance very far superior both in point of beauty and vivacity. It is a native of many parts of Asia, living, like the rest of this genus, in a gregarious manner. It chiefly occurs in the dry and mountainous deserts of Tartary, and in the southern parts of India and Persia. It is also said to be found in Africa, and to occur, though but very rarely, in some parts of Syria and Arabia; countries where it was in antient times extremely common. In this its natural state its colour is said to be white, or of a very pale silvery grey, with a slight tinge of straw-colour on the sides of the neck and body: along the back runs a deep-brown stripe of thickish wavy hair, to the beginning of the tail: this stripe is crossed over the shoulders, as in the tame animal, by another of similar colour; but it is said that this is peculiar to the male. The neck is furnished with a brown mane three or four inches long, consisting of soft woolly hair: the tail is tufted at the end by dusky hairs of about six inches in length: the forehead is arched, and the ears erect, pointed, and lined internally with white curling hairs. Its stands higher on its limbs than the domesticated animal, and its legs are more slender in proportion. The hair on the whole body is very fine, bright, soft, and silky; and on some parts is marked by a few obscure waves or undulations of a darker shade than the rest. Those which are found in Africa are said to be of a pale ash-colour, rather than of the cast above described.

The food of the wild ass consists chiefly of saline, or bitter and lactascent plants. It is also fond of salt or brackish water. The manners of these animals very much resemble those of the wild horse. They assemble in troops, under the conduct of a leader or sentinel; and are extremely shy and vigilant, and, like the former animals, dart off with the utmost rapidity on the sight of mankind. They have been at all times celebrated for their swiftness. Their voice resembles that of the common or domesticated ass, but is somewhat shriller.

From this animal the domestic ass has been gradually derived, which admits of considerable varieties as to size, beauty, and strength, in different countries. Those of the eastern parts of the world, as well as those of Africa, still partake, in a great degree, of the native elegance of their original or stock; and are very different from those commonly seen in the northern parts of Europe: for this animal seems to be much injured by the influence of a comparatively cold climate. See Plate Nat. Hist. fig. 185.

The generality of European asses have large slouching ears, a heavy appearance, and are of an ash-colour, more or less deep in different individuals, with a blackish dorsal stripe, crossed by another over the shoulders, and thus exhibiting the original mark of their species. In their manners they exhibit no superior marks of sagacity, but have the merit of being patient, quiet, and tractable, and are chiefly employed in the inferior offices of servitude. The ass is observed to be very temperate in his food, and by no means delicate in the choice of it; eating thistles, and a variety of coarse herbage which the horse refuses. He is said to be particularly fond of plantain, for which he will neglect every other herb of the pasture. In his choice of water he is remarkably nice, and will drink only of that which is clear. He has also an aversion to mud or water in his road, and will pass out of the way rather than wet his feet in a puddle. He is by no means void of docility, as vulgarly supposed; but may be made to practise several exercises not usual with his race. His voice, as is well known, is a most hideous bray; a discordant succession of flats and sharps. This is most strong in the male animal; the voice of the female being weaker, though somewhat shriller. It is singular, however, that some authors have denied that the female ass can properly be said to bray; and Aldrovandus censures Ovid for this line:

Et rudit e scabra turpis asella mola.

It may not be improper to observe, that the mule is nothing more than a hybrid animal, between this species and the horse, differing in strength, size, and beauty, according to the predominancy of its parental species. Mules are very little used in this country, but in Spain and some other parts of Europe are in much esteem, and have deservedly the reputation of being remarkably sure-footed.

4. Equus zebra, or the zebra, is a native of the hotter parts of Africa, being found from Æthiopia to the Cape of Good Hope, living in large herds, and possessing much of the manners both of the wild horse and the ass, being excessively swift and vigilant. It is of a still wilder or more unmanageable disposition than either of the former animals, and even such as have been taken very young are with much difficulty brought to any degree of familiarity, and have very rarely been rendered so far manageable as to submit to the bridle.

The size of the zebra is equal, or rather superior, to that of the ass, and its form more elegant; since, exclusive of its beautiful colours, the head and ears are well shaped, and of moderate size. The colour is either milk-white, or cream-colour, with a very slight cast of buff or pale ferruginous; and the whole animal is decorated on every part with very numerous black or blackish-brown stripes, disposed with the utmost symmetry, and exhibiting an appearance not so easily described in words as by a well-conducted figure. These stripes run in a transverse direction both on the body and limbs, and in a longitudinal direction down the face; and their regular and beautiful gradation, flexures, and termination on the different parts of the animal, cannot be viewed without admiration. The tail is of a moderate length, round, rather slender, marked with small blackish bars, and terminated by a thickish tuft of brown or black hair. The zebra seems to have been unknown to the antients; the onager of Pliny and other authors relating only to the wild ass.

Attempts have been made to domesticate the zebra, and to reduce it to obedience, like the horse; but as yet the success has not been very considerable. Experiments of this kind have been chiefly made in Holland; and we are told by the count de Buffon, that zebras have been yoked to the stadtholder's chariot: this, however, proved to be a piece of misinformation, and is accordingly contradicted in the sixth supplemental volume. Persevering attention may perhaps at length reduce this beautiful animal to a state of domesticity. If this was practicable, a new and elegant addition would be made to the luxuries of civilized life; since the zebra scarcely yields to the horse in gracefulness of figure, exclusive of its captivating colours. See Plate Nat. Hist. fig. 186.

5. Equus quagga, or the quagga, which till lately had been confounded with the zebra, is now acknowledged as a distinct species, much allied to the former, but marked with fewer and larger bands, which are of a browner colour than in the zebra, and are chiefly disposed on the fore parts of the animal, while the hind parts are rather spotted than striped. The ground-colour also of the quagga is of a ferruginous tinge, especially on the thighs and back. It is of a milder or more docile nature than the zebra, and is said to have been successfully used by some of the Dutch colonists at the Cape, in the manner of a horse, for draught, &c. It inhabits the same parts of Africa as the zebra, but is found in sepa-

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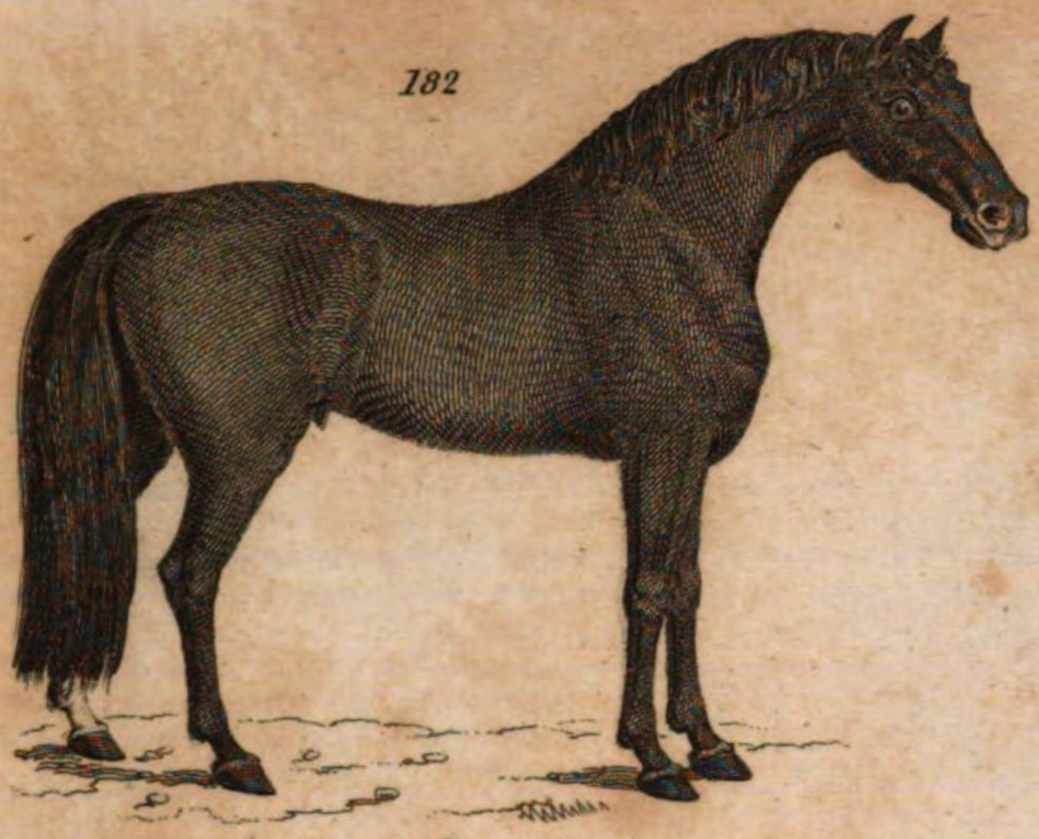

Arabian Horse

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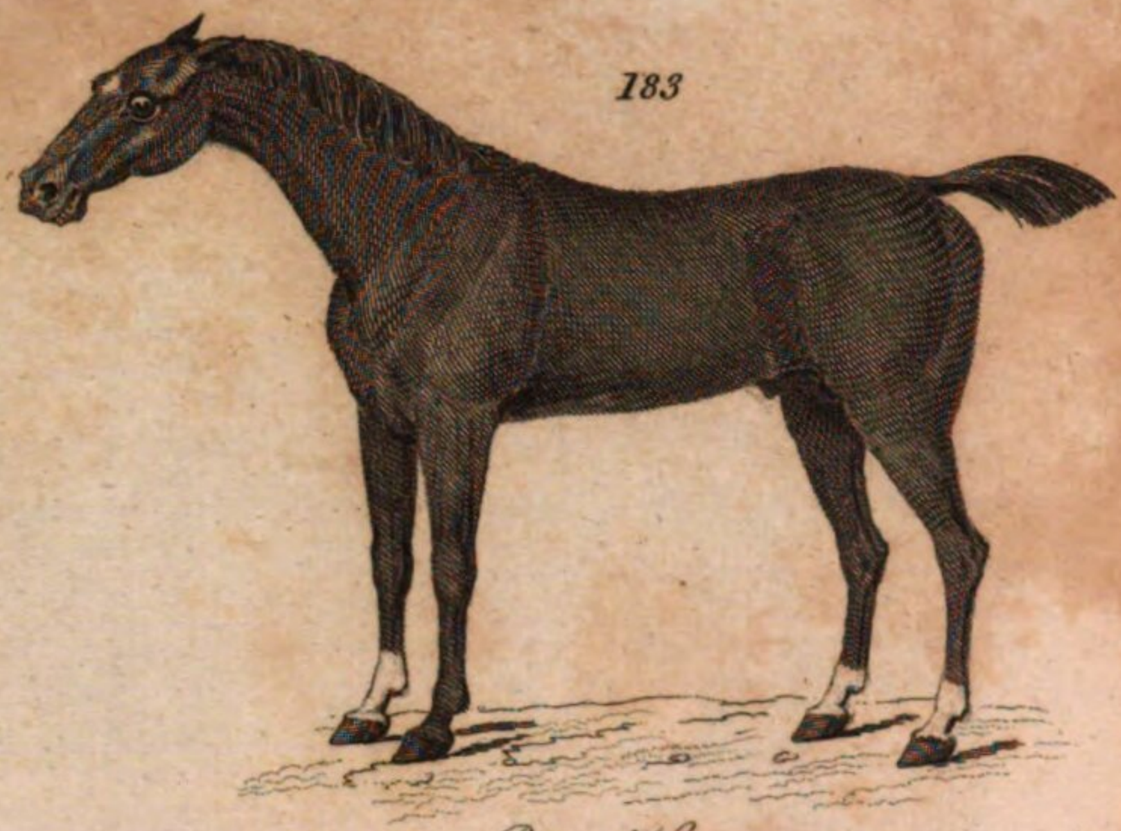

Race Horse

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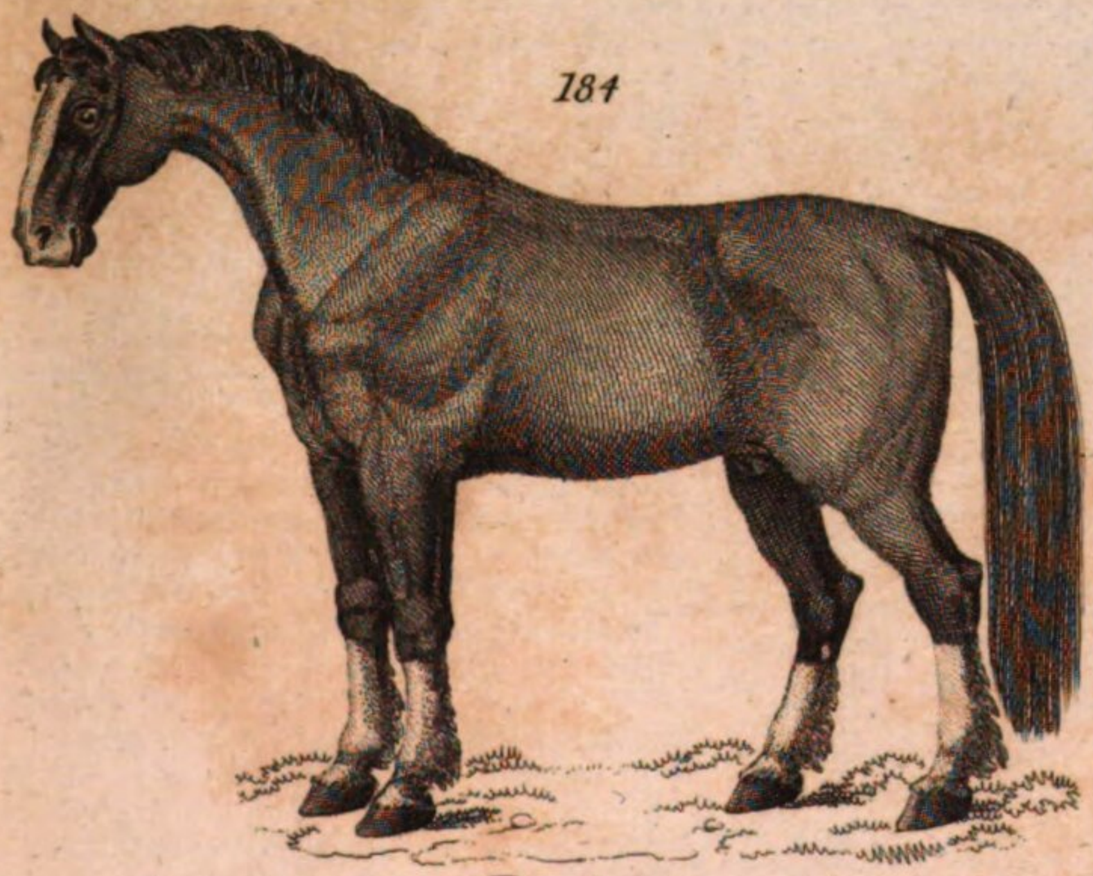

Draft Horse

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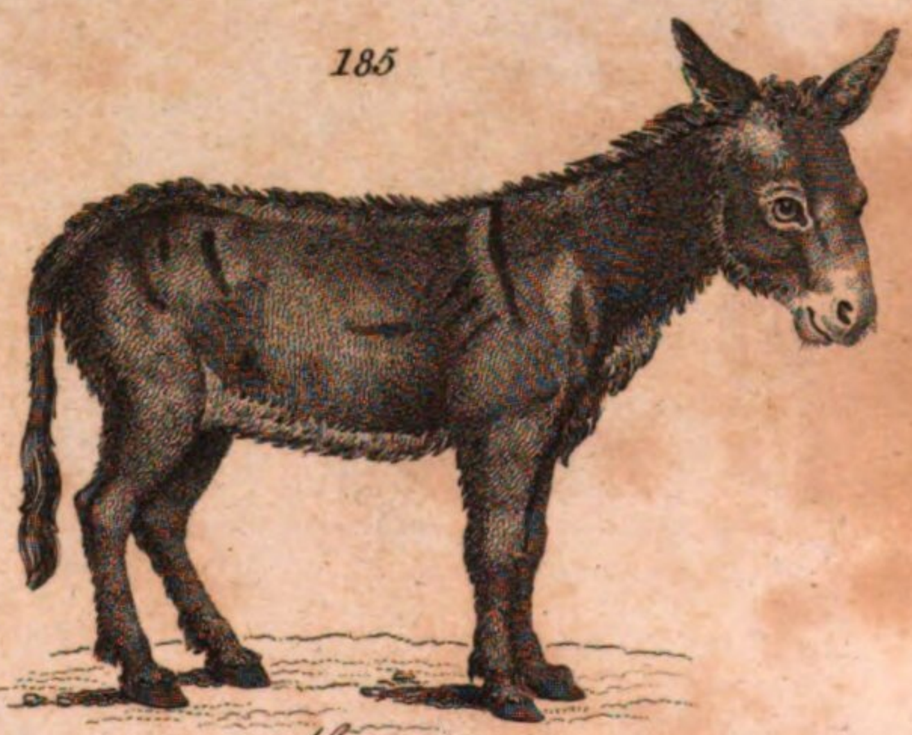

Ass

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Quagga

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Zebra

Published 1806 for Richard

rate herds, never associating with that species. See Plate Nat. Hist. fig. 187.

6. Equus bisculus, or cloven-footed horse. The very name of this species seems to imply a kind of equivocal and anomalous being; one of the most prominent characters of the present genus being a simple or undivided hoof. Indeed if only a single specimen of this animal had been described, we might have hesitated as to admitting it otherwise than as an accidental variety.

The cloven-footed horse is a native of South America, and was first described by Molina, in his Natural History of Chili. In its general appearance, size, colour, and many other particulars, both external and internal, it resembles the ass, but has the voice and the ears of a horse, and has no cross or transverse band over the shoulders. It is very wild, strong, and swift, and is found in the rocky regions of the Andes or Cordilleras of Peru and Chili. The hoofs are divided like those of ruminant animals.

It is singular that this curious species, which seems to form a kind of link between the cloven-hoofed and whole-hoofed tribes, should have so long remained unknown to the naturalists of Europe.

ERANARCHA, a public officer among the antient Greeks, whose business was to preside over and direct the alms and provisions made for the poor. Cornelius Nepos, in his life of Epaminondas, describes his office thus: when any person was reduced to poverty, taken captive, or had a daughter to marry, which he could not effect for want of money, &c. the eranarcha called an assembly of friends and neighbours, and taxed each according to his means and estate, to contribute towards his relief.

ERANTHEMUM, a genus of the monogynia order, in the diandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is quinquefid, with the tube filiform; the antheræ without the tube; the stigma simple.

There are five species, herbs or undershrubs of the Cape of Good Hope. Some of them are very ornamental inhabitants of our stoves, and would probably thrive in a greenhouse.

ERICA, *heath*, a genus of the monogynia order, in the octandria class of plants, and in the natural method ranking under the 18th order, bicornes. The calyx is tetraphyllous; the corolla quadrifid; the filaments inserted into the receptacle; the antheræ bifid; the capsule quadrilocular. There are upwards of 100 species, four of them natives of Britain, which are so well known, that no description need be given of them. In the Highlands of Scotland this plant is made subservient to a great variety of purposes. The poorer inhabitants make walls for their cottages with alternate layers of heath and a kind of mortar made of black earth and straw. The woody roots of the heath are placed in the centre; the tops externally and internally. They make their beds of it, by placing the roots downwards; and the tops only being uppermost, they are sufficiently soft to sleep upon. Cabins are also thatched with it. In the island of Ilay, ale is frequently made by brewing one part of malt and two of the tops of young heath, sometimes adding hops. Boethius relates, that this liquor was much used by the Picts. Woollen cloth boiled in alum-water, and afterwards in a strong decoction of heath-tops, comes out of a fine orange-colour. The stalks and tops will tan leather. Besoms, and faggots to burn in ovens, are also made of this plant. It is also used for filling up drains that are to be covered over. Sheep and goats will sometimes eat the tender shoots, but they are not fond of them. Cattle not accustomed to feed on heath, give bloody milk, but they are soon relieved by drinking plentifully of water. Horses will eat the tops. Bees extract a great deal of honey from the flowers; and where heath abounds, the honey has a reddish cast. There are many exotic species with which our greenhouse collections are enriched and adorned, as the triflora, tubiflora, australis, &c.

ERIDANUS, in astronomy, a constellation of the southern hemisphere, containing, according to different authors, 19, 30, or even 84 stars.

ERIGERON, *flea-bane*, a genus of the polygamia superflua order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the pappus hairy; the florets of the radius are linear, and very narrow. There are 30 species, of which the most remarkable is the viscosum, or male flea-bane of Theophrastus, and greater flea-bane of Dioscorides. It is a native of the south of France and Italy; and has a perennial root, whence arise many upright stalks near three feet high. The leaves in warm weather sweat out a clammy juice; the flowers are produced single upon pretty long footstalks, are of a yellow colour, and have an agreeable odour. The plants are easily propagated by seeds, and thrive best in a dry soil and sunny aspect.

ERINUS, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is pentaphyllous; the limb of the corolla quinquefid and equal, with its lobes emarginated, and the upper lip very short and reflexed; the capsule bilocular. There are 13 species, none of them natives of Britain. They grow from two inches to four feet in height, and are adorned with flowers of a white or purple colour. They are propagated by seeds, but in this country generally require to be kept in shelter.

ERIOCAULON, a genus of the trigynia order, in the triandria class of plants, and in the natural method ranking with the sixth order, ensatæ. The common calyx is an imbricated capitulum or knob; there are three equal petals, and the stamina are on the germen. There are six species, exotics of no note.

ERIOCEPHALUS, a genus of the polygamia necessaria order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is somewhat villous; there is no pappus; the calyx is decaphyllous and equal; the radius has five florets. There are two species, herbaceous plants of the Cape.

ERIOPHORUM, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking under the third order, calamariæ. The glumes are paleaceous, and imbricated all round; there is no corolla; and only one seed furnished with a very long down. There are six species, nearly allied to the grasses, only two natives of Britain.

ERITHALIS, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is quinquepartite; the calyx urceolated or bladder-like; the berry decemlocular, inferior. There are two species, trees of Jamaica and the Society Isles.

ERINACEUS, *hedgehog*, a genus of quadrupeds of the order of feræ. The generic character is; front teeth two both above and below, those of the upper jaw distant, of the lower approximated; canine teeth on each side, in the upper jaw five, in the lower three; grinders on each side, both above and below, four; body covered on the upper parts with spines.

1. Erinaceus Europæus. Common or European hedgehog. The hedgehog is found in most of the temperate parts of Europe and Asia, and, according to Mr. Pennant, is also seen in Madagascar. It commonly measures about 11 inches from the nose to the tip of the tail, which is about an inch long. Its colour is generally grey-brown, but it sometimes is found totally white, or of a yellowish white. It feeds principally on the roots of vegetables; but it also eats worms, as well as beetles and other insects. It wanders about chiefly by night, and during the day conceals itself in its hole, under the roots of some tree, or mossy bank. It produces four or five young at a birth, which are soon covered with prickles like those of the parent animal, but shorter and weaker. The nest is large, and is composed of moss.

The hedgehog, when disturbed, rolls itself up into a globular form, and thus presents to its adversary an invulnerable ball of prickles. From this state of security, it is not easily forced; scarcely any thing but cold water obliging it to unfold itself. It swims perfectly well when thrown into water.

The hedgehog is one of those animals which, during the winter, are supposed to continue in a state of torpidity. In that season it lies concealed in its hole, surrounded with a bed of moss, secure from the rigours of the most piercing frost, and at the return of spring recommences its wanderings.

The hedgehog may be rendered in a considerable degree domestic; and has frequently been introduced into houses for the purpose of expelling those troublesome insects the blattæ, or cockroaches, which it pursues with avidity, and is fond of feeding on. It is itself an occasional article of food in some places, and is said to be best in the month of August.

The hedgehog is generally considered as a harmless inoffensive animal, but has been freequently supposed (and to this day the absurd notion prevails in many places) to suck the teats of cows by night, and thus cause by its prickles those exulcerations which are sometimes seen on cattle. From this accusation, however, it is completely absolved by Mr. Pennant, who observes, that its mouth is by far too small to admit of this practice.

2. Erinaceus inauris. Earless hedgehog. This, on a general view, seems to be nothing more than a variety of the common hedge-

hog, differing chiefly, according to Seba, in having the spines on the upper parts of the body shorter, thicker, and stronger; the head, however, is somewhat shorter, and the snout blunter than in the common hedgehog, and there is no appearance of external ears; the whole animal is also of a white or very pale colour. Its length from nose to tail is about eight inches; the tail scarcely an inch long; the claws long and crooked.

3. Erinaceus auritus. Long-eared hedgehog. This species resembles the common hedgehog in form, and is found about the river Volga, and in the eastern parts beyond lake Baikal. In size it is said to vary, being in some places smaller, and in others larger, than the common species; but may be immediately distinguished by its ears, which are large, oval, open, and naked, with soft whitish hair on the inside, and edged with brown; the legs and feet are longer and thinner than those of the common hedgehog, and the tail shorter and almost naked; the upper part of the animal is covered with slender brown spines, with a whitish ring near the base, and another towards the tip; the legs and belly are covered with soft white fur. In its general manner of life this species is said to resemble the common hedgehog. The female produces six or seven young at a time, and is said sometimes to breed twice a year.

4. Erinaceus Madagascariensis. Striped hedgehog. This animal, which is a native of Madagascar, was first described by the count de Buffon, under the name of le tanrec; it should seem, however, that the specimen described had not attained its full growth, and consequently did not exhibit with sufficient clearness all the characters of the animal. It is of a black colour, with five longitudinal bands on the body; all the black parts are covered with hard hair; the white bands with small prickles, analogous to those of a porcupine. From the black bands on the back, spring long scattered hairs which reach to the ground; the head is covered with short black hairs or prickles; the snout is white; the eye surrounded by a white circle, and the feet are reddish. The tandreks move slowly, and grunt like pigs, for which reason they are called ground-hogs, or pig-porcupines, by the Europeans. They burrow under ground, and remain torpid three months in the year; they hide themselves in the day-time, and only appear after sunset in order to seek their food: they live chiefly on fruits and herbs; their body is a mere lump of fat: the natives of Madagascar eat them, but consider them as but an indifferent food. Madagascar is the only country in which the tandreks are found. See Plate Nat. Hist. fig. 188.

5. Erinaceus Malaccensis. Malacca hedgehog. This species has so completely the appearance of a porcupine, that nothing but a severe adherence to systematic arrangement from the teeth could justify its being placed in the present genus; yet even this particular seems not yet distinctly known, the animal being rarely imported into Europe. Mr. Pennant supposes that Linnæus might have been induced to consider it as belonging to the present genus, on account of the number of its toes; which are said to be five on the fore feet, instead of four, as in the porcupine. The accurate Brisson, however, considered it as a species of hedgehog and Linnæus, in compliance with his opinion transferred it from the genus hystrix to that of erinaceus. The particular size is not mentioned by Seba, but it appears to be a large species, since the length of its quills is said to be from an inch to a foot and a half, on different parts of the animal. It is therefore probably about the size of the common porcupine, and they are variegated in a similar manner; the ears are large and pendulous; and there is no crest or ruff of longer bristles than the rest on the back of the head, as in the common porcupine.

ERMIN. See MUSTELA.

ERMIN, in heraldry, is always argent and sable, that is, a white field, or fur, with black spots. These spots are not of any determinate number, but may be more or less, at the pleasure of the painter, as the skins are thought not to be naturally so spotted; but serving for lining the garments of great persons, the furriers were wont, in order to add to their beauty, to sow bits of the black tails of the creatures that produced them, upon the white of their skin, to render them the more conspicuous, which alteration was introduced into armory.

ERMIN, or *ears of corn*, an order of knights in France, instituted by Francis, the last of that name, duke of Britany.

This order was so called on account that the collar of it was made up of ears of corn, lying athwart one another in saltier, bound together, both above and below, each ear being crossed twice, the whole of gold. To this collar there hung a litte white beast, called an ermin, running over a bank of grass; diversified with flowers.

ERMINE', or CROSS ERMINE', is one composed of four ermine spots. It is to be observed, that the colours in these arms are not to be expressed, because neither this cross nor these arms can be of any other colour than white and black.

ERMINES are, by some English writers, held to be the reverse of erminé, that is, white spots on a black field; and yet the French use no such word, but call this black powdered with white contre-ermin, which is very proper, as it denotes the reverse of ermin.

ERMINITES should signify little ermines, but it is otherwise, for it expresses a white field powdered with black, only that every such spot has a little red hair on it.

ERNODIA, a genus of the class and order tetrandria monogynia. The calyx is four-parted; corolla one-petalled, salver-shaped; berry two-celled; seeds solitary. There is one species, a creeping plant of Jamaica.

ERODIUM, *crane's bill*, a genus of the class and order monadelphia pentandria, and in the natural method of the order gruinales. The calyx is five-parted; the corolla five-petalled; neus five scales, alternate with the filaments, and glands at the base of the stamina; fruit five-grained, with a spiral beak, bearded in the inside. This genus is vulgarly confounded with the geranium: indeed there are three genera, which have the same habits, but differing in the number of stamina. This plant has five, the geranium seven, and the pelasconium, or African geranium, ten. Of the erodium there are 28 species, including at least three which are natives of Britain, and several naturalized here: some are annual, and some perennial.

ERODIUS, a genus of insects of the order of coleoptera. The antennæ are moniliform; feelers filiform; body roundish, gibbous, immarginate; thorax transverse; shells closely united, longer than the abdomen; jaw horny, bifid; lip horny, emarginate. There are four species.

EROTEUM, a genus of the class and order pentandria monogynia. The calyx is five-leaved; the corolla five-petalled; the style trifid; berry juiceless, three-celled, many-seeded. There are two species, natives of Jamaica.

ERRHINES, in pharmacy, medicines which, when snuffed up the nose, promote a discharge of mucus from that part. See MATERIA MEDICA.

ERROR, in law, signifies an error in pleading, or in the process; and the writ which is brought for remedy thereof, is called a writ of error. A writ of error is a commission to judges of a superior court, by which they are authorized to examine the record upon which a judgment was given in an inferior court, and on such examination, to affirm or reverse the same according to law. Jenk. Rep. 25. For particulars as to the practice of writs of error, see Impey's K. B. & C. P.

ERUCA, in general, denotes caterpillars of all kinds. The caterpillar state is that through which every butterfly must pass before it arrives at its perfection and beauty: and in the same manner, all the known winged animals, except only the puceron, pass through a reptile state; none of them, except this, being produced in their winged form. The change from caterpillar to butterfly was long esteemed a sort of metamorphosis, a real change of one animal into another; but this is by no means the case. The egg of a butterfly produces a butterfly, with all the lineaments of its parent; only these are not disclosed at first, but for the greater part of the animal's life they are covered with a sort of case or muscular coat, in which are legs for walking: these only suit it in this state; but its mouth takes in nourishment, which is conveyed to the included animal; and after a proper time this covering is thrown off, and the butterfly, which all the while might be discovered in it by an accurate observer with the help of a microscope, appears in its proper form. Before it passes into this state, however, there requires a state of rest for the wings to harden, and the several other parts to acquire their proper firmness: this is transacted in a time of perfect rest, when the animal lies in what is called the nymph or chrysalis state, in appearance only a lump of inanimate matter. There is a settled and determined time for each of these changes in every species; but in the several different kinds, the periods are very different.

There is no sign of sex in the animal while in the caterpillar state: the propagation of the species is the business of the creature in its ultimate perfection; and till that, these parts are never excluded: one female butterfly, when she has been impregnated by the male, will produce 300 or 400 eggs, or even more. There is no way of knowing the sexes of these little creatures by viewing the parts; but the whole figure and manner of the animal makes the difference. The females are always larger than the males; they are also more slow in their motions; and some of them have no wings, or at the most

only very small ones. The males also have a sort of beards, more beautiful than the antennæ or horns of the females; the female is much stronger as well as bigger than the male, and not unfrequently, in case of danger or disturbance, she flies away with him in time of copulation. On dissecting the female, her uterus affords an astonishing sight. The number of eggs in the tubes is amazing; but these have not all the same figure; and in some species, as the silk-worm, &c. the eggs are of a beautiful blue; if any yellowish ones are seen among them, they are judged to be defective.

The care of all the butterfly tribe to lodge their eggs in safety is surprising. Those whose eggs are to be hatched in a few weeks, and who are to live in the caterpillar state during part of the remaining summer, always lay them on the leaves of such plants as will afford a proper nourishment; but, on the contrary, those whose eggs are to remain unhatched till the following spring, always lay them on the branches of trees and shrubs, and usually are careful to select such places as are least exposed to the rigour of the ensuing season, and frequently cover them from it in an artful manner. Some make a general coat of a hairy matter over them, taking the hairs from their own bodies for that purpose; others hide themselves in hollow places in trees, and in other sheltered cells, and there live in a kind of torpid state during the whole winter, that they may deposit their eggs in the succeeding spring, at a time when there will be no severities of weather for them to combat. The day butterflies only do this, and of these but a very few species; but the night ones, or phalænæ, all, without exception, lay their eggs as soon as they have been in copulation with the male, and die immediately afterwards.

It is well known, that the common and natural food of these creatures is the leaves and verdure of vegetables; yet, as weak and harmless as they seem, they will many of them destroy their fellows whenever they get an opportunity. Mr. Reaumur gives us an instance of this in 20 caterpillars of the oak, which he kept in a box with a sufficient quantity of their natural food; yet their numbers daily decreased, till at last there remained only one. This is, however, only the case in some few species, the generality of these animals being very peaceable, many species living together in the same place without molesting one another. These species, however, though freed from such dangers, are exposed to others of a much more terrible kind; the worms or maggots of several sorts of flies are frequently found about them, some preying upon their outside, others lodged within them under the skin, but both kinds eating the poor defenceless creature up alive. Those which feed on the outsides are easily discovered: the others are more hidden; and frequently the caterpillar, which seems very hearty and vigorous, and very fleshy, will be found, upon opening, to be a mere skin, the internal parts being found to be all eaten away, and all the food that he swallows serving only to feed a vast number of worms, or maggots, which crawl about at liberty within him. These devouring worms are of many different species; some being of the gregarious, some of the solitary kinds, and some spinning webs of their own silk to transform themselves in, others undergoing that change without any such covering. The beautiful cabbage-caterpillar is one of those unhappy kinds which frequently are infested with the gregarious kinds, large numbers of which spin themselves webs one after another, and afterwards come out in the shape of the parent-fly to whose eggs they owed their origin.

These intestine enemies are a sure prevention of the butterfly's appearing at its proper time; and as many of the former naturalists, who knew what butterfly to expect from a peculiar species of caterpillar which they preserved, often saw a parcel of flies come out in the place of it, they having no idea that the fly had laid its eggs in the flesh of the poor creature, supposed that this was one of its natural transformations, and that certain species of caterpillars sometimes produced butterflies, sometimes small flies. These, and many other destroyers, among which the birds are to be reckoned in the principal place, serve the purpose of preventing the too great number of these mischievous animals. Their usual habitation being the leaves and flowers of plants, they are, in their feeding, much exposed to all those destroyers; yet nature has taken care to preserve a great number, by making many of them so exactly of the colour of the leaves they feed on, that they are not easily distinguished from them; and by giving others a caution of keeping on the under part of the leaves, and being by that means out of sight. But some species are much less exposed, and of much more mischief to the plants they feed on, by devouring more essential parts of them. Of these some eat the roots, and others the interior part of the trunk, destroying the vessels that imbibe, and those that distribute the juices. These are different from the common caterpillars in this, that their skin is much less rough and hard; and these are secure from our observation, and in general from their great destroyers, the birds. They are not, however, absolutely safe from the common dangers of the other species; for there is a kind of worms that find their food and habitation even in the bodies of these. The root-caterpillars, and those which live within the branches of plants, are much more easily found out. The roots of scrophularia, and the stalks of lettuces, and some other plants, afford caterpillars which seem all of the same species. Those found in the lettuces are extremely plentiful some years, and destroy vast quantities of that plant. These usually have their first habitation in the stalk, near the root.

Nothing is more surprising in insects than their industry; and in this the caterpillars yield to no kind, not to mention their silk, the spinning of which is one great proof of it. The sheaths and cases which some of these insects build for passing their transformations under, are by some made with their own hair, mixed with pieces of bark, leaves, and other parts of trees, with paper, and other materials; and the structure of these is well worthy our attention. Yet there are others whose workmanship, in this article, far exceeds these. There is one which builds in wood, and is able to give its case a hardness greater than that of the wood itself in its natural state. This is the strange horned caterpillar of the willow, which is one of those that eat their exuviæ. This creature has extremely sharp teeth, and with these it cuts the wood into a number of small fragments; these fragments it afterwards unites together into a case, of what shape it pleases, by means of a peculiar silk, which is no other than a tough and viscous juice, which hardens as it dries, and is a strong and firm cement. The solidity of the case being thus provided for, we are to consider, that the caterpillar inclosed in it is to become a butterfly; and the wonder is, in what manner a creature of this helpless kind, which has neither legs to dig, nor teeth to gnaw with, is to make its way out of so firm and strong a lodgment as this in which it is hatched. The butterfly, as soon as hatched, discharges a liquor which softens the viscous matter that holds the case together; and so its several fragments falling to pieces, the way out lies open. Reaumur judged, from the effects, that this liquor must be of a singular nature, and very different from the generality of animal fluids; and in dissecting this creature in the caterpillar state, there will always be found near the mouth, and under the œsophagus, a bladder of the size of a small pea, full of a limpid liquor, of a very quick and penetrating smell, and which, upon trial, proves to be a very powerful acid; and among other properties, which it has in common with other acids, it sensibly softens the glue of the case, on a common application. It is evident that this liquor, besides its use to the caterpillar, remains with it in the chrysalis state, and is what gives it a power of dissolving the structure of the case, and making its way through in a proper manner at the necessary time. Boerhaave adopted the opinion, that there are no true acids in animals, except in the stomach or intestines; but this familiar instance proves the contrary.

Another very curious and mysterious artifice is that by which some species of caterpillars, when the time of their changing into the chrysalis state is coming on, make themselves lodgments in the leaves of the trees, by rolling them up in such a manner as to make themselves a sort of hollow cylindric case, proportioned to the thickness of their body, well defended against the injuries of the air, and carefully secured for their state of tranquillity. Besides these caterpillars, which in this manner roll up the leaves of plants, there are other species which only bend them once, and others, which by means of thin threads, connect many leaves together to make them a case. All this is a very surprising work, but much inferior to this method of rolling. The different species of caterpillars have different inclinations, not only in their spinning and their choice of food, but even in their manners and behaviour one to another. Some never part company from the time of their being hatched to their last change, but live and feed together, and undergo together their change into the chrysalis state. Others separate one from another as soon as able to crawl about, and each seeks its fortune single; and there are others which regularly live to a certain time of their lives in community, and then separate, each to shift for itself, and never to meet again in that state.

Caterpillars are very destructive to gardens, particularly those of two species. The one, that which afterwards becomes the com-

mon white butterfly. This is of a yellowish-white colour, spotted with black, and infests the leavesof cabbages, cauliflowers, and the Indian cress, of which it eats of all the tender parts, leaving only the fibres entire; so that whole plantations are often seen destroyed by them in autumn, especially such as are near large buildings, or are crowded with trees. There is no remedy against this evil but the pulling the creatures off before they are spread from their nests, and watching the butterflies, which are daily, in the hot weather, depositing their eggs on these plants. These, however, feed principally on the outside of the leaves of the plants, and are therefore the easier taken off; but the other kind lies near the centre, and therefore is with much more difficulty discovered. This is much larger; and the skin is very tough, and of a brown colour. It is called by the gardeners a grub, and is extremely pernicious. The eggs which produce it are usually deposited in the very heart or centre of the plant, particularly in cabbages; and the creature, when formed, and grown to some size, eats it way through all the blades, and leaves its dung in great quantities behind it, which spoils the cabbage. This insect also burrows under the surface of the ground, and makes sad havoc among young plants, by eating off their tender shanks, and drawing them into its holes. This mischief is chiefly done in the night; but wherever a plant is seen thus destroyed, if the earth is stirred with a finger an inch deep, the creature will be certainly found, and this is the only way of destroying them.

When these animals attack fruit-trees, the best preservative is to boil together a quantity of rue, wormwood, and the common tobacco, of each equal parts, in common water, to make the liquor very strong, and sprinkle it on the leaves and young branches every night and morning, during the time when the fruit is ripening.

ERUCÆ *aquaticæ*, *water caterpillars*. It may seem incredible, that there is any such thing as a caterpillar whose habitation is under water; but experience and observation prove, that there are such, and that they feed on the water-plants as regularly as the common kinds do on those at land. These are not named at random like many of the aquatic animals of the larger kinds, as the sea-wolf, the sea-horse, &c. which might as well be called any thing else as wolves and horses; but they are properly what they are called, and do not respire in the manner of the fish-tribe, but by their stigmata as other caterpillars. M. Reaumur, in his observations, met with two species of these; the one upon the pond-weed, the other upon the lenticula or duck-meat. These are both very industrious animals; but the first being much the largest, its operations are more easily distinguished. This, though truly an aquatic animal, swims but badly, and does not at all love to wet itself. The parent butterfly lays her egg on the leaf of a certain plant; and as soon as the young caterpillar is hatched, it gnaws out a piece of the leaf, of a roundish shape. This it carries to another part of the same leaf, and lays it in such a manner, that there may be a hollow between, in which it may lodge. It then fastens down this piece to the larger leaf with silk of its own spinning, only leaving certain holes at which it can put out its head, and get to gnaw any of the leaves that are near. It easily gets out, though the aperture is naturally small, since a little force from its body bends up the upper leaf and down the lower, both being flexible; and when the creature is out, it has a sort of down that defends it from being wetted, and the natural elasticity of the leaves and of the silk joins the aperture up again, so that no water can get in. The leaves of this kind of plant are also naturally very slippery, and not easily wetted by water. It soon happens that this habitation becomes too small for the animal, in which case it makes just such another; and after that, at times, several others, each being only made fit for it at the size it is then of. The changes of this creature into the chrysalis and butterfly states are in the common method. The butterfly gets out of a chrysalis which was placed on the surface of the water; the lightness of the animal easily sustains it on the water till its wings are dried, and then it leaves that element, never to return to it again.

ERUCÆ *sylvestres*, wood-caterpillars; the name of a sort of caterpillars which do not live, after the manner of others, on leaves of trees or plants, or open to our observation; but under the bark, in the trunk and branches, and in the roots of trees, and sometimes in the body of fruits. These are easily distinguished from those worms and maggots which are found in roots and fruits, and owe their origin to flies of another kind; but are liable to be confounded with a sort of animals, called by M. Reaumur, false or bastard caterpillars, which bear a great resemblance in their figure to real caterpillars, but which have more legs than any of the true ones have, and are finally transformed into four-winged flies, which are not true butterflies.

The butterflies which are the parents of those caterpillars that lie immured in trees or fruits, lay their eggs on the surface; and the young caterpillars, when hatched, eat their way in. What appears something surprising, however, in this is, that there usually is only one caterpillar in a fruit which is large enough to afford food to a great number; and if there are sometimes found two creatures within, one is usually a caterpillar, the other a worm of some other kind. The whole occasion of this is, that the operation of penetrating into the fruit is so difficult to the young animal, that it seldom succeeds in it; and though the butterfly deposits many eggs on each fruit, and these all hatch, yet it is only here and there one on a fruit that can find its way into it.

These creatures, when once lodged in their prison, have nothing to do but to eat up the substances which inclose them, leaving the outer hard shell unhurt, which still serves as a case for them. This is a very frequent case in grains of corn, where the farinaceous substance serves as aliment, and the hard outer skin becomes a firm hollow case afterwards for the animal. The farinaceous substance in this case usually proves enough for the animal in its caterpillar state; but if it does not, the creature has recourse to a very singular expedient: it eats again its own excrement, and finds its now stronger stomach able to separate nourishment from that very matter which had before passed off from its weaker stomach undigested.

Of these species of caterpillars, some go out of their prison in order to change into their chrysalis, and thence into their butterfly state; but the greater number remain there, and pass through all their changes within. These caterpillars, like all the other kinds, have certain flesh-eating worms, whose parents are of the fly-kind, for their terrible enemies and destroyers; and it is not unfrequent, on opening one of these spoiled fruits, instead of the expected caterpillar, to find a fly just ready to come out: this has been produced from the chrysalis of a worm, which had found its way into the fruit, and eaten up the caterpillar, which was the original possessor of the place.

ERUCTATIONS, in medicine, are the effect of flatulent foods, and the crudities thence arising.

ERUPTION, in medicine, a sudden and copious excretion of humours, as pus or blood; it signifies also the same with exanthema, any breaking out; as the pustules of the plague, small-pox, measles, &c. See MEDICINE.

ERVUM, the lentil, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32nd order, papilionaceæ. The calyx is quinquepartite, the length of the corolla. There are six species; of which the most remarkable is the lens, or common lentil. It is cultivated in many parts of England, either as fodder for cattle, or for the seeds, which are frequently used in meagre soups. It is an annual plant, and rises with weak stalks about 18 inches high, with winged leaves composed of several pairs of narrow lobes, terminated by a clasper or tendril, which fastens to any neighbouring plant, and is thereby supported; the flowers come out three or four together, upon short footstalks from the side of the branches. They are small, of a pale purple colour, and are succeeded by short flat pods, containing two or three seeds which are flat, round, and a little convex in the middle. The seeds of this plant are most commonly sown in the month of March, where the land is dry; but in moist ground, the best time is April. The usual quantity of seed allowed for an acre of land is from one bushel and a half to two bushels. If these are sown in drills in the same manner as peas, they will succeed better than when sown broadcast: the drills should be a foot and a half asunder, to allow room for the Dutch hoe to clean the ground between them; for if the weeds are permitted to grow among them, they will get above the lentils and starve them.

There is another sort of lentil also cultivated in this country, under the name of French lentil. It is twice the size of the former, both in plant and seed; and is much better worth cultivation than the other. It should be sown in March, after a single ploughing, in the ground that bore corn the year before. Manure is not absolutely necessary, though it will undoubtedly increase the crop. Its grass is said to be very copious; it may be mowed many times in the year, and affords a healthy as well as an agreeable food to horses, cows, and sheep; the milk of cows fed with it is said to be very copious and good. Long and numerous pods ripen about the beginning of winter, which afford a new kind of

legumen, to be eaten as common lentils; when fresh, it makes admirable peas-soup; dry, it is greedily eaten by the poultry. The dried herb is also a good resource for cattle in winter. It grows on any kind of ground.

ERYNGIUM, sea-holly, or eryngo, a genus of the digynia order, in the pentandria class of plants; and in the natural method ranking under the 45th order, umbellatæ. The flowers are collected into a round head, and the receptacle is paleaceous. There are 11 species; most of which are hardy herbaceous perennials, producing erect stalks from one to two or three feet high; with simple, entire, or divided prickly leaves; and the stalks terminated by roundish aggregate heads of quinquepetalous flowers, of white, blue, or purple colours. They all flower mostly in July, and the seeds ripen in September. They are propagated by seeds sown in a bed or border, either in spring or autumn. The plants are to be removed the autumn after they come up, into those places where they are designed to remain. The leaves of one of the species (viz. the maritimum, which grows naturally on the sea-coasts of England and Scotland) are sweetish, with a light aromatic warmth and pungency. The young flowering shoots, eaten like asparagus, are very grateful and nourishing.

ERYSIMUM, hedge-mustard; a genus of the siliquosa order, in the tetradynamia class of plants; and in the natural method ranking under the 39th order, siliquosæ. The siliqua is long, linear, and exactly tetragonal; the calyx close. There are eight species; of which the most remarkable is the officinale, hedge-mustard, or bank-cresses. It grows naturally in Britain under walls, by the sides of highways, and among rubbish. It is warm and acrid to the taste; and, when cultivated, is used as a vernal potherb. Birds are fond of the seeds; sheep and goats eat the herb; cows, horses, and swine, refuse it. The seeds are said to promote expectoration, and excite urine, but they are scarcely ever employed in medicine at present.

ERYSIPELAS, in medicine, an eruption of a fiery or acrid humour, from which no part of the body is exempted, though it chiefly attacks the face. See MEDICINE.

ERYTHRINA, coral-tree; a genus of the decandria order, in the diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ. The calyx is bilabiate, the one lip above, the other below; the vexillum of the corolla is very long, and lanceolated. There are seven species, all of them shrubby flowering exotics for the stove, adorned chiefly with trifoliate or three-lobed leaves, and scarlet spikes of papilionaceous flowers. They are all natives of the warm parts of Africa and America; and must always be kept in pots, which are to remain constantly in stoves in this country. They are propagated by seeds, which are annually imported hither from Africa and America. They are to be sown half an inch deep in pots of light rich earth, which are then to be plunged in a moderate hotbed; and when the plants are two inches high, they are to be separated into small pots, plunged in the bark-bed, giving them frequent waterings, and as they increase in growth shifting them into larger pots. The inhabitants of Malabar make sheaths of the wood for swords and knives. They use the same, together with the bark, in washing a sort of garments which they call sarassas; and make of the flowers the confection caryl. The leaves pulverized, and boiled with the mature cocoa-nut, have been deemed useful in venereal complaints. The juice of the leaves, combined with any greasy matter, also cures the itch and some other eruptions.

ERYTHRONIUM, dog's-tooth violet, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 11th order, sarmentaceæ. The corolla is hexapetalous and campanulated, with a nectarium of two tubercles adhering to the inner base of every other petal. There is only one species; which, however, admits of several varieties in its flowers, as white, purple, pale red, dark red, crimson, and yellow. The plants are low and herbaceous, with a purple stalk and hexapetalous flowers. All the varieties are hardy and durable; and may be planted in small patches in borders, where they will make a good appearance. They rarely perfect their seeds in this country, but may be propagated by offsets. In Siberia, according to Gmelin, they dry and mix the root of this plant with their soups. It grows there in abundance, and is called by the people of the country bess.

ERYTHROXYLON, a genus of the trigynia order, in the decandria class of plants; and in the natural method ranking with those the order of which is doubtful. The calyx is turbinated; the petals of the corolla have each a nectariferous emarginated scale at the base; the stamina are connected at the base; the fruit a bilocular plum. There are five species, beautiful shrubs of the West Indies.

ESCALADE, in war, a furious attack of a wall or a rampart; carried on with ladders, to pass the ditch or mount the rampart; without proceeding in form, breaking ground, or carrying on regular works to secure the men. When the troops are prepared to pass the ditch, either with the assistance of boards, hurdles, and fascines, when it is muddy, or with small boats of tin, or baskets covered with skins or oil-cloth, when it is deep and filled with water, a party must be placed on the counterscarp, opposite to the landing-place, ready to fire at the garrison if they are alarmed, and oppose the mounting on the rampart. If the ditch is dry, the ladders are fixed in some place farthest distant from the sentry; and as soon as they get upon the rampart, they put themselves in order to receive the enemy; if the sentry is surprised and silently overcome, the detachment hastens to break open the gate, and to let in the rest of the party. If the ditch is wet, the rampart high, and provided with a revêtement, it will be difficult to surprise the town in this way; but if there is no revêtement, the troops may hide themselves along the outside of the rampart till all are over. Since the invention and use of gunpowder, and the walls of cities have been flanked, they are seldom taken by escalade.

ESCALLONIA, a genus of the monogynia order, in the pentandria class of plants. The fruit is bilocular and polyspermous; the petals distant and tongue-shaped; the stigma headed. There are two species, shrubs of the West Indies and South America.

ESCAPE, in law, is where one who is arrested gains his liberty before he is delivered by course of law.

Escapes are either in civil or criminal cases; and in both respects, escapes may be distinguished into voluntary and negligent: voluntary, where it is with the consent of the keeper; negligent where it is for want of due care in him.

In civil cases, after the prisoner has been suffered voluntarily to escape, the sheriff can never after retake him, but must answer for the debt; but the plaintiff may retake him at any time. In the case of a negligent escape, the sheriff, upon fresh pursuit, may retake the prisoner, and the sheriff shall be excused if he has him again before any action brought against himself for the escape.

When a defendant is once in custody in execution, upon a capias ad satisfaciendum, he is to be kept in close and safe custody; and if he is afterwards seen at large, it is an escape, and the plaintiff may have an action thereupon for his whole debt: for though upon arrests, and what is called mesne process (being such as intervenes between the commencement and end of a suit), the sheriff, till the statute 8 and 9 W. c. 27, might have indulged the defendant as he pleased, so that he produced him in court to answer the plaintiff at the return of the writ; yet, upon a taking in execution, he could never give any indulgence; for in that case, confinement is the whole of the debtor's punishment, and of the satisfaction made to the creditor.

A rescue of a prisoner in execution, either in going to gaol, or in gaol, or a breach of prison, will not excuse the sheriff from being guilty of and answering for the escape; for he ought to have sufficient force to keep him, since he may command the power of the county. 3 Black. 415 and 6.

In criminal cases, an escape of a person arrested, by eluding the vigilance of his keeper before he is put in hold, is an offence against public justice, and the party himself is punishable by fine and imprisonment; but the officer permitting such escape, either by negligence or connivance, is much more culpable than the prisoner, who has the natural desire of liberty to plead in his behalf. Officers therefore, who after arrest negligently permit a felon to escape, are also punishable by fine; but voluntary escapes amount to the same kind of offence, and are punishable in the same degree, as the offence of which the prisoner is guilty, and for which he is in custody, whether treason, felony, or trespass; and this whether he was actually committed to gaol, or only under a bare arrest. But the officer cannot be thus punished, till the original delinquent is actually found guilty or convicted by verdict, confession, or outlawry; otherwise, it might happen that the officer should be punished for treason or felony, and the party escaping turn out to be an innocent man. But before the conviction of the principal party, the officer thus neglecting his duty may be fined and imprisoned for a misdemeanor. 4 Black. 129.

If any person shall convey or cause to be conveyed into any gaol, any disguise, instrument, or arms, proper to facilitate the escape of prisoners, attainted or convicted of treason or felony, although no escape or attempt to escape be made; such person so offending, and convicted, shall be deemed guilty of felony, and be transported for seven years. 16 Geo. II. c. 31.

ESCAPE-WARRANT, a process which issues

out against a person, committed in the king's bench or Fleet prisons, that, without being duly discharged, takes upon him to go at large.

Upon this warrant, which is obtained on oath, a person may be apprehended on a Sunday.

ESCHALOT. See ALLIUM.

ESCHAR, in surgery, the crust or scab occasioned by burns or caustic medicines. See SURGERY.

ESCHAROTICS, in pharmacy, medicines which produce eschars. See ESCHAR.

ESCHEAT, in our law, denotes an obstruction of the course of descent, and a consequent determination of the tenure by some unforeseen contingency; in which case, the land naturally results back, by a kind of reversion, to the original grantor, or lord of the fee. 2 Black. 244.

Escheat happens either for want of heirs of the person last seized, or by his attainder for a crime by him committed; in which latter case, the blood is tainted, stained, or corrupted, and the inheritable quality of it is thereby extinguished.

For want of heirs, is where the tenant dies without any relations on the part of any of his ancestors, or where he dies without any relations of those ancestors, paternal or maternal, from whom his estate descended, or where he dies without any relations of the whole blood. Bastards are also incapable of inheritance; and therefore if there is no other claimant than such illegitimate children, the land shall escheat to the lord; and, as bastards cannot be heirs themselves, so neither can they have any heirs but those of their own bodies; and therefore if a bastard purchases land, and dies seized thereof without issue and intestate, the land shall escheat to the lord of the fee. Aliens also, that is, persons born out of the king's allegiance, are incapable of taking by descent; and unless naturalized, are also incapable of taking by purchase; and therefore, if there are no natural-born subjects to claim, such lands shall in like manner escheat.

By attainder for treason or other felony, the blood of the person attainted is corrupted and stained, and the original donation of the feud is thereby determined, it being always granted to the vassal on the implied condition of his well demeaning himself. In consequence of which corruption and extinction of hereditary blood, the land of all felons would immediately revert to the lord, but that the superior law of forfeiture intervenes, and intercepts it in his passage; in case of treason, for ever; in case of other felony, for only a year and a day; after which time it goes to the lord, in a regular course of escheat. 2 Black. c. 15.

ESCHEATOR, was an antient officer, so called because his office was properly to look to escheats, wardships, and other casualties belonging to the crown. This office had its chief dependance on the courts of wards, but is now out of date. Co. Lit. 13 b. 4 Inst. 225.

ESCHRAKITES, a sect of Mahometans, who believe that man's sovereign good consists in the contemplation of God. They avoid all manner of vice, and appear always in good humour, despising the sensual paradise of Mahomet. The most able preachers in the royal mosques are of this sect.

ESCLATTE, in heraldry, signifies a thing forcibly broken, or rather a shield that has been broken and shattered with the stroke of a battle-ax.

ESCROW, among lawyers, a deed delivered to a third person, to be the deed of the party making it upon a future condition, that when a certain thing is performed, it shall be delivered to the party to whom it was made, to take effect as the deed of the person first delivering it.

ESCUAGE, in our old customs, a kind of knight's-service, called service of the shield, by which the tenant was bound to follow his lord to the wars at his own charge. It is also used for a sum of money paid to the lord in lieu of such service; or even for a reasonable aid, levied by the lord on his tenants who held by the knight's-service.

ESCULUS, the horse-chesnut. See ÆSCULUS.

ESCURIAL, a palace of the king of Spain, twenty-one miles north-west of Madrid; being one of the largest and most beautiful in the world. It has eleven thousand windows, fourteen thousand doors, one thousand eight hundred pillars, seventeen cloisters or piazzas, and twenty-two courts; with every convenience and ornament that can render a place agreeable in so hot a climate, as an extensive park, groves, fountains, cascades, grottos, &c. It is whimsically constructed in the form of a gridiron, being dedicated to St. Laurence in commemoration of a victory, gained on the anniversary of that saint (who is said to have been broiled to death on a gridiron) in 1557. The apartment which the royal family inhabits is the handle of the instrument. The rest of the building contains offices, a church, a convent (in which are 200 monks), and a library containing 30,000 volumes.

ESCUTCHEON, in heraldry, is derived from the French escusson, and that from the Latin scutum, and signifies the shield whereon coats of arms are represented.

ESCUTCHEON *of pretence*, that on which a man carries his wife's coat of arms; being an heiress, and having issue by her. It is placed over the coat of the husband, who thereby shows forth his pretensions to her lands.

ESNECY, in law, a private prerogative allowed to the eldest coparcener, where an estate is descended to daughters for want of an heir male, to choose first, after the estate of inheritance is divided. It has been also extended to the eldest son and his issue, holding first, this right being jus primogenituræ.

ESOX, pike, a genus of fishes of the order abdominales. The generic character is, head somewhat flattened above, mouth wide; teeth sharp, in the jaws, palate, and tongue; body lengthened; dorsal and anal fin (in most species) placed near the tail, and opposite each other. There are nine species, of which the most remarkable are:

1. Esox lucius, or common pike. To the general history of this fish perhaps little can be added to what Mr. Pennant has already detailed in the third volume of the British Zoology. It is, says that agreeable writer, a native of most of the lakes and smaller rivers in Europe, but the largest are those of Lapland, which are sometimes eight feet in length: they are taken there in great abundance, dried, and exported for sale. The largest specimen of English growth is said by Mr. Pennant to have weighed thirty-five pounds. The head of the pike is very flat; the upper jaw broad, and shorter than the lower, which turns up a little at the end, and is marked with minute punctures: the teeth are very sharp, disposed only in front of the upper jaw, but in both sides of the lower, as well as in the roof of the mouth, and often on the tongue: the number, according to Bloch, is not less than seven hundred, without reckoning the farthest of all, or those nearest the throat: it is also to be observed that those which are situated on the jaws are alternately fixed and moveable; the gape is very wide, and the eyes small: the dorsal fin is placed very low on the back, and consists of twenty-one rays; the pectoral of fifteen; the ventral of eleven, and the anal of eighteen; the tail is slightly forked, or rather lunated. The usual colour of this fish is a pale olive-grey, deepest on the back, and marked on the sides by several yellowish spots or patches: the abdomen is white, slightly spotted with black. When in its highest perfection however the colours are frequently more brilliant; the sides being of a bright olive with yellow spots, the back dark green, and the belly silvery. Dr. Bloch assures us that in Holland the pike is sometimes found of an orange-colour, marked with black spots: the scales are rather small, hard, and of an oblong shape.

The voracity of the pike is commemorated by all ichthyological authors. Mr. Pennant observes that he himself has known a pike that was choaked in attempting to swallow one of its own species which proved too large a morsel. It will also devour water-rats, and young ducks which happen to be swimming near it. In a manuscript note to a copy of Plott's History of Staffordshire, the following highly singular anecdote is recorded "At lord Gower's canal at Trentham, a pike seized the head of a swan as she was feeding under water, and gorged so much of it as killed them both: the servants, perceiving the swan with its head under water for a longer time than usual, took a boat and found both swan and pike dead."

But there are instances, says Mr. Pennant, still more surprising, and which indeed border a little on the marvellous. Gesner relates that a famished pike in the Rhone, seized on the lips of a mule that was brought to water, and that the beast drew the fish out before it could disengage itself: he adds that people have been bitten by these voracious animals while they were washing their legs, and that they will even contend with the otter for its prey, and endeavour to force it out of its mouth.

The smaller kind of fishes are said to shew the same uneasiness and detestation at the presence of a pike as the smaller birds do at the sight of a hawk or an owl, and when the pike, as is often the case, lies dormant near the surface of the water, are observed to swim round in vast numbers, and in the greatest anxiety. In the ditches near the Thames pike are often haltered in a noose, and taken while they lie thus asleep, as they are frequently found in the month of May.

The longevity of the pike is very remarkable, if, as Mr. Pennant observes, we may credit the accounts given by authors. Rzaczynski in his Natural History of Poland tells us of one that was ninety years old; but Gesner

relates that in the year 1497, a pike was taken near Hailburn, in Suabia, with a brazen ring affixed to it, on which were these words in Greek characters "I am the fish which was first of all put into this lake by the hands of the governor of the universe Frederic the Second, the fifth of October 1230;" so that, adds Mr. Pennant, the former must have been an infant to this Methusalem of a fish.

The pike spawns in March and April, according to the warmth or coldness of the season; depositing its ova among the weeds, &c. near the water's edge: the young are said to be of very quick growth: indeed Bloch considers it as the quickest grower of all the European fishes whose progress he has had an opportunity of observing. The first year, according to this author, it arrives at the length of from six to ten inches; the second to twelve or fourteen; and the third to eighteen or twenty. The stomach of the pike is strong and muscular, and of very considerable length: it is also furnished with several large and red pleats: in the intestinal canal have been observed several kinds of worms and particularly tæniæ, of which no fewer than a hundred have been seen in a single fish.

2. Esox sphyræna, or sea-pike. This species in its general habit or appearance is considerably allied to the common pike, but is of a silvery blueish colour, dusky on the back, and slightly tinged with yellow on the head and about the gills: the first dorsal fin is situated on the middle of the back, and is furnished with only four rays, which are all strong or spiny: the second, which is placed opposite the anal fin, consists of about ten rays, of which the first only is spiny: both these dorsal fins, together with the tail, which is deeply forked, are of a dusky tinge; the pectoral, ventral, and anal, are of a pale red, the eyes are moderately large: the lower jaw longer than the upper; the scales middle-sized, and the lateral line nearly straight. This fish is an inhabitant of the Mediterranean and Atlantic seas, growing to the length of about two feet. It is said to be in considerable esteem for the table, the flesh resembling that of the cod-fish.

3. Esox barracuda, or barracuda pike, has the habit of the common pike, but is of a longer form, and more slender or taper in proportion towards the tail: size very great, some having been seen of ten feet in length; but the more common size is from six to eight feet. This is said to be an extremely strong, fierce, and dangerous fish, swimming with great rapidity, and preying on most others: it is even said sometimes to attack and destroy bathers, in the same manner as the shark. It is found in great plenty in the tropical seas, and is frequent about the West Indian islands. It is in no estimation as a food, the flesh being rank; and even sometimes, according to common report, highly noxious, occasioning all the symptoms of the most fatal poisons; yet, in spite of these bad qualities, we are assured that the hungry Bahamians frequently make their repast "on its unwholesome carcase."

4. Esox vulpes, or the fox pike. Its general length is about sixteen inches: habit somewhat similar to that of a common pike, but remarkably slender or taper towards the tail, which is very deeply and widely forked; mouth of moderate width: jaws equal, and with a single row of sharp teeth in each: dorsal fin situated in the middle of the back: scales rather large, thin, and rounded: colour of the whole fish brown, paler or lighter beneath: native of Carolina and the West Indian islands.

5. Esox malabaricus, or Malabar pike, is in length about twelve inches; habit distantly allied to that of the common pike, but with the tail rounded, and the dorsal fin placed on the middle of the back: colour yellowish, dusky on the back; lower jaw longer than the upper; eyes rather large; scales large, and very distinct; the lateral line bending a little downwards at its origin from the gill-covers, and then running straight to the tail; all the fins, together with the tail, of a very pale transparent brown, barred by several rows of deep-brown spots. Native of Malabar, inhabiting rivers and rivulets, and in considerable esteem for the table.

6. Esox bellone, gar fish, or sea-needle, is well known by its protracted snout, and the bones, which are green when boiled.

ESPALIERS, in gardening, are rows of trees planted about a whole garden or plantation, or in hedges, so as to inclose quarters or separate parts of a garden; and are trained up regularly to a lattice of wood-work in a close hedge, for the defen e of tender plants against the injuries of wind and weather.

ESPLANADE, in fortification, the sloping of the parapet of the covered way towards the campaign. It is the same with glacis, and is more properly the empty space betwixt a citadel and the houses of a town, commonly called a place of arms. See FORTIFICATION.

ESPLEES, in law, the general products which lands yield, or the profit or commodity that is to be taken or made of a thing; as of a common, the taking of grass by the mouths of the beasts that common there; of an advowson, taking of tythes by the parson; of wood, the selling of wood; of an orchard, selling the fruit growing there; of a mill, the taking of toll, &c.

These and such-like issues are termed esplees. In a writ of right of land, advowson, &c. the demandant must allege in his count, that he or his ancestors took the esplees of the thing demanded, otherwise the pleading is not good.

ESPOUSALS, in law, signifies a contract or promise made between a man and a woman, to marry each other; and in cases where marriage may be consummated, espousals go before. Marriage is termed an espousal *de præsenti*.

ESQUIRE, *armiger*, was antiently the person that attended a knight in time of war, and carried his shield.

This title has not, for a long time, had any relation to the office of the person, as to carry arms, &c. Those to whom the title of esquire is now of right due, are all noblemen's younger sons, and the eldest sons of such younger sons; the eldest sons of knights, and their eldest sons; the officers of the king's courts, and of his household; counsellors at law, justices of the peace, &c. when in the commission; but a sheriff of a county, who is a superior officer, retains the title of esquire during life, in consequence of the trust once reposed in him: the heads of some antient families are said to be esquires by prescription; and by custom, or by way of compliment, this title is given to every gentleman who lives on his private fortune, and to rich merchants: it is even assumed by almost every tradesman who can drive his gig, or who takes upon him to live in two houses, though he should be unable to pay the expences of one.

ESQUIRES *of the king*, are such as have that title by creation, wherein there is some formality used, as the putting about their necks a collar of SS, and bestowing on them a pair of silver spurs, &c.

There are four esquires of the body to attend the king's person.

If an esquire be arraigned of high treason, he ought to be tried by a jury each whereof have 40*s*. of freehold, and 100*l*. in goods; and a knight has no other privilege. The heir apparent of an esquire is privileged to keep greyhounds, setting-dogs, or nets to take partridges and pheasants, though he cannot dispend 10*l*. of estate of inheritance, or the value of 30*l*. of estate for life.

ESSENCE, in philosophy, that which constitutes the particular nature of each genus or kind, and distinguishes it from all others; being nothing but that abstract idea to which this name is affixed, so that every thing contained in it is essential to that particular kind.

ESSENDO QUIETUM DE TOLONIO, in law, a writ which lies for citizens, burgesses, &c. who by charter or prescription ought to be free from toll, in case the same is exacted of them.

ESSENES, or *essenians*, in jewish antiquity, one of the three sects among that people, who exceeded the Pharisees in their most rigorous observances. They allowed a future state, but denied a resurrection from the dead. Their way of life was very singular: they did not marry, but adopted the children of others, whom they bred up in the institutions of their sect: they despised riches, and had all things in common; and never changed their cloaths till they were entirely worn out. When initiated, they were strictly bound not to communicate the mysteries of their sect to others; and if any of their members were found guilty of enormous crimes, they were expelled.

ESSOIN, in law, an excuse for a person summoned to appear and answer to an action, on account of sickness or other just cause of his absence.

It is a kind of imparlance or craving of longer time, and obtains in real, personal, and mixed actions.

There are divers essoins: as de ultra mare, when the defendant is beyond sea, whereby he is allowed forty days; in an expedition to the Holy Land, a year and a day; infirmity, called common essoin, when he is sick in bed; and lastly, in the king's service.

ESSOIN-DAY, is regularly the first day of every term, though the fourth day after is also allowed by way of indulgence.

ESSOIN DE MALO VILLÆ, is where the defendant appears in court, but before pleading, falls sick in a certain village: this is also allowed, if found true.

ESTATE, in law, signifies such inheritance, freehold, term for years, tenantcy by statute-merchant, staple, elegit, or the like, as any man has in lands and tenements. Estates are real, of lands, tenements, &c. or personal, of goods or chattels; otherwise distinguished into freeholds that descend to the heir, and chattels which go to the executors. Co. Lit. 315.

Of estate in fee-simple. An estate in fee-simple, is an estate, lands, tenements, lordships, advowsons, commons, estovers, and all hereditaments, to a man and his heirs for ever: also, where a corporation sole or aggregate are capable of holding in succession, and lands are given to them and their successors, they are said to have a fee-simple. 2 Bac. Abr. 249.

Of estate in tail. An estate is said to be intailed, when it is ascertained what issue shall inherit it.

What things may be intailed, by the statute of intails. The statute makes use of the word tenementum, and therefore the estate to be intailed, may be as well incorporeal as corporeal inheritances, because the word tenementum comprehends the one as well as the other, and consequently, not only lands may be intailed, but all rents, commons, estovers, or other profits arising from lands. Co. Lit. 19, b. 20, a.

What words create an estate tail. When the notion of succession prevailed, it was necessary in feudal donations to use the word heirs, to distinguish such descendible feud from that which was granted only for life; but as to the word body, it was necessary to make use of that in the donation, but it might be expressed by any equivalent words, and therefore a gift to a man and hæredibus de se, or de carne quo sibi contigerit habere, or procreavit, is a good estate tail; for these sufficiently circumscribe the word heirs, to the descendants of the feudatory: and the reason of the difference is, because inheritances are only derived from the law, and the law requires the word heirs, that comprehends the whole notion of such legal representation; but the limiting the inheritance to the descendants of this or the other body, is only the particular intention of the person that forms the gift, and therefore the law leaves every man to express himself in such manner as may manifest that intention. 2 Bac. Abr. 259.

Of tenant in tail charging his estate. The statute de donis, affecting a perpetuity, restrained the donee in tail, either from alienating or charging his estate tail; and by that act the tenant in tail was likewise to leave the land to his heirs as he received it from the donor; and upon that statute the heir in tail might have avoided any alienation or incumbrance of his ancestors; and as the law stood upon that act, so might he in reversion, when the heirs of the donee failed, which were inheritable to the gift. The crown long struggled to break through the perpetuity which was established by this law; and in the reign of Ed. IV. we find the pretended recompence given against the vouchee in the common recovery to be allowed as equivalent for the estate tail; and because the recompence was to go in succession as the land in tail should have done, therefore they allowed the recovery to bar the reversion as well as the issue in tail, because he in the reversion was to have the recompence in failure of issue of the donee. 2 Bac. Abr. 265. See RECOVERY.

ESTOILEE, or *cross estoilée*, in heraldry, a star with only four long rays in form of a cross; and, accordingly, broad in the centre, and terminating in sharp points.

ESTOPPEL, in law, an impediment or bar to an action, which arises from a person's own act; or rather, where he is forbidden by law to speak against his deed, which he may not do, even to plead the truth. Thus where a person is bound in a bond by such a name, and is afterwards sued by the same name on the obligation, he shall not be allowed to say he is misnamed, but shall answer according to the bond, though it be wrong. Hence the parties in all deeds are estopped from saying any thing against them. However, a plaintiff is not estopped from saying any thing against what he had said in his writ or declaration; and though parties may be estopped, yet juries are not so, who may find things out of the record.

ESTOVERS, in law, is a liberty of taking necessary wood for the use or furniture of a house or farm. And this any tenant may take from off the land let or demised to him, without waiting for any leave, assignment, or appointment of the lessor, unless he is restrained by special covenant to the contrary. 2 Black. 35.

ESTRAYS AND WAIFS, in law. Estrays are where any horses, sheep, hogs, beasts, or swans, or any beast that is not wild, come into a lordship, and are not owned by any man. Kitch. 23. The reason of estray is, because when no person can make title to the thing the law gives it to the king, if the owner does not claim it within a year and a day.

Waifs are goods which are stolen, and waved or left by the felon, on his being pursued, for fear of being apprehended, and forfeited to the king or lord of the manor: and though waifs are generally spoken of things stolen, yet if a man is pursued with hue and cry as a felon, and he flies and leaves his own goods, these will be forfeited as goods stolen; but they are properly the fugitive's goods, and not forfeited till it is found before the coroner, or otherwise of record, that he fled for the felony. 2 Haw. 450.

Waifs and strays were antiently the property of the finders by the law of nature, and afterwards the property of the king by the law of nations. Dalt. Sher. 79. Waifs and strays not claimed within the year and day are the lord's. For where the lord has a beast a year and a day, and it has been cried in the church and markets, the property is changed. Kitch. 80. But it must be a year and a day from the time of proclamation, and not from the time of seizure; for it does not become an estray till after the first proclamation. 11 Mod. 89.

ESTREAT, is a true copy or note of some original writing on record, and especially of fines and amercements imposed in the rolls of a court, and extracted or drawn out thence, and certified into the court of exchequer: whereupon process is awarded to the sheriff to levy the same.

ESTREPEMENT, or ESTREPAMENT, the spoil made by a tenant for life, upon any lands or woods, to the prejudice of the reversioner.

Estrepement also signifies a writ which lies in two cases; the one is when the person having an action depending (as a formedon, or dum fuit infra ætatem, or writ of right, or any other), wherein the demandant is not to recover damages, sues to inhibit the tenant from making waste during the suit. The other is for the demandant that is adjudged to recover seisin of the land in question, and before execution sued by the writ habere facias seisinam, for fear of waste to be made before he can get possession: he then sues out this writ.

ETCHING, is a manner of engraving on copper, in which the lines or strokes, instead of being cut with a tool or graver, are corroded in with aquafortis.

It is a much later invention than the art of engraving by cutting the lines on the copper, and has many advantages over it for some purposes; though it cannot supersede the use of the graver entirely, as there are many things that cannot be etched so well as they can be graved.

In almost all the engravings on copper that are executed in the stroke manner, etching and graving are combined, the plate being generally begun by etching, and finished with the graver. Landscapes, architecture, and machinery, are the subjects that receive most assistance from the art of etching; for it is not so applicable to portraits and historical designs.

We shall first describe the various instruments and materials used in the art.

Copper-plates may be had ready prepared at the coppersmiths by those who reside in large towns; but when this cannot be had, procure a piece of pretty thick sheet-copper from a brazier, rather larger than your drawing, and let him planish it well; then take a piece of pumice-stone, and with water rub it all one way, till the surface is as smooth and level as it can be made by that means: a piece of charcoal is next used with water for polishing it still farther, and removing the deep scratches made by the pumice-stone; and it is then finished with a piece of charcoal of a finer grain, with a little oil.

Etching-points or needles are pointed instruments of steel, about an inch long, fixed in handles of hard wood, about six inches in length, and of the size of a goose-quill. They should be well tempered, and very accurately fixed in the centre of the handle. They must be brought to an accurately conical point, by rubbing upon an oil-stone, with which it is also very necessary to be provided. Several of these points will be necessary.

A parallel-ruler is necessary for drawing parallel straight lines. This is best when faced with brass, as it is not then so liable to be bruised by accident.

Compasses are useful for striking circles and measuring distances.

Aquafortis, or, what is better, spirit of nitre (nitrous acid), is used for corroding the copper, or biting in, as it is called. This must be kept in a bottle with a glass stopple, for its fumes destroy corks. A stopple made of wax will serve as a substitute, or a cork well covered with wax.

Bordering-wax, for surrounding the margin of the copper-plate when the aquafortis is pouring on. This may be bought ready prepared, but it may be made as follows:

Take one-third of bee's-wax to two-thirds of pitch; melt them in an iron ladle, and pour them, when melted, into water lukewarm; then mould it with your hand till it is thoroughly incorporated, and all the water squeezed out. Form it into rolls of convenient size.

Turpentine-varnish is used for covering the copper-plate with, in any part where you do not wish the aquafortis to bite. This may be diluted to a proper consistence with turpen-

tine, and mixed with lamp-black that it may be seen better when laid upon the plate.

Etching-ground is used for covering the plate all over, previous to drawing the lines on it with the needles. It is prepared in the following manner:

Take of virgin-wax and asphaltum, each twenty ounces; of black-pitch and Burgundy-pitch, each half an ounce; melt the wax and pitch in a new earthenware glazed pipkin, and add to them, by degrees, the asphaltum, finely powdered. Let the whole boil till such time as by taking a drop upon a plate, it will break when it is cold, on bending it double two or three times between the fingers. The varnish being then enough boiled, must be taken off from the fire, and letting it cool a little, must be poured into warm water, that it may work the more easily with the hands, so as to form into balls for use.

It must be observed, first, that the fire be not too violent, for fear of burning the ingredients; a slight simmering will be sufficient. Secondly, that while the asphaltum is putting in, and even after it is mixed with them, the ingredients should be stirred continually with a spatula; and, thirdly, that the water into which this composition is thrown, should be nearly of the same degree of warmth with it, to prevent a kind of cracking, which happens when the water is too cold.

The varnish ought always to be harder in summer than winter, and it will become so if it is suffered to boil longer, or if a greater proportion of the asphaltum is used. The experiment above-mentioned, of the drop suffered to cool, will determine the degree of hardness or softness that may be suitable to the season when it is used.

To lay the ground for etching, proceed in the following manner. Having cleaned the copper-plate with some fine whiting and a linen rag, to free it from all grease, fix a hand-vice to some part of it where no work is intended to be, to serve as a handle for managing it by when warm. Roll up some coarse brown paper, and light one end; then hold the back of the plate over the burning paper, moving it about until every part of it is equally heated, so as to melt the etching-ground, which should be wrapped up in a bit of taffety, to prevent any dirt that may happen to be among it from mixing with what is melted upon the plate. If the plate is large, it will be best to heat it over a chafing-dish with some clear coals. It must be heated just sufficient to melt the ground, but not so much as to burn it. When a sufficient quantity of the etching-ground has been rubbed upon the plate, it must be dabbed, or beaten gently, while the plate is hot, with a small dabber made of cotton wrapped up in a piece of taffety, by which operation the ground is distributed more equally over the plate than it could be by any other means.

When the plate is thus uniformly and thinly covered with the varnish, it must be blackened by smoking it with a wax-taper. For this purpose twist together three or four pieces of wax-taper, to make a larger flame, and while the plate is still warm, hold it with the varnished side downwards, and move the smoky part of the lighted taper over its surface, till it is made almost quite black; taking care not to let the wick touch the varnish, and that the latter get no smear or stain.

In laying the etching-ground, great care must be taken that no particles of dust or dirt of any kind settle upon it, as that would be found very troublesome in etching; the room therefore in which it is laid should be as still as possible, and free from dust.

The ground being now laid, and suffered to cool, the next operation is to transfer the design to the plate.

For this purpose a tracing on oiled paper must now be made, from the design to be etched, with pen and ink, having a very small quantity of ox's gall mixed with it, to make the oiled paper take it; also a piece of thin paper, of the same size, must be rubbed over with red chalk, powdered, by means of some cotton. Then laying the red-chalked paper, with its chalked side next the ground, on the plate, put the tracing over it, and fasten them both together, and to the plate, by a little bit of the bordering-wax.

When all this is prepared, take a blunt etching-needle, and go gently all over the lines in the tracing; by which means the chalked paper will be pressed against the ground, and the lines of the tracing will be transferred to the ground: on taking off the papers they will be seen distinctly.

The plate is now prepared for drawing through the lines which have been marked upon the ground. For this the etching-points or needles are employed, leaning hard or lightly, according to the degree of strength required in the lines. Points of different sizes and forms are also used for making lines of different thickness, though commonly this is effected by the biting in with the aquafortis.

A margin or border of wax must now be formed all round the plate, to hold the aquafortis when it is poured on. To do this, the bordering-wax already described must be put into lukewarm water to soften it, and render it easily worked by the hand. When sufficiently pliable it must be drawn out into long rolls, and put round the edges of the plate, pressing it down firm, and forming it with the fingers into a neat wall or margin. A spout must be formed in one corner, to pour off the aquafortis afterwards.

The nitrous acid (spirit of nitre) is now to be diluted with four or five times as much water, or more (according as you wish the plate to be bitten quick or slow), and poured upon the plate. In a few minutes you will see minute bubbles of air filling all the lines that have been drawn on the copper, which are to be removed by a feather; and the plate must be now and then swept, as it is called, or kept free from air-bubbles. By the more or less rapid production of these bubbles, you judge of the rapidity with which the acid acts upon the copper. The biting-in of the plate is the most uncertain part of the process, and nothing but very great experience can enable any one to tell when the plate is bitten enough, as you cannot easily see the thickness and depth of the line till the ground is taken off.

When you judge from the time the acid has been on, and the rapidity of the biting, that those lines which you wish to be the faintest are as deep as you wish, you pour off the aquafortis by the spout, wash the plate with water, and dry it, by blowing with bellows, or by the fire, taking care not to melt the ground.

Those lines that are not intended to be bitten any deeper, must now be stopped up with turpentine-varnish mixed with a little lamp-black, and laid on with a camel's-hair pencil; and when this is thoroughly dry the aquafortis may be poured on again, to bite the other lines that are required to be deeper.

This process of stopping out and biting in is to be repeated as often as there are to be lines of different degrees of thickness, taking care not to make any mistake in stopping out wrong lines.

It is also necessary to be particularly careful to stop out with the varnish those parts from which the ground may happen to have come off by the action of the acid, otherwise you will have parts bitten that were not intended, which is called foul-biting.

When the biting in is quite finished, the next operation is to remove the bordering-wax and the ground, in order that you may see what success you have had; for till then this cannot be known exactly.

To take off the bordering-wax the plate must be heated by a piece of lighted paper, which softens the wax in contact with the plate, and occasions it to come off quite clean.

Oil of turpentine is now poured upon the ground, and the plate is rubbed with a bit of linen rag, which removes all the ground. Lastly, it is cleaned off with whitening.

The success of the etching may now be known, but it is necessary to get an impression taken upon paper by a copper-plate printer. This impression is called a proof.

If any parts are not bitten so deep as were intended, the process may be repeated, provided the lines are not too faintly bitten to admit of it. This second biting-in in the same lines is called re-biting, and is done as follows: Melt a little of the etching-ground on a spare piece of copper, and dab it a little, to get some on the dabber; then having cleaned out with whiting the lines that are to be rebitten, heat the plate gently, and dab it very lightly with the dabber. By this the parts between the lines will be covered with the ground; but the lines themselves will not be filled up, and consequently will be exposed to the action of the aquafortis. This is a very delicate process, and must be performed with great care. The rest of the plate must now be varnished over, the bordering-wax put on again, and the biting repeated in the same manner as at first.

If any part should be bitten too deep, it is more difficult to recover it, or make it fainter: this is generally done by burnishing the part down, or rubbing it with a piece of charcoal. This will make the lines shallower, and cause them not to print so black.

Should any small parts of the lines have missed altogether in the biting, they may be cut with the graver; which is also sometimes employed to cross the lines of the etching, and thus to work up a more finished effect.

Dry-pointing, as it is called, is another method employed for softening the harsh effects usually apparent in an etching. This is done by cutting with the etching-point upon the copper without any ground or varnish. This does not make a very deep line, and is used for covering the light, where very delicate tints and soft shadows are wanting. By varying these processes of etching, gra-

ving, and dry-pointing, as is thought necessary, the plate is worked up to the full effect intended; and it is then sent to the writing-engraver, to grave whatever letters may be required to be put upon it.

Etching on glass.—Glass resists the action of all the acids, except the fluoric acid. By this, however, it is corroded in the same manner as copper is by aquafortis; and plates of glass may be engraven in the same manner as copper.

There are several methods of performing this. We shall first describe the mode of etching by means of the fluoric acid in the state of gas. Having covered over the glass to be etched with a thin coat of virgin-wax (which is only common bee's-wax bleached white), draw the design upon it in the same manner as in etching on copper. Then take some fluor spar, commonly called Derbyshire spar, pound it fine, and put it into a leaden vessel, pouring some sulphuric acid over it. Place the glass with the etched side lowermost over this vessel, two or three inches above it. Apply a gentle heat to the leaden vessel; this will cause the acid to act upon the fluor spar, and disengage the gas, which will corrode the glass. When it is sufficiently corroded, remove the wax by oil of turpentine.

This etching may be also performed by raising a margin of bordering-wax all round the glass, in the same manner as on copper, and pouring on the liquid fluoric acid, which acts upon the glass. The method of making this acid is described under FLUORIC ACID, and in the article CHEMISTRY.

A third method of etching on glass is as follows: Having put the wax on the glass, draw your design, and raise a margin all round it. Then put pounded fluor spar, with some sulphuric acid diluted with water, upon the glass. The sulphuric acid will disengage the fluoric, which will be absorbed by the water, and corrode the glass.

ETHICS, or MORALITY, the science of manners or duty, which it traces from man's nature and condition, and shews to terminate in his happiness; or, in other words, it is the knowledge of our duty and felicity, or the art of being virtuous and happy.

Moral philosophy inquires, not how man might have been, but how he is constituted; not into what principles or dispositions his actions may be artfully resolved, but from what principles and dispositions they actually rose; not what he may, by education, habit, or foreign influence, come to be or do, but what by his nature or original frame, he is framed to be and do. From a view, therefore, of man's faculties, appetites, and passions, it appears, that the health and perfection of man must be in the supremacy of conscience and reason, and in the subordination of the passions and affections to their authority and direction; and his virtue or goodness must consist in acting agreeably to this order and economy.

It is true, some eminent philosophers have attempted to lay the foundation of morals much deeper, viz. in the nature and reason, the truth and fitness of things. Senses and affections, they tell us, are vague and precarious; and though they were not, yet are irrational principles of action, and consequently very improper foundations, on which to rest the eternal and immutable obligations of morality. Hence they talk much of the abstract nature and reason of things, of eternal differences, unalterable relations, fitnesses and unfitnesses resulting from those relations; and from these eternal reasons, differences, relations, and their consequent fitnesses, they suppose moral obligation to arise. A conduct agreeable to them, or, in other words, to truth, they call virtue; and the reverse, vice. But the truth is, that we might perceive all the possible relations, differences, and reasons of things, and yet be wholly indifferent to this or that conduct, unless we were endued with some sense or affection by which we approved and loved the one, and disapproved and disliked the other conduct. Reason may perceive a fitness to a certain end; but without some sense or affection we cannot propose or indeed have any idea of an end or motive; and, without an end, we cannot conceive any inducement to action. Therefore, before we can understand the natures, reasons, and fitnesses of things, which are said to be the foundation of morals, we must know what natures are meant, to what ends they are fitted, and from what principles or affections they are prompted to act; otherwise we cannot judge of the duty required, or of the conduct becoming that being whom we suppose under moral obligation. But let the natures be once given, and the relations which subsist among them be ascertained, we can then determine what conduct will be obligatory to such natures, and adapted to their condition and economy. And to the same natures, placed in the same relations, the same conduct will be eternally and invariably proper and obligatory.

Besides, to call morality a conformity to truth, gives no idea, no characteristic of it, but what seems equally applicable to vice. For whatever propositions are predicable of virtue (as, that it flows from good affections, or is agreeable to the order of our nature, tends to produce happiness, is beheld with approbation, &c.); the contrary propositions are equally true, and may be equally predicated, of vice.

Another set of philosophers establish morals upon a better foundation, the will or positive appointment of the Deity, and call virtue a conformity to that will or appointment. All obligation, they say, supposes one who obliges, or who has a right to prescribe, and can reward the obedient, and punish the disobedient. This can be none but the Creator. His will, therefore, is our law, which we are bound to obey. And this, they tell us, is alone sufficient to bind or oblige such imperfect and corrupt creatures as we are, who are but feebly moved with a sense of the beauty and excellence of virtue, and strongly swayed by passion or views of interest.

This scheme of morality entirely coincides with that deduced from our inward structure and condition, since these are the effects of the divine will. Whatever, therefore, is agreeable or correspondent to our inward structure, must likewise be agreeable, or correspond to the will of God. So that all the indications or sanctions of our duty, which are declared or enforced by our structure, are, and may be, considered as indications or sanctions of the will of our Creator. If these indications, through inattention to, or abuse of, our structure, prove insufficient to declare; or if these sanctions, through the weakness or wickedness of men, prove insufficient to enforce obedience to the divine will, and the Deity is pleased to add new indications or new sanctions; these additional indications and sanctions cannot, and are not supposed by the assertors of this scheme, to add any new duty or new moral obligation; but only a new and purer promulgation of our duty, or a new and stronger sanction or motive from interest to perform that duty, and to fulfil that obligation to which we were bound before. It makes no difference as to the matter of obligation, after what manner the will of our Creator is enforced or declared to us, whether by word or writ, or by certain inward notices and determinations of our own minds, arising according to a necessary law of our nature. Again, if the scheme of duty, as deduced from moral perceptions, and the affections of our nature, is thought too slight a foundation on which to rest morality, because these are found insufficient to bind or rather to compel men to their duty, we fear the same objection will militate against the scheme of conformity to the divine will, since all the declarations and sanctions of it have not hitherto had their due effect, in producing a thorough and universal reformation.

When some speak of the will of God as the rule of duty, they do not certainly mean a blind, arbitrary principle of action, but such a principle as is directed by reason and governed by wisdom, or a regard to certain ends in preference to others: for unless we suppose some principle in the Deity analogous to our sense of obligation, some antecedent affection or determination of his nature to prefer some ends before others, we cannot assign any sufficient reason why he should will one thing more than another. Whatever, therefore, is the ground of his choice or will, must be the ground of obligation, and not the choice or will itself. That this is the case, appears farther from the common distinction which divines and philosophers make between moral and positive commands and duties. The former they think obligatory antecedent to will, or at least to any declaration of it; the latter, obligatory only in consequence of a positive appointment of the divine will. But what foundation can there be for this distinction, if all duty and obligation is equally the result of mere will?

Whatever may have been the reasoning of heathen philosophers on this subject (and to which, indeed, this article chiefly refers), the professors of christianity have no difficulty in understanding what is the will of God, and consequently what are the true principles of moral duty. That these were not understood by the wisest of the heathens, is evident from their practice, and still more so from even their speculative, their cool, deliberate, and well digested reasonings. (See Gregory's Essays Historical and Moral; Essay on the Principles of Morals.) But christians are furnished not only with the strongest motives but with the most clear and decisive precepts for the performance of their duty. The excellence of the gospel in this respect supersedes the necessity of all human speculations; and hence nothing can be more idle or fruitless than to search for moral instructions in the writings of the heathens. Nor can any thing be more a work of supererogation to men who have the Bible in their hands, than

systems of ethics, or lectures on moral philosophy! On this account we have made this article very short, and given rather the opinions of others than our own, merely to shew (as matter of information) what has been said and thought upon the subject.

Before we conclude this article, it will be proper to say something of the extraordinary hypothesis of Hobbes, concerning the foundation of morality. This philosopher, who saw his country involved in all the distraction and misery of a civil war, seems to have taken too narrow and partial a view of our nature, and has therefore drawn it in a very odious and uncomfortable light. Next to the desire of self-preservation, he makes the love of glory and of power to be the governing passions in man; and from these, by an arbitrary, unnatural, and unsupported hypothesis, contrary to common experience and common language, he attempts to deduce all the other passions which inflame the minds and influence the manners of men. According to him all men are equal, all desire and have a right to the same things, and want to excel each other in power and honour; but as it is impossible for all to possess the same things, or to obtain a pre-eminence in power and honour, hence must arise a state of war and mutual carnage; which is what he calls a state of nature. But this shrewd philosopher subjoins, that men being aware that such a state must terminate in their own destruction, agreed to surrender their private unlimited right into the hands of the majority, or such as the majority should appoint, and to subject themselves for the future to common laws or to common judges or magistrates. In consequence of this surrender, and of this mutual compact or agreement, they are secured against mutual hostilities, and bound or obliged to a peaceable behaviour; so that it is no longer lawful or just (he certainly means safe or prudent) to invade and incroach on one another, since this would be a violation of his promise. But one may ask him, what obligation is a man under to keep his promise or stand to his compact, if there is no obligation, no moral tie, distinct from that promise? On the whole, his state of nature is a mere chimera, and the superstructure he has raised on it no less so.

ETHER. See Æther.

ETHMOIDAL, in anatomy, one of the common sutures of the skull, which goes round the os ethmoides, from which it derives its name, separating it from the bone in contact with it.

ETHNOPHRONES, in church history, a sect of Christians of the seventh century, who, professing christianity, joined to it all the ceremonies and follies of Paganism, such as judicial astrology, divinations of all kinds, &c. and who observed all the feasts, times, and seasons, of the Gentiles.

ETHOPOEIA, or Ethology, in rhetoric, a draught or description, expressing the manners, passions, genius, tempers, aims, &c. of any person. Such is that noted picture of Catiline, as drawn by Sallust: *fuit magna vi & animi*, &c. "He was a man of great vigour both of body and mind: but of a disposition extremely profligate and depraved. From his youth he took pleasure in civil wars, massacres, depredations, and intestine broils; and in these he employed his younger days. His body was formed for enduring cold, hunger, and want of rest, to a degree indeed incredible: his spirit was daring, subtle, and changeable; he was expert in all the arts of simulation and dissimulation, covetous of what belonged to others, lavish of his own, violent in his passions: he had eloquence enough, but a small share of wisdom; his boundless soul was constantly engaged in extravagant and romantic projects, too high to be attempted."

ETHULIA, a genus of the class and order syngenesia polygamia æqualis. The receptacle is naked; down none. There are six species, chiefly annuals of the East Indies.

ETHUSA, fool's parsley. See Æthusa.

ETNA. See Volcano.

ETYMOLOGY, that part of grammar which considers and explains the origin and derivation of words, in order to arrive at their first and primary signification, whence Quintilian calls it *originatio*.

The best treatise on the etymology of English words, and for the ascertaining of their force and usage, is unquestionably the Epea Pteroenta of Mr. Horne Tooke, already quoted in this work.

EVACUANTS. See Materia Medica.

EVANTES, in antiquity, the priestesses of Bacchus, thus called, because in celebrating the orgia, they ran about as if distracted, crying, *evan, evan, ohé evan*.

EVAPORATION, in chemistry, the setting a liquor in a gentle heat or in the air, to discharge its superfluous humidity, reduce it to a proper consistence, or obtain its dry remainder.

Evaporation, though generally considered as the effect of the heat and motion of the air, may be produced by a different cause. Fluids lose more by evaporation in the severest frost than when the air is moderately warm. Thus, in the great frost of 1708, it was found that the greater the cold the more considerable the evaporation. Ice itself loses much by evaporation.

Evaporation, in natural philosophy, is the conversion of water into vapour, which in consequence of becoming lighter than the atmosphere, is raised considerably above the surface of the earth, and afterwards by a partial condensation forms clouds. It differs from exhalation, which is properly a dispersion of dry particles from a body.

We are indebted to the experiments of Saussure and Deluc for much of our knowledge of the qualities of vapour. It is an elastic invisible fluid like common air, but lighter; being to common air of the same elasticity, according to Saussure, as 10 to 14, or, according to Kirwan, as 10 to 12.

When water is heated to 212°, it boils, and is rapidly converted into steam; and the same change takes place in much lower temperatures; but in that case the evaporation is slower, and the elasticity of the steam is smaller. As a very considerable proportion of the earth's surface is covered with water, and as this water is constantly evaporating and mixing with the atmosphere in the state of vapour, a precise determination of the rate of evaporation must be of very great importance in meteorology. Accordingly, many experiments have been made to determine the point by different philosophers. No person has succeeded so completely as Mr. Dalton: but many curious particulars had been previously ascertained by the labours of Richman, Lambert, Wallerius, Leidenfrost, Watson, Saussure, Deluc, Kirwan, and others.

1. The evaporation is confined entirely to the surface of the water: hence it is in all cases proportional to the surface of the water exposed to the atmosphere. Much more vapour of course rises in maritime countries, or those interspersed with lakes, than in inland countries.

2. Much more vapour rises during hot weather than during cold: hence the quantity evaporated depends in some measure upon temperature. The precise law has been happily discovered by Mr. Dalton. This philosopher took a cylindrical vessel of tin, whose diameter was $3\frac{1}{4}$ inches, and its depth $2\frac{1}{2}$ inches, filled it with water, and kept it just boiling for some time. The loss of weight in the minute was 30 grains, when the experiment was made in a close room without any draught of air; 35 grains when the vessel was placed over fire in the usual fireplace, there being a moderate draught of air, and the room close; 40 with a brisker fire and a stronger draught; and when the draught was very strong, he supposes the evaporation might amount to 60 grains in the minute. At the temperature of 180°, the quantity evaporated was one half of what was lost at 212°.

At 164° it was	$\frac{1}{3}$ of that at 212°.
152	$\frac{1}{4}$
144	$\frac{1}{5}$
138	$\frac{1}{6}$

And in general the quantity evaporated from a given surface of water per minute at any temperature is to the quantity evaporated from the same surface at 212°, as the force of vapour at the first temperature is to the force of vapour at 212°. Hence, in order to discover the quantity which will be lost by evaporation from water of a given temperature, we have only to ascertain the force of vapour at that temperature. Hence we see that the presence of atmospheric air obstructs the evaporation of water; but this evaporation is overcome in proportion to the force of the vapour. Mr. Dalton ascribes this obstruction to the vis inertiæ of air.

3. The quantity of vapour which rises from water, even when the temperature is the same, varies according to circumstances. It is least of all in calm weather, greater when a breeze blows, and greatest of all with a strong wind. The following table, drawn up by Mr. Dalton, shews the quantity of vapour raised from a circular surface of six inches in diameter in atmospheric temperatures. The first column expresses the temperature; the second the corresponding force of vapour; the other three columns give the number of grains of water that would be evaporated from a surface of six inches in diameter in the respective temperatures, on the supposition of there being previously no aqueous vapour in the atmosphere. These columns present the extremes and the mean of evaporation likely to be noticed, or nearly such; for the first is calculated upon the supposition of 35 grains loss per minute from the vessel of $3\frac{1}{4}$ inches in diameter; the second 45, and the third 55 grains per minute.

Temperature.	Force of vapour in inches.	Evaporating force in grains.		
212°	30	120	154	189
20°	.129	.52	.67	.82
21	.134	.54	.69	.85
22	.139	.56	.71	.88
23	.144	.58	.73	.91
24	.150	.60	.77	.94
25	.156	.62	.79	.97
26	.162	.65	.82	1.02
27	.168	.67	.86	1.05
28	.174	.70	.90	1.10
29	.180	.72	.93	1.13
30	.186	.74	.95	1.17
31	.193	.77	.99	1.21
32	.200	.80	1.03	1.26
33	.207	.83	1.07	1.30
34	.214	.86	1.11	1.35
35	.221	.89	1.14	1.39
36	.229	.92	1.18	1.45
37	.237	.95	1.22	1.49
38	.245	.98	1.26	1.54
39	.254	1.02	1.31	1.60
40	.263	1.05	1.35	1.65
41	.273	1.09	1.40	1.71
42	.283	1.13	1.45	1.78
43	.294	1.18	1.51	1.85
44	.305	1.22	1.57	1.92
45	.316	1.26	1.62	1.99
46	.327	1.31	1.68	2.06
47	.339	1.36	1.75	2.13
48	.351	1.40	1.80	2.20
49	.363	1.45	1.86	2.28
50	.375	1.50	1.92	2.36
51	.388	1.55	1.99	2.44
52	.401	1.60	2.06	2.51
53	.415	1.66	2.13	2.61
54	.429	1.71	2.20	2.69
55	.443	1.77	2.28	2.78
56	.458	1.83	2.35	2.88
57	.474	1.90	2.43	2.98
58	.490	1.96	2.52	3.08
59	.507	2.03	2.61	3.19
60	.524	2.10	2.70	3.30
61	.542	2.17	2.79	3.41
62	.560	2.24	2.88	3.52
63	.578	2.31	2.97	3.63
64	.597	2.39	3.07	3.76
65	.616	2.46	3.16	3.87
66	.635	2.54	3.27	3.99
67	.655	2.62	3.37	4.12
68	.676	2.70	3.47	4.24
69	.698	2.79	3.59	4.38
70	.721	2.88	3.70	4.53
71	.745	2.98	3.83	4.68
72	.770	3.08	3.96	4.84
73	.796	3.18	4.09	5.00
74	.823	3.29	4.23	5.17
75	.851	3.40	4.37	5.34
76	.880	3.52	4.52	5.53
77	.910	3.65	4.68	5.72
78	.940	3.76	4.83	5.91
79	.971	3.88	4.99	6.10
80	1.00	4.00	5.14	6.29
81	1.04	4.16	5.35	6.54
82	1.07	4.28	5.50	6.73
83	1.10	4.40	5.66	6.91
84	1.14	4.56	5.86	7.17
85	1.17	4.68	6.07	7.46

4. Such is the quantity of vapour which would rise in diferent circumstances, on the supposition that no vapour existed in the atmosphere. But this is a supposition which can never be admitted, as the atmosphere is in no case totally free from vapour. Now when we wish to ascertain the rate at which evaporation is going on, we have only to find the force of the vapour already in the atmosphere, and subtract it from the force of vapour at the given temperature: the remainder gives us the actual force of evaporation; from which, by the table, we readily find the rate of evaporation. Thus, suppose we wish to know the rate of evaporation at the temperature 59°. From the table we see that the force of vapour at 59° is 0.5, or $\frac{1}{60}$ its force at 212°. Suppose we find by trials that the force of the vapour already existing in the atmosphere is 0.25, or the half of $\frac{1}{60}$. To ascertain the rate of evaporation, we must subtract the 0.25 from 0.5; the remainder 0.25 gives us the force of evaporation required; which is precisely one half of what it would be if no vapour had previously existed in the atmosphere.

By the table we see that on that supposition a surface of six inches diameter would lose one grain by evaporation per minute, instead of two grains, which would have been converted into vapour if no vapour had previously existed in the atmosphere. If the force of the vapour in the atmosphere had amounted to 0.5, which is equal to the force of vapour at the temperature of 59°, in that case no vapour whatever would rise from the water; and if the force of the vapour already in the atmosphere exceeded 0.5, instead of evaporation, moisture would be deposited on the surface of the water.

These general observations, for all of which we are indebted to Mr. Dalton, account in a satisfactory manner for all the anomalies which had puzzled preceding philosophers; and include under them all the less general laws which they had discovered. We must consider the discoveries of Mr. Dalton as the most important additions made to the science of meteorology for these many years.

5. As the force of the vapour actually in the atmosphere is seldom equal to the force of vapour of the temperature of the atmosphere, evaporation, with a few exceptions, may be considered as constantly going on.

Various attempts have been made to ascertain the quantity evaporated in the course of a year; but the difficulty of the problem is so great, that we can expect only an approximation towards a solution. From the experiments of Dr. Dobson of Liverpool in the years 1772, 1773, 1774, and 1775, it appears that the mean annual evaporation from the surface of water amounted to 36.78 inches. The proportion for every month was the following:

	Inches.		Inches.
January -	1.50	July - -	5.11
February -	1.77	August - -	5.01
March -	2.64	September -	3.18
April - -	3.30	October -	2.51
May - -	4.34	November -	1.51
June - -	4.41	December -	1.49

Mr. Dalton found the evaporation from the surface of water in one of the driest and hottest days of summer rather more than 0.2 of an inch.

If we believe Mr. Williams, the evaporation from the surface of land covered with trees and other vegetables is one-third greater than from the surface of water; but this has not been confirmed by other philosophers. From his experiments it appears, that in Bradford in New England the evaporation, during 1772, amounted to 42.65 inches. But from the way that his experiments were conducted, the amount was probably too great.

From an experiment of Dr. Watson, made on the 2d of June 1779, after a month's drought, it appears, that the evaporation from a square inch of a grass plot amounted to 1.2 grains in an hour, or 28.8 grains in 24 hours, which is 0.061 of an inch. In another experiment, after there had been no rain for a week, the heat of the earth being 110°, the evaporation was found almost twice as great, or = 0.108 of an inch in the day. The mean of these two experiments is 0.084 inches, amounting for the whole of June to 2.62 inches. If we suppose this to bear the same proportion to the whole year that the evaporation in Dr. Dobson's experiments for June do to the annual evaporation, we shall obtain an annual evaporation, amounting to about 22 inches. This is much smaller than that obtained by Mr. Williams. But Dr. Watson's method was not susceptible of precision. He collected the vapour raised on the inside of a drinking-glass; but it was impossible that the glass could condense much more than one half of what did rise, or would have been raised in other circumstances. But then the experiments were made in the hottest part of the day, when much more vapour is raised than during any part of it.

The most exact set of experiments on the evaporation from the earth was made by Mr. Dalton and Mr. Hoyle, during 1796, and the two succeeding years. The method which they adopted was this: Having got a cylindrical vessel of tinned iron, ten inches in diameter, and three feet deep, there were inserted into it two pipes turned downwards for the water to run off into bottles: the one pipe was near the bottom of the vessel, the other was an inch from the top. The vessel was filled up for a few inches with gravel and sand, and all the rest with good fresh soil. It was then put into a hole in the ground, and the space around filled up with earth, except on one side, for the convenience of putting bottles to the two pipes; then some water was poured on to sadden the earth, and as much of it as would was suffered to run through without notice, by which the earth might be considered as saturated with water. For some weeks the soil was kept above the level of the upper pipe, but latterly it was constantly a little below it, which precluded any water running off through it. For the first year the soil at top was bare; but for the two last years it was covered with grass the same as any green field. Things being thus circumstanced, a regular register was kept of the quantity of rain water that ran off from the surface of the earth through the upper pipe (whilst that took place), and also of the quantity of that which sunk down through the three feet of earth, and ran out through the lower pipe. A rain-gauge of the same diameter was kept close by to find the quantity of rain for any corresponding time. The weight of the water which ran through the pipes being subtracted from the water in the rain-gauge, the remainder was considered as the weight of the water evaporated from the earth in the vessel. The following table exhibits the mean annual result of these experiments.

	Water through the two pipes. Inch. 1796.	Inch. 1797.	Inch. 1798.	Mean. Inch.	Mean Rain. Inch.	Mean Evap. Inch.
January -	1.897 —	.680 —	1.774 +	1.450 +	2.458	1.008
February -	1.778 —	.918 —	1.122	1.273	1.801	.528
March - -	.431 —	.070 —	.335	.279	.902	.623
April - -	.220 —	.295 —	.180	.232	1.717	1.485
May - -	2.027 —	2.443 +	.010	1.493 +	4.177	2.684
June - -	.171 —	.726	——	.299	2.483	2.184
July - -	.153 —	.025	——	.059	4.154	4.095
August -	——	——	.504	.168	3.554	3.386
September -	——	.976	——	.325	3.279	2.954
October -	——	.680	——	.227	2.899	2.672
November -	——	1.044	1.594	.879	2.934	2.055
December -	.200	3.077	1.878 +	1.718 +	3.202	1.484
	6.877 —	10.934 —	7.379	8.402	33.560	25.158
Rain -	30.629 —	38.791 —	31.259			
Evaporation	23.725 —	27.857 —	23.862			

From these experiments it appears that the quantity of vapour raised annually at Manchester is about 25 inches. If to this we add five inches for the dew with Mr. Dalton, it will make the annual evaporation 30 inches. Now, if we consider the situation of England, and the greater quantity of vapour raised from water, it will not surely be considered as too great an allowance if we estimate the mean annual evaporation over the whole surface of the globe at 35 inches. Now, 35 inches from every square inch on the superficies of the globe make 94,450 cubic miles, equal to the water annually evaporated over the whole globe.

Was this prodigious mass of water all to subsist in the atmosphere at once, it would increase its mass by about a twelfth, and raise the barometer nearly three inches. But this never happens; no day passes without rain in some part of the earth, so that part of the evaporated water is constantly precipitated again. Indeed it would be impossible for the whole of the evaporated water to subsist in the atmosphere at once, at least in the state of vapour.

EUCALYPTUS, a genus of the hexandria monogynia class and order. The calyx is superior, permanent, truncate before flowering, covered with an hemispherical deciduous lid. Corolla, none; capsule four-celled, opening at top, inclosing many seeds. There are two species, lofty trees of New Holland; called also the red-gum tree, from a gummy matter, in which one of them, the resinifera, abounds. A single tree will, on being tapped, afford more than 60 gallons of juice, which when dried becomes a powerfully astringent gum resin, resembling that known in the shops by the name of kino, and found eminently efficacious in dysenteries, &c. Water dissolves of it only one-sixth part, but it dissolves abundantly in spirit of wine, to which it gives a blood-red colour.

EUCLEA, a genus of the dicecia dodecandria class and order. In both male and female the calyx is four or five-toothed; the corolla four or five-parted; the male stamina 12 to 15. In the female, the germ is superior; the styles two; berry two-celled. There is one species, a branching tree of the Cape.

EUCOMIS, a genus of the class and order hexandria monogynia. The calyx is inferior, six-parted, permanent, spreading; filaments united at the base into a nectary growing to the corolla. There are four species, plants of the Cape.

EUDIOMETER, an instrument for ascertaining the purity of the atmospherical air, or the quantity of oxygenous gas contained in it, chiefly by means of its diminution on a mixture with nitrous acid, or some similar substance.

After the composition of the atmosphere was known to philosophers, it was taken for granted that the proportion of its oxygen varied in different times and in different places; and that upon this variation the purity or noxious qualities of air depended. Hence it became an object of the greatest importance to be in possession of a method of determining readily the quantity of oxygen in a given portion of air. Accordingly, various methods were proposed, all of them depending upon the property which bodies possess of absorbing the oxygen of the air without acting upon its azote. These bodies were mixed with a certain known quantity of atmospheric air, in graduated glass vessels inverted over water, and the proportion of oxygen was determined by the diminution of bulk. These instruments received the name of eudiometers, because they were considered as measurers of the purity of air. The eudiometers proposed by different chemists may be reduced to five.

1. The first eudiometer was made in consequence of Dr. Priestley's discovery, that when nitrous gas is mixed with air over water, the bulk of the mixture diminishes rapidly, in consequence of the combination of the gas with the oxygen of the air, and the absorption of the nitric acid thus formed by the water. When nitrous gas is mixed with azotic gas, no diminution at all takes place. When it is mixed with oxygen gas in proper proportions, the absorption is complete. Hence it is evident, that in all cases of a mixture of these two gases, the diminution will be proportional to the quantity of the oxygen. Of course it will indicate the proportion of oxygen in air; and by mixing it with different portions of air, it will indicate the different quantities of oxygen which they contain, provided the component parts of air are susceptible of variation. Dr. Priestley's method was, to mix together equal bulks of air and nitrous gas in a low jar, and then to transfer the mixture into a narrow graduated glass tube about three feet long, in order to measure the diminution of bulk. He expressed this diminution by the number of hundredth parts remaining. Thus, suppose he had mixed together equal parts of nitrous gas and air, the sum total of this mixture was 200 (or 2.00): suppose the residuum when measured in the graduated tube to amount to 104 (or 1.04), and of course that 96 parts of the whole had disappeared, he denoted the purity of the air thus tried by 104. A more convenient instrument was invented by Dr. Falconer of Bath; and Fontana greatly improved this method of measuring the purity of air. A description of his eudiometer was published by Ingenhouz, in the first volume of his Experiments: it was still farther improved by Mr. Cavendish in 1783; and Humboldt has lately made a very laborious set of experiments in order to bring it to a state of complete accuracy. But after all the exertions of these philosophers, the method of analysing air by means of nitrous gas is liable to so many anomalies, that it cannot be depended on.

Priestley and Fontana have proved, that the way of mixing the two airs occasions a great difference in the result: the figure of the vessels is equally important, and so is the water over which the mixture is made. And even when all these things are the same, the impurity of the nitrous gas may occasion the most enormous differences in the results.

Humboldt has shewn that the nitrous gas ought to be prepared by means of nitric acid of the density 1.170; when a much stronger or weaker acid is employed, the gas produced is always contaminated with a great proportion of azotic gas. He has pointed out the solution of sulphat of iron as proper to ascertain the purity of the nitrous gas employed, by absorbing the nitrous gas, and leaving the azotic gas or other foreign gases. He has shewn that when nitrous gas of the same degree of purity is made to mix very slowly with air, the vessel being carefully agitated during the mixture, the results, provided the experiment is performed with address, correspond with each other. And he has made it probable, that when equal quantities of air and nitrous gas, so pure as to contain only about 0.1 of azotic gas mixed with it, are agitated together slowly over water, the diminution divided by 3.55, gives the quantity of oxygen contained in the air examined. But notwithstanding the ingenuity of his experiments, the anomalies attending this method are still so great as not to render it susceptible of accuracy. For that reason it is unnecessary to give a particular description of the different eudiometers invented to ascertain the purity of air by means of nitrous gas. The result of the numerous experiments which have been made with nitrous gas is, that the proportion of oxygen in atmospheric air varies in different places and at different times. The minimum is about 0.22, the maximum about 0.30; consequently if this method of analysing air is to be depended on, we must consider that fluid not as a permanent chemical compound, but as a body subjected to all the variations to which accidental mixtures are liable.

2. The second kind of eudiometer was proposed by Volta. The substance employed by that philosopher to separate the oxygen from the air was hydrogen gas. His method was, to mix given proportions of the air to be

examined and hydrogen gas in a graduated glass tube; to fire the mixture by an electric spark; and to judge of the purity of the air by the bulk of the residuum. But this method is not susceptible of even so great a degree of accuracy as the preceding, when the object is to ascertain the precise quantity of oxygen gas in a given bulk of air. For if too little hydrogen gas is mixed with the air, not only the whole of the oxygen will not be abstracted, but a portion of the azote will disappear in consequence of the formation of nitric acid. On the other hand, if too much hydrogen is added, part of it will remain after the firing of the mixture, and increase the bulk of the residuum. Volta's eudiometer, then, though it may have its uses, is scarcely susceptible of giving us the analysis of air.

3. For the third kind of eudiometer, we are indebted to Scheele. It is merely a graduated glass vessel, containing a given quantity of air exposed to newly prepared liquid alkaline or earthy sulphurets, or to a mixture of iron-filings and sulphur, formed into a paste with water. These substances absorb the whole of the oxygen of the air, which converts a portion of the sulphur into an acid. The oxygen contained in the air thus examined, is judged of by the diminution of bulk which the air has undergone. This method is not only exceedingly simple, but it requires very little address, and yet is susceptible of as great accuracy as any other whatever. The only objection to which it is liable is its slowness; for when the quantity of air operated on is considerable, several days elapse before the diminution has reached its maximum.

But this objection has been completely obviated by M. De Marti, who has brought Scheele's eudiometer to a state of perfection. He found that a mixture of iron-filings and sulphur does not answer well, because it emits a small quantity of hydrogen gas, evolved by the action of the sulphuric acid formed by the absorption of the oxygen of the air upon the iron; but the hydrogureted sulphurets, formed by boiling together sulphur and liquid potass or lime-water, answered the purpose perfectly. These substances, indeed, when newly prepared, have the property of absorbing a small portion of azotic gas; but they lose this property when saturated with that gas, which is easily effected by agitating them for a few minutes with a small portion of atmospheric air. His apparatus is merely a glass tube, ten inches long, and rather less than half an inch in diameter, open at one end, and hermetically sealed at the other. The close end is divided into 100 equal parts, having an interval of one line between each division. The use of this tube is to measure the portion of air to be employed in the experiment. The tube is filled with water; and by allowing the water to run out gradually while the tube is inverted, and the open end kept shut with the finger, the graduated part is exactly filled with air. These hundredth parts of air are introduced into a glass bottle filled with liquid sulphuret of lime previously saturated with azotic gas, and capable of holding from two to four times the bulk of the air introduced. The bottle is then to be corked with a ground glass stopper, and agitated for five minutes. After this the cork is to be withdrawn while the mouth of the phial is under water; and for the greater security, it may be corked and agitated again. After this, the air is to be again transferred to the graduated glass tube, in order to ascertain the diminution of its bulk.

Air, examined by this process, suffers precisely the same diminution in whatever circumstances the experiments are made: no variation is observed whether the wind is high or low, or from what quarter soever it blows; whether the air tried is moist or dry, hot or cold; whether the barometer is high or low. Neither the season of the year, nor the situation of the place, its vicinity to the sea, to marshes, or to mountains, makes any difference. M. De Marti found the diminution always between 0.21 and 0.23. Hence we may conclude that air is composed of

0.78 azotic gas
0.22 oxygen gas.

1.00

Scheele indeed found, that the absorption amounted to 0.27; but that was because he neglected to saturate his sulphuret with azotic gas; for when the portion of azotic gas which must have been absorbed, and which has been indicated by De Marti, is subtracted, the portion of oxygen in air, as indicated by his experiments, is reduced very nearly to 0.22. The trifling variations perceptible in his experiments were no doubt owing to the quantities of the mixture of sulphur and iron, by which he abstracted the oxygen, not being exactly the same at different times; the consequence of which would be, an unequal absorption of azotic gas.

4. In the fourth kind of eudiometer, the abstraction of the oxygen of air is accomplished by means of phosphorus. This eudiometer was first proposed by Achard. It was considerably improved by Reboul, and by Seguin and Lavoisier; but Berthollet has lately brought it to a state of perfection, as it is equally simple with the eudiometer of De Marti, and scarcely inferior to it in precision.

Instead of the rapid combustion of phosphorus, this last philosopher has substituted its spontaneous combustion, which absorbs the oxygen of air completely; and when the quantity of air operated on is small, the process is over in a short time. The whole apparatus consists in a narrow graduated tube of glass containing the air to be examined, into which is introduced a cylinder of phosphorus fixed upon a glass rod, while the tube stands inverted over water. The phosphorus should be so long as to traverse nearly the whole of the air. Immediately white vapours rise from the phosphorus and fill the tube. These continue till the whole of the oxygen combines with phosphorus. They consist of phosphorous acid, which falls by its weight to the bottom of the vessel, and is absorbed by the water. The residuum is merely the azotic gas of the air, holding a portion of phosphorus in solution. Berthollet has ascertained, that by this foreign body its bulk is increased one-fortieth part. Consequently, the bulk of the residuum, diminished by $\frac{1}{40}$, gives us the bulk of the azotic gas of the air examined; which bulk, subtracted from the original mass of air, gives us the proportion of oxygen gas contained in it.

All the different experiments which have been made by means of this eudiometer, agree precisely in their result, and indicate that the proportions of the ingredients of air are always the same, namely, about 0.22 parts of oxygen gas, and 0.78 of azotic gas. Berthollet found these proportions in Egypt and in France, and Dr. Thomson found them constantly in Edinburgh in all the different seasons of the year. Thus we see that the analysis of air by means of phosphorus, agrees precisely with its analysis by means of hydrogureted sulphurets.

5. The fifth eudiometer has been lately proposed by Mr. Davy. In it the substance used to absorb the oxygen from air is a solution of sulphat or muriat of iron in water, and impregnated with nitrous gas. A small graduated glass tube, filled with the air to be examined, is plunged into the nitrous solution, and moved a little backwards and forwards. The whole of the oxygen is absorbed in a few minutes. The state of greatest absorption ought to be marked, as the mixture afterwards emits a little gas which would alter the result. By means of this and the two preceding eudiometers, Mr. Davy examined the air at Bristol, and found it always to contain about 0.21 of oxygen. Air sent to Dr. Beddoes from the coast of Guinea gave exactly the same result. This eudiometer, then, corresponds exactly with the two last.

In all these different methods of analysing air, it is necessary to operate on air of a determinate density, and to take care that the residuum is neither more condensed nor dilated than the air was when first operated on. If these things are not attended to, no dependance whatever can be placed upon the result of the experiments, how carefully soever they may have been performed. Now there are three things which alter the volume of air and other elastic fluids: 1. A change in the height of the barometer. 2. An increase or diminution of their quantity; the vessel in which they are contained remaining the same, and standing in the same quantity of water or mercury. 3. A change in the temperature of the air.

EVERGREEN, in gardening, a species of perennials which continue their verdure, leaves, &c. all the year: such are hollies, phillyrias, laurustinuses, bays, pines, firs, and cedars of Lebanon. See GARDENING.

EVES-DROPPERS, are such as stand under walls or windows, by night or day, to hear news, and to carry them to others, to cause strife and contention among neighbours. These are evil members in the commonwealth, and therefore by stat. Westminster 1. c. 33, are to be punished; and this misdemeanor is presentable and punishable in the court leet.

EUGENIA, the yamboo, a genus of the monogynia order, in the icosandria class of plants, and in the natural method ranking under the 19th order, hesperideæ. The calyx is quadripartite, superior; the petals four; the fruit a monospermous quadrangular plum. There are 11 species, natives of the hot parts of Asia and America. They rise from 20 to 30 feet high; and bear plum-shaped fruit, inclosing one nut. They are too tender to live in this country, unless they are constantly kept in a stove.

EVICTION, in law, signifies a recovery of lands or tenements by law.

When lands, &c. are evicted before rent

reserved upon a lease becomes due, the lessee is not liable to pay any rent. Likewise, if on an exchange of lands, either of the parties is evicted of the land given in exchange, the party evicted may in that case re-enter his own lands. And a widow being evicted of her thirds, shall be endowed in the other lands of the heir.

EVIDENCE, is the testimony adduced before a court or magistrate of competent jurisdiction, by which such court or magistrate are enabled to ascertain any fact which may be litigated between the parties.

This may be of two kinds, viz. written or verbal: the former by deeds, bonds, or other written documents; the latter by witnesses examined viva voce.

Evidence may be further divided into absolute and presumptive; the former is direct, in positive or absolute affirmance or denial of any particular fact; the latter collateral, and from the conduct of the parties, affords an inference that such a particular fact did or did not occur.

The party making an affirmative allegation which is denied by his adversary, is in general required to prove it: unless indeed a man is charged with not doing an act, which by law he is required to do; for here a different rule must necessarily prevail. And the rule is, that the evidence must be applied to the particular fact in dispute; and therefore no evidence not relating to the issue, or in some manner connected with it, can be received; nor can the character of either party, unless put in issue by the very proceeding itself, be called in question; for the cause is to be decided on its own circumstances, and not to be prejudiced by any matter foreign to it.

It is an established principle, that the best evidence the nature of the case will admit shall be produced; for if it appears, that better evidence might have been brought forward, the very circumstance of its being withheld, furnishes a suspicion that it would have prejudiced the party in whose power it is, had he produced it. Thus if a written contract is in the custody of the party, no verbal testimony can be received of its contents.

The law never gives credit to the bare assertion of any one, however high his rank or pure his morals; but requires (except in particular cases with respect to quakers) the sanction of an oath, and the personal attendance of the party in court that he may be examined and cross-examined by the different parties; and therefore in cases depending on parole or verbal evidence, the testimony of persons who are themselves conversant with the facts they relate, must be produced; the law paying no regard, except under special circumstances, to any hearsay evidence. Thus in some cases, the memorandum in writing made at the time, by a person since deceased, in the ordinary way of his business, and which is corroborated by other circumstances, will be admitted as evidence of the fact.

What a party himself has been heard to say, does not fall within the objection. As to hearsay evidence, any thing therefore, which the party admits, or which another asserts in his presence and he does not contradict, is received as evidence against him; but what is said by his wife, or any other member of his family, in his absence, will be rejected.

But a distinction must be made between admission, and an offer of compromise, after a dispute has arisen. An offer to pay a sum of money in order to get rid of an action, is not received in evidence of a debt, because such offers are made to stop litigation, without regard to the question whether any thing or what is due.

Admissions of particular articles before arbitration are also good evidence, for they are not made with a view to compromise, but the parties are contesting their rights as much as they could do on a trial.

In cases where positive and direct evidence is not to be looked for, the proof of circumstance and fact consistent with the claim of one party, and inconsistent with that of the other, is deemed sufficient to enable the jury, under the direction of the court of justice, to presume the particular fact, which is the subject of controversy; for the mind comparing the circumstances of the particular case, judges therefrom as to the probability of the story, and for want of better evidence, draws a conclusion from that before it.

Written evidence has been divided into two classes: the one that which is public, the other private; and this first has been subdivided into matters of record, and others of an inferior nature.

The memorials of the legislature, such as acts of parliament, and other proceedings of the two houses, where acting in a legislative character, and judgment of the king's superior courts of justice, are denominated records; and are so respected by the law, that no evidence whatever can be received in contradiction of them; but these are not permitted to be removed from place to place, to serve a private purpose; and are therefore proved by copies of them, which in the absence of the original, are the next best evidence.

Of persons incompetent to give evidence.—All persons who are examined as witnesses, must be fully possessed of their understanding; that is, such an understanding as enables them to retain in memory the events of which they have been witnesses, and give them a knowledge of right and wrong.

A conviction of treason or felony, and every species thereof, such as perjury, conspiracy, barratry, &c. prevents a man when convicted of them, from being examined in a court of justice. When a man is convicted of any of the offences before-mentioned, and judgment is entered up, he is for ever after incompetent to give evidence, unless the stigma is removed, which in case of a conviction of perjury, on the stat. of 5 Eliz. c. 9. can never be by any means short of a reversal of the judgment; for the statute has in this case, made his incompetency part of his punishment: but if a man is convicted of perjury, or any other offence, at the common law, and the king pardons him in particular, or grants a general pardon to all such convicts, this restores him to his credit, and the judgment no longer forms an objection to his testimony; but an actual pardon must be shewn under the great seal, the warrant for it under the king's sign manual not being sufficient. To found this objection to the testimony of a witness, the party who intends to make it, should be prepared with a copy of the judgment regularly entered upon the verdict of conviction; for until such judgment is entered, the witness is not deprived of his legal privileges.

Persons may also be incompetent witnesses, by reason of their interest in the cause. The rule which has the most extensive operation in the exclusion of witnesses, and which has been found most difficult in its application, is that which prevents persons interested in the event of a suit, unless in a few excepted cases of evident necessity, from being witnesses in it. Of late years the courts have endeavoured, as far as possible consistent with authorities, to let the objection go to the credit rather than the competency of a witness; and the general rule now established is, that no objection can be made to a witness on this ground, unless he is distinctly interested, that is, unless he may be immediately benefited or injured by the event of the suit, or unless the verdict to be obtained by his evidence, or given against it, will be evidence for or against him in another action, in which he may afterwards be a party; any smaller degree of interest, as the possibility that he may be liable to an action in a certain event, or that, standing in a similar situation with the party by whom he is called, the decision in that cause, may by possibility influence the minds of a jury in his own, or the like, though it furnishes a strong argument against his credibility, does not destroy his competency.

On the question, how far persons who have been defrauded of securities, or injured by a perjury or other crime, can be witnesses in prosecuting for those offences, the event of which might possibly exonerate them from an obligation they are charged to have entered into, or restore to them money which they have been obliged to pay; the general principle now established is this: the question in a criminal prosecution or personal act, being the same with that in a civil cause in which the witnesses are interested, goes generally to the credit, unless the judgment in the prosecution where they are witnesses, can be given in evidence in this cause wherein they are interested. But though this is the general rule, an exception to it seems to be established in the case of forgery; for many cases have been decided, that a person whose hand-writing has been forged to an instrument, whereby if good he would be charged with a sum of money, or one who has paid money in consequence of such forgery, cannot be a witness on the indictment. In cases where the party injured cannot by possibility derive any benefit from the verdict in the prosecution, as in indictments for assault, and the like personal injury, his competence has never been doubted. It is a general rule that a party cannot be examined as a witness, for he is in the highest degree interested in the event of it; but where a man is not in point of fact interested, but only a nominal party, as where members of a charitable institution are defendants in their corporate character, there is no objection to an individual member being examined as a witness for the corporation; for in this case he is giving evidence for the public body only, and not for himself as an individual. Peake's N. P. Cas. 153. Bul. N. P. 293.

But in tances sometimes occur, in which persons substantially interested, and even parties in a cause, are permitted to be examined from the necessity of the case, and absolute impossibility of procuring other evidence.

In an action on the statute of Winton, the party robbed is a witness: and on the same principle of necessity it has been holden, that persons who become interested in the common course of business, and who alone can have knowledge of the fact, may be called as witnesses to prove it: as in the case of a servant who has been paid money, or a porter who in the way of his business delivers out or receives parcels, though the evidence whereby he charges another with the money or goods, exonerates himself from his liability to account to his master for them; for if this interest was to exclude testimony, there never would be evidence of any such facts. Bul. N. P. 289.

As no one can be witness for himself, it follows of course husband and wife, whose interest the law has united, are incompetent to give evidence on behalf of each other, or of any person whose interest is the same; and the law, considering the policy of marriage, also prevents them giving evidence against each other: for it would be hard that a wife, who could not be a witness for her husband, should be a witness against him; such a rule would occasion implacable divisions and quarrels between them. In like manner, as the law respects the private peace of men, it considers the confidential communications made for the purpose of defence in a court of justice. By permitting a party to intrust his cause in the hands of a third person, it establishes a confidence and trust between the client and person so employed.

Barristers and attorneys, to whom facts are related professionally during a cause, or in contemplation of it, are neither obliged nor permitted to disclose the facts so divulged during the pendency of that cause, nor at any future time; and if a foreigner, in communication with his attorney, has recourse to an interpreter, he is equally bound to secrecy.

Where a man has, by putting his name to an instrument, given a sanction to it, he has been held by some judges to be precluded or stopped from giving any evidence in a court of justice which may invalidate it; as in the case of a party to a bill of exchange or promissory note, who has been said not to be an admissible witness to destroy it, on the grounds that it would enable two persons to combine together, and by holding out a false credit to the world, deceive and impose on mankind. On this principle it was held, that an indorser could not be a witness to prove notes usurious, in an action or a bond founded on such notes, though the notes themselves had been delivered up, on the execution of the bond. At one time this seems to have been understood as a general principle applicable to all instruments; but in a case where an underwriter of a policy of insurance, was called to prove the instrument void as against another underwriter, and objected to on this ground, the court declared, that it extended only to negotiable instruments, and he was admitted to give evidence destructive of the policy.

When a witness is not liable to any legal objection, he is first examined by the counsel for the party on whose behalf he comes to give evidence, as to his knowledge of the fact he is to prove This examination, in cases of any intricacy, is a duty of no small importance in the counsel; for as on the one hand, the law will not allow him to put what are called leading questions, viz. to form them in such a way as would instruct the witness in the answers he is to give; so on the other, he should be careful that he makes himself sufficiently understood by the witness, who may otherwise omit some material circumstance of the case.

The party examined must depose those facts only of which he has an immediate knowledge and recollection; he may refresh his memory with a copy taken by himself from a day-book; and if he can then speak positively as to his recollection, it is sufficient; but if he has no recollection further than finding the entry in his book, the book itself must be produced. Where the defendant had signed acknowledgments of having received money, in a day-book of the plaintiff, and the plaintiff's clerk afterwards read over the items to him, and he acknowledged them all right, it was held, that the witness might refresh his memory by referring to the books, although there was no stop to the items on which the receipt was written, for this was only proving a verbal acknowledgment, and not a written receipt.

Lord Ellenborough, upon the authority of lord chief justice Tully, has recently laid down a very important doctrine, viz. that no witness shall be bound to answer any question which tends to degrade himself, or to shew him to be infamous.

EULOGY, in church history, a name by which the Greeks call the panis benedictus, or bread over which a blessing is pronounced, and which is distributed to those who are unqualified to communicate. The name eulogiæ was antiently given to the consecrated pieces of bread, which the bishops and priests sent to each other, for the keeping up a friendly correspondence: those presents likewise which were made out of respect or obligation, were called eulogiæ. St. Paulinus, bishop of Nola, about the end of the sixth century, having sent five eulogiæ, at one time, to Romanian, says, "I send you five pieces of bread, the ammunition of the warfare of Jesus Christ, under whose standard we fight."

EULOGY means likewise an encomium on any person, on account of some virtue or good quality. See ELOGY.

EUMENIDES, Furies, in antiquity.

EUNOMIANS, in church history, christians in the fourth century. They were a branch of Arians, and took their name from Eunomius, bishop of Cyzicus, who was instructed by Ætius in the points which were then controverted in the church, after having at first followed the profession of arms. Eunomius so well answered the designs of his master, and declaimed so vehemently against the divinity of the Word, that the people had recourse to the authority of the prince, and had him banished; but the Arians obtained his recall, and elected him bishop of Cyzicus. The manners and doctrines of the Eunomians were the same with those of the Arians.

EVOCATION, in Roman antiquity, a solemn invitation preferred by way of prayer, to the gods and goddesses of a besieged town, to forsake it and come over to the Romans; who always took it for granted that their prayers were heard, provided they could make themselves masters of the place.

EVOLUTE, in the higher geometry, a curve which, by being gradually opened, describes another curve. Such is the curve B C F (plate Miscel. fig. 85); for if a thread F C M be wrapped about, or applied to, the said curve, and then unwound again, the point M thereof will describe another curve A M M, called by Mr. Huygens, a curve described from evolution. The part of the thread, M C, is called the radius of the evolute, or of the osculatory circle described on the centre C with the radius M C.

Hence, 1. when the point B falls in A, the radius of the evolute M C is equal to the arch B C; but if not, to A B and the arch B C. 2. The radius of the evolute C M is perpendicular to the curve A M. 3. Because the radius M C of the evolute continually touches it, it is evident from its generation, that it may be described through innumerable points, if the tangents in the parts of the evolute are produced until they become equal to their corresponding arches. 4. The evolute of the common parabola is a parabola of the second kind, whose parameter is $\frac{27}{16}$ of the common one. 5. The evolute of a cycloid is another cycloid equal and similar to it. 6. All the arches of evolute curves are rectifiable, if the radii of the evolute can be expressed geometrically. Those who desire a more particular account of these curves, may refer to sir Isaac Newton's and MacLaurin's Fluxions, also Rowe's, Simpson's, and Vince's Fluxions.

EVOLUTION. See ALGEBRA.

EVOLUTION, in the art of war, the motion made by a body of troops, when they are obliged to change their form and disposition, in order to preserve a post, or occupy another, to attack an enemy with more advantage, or to be in a condition of defending themselves the better. See TACTICS.

EVOLVULUS, a genus of the tetragynia order, in the pentandria class of plants; and in the natural method ranking under the 29th order, campanaceæ. The calyx is pentaphyllous; the corolla quinquefid and verticillated; the capsule trilocular; the seeds solitary. There are seven species, herbaceous plants, chiefly annuals of the East and West Indies.

EUNONYMUS, the spindle-tree; a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 43d order, dumosæ. The corolla is pentapetalous; the capsule pentagonal, quinquelocular, quinquevalved, and coloured; the seeds hooded. There are eight species. Of these the most remarkable are; 1. the Europæus, has an upright woody stem ten or fifteen feet high, with oblong opposite leaves: from the sides of the branches proceed small bunches of greenish quadrifid flowers, succeeded by pentagonous capsules, disclosing their red seeds in a beautiful manner in autumn. 2. The Americanus, or evergreen spindle tree, has a shrubby stem, dividing into many opposite branches, rising six or eight feet high, with spear-shaped ever-

green leaves growing opposite, and from the sides and ends of the branches. The flowers are quinquefid and whitish, and come out in small bunches, succeeded by roundish, rough, and protuberant capsules, which rarely perfect their seeds in this country. Both these species are hardy, and will succeed in any soil or situation. The berries of the first sort vomit and purge very violently, and are fatal to sheep. If powdered and sprinkled in the air, they destroy lice. If the wood is cut when the plant is in blossom, it is tough and not easily broken; and in that state it is used by watchmakers for cleaning watches, and for making skewers and tooth-pickers. Cows, goats, and sheep, eat this plant; horses refuse it.

EUPAREA, a genus of the class and order pen andria monogynia. The calyx is five-leaved: corolla, five or twelve petalled: berry superior, one-celled: seeds many. There is one species, an herbaceous plant of New Holland.

EUPATORIUM, hemp-agrimony; a genus of the polygamia æqualis order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the pappus feathery; the calyx imbricated and oblong; the style semibifid and long. There are 49 species, many of them herbaceous flowery perennials, producing annual stalks from two to three or five feet high, terminated by clusters of compound flowers of a red, purple, or white colour. They are easily propagated by seeds, or parting the roots in autumn or spring. One species, viz. the cannabinum, or water hemp-agrimony, is a native of Britain. It is found wild by the sides of rivers and ditches, and has pale red blossoms. It has an acrid smell, and a very bitter taste, with a considerable share of pungency. The leaves are much recommended for strengthening the tone of the viscera, and as an aperient; and said to have excellent effects in the dropsy, jaundice, and scorbutic disorders. Boerhaave informs us, that this is the common medicine of the turf-diggers in Holland, against scurvies, foul ulcers, and swellings in the feet, to which they are subject. The root of this plant is said to operate as a strong cathartic: but it is hardly used in Britain, and has no place in our pharmacopœias.

EUPHEMISM, in rhetoric, a figure which expresses things in themselves disagreeable and shocking, in terms implying the contrary quality: thus, the Pontus, or Black Sea, having the epithet αξινος, *i.e.* inhospitable, given it, from the savage cruelty of those who inhabited the neighbouring countries, this name, by euphemism, was changed into that of Euxinus.

Thus Ovid, Trist. lib. iii. el. 13.

Dum me terrarum pars penè novissima Ponti,
Euxinus falso nomine dictus, habet.

And again, in Trist. lib. v. el. 10.

Quem tenet Euxini mendax cognomine litus.

In which significations, nobody will deny its being a species of irony: but every euphemism is not irony, for we sometimes use improper and soft terms in the same sense with the proper and harsh.

EUPHONY, in grammar, an easiness, smoothness, and elegance in pronunciation. It is properly a figure, whereby we suppress a letter that is too harsh, and convert it into a smoother, contrary to the ordinary rules; of this there are abundance of examples in all languages.

EUPHORBIA, spurge, a genus of the trigynia order, in the dodecandria class of plants; and in the natural method ranking under the 38th order, tricoccæ. The corolla is tetrapetalous or pentapetalous, placed on the calyx; the calyx is monophyllous and ventricose; the capsule tricoccous. There are 98 species, six of which are natives of Great Britain. They are mostly shrubby and herbaceous succulents, frequently armed with thorns, having stalks from ten or twelve inches to as many feet in height, with quadripetalous flowers of a whitish or yellow colour. They are easily propagated by cuttings; but the foreign kinds must be always kept in pots in a stove. If kept dry, they may be preserved for several months out of the ground, and then planted; when they will as readily take root as though they had been fresh. The juice of all the species is so acrid, that it corrodes and ulcerates the body wherever it is applied; so that physicians have seldom ventured to prescribe it internally. Warts, or corns, anointed with the juice, presently disappear. A drop of it put into the hollow of an aching tooth, gives relief, like other corrosives, by destroying the nerve. Some people rub it behind the ears, that it may blister. One of the foreign species, named esula, is such a violent corrosive, that if applied to any part of the body, it produces a violent inflammation, which is soon succeeded by a swelling that degenerates into a gangrene, and proves mortal. There is a species at the Cape, which supplies the Hottentots with an ingredient for poisoning their arrows. Their method of making this pernicious mixture, is by first taking the juice extracted from the euphorbia, and a kind of caterpillar peculiar to another plant which has much the appearance of a species of rhus. They mix the animal and vegetable matter; and after drying it, they point their arrows with this composition, which is supposed to be the most effectual poison of the whole country. The euphorbia itself is also used for this purpose, by throwing the branches into fountains of water frequented by wild beasts, which after drinking the water thus poisoned, seldom get one thousand yards from the brink of the fountain before they fall down and expire. This plant grows from about fifteen to twenty feet in height, sending out many branches full of strong spines. The natives cut off as many of the branches as they think necessary for the destruction of the animals they intend to poison. They generally conduct the water a few yards from the spring into a pit made for the purpose; after which they put in the euphorbia, and cover the spring, so that the creatures have no choice. No animal escapes which drinks of such water, though the flesh is not injured by the poison. The euphorbias may be easily distinguished from the cactuses and other plants, which they resemble, by pricking them with a pin, when a milky juice will always exude from the puncture. See Plate Nat. Hist. fig. 189.

EUPHORBIUM, in pharmacy, a gum resin brought us always in loose, smooth, and glossy gold-coloured drops or granules. See PHARMACY.

EUPHRASIA, eyebright (from a vulgar notion that it was good in disorders of the eyes); a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The calyx is quadrifid and cylindrical; the capsule bilocular, ovato-oblong; the shorter two antheræ, with the base of the one lobe, terminated by a small spine. There are nine species; two of which annuals, viz. the officinalis and odontites, are natives of Britain. The first of these, which has blue flowers, is a weak astringent, and was formerly much celebrated in disorders of the eyes; but the present practice has not only disregarded its internal, but also its external, use. This plant will not grow but when surrounded by others taller than itself. Cows, horses, goats, and sheep, eat it; swine refuse it.

EURYA, a genus of the class and order dodecandria monogynia. The calyx is five-leaved, calycled; corolla, five-petalled; stamina, three; capsule, five-celled. There is one species, a shrubby plant of Japan.

EURYANDRA, a genus of the polyandria trigynia class and order. The calyx is five-leaved: corolla, three-petalled; filaments much dilated at top, with two disjointed antheræ; follicles, three. There is one species, a climbing plant of New Caledonia.

EURYTHMY, in architecture, painting, and sculpture, is a certain majesty, elegance, and easiness, appearing in the composition of divers members, or parts of a body, painting, or sculpture, and resulting from the fine proportion of it. Vitruvius ranks the eurythmia among the essential parts of architecture; he describes it as consisting in the beauty of the construction, or assemblage of the several parts of the work, which renders its aspect, or its whole appearance, grateful; *e. g.* when the height corresponds to the breadth, and the breadth to the length.

EUSEBIANS, a name given to a sect of Arians, on account of the favour and countenance which Eusebius, bishop of Cæsarea, shewed and procured for them at their first rise.

EUSTATHIANS, the same with the catholics of Antioch, in the fourth century; so called from their refusing to acknowledge any other bishop beside St. Eustathius, who was deposed by the Arians.

EUSTYLE, in architecture, a sort of building in which the pillars are placed at the most convenient distance from one another, the intercolumniations being just two diameters and a quarter of the column, except those in the middle of the face, before, and behind, which are three diameters distant.

EUTYCHIANS, in church history, christians in the fifth century, who embraced the errors of the monk Eutyches, maintaining that there was only one nature in Jesus Christ. The divine nature, according to them, had so entirely swallowed up the human, that the latter could not be distinguished; insomuch, that Jesus Christ was merely God, and had nothing of humanity but the appearance.

EWRY, in the British customs, an officer in the king's household, who has the care of the table-linen, of laying the cloth, and serving up water, in silver ewers, after dinner.

EXACTION, in law, a wrong done by an officer, or a person in pretended authority, in taking a reward or fee that is not allowed by law. A person guilty of exaction may be fined and imprisoned. It is often confounded with extortion.

EXACUM, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 20th order, rotaceæ. The calyx is tetraphyllous; the corolla quadrifid, with the tube globular; the capsule two-furrowed, bilocular, polyspermous, and opening at the top. There are 10 species, allied to the gentians, chiefly annuals, of the East Indies and Cape.

EXÆRESIS, in surgery, the operation of extracting or taking away something that is hurtful to the human body.

EXAGGERATION, in rhetoric, a kind of hyperbole, whereby things are augmented or amplified, by saying more than the truth, either as to good or bad. There are two kinds of exaggeration; the one of things, the other of words. The first is produced, 1. By a multitude of definitions. 2. By a multitude of adjuncts. 3. By a detail of causes and effects. 4. By an enumeration of consequences. 5. By comparisons. And 6. By the contrast of epithets and rational inference.

Exaggeration by words is effected, 1. By using metaphors. 2. By hyperboles. 3. By synonymous terms. 4. By a collection of splendid and magnificent expressions. 5. By periphrasis. 6. By repetition. And, lastly, by confirmation with an oath: as for example, "Parietes, medius fidius, gratias tibi agere gestiunt."

EXAGGERATION, in painting, a method by which the artist, in representing things, charges them too much, or makes them too strong, either in respect of the design or the colouring. It differs from caricaturing, as the latter perverts or gives a turn to the features of the face, &c. which they had not; whereas exaggeration only heightens or improves what they had.

EXAMINATION. Justices before whom any person shall be brought for manslaughter or for felony, or for suspicion thereof, before they commit such prisoner, shall take his examination, and information of those who bring him, of the fact and circumstances; and as much thereof as shall be material to prove the felony, shall be put in writing within two days after the examination; and the same shall certify in such manner as they should do if such prisoner had been bailed, upon such pain as in the act 1 and 2 P. and M. c. 13. is limited.

EXAMINERS, in chancery, two officers of that court, who examine, upon oath, witnesses produced in causes depending there, by either the complainant or defendant, where the witnesses live in London or near it. Sometimes parties themselves, by particular order, are examined. In the country, above twenty miles from London, on the parties joining in commission, witnesses are examined by commissioners, being usually counsellors or attorneys not concerned in the cause.

EXANTHEMA, among physicians, denotes any kind of efflorescence or eruption, as the measles, purple spots in the plague or malignant fevers, &c.

EXARCH, in antiquity, an officer sent by the emperors of the East into Italy, in quality of vicar, or rather præfect, to defend that part of Italy which was under their obedience, and particularly the city of Ravenna, against the Lombards. The exarch resided at Ravenna, which place, with Rome, was all that was left to the emperors of their Italian dominions. The first exarch was under Justin the Younger, in the year 567, after Belisarius and Narses had driven the barbarians out of Italy. The last was Eutychius, defeated by Adolphus, king of the Lombards, in 752. But Pepin, king of France, deprived him of the exarchate, and made a gift of it to the pope, ordering his chaplain to lay the keys of all the towns on the altar of St. Peter and Paul at Rome.

EXARCH also denotes an officer still subsisting in the Greek church, being a kind of visitor, or one deputed by the patriarch into provinces, to see whether the bishops do their duty, and whether the rest of the clergy observe the canons of the church.

There is another officer also of this name under the patriarchs of the Greek church, who has the care and inspection of the patriarchal monasteries, or such as depend immediately on the patriarch.

EXAUCTORATION, *exauctoratio*, in Roman antiquity, corresponded, in some measure, to our keeping soldiers or sailors in half-pay; but differed in this, that the exauctorati milites were deprived of their pay and arms, without being absolutely discharged. Sometimes it signifies a full but ignominious discharge.

EXCALCEATION, among the Hebrews, was a particular law, whereby a widow, whom her husband's brother refused to marry, had a right to summon him to a court of justice, and, upon his refusal, might excalceate him, that is, pull off one of his shoes, and spit in his face; both of them actions of great ignominy.

EXCELLENCY, a title antiently given to kings and emperors, but now to embassadors and other persons, who are not qualified for that of "highness," and yet are to be elevated above the other inferior dignities.

In England and France the title is now peculiar to embassadors, but very common in Germany and Italy. Those it was first appropriated to were the princes of the blood of the several royal houses; but they quitted it for that of highness, upon several great lords assuming excellency. The embassadors have only borne it since the year 1593, when the pope complimented the duke de Nevers, embassador from Henry IV. of France, with the title of excellency; and though it was on account of his birth, and not of his character, yet the embassadors of all nations have ever since claimed the same appellation.

The embassadors of Venice have only had the title of excellency since the year 1636, when the emperor and king of Spain consented to allow it to them. The court of Rome never allows that title to any embassador who is a churchman, as judging it a secular title.

The embassadors of France at Rome antiently gave the title of excellency to all the relations of the pope then reigning, and to several other noblemen; but now they are more reserved in that respect, though they still treat all the Roman princes with excellency: on the other hand, the court of Rome bestowed the same title on the chancellor, ministers, and secretaries of state, and presidents of the sovereign courts of France, the presidents of the councils in Spain, and the chancellor of Poland, if they were not ecclesiastics.

EXCENTRIC, in geometry, a term applied to circles and spheres which have not the same centre, and consequently are not parallel; in opposition to concentric, where they are parallel, having one common centre.

EXCENTRIC, or *excentric circle*, in astronomy, is the circle described from the centre of the orbit of a planet, with half the greatest axis as a radius; or it is the circle that circumscribes the elliptic orbit of the planet, as the circle AQB. See Plate Miscel. fig. 86.

EXCENTRIC *anomaly*, or *anomaly of the centre*, is an arc AQ of the excentric circle, intercepted between the aphelion A, and the right line QH, drawn through the centre P of the planet perpendicular to the line of the apses AB.

EXCENTRIC *place of a planet*, is the point of the orbit where the circle of inclination coming from the place of a planet in its orbit, falls thereon with right angles.

EXCENTRICITY, in astronomy, is the distance CS between the sun S and the centre C of a planet's orbit; or the distance of the centre from the focus of the elliptic orbit, called also the simple or single excentricity. Fig. 86.

When the greatest equation of the centre is given, the excentricity of the earth's orbit may be found by the following proportion, viz.

As the diameter of a circle in degrees,
Is to the diameter in equal parts;
So the greatest equat. of the centre in degrees,
To the excentricity in equal parts. Thus,
Greatest equat. of the cent. $1^\circ\ 55'\ 33'' = 1^\circ{\cdot}9258333$ &c.

The diameter of a circle being 1, its circumference is 3·1415926.

Then $3{\cdot}1415926 : 1 :: 360^\circ : 114^\circ{\cdot}5915609$ diameter in degrees.

And $114{\cdot}5915609 : 1 :: 1{\cdot}9258333 : 0{\cdot}016806$, the excentricity.

Hence, adding this to 1, and subtracting it from 1,

Give 1·016806 = AS the aphelion distance,

And 0·983194 = BS the perihelion distance.

See Robertson's Elements of Navigation, book 5, pa. 236.

Otherwise, thus: Since it is found that the sun's greatest apparent semidiameter, is to his least, as 32′ 43″ to 31′ 38″, or as 1963″ to 1898″; the sun's greatest distance from the earth will be to his least, or AS to SB, as 1963 to 1898; of which,

The half-dif. is $32\frac{1}{2}$ = CS,

And half-sum $1930\frac{1}{2}$ = CB; wherefore,

as $1930\frac{1}{2} : 32\frac{1}{2} :: 1 : {\cdot}016835$ = CS the excentricity, to the mean distance or semi-axis 1; which is nearly the same as before.

The excentricities of the orbits of the several planets, in parts of their own mean distances 1000, and also in English miles, are

as below, viz. the excentricity of the orbit of

	Parts,	Miles.
Mercury	210	7,730,000
Venus -	7	482,000
Earth -	17	1,618,000
Mars -	93	13,486,000
Jupiter -	48	23,760,000
Saturn -	55	49,940,000
Herschel -	47½	86,000,000
Piazzi	0,0364	

Double EXCENTRICITY, is the distance between the two foci of the elliptic orbit, and is equal to double the single excentricity above given.

To find the excentricity of the earth's orbit, and the place of the apsides.—Take an observation of Mars when he is in opposition with the Sun, and then if Mars be in M (Plate Miscel. fig. 87.) the Sun in S, and the Earth in T, they will be all in the same right line M T S. When Mars, after 687 days, returns again to the same point M, and the Earth, not reaching the same till after 730½ days, in which time she completes two revolutions in her orbit, is found in the point A, observe the place of the Sun seen from the Earth by the right line A S, and the place of Mars seen by the right line A M. We have, therefore, by means of the Sun's place in E, at the time of the second observation, and his place in F, at the time of the first observation, the angle E S F given, to which the angle M S A is equal. And by knowing the place of the Sun and Mars in the 2d observation, we have the distance of Mars from the Sun, or the angle M A S. In the same manner may be found the angle M S B, and B S, the distance of the Earth from the Sun in decimal parts of M S, when Mars returns a second time to M, and likewise the angle M S C, and the right line S C, when Mars returns a third time to M. Wherefore since the focus of the earth's orbit is in S, and A, B, and C are points in that orbit, the line of the apsides will be determined, the orbit will be described, and consequently the excentricity will be known. The excentricity of all the primary planets, and the position of the line of apsides, may be found in the same manner, if three heliocentric places of the planet, together with its true distance from the Sun, are known. But it must be observed, that we suppose that the planet, in the same point of its orbit, has the same distance from the Sun, which we may easily suppose on account of the slowness of the motion of the aphelia.

The excentricity of the moon's orbit is about 3, 3 of the semi-diameter of the Earth, and now and then it grows greater and now and then it diminishes. It is greatest when the line of the apsides is coincident with the syzygia, or is in the line which joins the centres of the Sun and Earth. And the excentricity is least when the line of the apsides cuts the other at right angles. The difference between the greatest and least excentricity is so considerable, that it exceeds the half of the least excentricity.

EXCEPTION in law, is a stop or stay to any action. In law proceedings, it is a denial of a matter alleged in bar to an action; and in chancery, it is what is alleged against the sufficiency of an answer.

EXCEPTION TO EVIDENCE. At common law, a writ of error lay for an error in law, apparent on the record, or for an error in fact, where either party died before judgment; yet it lay not for an error in law not appearing on the record. 2 Inst. 426.

By the stat. of Westminster 2, when one impleaded before any of the justices, alleges an exception, praying they will allow it; and if they will not, if he that alleges the exception writes the same, and requires the justices will put thereto their seals; the justices shall so do: and if upon complaint made of the justices, the king causes the record to come before him, and the exception is not found in the roll, and the plaintiff shews the written exception, with the seal of the justices thereto put, the justice shall be commanded to appear at a certain day, either to confess or deny his seal, and if he cannot deny his seal, they shall proceed to judgment according to the exception, as it ought to be allowed or disallowed.

The statute extends to the plaintiff as well as the defendant, also to him who comes in loco tenentis, as one that prays to be received, or the vouchee; and in all actions, whether real, personal, or mixt. 2 Inst. 427.

EXCEPTION *in deeds and writings*, the exception in a clause whereby the donor, feoffer, grantor, or other person contracting, excepts or takes a particular thing out of a general thing granted or conveyed. The thing excepted is exempted, and does not pass by the grant, neither is it parcel of the thing granted; as if a manor be granted, excepting one acre, hereby in judgment of law, that acre is severed from the manor. 1 Wood's Convey. 241. Exception must be of such a thing as he who makes it may have, and does belong to him. It must not be the whole thing granted, but part thereof only. The thing excepted, must be part of the thing granted before, and not of some other thing. The thing excepted, must be such a thing as may be severed from the thing granted, and not inseparable incidents. It must be of a particular thing out of a general, or of an entire thing, and not of a particular out of a particular, or the whole thing itself granted. An exception must be conformable to the grant, and not repugnant thereto; and the thing excepted must be certainly described and set down.

EXCESS, in arithmetic and geometry, is the difference between any two unequal numbers or quantities, or that which is left after the lesser is taken from or out of the greater.

EXCHANGE, in law, is a mutual grant of equal interests, the one in consideration of the other. 2 Black. 323.

An exchange may be made of things that lie either in grant or in livery. But no livery of seisin, even in exchanges of freehold, is necessary to perfect the conveyance: for each party stands in the place of the other, and occupies his right, and each of them has already had corporal possession of his own land. But entry must be made on both sides; for if either party die before the entry, exchange is void, for want of sufficient notoriety. Id.

In exchange, the estates of both parties should be equal; that is, if the one has a fee-simple in the one land, the other should have like estate in the other land: and if the one has fee-tail in the one land, the other ought to have the like estate in the other land: and so of other estates. But it is not material in the exchange, that the lands be of equal value, but only that they be equal in kind and manner of the estate given and taken. 1 Inst. 51.

EXCHANGES, are carried on by merchants and bankers all over Europe, and are transacted on the Royal Exchange of London, the Royal Exchange of Dublin, the Exchange of Amsterdam, and those of the principal cities of the continent. The mode of exchanging between one kingdom or nation and another, is, the one gives the certain price, and the other the uncertain price of exchange to each other: *i. e.* England gives the certain price, viz. one pound sterling, to France, for an uncertain number of livres to be paid or received there, and gives the same to Hamburgh, Holland, and the Netherlands, for an uncertain number of schillings and pence Flemish, or of guilders and stivers; and she gives the uncertain price, viz. an uncertain number of pence and parts of pence, to other nations: as for example, she gives from 60*d.* to 70*d.* (more or less) to Lisbon or Oporto for one of their milreis (or 1000 reis); from 30*d.* to 40*d.* to Madrid, Cadiz, &c. for their piastre or dollar; from 35*d.* to 55*d.* to Genoa and Leghorn for a pezzo, or dollar of 5 livres banco at Genoa, and 6 livres at Leghorn; from 25*d.* to 45*d.* to Naples for a ducat of 10 carlins or 100 grains; from 36*d.* to 56*d.* to Venice for a ducato banco of 24 grossi; from 30*d.* to 40*d.* to Petersburgh for a rouble of 100 copecks; and to Dublin and all parts of Ireland 100*l.* sterling for an uncertain number of pounds, shillings, and pence Irish, to be paid or received there, viz. from 105*l.* up to 115*l.* Irish, as exchange may be.

The par of exchange (or par pro pari) is the intrinsic value of the different species of money on the continent, equalized to those of England, and vice versa; as for instance, the par of exchange between England and Ireland is 8⅓ per cent. or, in other words, 108*l.* 6*s.* 8*d.* Irish, are equal to 100*l.* English; the English shilling being current in that country for 13*d.* consequently the pound sterling is 1*l.* 1*s.* 8*d.* therefore when the exchange from London on Dublin is 12*l.* per cent. there is a profit or saving of 3*l.* 13*s.* 4*d.* per cent. on every 100*l.* sterling remitted to Ireland.

The course of exchange is always fluctuating, sometimes under, and sometimes over the par of exchange, and is chiefly governed by the balance of trade being for or against the negotiating parties; so that when the exchange is above par, the balance of trade is certainly against them, and when it is under par, it is consequently in their favour. If London ships to Hamburgh merchandize to the amount of 500,000*l.* and at the same time Hamburgh ships to London goods or merchandize to only the amount of 300,000*l.* Hamburgh can only discharge to the amount of 300,000*l.* by bills of exchange, and for the remaining balance of 200,000*l.* she must procure bills of exchange at the lowest possible premium elsewhere, in order to liquidate the debt due to London, (as it is not to be supposed that Hamburgh, being indebted to London, can furnish bills on equally good terms with another city not indebted to London): thus Hamburgh by paying a premium (of

suppose 1 per cent.) for bills of exchange, would have to pay 202,000*l.* in order to liquidate the aforesaid balance of 200,000*l.* thereby losing 2000*l.* on the transaction.

Thus it is that the balance of trade effects the fluctuation of exchanges. The principal exchanges of Europe are governed by those of London, Amsterdam, and Venice, and the exchanges from foreign countries are to be only had by advices from the merchants and bankers residing abroad.

It frequently happens, that sums of money sent to the continent for subsidies and the like purposes, have their influence on the course of exchange, as it enables the merchants resident there to keep down the exchange, were they even obliged to remit over their balances in cash.

When England remits to Spain, Portugal, Italy, or any other kingdom or nation to which it gives the uncertain price, the lower the price of exchange is, the more it is to the advantage of England; as for instance, giving to Spain 35*d.* for their piastre or dollar, instead of giving 36*d.* to 38*d.* giving 60*d.* to Portugal for the milreis, instead of giving 66*d.* the same with Italy, &c. The contrary is to be observed in drawing.

When England remits to France, Holland, Hamburgh, Ireland, and all other places to which it gives the certain price, the higher the exchange is, the better: as for instance giving to France 1*l.* sterling for 26 livres, is better than 25 or 24 livres; giving to Holland 1*l.* sterling for 36 schillings Flemish, is better than 35 or 34 schillings Flemish; or 112*l.* Irish for the 100*l.* sterling, than 108*l.* 6*s.* 8*d.* the par of exchange; the contrary to be observed in drawing.

It is to be remarked that the course of exchange governs the entire sum which is to be negotiated; and although it would appear at the place which gives the certain price, that the fluctuation falls altogether upon the other, yet it is not so, as it falls equally on both; for one may as well say that 100*l.* sterling is only equal to 106*l.* Irish, when the exchange is 6 per cent. (though the par is 108*l.* 6*s.* 8*d.*) as that 100*l.* sterling is equal in value to 112*l.* Irish, when the exchange is 12 per cent. and so of other exchanges. The certain price always falls or rises in its value, as the course is above or below par, and the uncertain price fluctuates in value the contrary way.

As banco money of Holland is always better than cash or current money, so there is usually a difference which is called the agio, and fluctuates from $1\frac{1}{8}$ to $5\frac{3}{8}$ per cent.

The exchanges on the continent are negotiated in the following manner, subject to the like fluctuations as before mentioned: viz.

From Amsterdam to London, from 30 to 40 schillings Flemish, per pound sterling.
- to Paris, Bourdeaux, &c. from 50 to 60 groots Flemish, per ecu of 3 livres.
- to Madrid, Cadiz, &c. from 90 to 100 ditto, per ducat of 375 marvedis plate.
- to Lisbon, Porto, &c. from 40 to 50 ditto, per crusado, or crown of 400 reis.
- to Genoa and Leghorn, from 80 to 90 ditto, per pezzo or dollar, of 5 livres banco at Genoa, or 6 livres at Leghorn.
- to Hamburgh, fron 30 to 40 stivers, per exchange ducat of 2 marks.
- to Petersburgh, from 40 to 50 stivers current per rouble.

From Paris, Bourdeaux, &c. to London, from 20*d.* to 36*d.* per ecu, or crown of 3 livres.
- to Amsterdam, from 50 to 60 groots Flemish, per ecu of ditto.
- to Madrid, Cadiz, &c. from 13 to 17 livres, per doubloon, of 32 reals old plate.
- to Lisbon, Porto, &c. from 4 to 500 reis per ecu.
- to Genoa and Leghorn, from 90 to 100 sous, per dollar or pezzi of livres, 5.15 fuera banco at Genoa, or 6 livres at Leghorn.
- to Hamburgh, from 25 to 28 schillings banco, per ecu of three livres.

From Naples to London, from 30*d.* to 50*d.* per ducato.

From Venice to London, from 40*d.* to 60*d.* per ducat of 24 grossi.

From Madrid, Cadiz, &c. to London, from 30*d.* to 40*d.* per peso or dollar of 8 reals old plate.
- to Hamburgh, from 70 to 80 groots, per ducat of 375 marvedis.
- to Amsterdam, from 90 to 100 groots Flemish, per ditto.
- to Paris, Bourdeaux, &c. from 13 to 17 livres per doubloon of 32 reals old plate.
- to Lisbon, Porto, &c. from 2000 to 2200 reis, per doubloon old plate.
- to Genoa, from 620 to 660 marvedis plate, per escudo d'ore marche.
- to ditto, from 21 to 25 livres fuera banco, per pistole of 40 reals plata.
- to Leghorn, from 120 to 130 pesos or Spanish dollars, for 100 pezzi or Leghorn dollars of 6 liras each.

From Lisbon and Porto to London, from 60*d.* to 75*d.* per millrea.
- to Amsterdam, from 40 to 50 groots Flemish per crusado of 400 reis.
- to Paris, Bourdeaux, &c. from 450 to 500 reis per ecu of 3 livres.
- to Madrid, &c. from 2000 to 2200 reis per doubloon, of 32 reals plata.
- to Genoa and Leghorn, from 600 to 800 reis, per peso or dollar of livres 5.15 at Genoa, or 6 livres at Leghorn.
- to Hamburgh, from 40 to 50 groots Flemish, per crusado of 400 reis.

From Genoa and Leghorn to London, from 40*d.* to 50*d.* per dollar or pezzo of 5 livres banco.
- to Amsterdam from 80 to 90 groots Flemish, per ditto.
- to Paris, Bourdeaux, &c. from 90 to 100 sols, per ditto.
- to Madrid, from 620 to 660 marvedis plate, per escudo d'ore marche, (or 22 to 24 livres per pistole of 40 reals plata.)
- to Cadiz from 120 to 130 pesos per 100 pezzi.
- to Lisbon, Porto, &c. from 600 to 800 reis per dollar, of livres 5.15 fuero banco.

From Hamburgh to London, from 30 to 40 schillings Flemish per pound sterling.
- to Paris, Bourdeaux, &c. from 25 to 28 schillings bank, per ecu of 3 livres.
- to Madrid, Cadiz, &c. from 60 to 80 groots, per ducat of 375 marvedis.
- to Amsterdam, from 30 to 40 stivers, per 2 banco marks.
- to ditto (in current money, at 120 marks, from 105 to 110 guilders.)
- to Lisbon and Porto, from 40 to 50 groots Flemish, per crusado of 400 reis.

From Petersburgh to London, from 25*d.* to 40*d.* per rouble.
- to Amsterdam from 40 to 50 stivers per rouble.
- to Hamburgh, from 25 to 35 schillings banco per rouble.

We shall now give some examples of the operations of exchange between London and those places with which she has a direct exchange.

Moneys of exchange and regulations with regard to London.

A pound = 20 shillings, or 240 pence
A shilling = 12 pence, or 48 farthings.

Accounts are kept in pounds, shillings, and pence: some reckon farthings.

Value of usances for bills drawn from

France, Hamburgh, and Holland - -	1 month after date.
Portugal and Spain	2 months after date
Italy - - -	3 months after date

There are three days of grace, which begin the day after the bills are due, and on the third day they must be paid or protested. Bills due on Sunday must be paid or protested on Saturday: for those at sight, no days of grace are allowed.

LONDON.—*Course of Exchange.*

Uncertain Prices.		Certain Prices.
Amsterdam	*giv.*	37 shillings Flemish *for* 1 pound sterling.
Dublin -	*giv.*	110¼ pounds Irish *for* 100 pounds British.
France -	*giv.*	25 livres tournois *for* 1 pound sterling.
Idem	*giv.*	25 francs - - *for* 1 pound sterling.
Genoa	*rec.*	46 pence sterling *for* 1 pezza fuori di banco.
Hamburgh	*giv.*	35 shillings Flemish *for* 1 pound sterling.
Leghorn	*rec.*	50 pence sterling *for* 1 pezza of 8 reals.
Naples	*rec.*	39 pence sterling *for* 1 ducat di regno.
Portugal	*rec.*	63½ pence sterling *for* milreis.
Rotterdam	*giv.*	12 florins current *for* 1 pound sterling.
Spain -	*rec.*	36 pence sterling *for* 1 dollar of exchange.
Venice -	*giv.*	58 lire piccole *for* 1 pound sterling.

N. B. As Bourdeaux and Bayonne exchange with London by francs, it is thought expedient to include the calculation of this exchange under the head of France.

London on Amsterdam.

Reduce 4086 florins 4 stivers 6 penings banco into pounds, shillings, and pence sterling, at the exchange of 38 shillings 2 grotes Flemish banco per pound sterling.

Here 1 florin = 40 grotes
12 grotes = 1 shilling
38 shill. 2 grot. = 1 pound.

Rule.—Multiply 4086 4 6 by 40 grotes; divide the product by 38 2, price of exchange, and by 12 grotes.

38 2	4086 4 6
12	40
458 div.	163440
for 4 stivers	8
for 6 penings	¾
	458)163448 ¾(356 17 6 result by common division.

N. B. When the price of exchange consists of shillings Flemish only, multiply the sum by 10 instead of 40, and multiply the price of exchange by 3 instead of 12.

London on Dublin.

Reduce 293 pounds 10 shillings 6 pence Irish into pounds, shillings, and pence British, at the exchange of 14 per cent.

114*l.* Irish = 100*l.* British.

Rule.—Multiply 293 10 6 by 100, and divide the product by 114, price of exchange.

	293 10 6
	100
	29300
for 10 shill.	50
for 6 pence	2 10
	114)29352 10(257 9 6 result by common division.

To prove this operation, that is, to calculate the exchange of Dublin on London, multiply 257 9 6 by 114, price of exchange, and divide the product by 100.

N. B. British money is 8⅓ per cent. better than the Irish; therefore

12 pounds British = 13 pounds Irish.

London on France.

Reduce 3222 livres 2 sols 9 deniers tournois into pounds, shillings, and pence sterling, at the exchange of 25 livres 14 sols tournois per pound sterling.

Here 25 liv. 14 sols = 1 pound.

Rule.—Divide 3222 2 9 by 25 14, price of exchange.

25 14	3222 2 9
20 fraction	20 fraction
514 div.	514)64442 15(125 7 6 result.

Reduce 2545 francs 41 cents into pounds, shillings, and pence sterling, at the exchange of 24 francs 80 cents per pound sterling.

Here 24 francs 80 cents = 1 pound.

Rule.—Divide 2545 41 by 24 80, price of exchange.

2480)254541(102 12 9 result.

London on Genoa.

Reduce 1277 pezze 13 soldi 4 denari fuori di banco into pounds, shillings, and pence sterling, at the exchange of 45 pence sterling, per pezza of 115 soldi fuori di banco.

Here 1 pezza = 45 pence
240 pence = 1 pound.

Rule.—Multiply 1277 13 4 by 45, price of exchange, and divide the product by 240 pence.

	1277 13 4
	45
	6385
	5108
for 10 soldi	- 22 10
for 3 do. 4 denari	7 10
	12)57495
	20) 4791 3
	239 11 3 result.

London on Hamburgh.

Reduce 1416 marcs 1 shilling 6 fenings lubs banco into pounds, shillings, and pence sterling, at the exchange of 35 shillings 4 grotes Flemish banco per pound sterling.

Here 1 marc = 32 grotes
12 grotes = 1 shilling
35 shill. 4 grot. = 1 pound.

Rule.—Multiply 1416 1 6 by 32 grotes; divide the product by 35 4, price of exchange, and by 12 grotes.

35 4	1416 1 6
12	32
424 div.	2832
	4248
for 1 shilling	- 2
for 6 fenings	- 1
	424)45315(106 17 6 result.

N. B. When the price of exchange consists of shillings Flemish only, multiply the sum by 8 instead of 32, and multiply the price of exchange by 3 instead of 12.

London on Leghorn.

Reduce 664 pezze 7 soldi 6 denari of 8 reals, into pounds, shillings, and pence sterling, at the exchange of 48 pence sterling per pezza of 8 reals.

1 pezza = 48 pence
240 pence = 1 pound.

Rule.—Multiply 664 7 6 by 48, price of exchange, and divide the product by 240 pence.

	664 7 6
	48
	5312
	2656
for 5 soldi	12
for 2 do. 6 den.	6
	12)31890
	20) 2657 6
	132 17 6 result.

London on Naples.

Reduce 1014 ducats 16 grains di regno into pounds, shillings, and pence sterling, at the exchange of 37½ pence sterling per ducat di regno.

1 ducat = 37½ pence
240 pence = 10 pound.

Rule.—Multiply 1014 16 by 37½ price of exchange, and divide the product by 240 pence.

	1014 16
	37½
	7098
	3042
for ½ - -	507
for 16 grains -	6
	12)38031
	20) 3169 3
	158 9 3 result.

London on Portugal.

Reduce 566880 reis into pounds, shillings, and pence sterling, at the exchange of 62½ pence per mil reis.

1000 reis = 62½ pence
240 pence = 1 pound.

Rule.—Multiply 566880 by 62½, price of exchange; divide the product by 1000 reis, and the quotient by 240 pence.

566880
62½

1133760
3401280
for ½ 283440

1,000)35430,000

12)35430

20) 2952 6

147 12 6 result.

N. B. To divide the product by 1000 separate the three right hand figures, and when they are or exceed 500, add one unit.

London on Rotterdam.

Reduce 2401 florins 17 stivers 8 penings current into pounds, shillings, and pence sterling, at the exchange of 12 florins 4 stivers current per pound sterling.

12 florins 4 stivers = 1 pound.

Rule.—Divide 2401 17 8 by 12 4 price of exchange.

12 4	2401 17 8
20 fraction	20 fraction
244 div.	244)48037½(196 17 6 result.

London on Spain.

Reduce 2643 dollars 6 reals 17 maravedis of plate into pounds, shillings, and pence sterling, at the exchange of 35½ pence sterling per dollar of exchange.

1 dollar = 35½ pence
240 pence = 1 pound.

Rule.—Multiply 2643 6 17 by 35½, price of exchange, and divide the product by 240 pence.

2643 6 17
35½

13215
7929

for ½	-	1321	4
for 4 reals	-	17	6
for 2 ditto	-	8	7
for 17 maravedis		2	1 25½

12)93855 2 25½

20) 7821 3

391 1 3 result.

London on Venice.

Reduce 14783 lire 3 soldi 9 denari piccole into pounds, shillings, and pence sterling, at the exchange of 59 lire piccole effective per pound sterling.

59 lire = 1 pound.

Rule.—Divide 14783 3 9 by 59, price of exchange.

59)14783 3 9(250 11 3 result.

We shall now give some other examples of the operations of exchange. First, between Holland and some places with which she has a direct exchange.

Amsterdam and Holland.

Moneys of Exchange, and Regulations.

A rixdollar (rixdalder) = 2½ florins = 50 stivers = 8⅓ shillings Flemish or 100 grotes Flemish.

A florin or guilder (gulden) = 20 stivers = 3⅓ shillings Flemish or 40 grotes Flemish.

A stiver (stuyver) = 16 penings or 2 grotes Flemish.

A pound Flemish (pond Flaams) = 20 shillings Flemish = 240 grotes Flemish or 6 florins.

A shilling Flemish (schilling Flaams) = 12 grotes Flemish or 6 stivers.

A grote Flemish (groot Flaams) = ½ stiver or 8 penings.

2 rixdollars = 5 florins
3 rixdollars = 25 shillings Flemish
3 florins = 10 shillings Flemish.

Accounts are kept in florins, stivers, and penings.

Value of usances for bills drawn from England and France, 1 month after date.

Italy, Portugal, and Spain, 2 months after date.

Dantzic and Konigsberg, 40 a 70 days after date.

Germany and Switzerland 14 days after sight.

There are 6 days of grace, Sundays and holidays included, for bills of exchange drawn in current money; but for those drawn in bank money, no days of grace are generally allowed, and bills are protested on the second or third day after they become due.

AMSTERDAM and HOLLAND.—*Course of Exchange.*

		Uncertain Prices.		Certain Prices.
London	*rec.*	37 shillings Flemish	*for*	1 pound sterling.
Idem	*rec.*	12 florins current	*for*	1 pound sterling.
Breslaw	*rec.*	44 stivers banco	*for*	1 libra banco.
Dantzic	*rec.*	1 pound Flemish	*for*	372 groshen current.
France	*rec.*	54 grotes Flemish	*for*	3 francs.
Francfort	*giv.*	139 rixdollars	*for*	100 rix dollars current.
Geneva	*rec.*	90 grotes Flemish	*for*	1 crown current.
Genoa	*rec.*	83 grotes Flemish	*for*	1 pezza fuori di banco.
Hamburgh	*rec.*	33 stivers banco	*for*	1 marc lubs banco.
Idem	*rec.*	106 florins current	*for*	120 marcs lubs banco.
Leghorn	*rec.*	88 grotes Flemish	*for*	1 pezza of 8 reals.
Portugal	*rec.*	44 grotes Flemish	*for*	1 crusade of 400 reis.
Spain	*rec.*	89 grotes Flemish	*for*	1 ducat of exchange.
Venice	*giv.*	4 lire 18 soldi	*for*	1 florin banco.
Vienna	*rec.*	25 stivers banco	*for*	1 rixdollar current.

Amsterdam on London.

Reduce 356 pounds 17 shillings 6 pence sterling into florins, stivers, and penings banco, at the exchange of 38 shillings 2 grotes Flemish banco per pound sterling.

1 pound = 38 shill. 2 grotes
1 shilling = 12 grotes
40 grotes = 1 florin.

Rule.—Multiply 356 17 6 by 38 2, price of exchange, and by 12 grotes; divide the product by 40 grotes.

356 17 6
38 2 × 12 = 458

2848
1780
1424

for 10 shillings		229	
for 5 ditto	-	114	10
for 2 do. 6 pence		57	5

40)163448 15(4086 4 6 result.

N. B. When the price of exchange consists of shillings Flemish only, multiply the price of exchange by three instead of 12, and divide the product by 10 instead of 40.

Amsterdam and Rotterdam on London.

Reduce 196 pounds 17 shillings 6 pence sterling into florins, stivers, and penings current, at the exchange of 12 florins 4 stivers current per pound sterling.

1 pound = 12 florins 4 stivers.

Rule.—Multiply 196 17 6 by 12 4, price of exchange.

196 17 6
12 4

392
196

for 4 stivers	-	39	4
for 10 shillings	-	6	2
for 5 ditto	-	3	1
for 2 ditto 6 pence		1	10 8

2401 17 8 result.

Amsterdam on France.

Reduce 1056 francs 75 cents into florins, stivers, and penings banco, at the exchange of 54 grotes Flemish banco for 3 francs.

3 francs = 54 grotes
40 grotes = 1 florin.

Rule.—Multiply 1056 75 by 54, price of exchange, and divide the product by 120, fixed number.

1056 75
54

4224
5280

for 50 cents	27
for 25 cents	13½

120)57064½(475 10 12 result

Amsterdam on Genoa.

Reduce 572 pezze fuori di banco into florins and stivers banco, at the exchange of 85 grotes Flemish banco per pezza of 115 soldi fuori di banco.

1 pezza = 85 grotes
40 grotes = 1 florin.

Rule.—Multiply 572 by 85 grotes, and divide the product by 40 grotes.

The result is 1215 10.

Amsterdam on Hamburgh.

Reduce 3746 marcs 5 shillings 4 fenings lubs banco into florins, stivers, and penings banco, at the exchange of 34½ stivers banco for 2 marcs lubs banco.

2 marcs = 34½ stivers
20 stivers = 1 florin.

Rule.—Multiply 3746 5 4 by 34½, price of exchange, and divide the product by 40, fixed number.

3746 5 4
34½

14984
11238

for ½ -	1873		
for 4 shillings	8	10	
for 1 shilling	2	2	6
for 4 fenings		11	6

40)129248½(3231 4 4 result.

Reduce 2854 marcs 8 shillings lubs banco into florins, stivers, and penings current, at the exchange of 106 florins current for 120 marcs lubs banco.

120 marcs = 106 florins.

Rule.—Multiply 2854 8 by 106, price of exchange, and divide the product by 120 marcs.

2854 8
106

17124
28540

for 8 shillings 53

120)302577(2521 9 8 result.

The United States of America.

Moneys of exchange, and regulations.

A dollar = 100 cents.

Accounts are kept in dollars and cents.

Each dollar is rated at 4 shillings 6 pence sterling at par; therefore

40 dollars = 9 pounds sterling.

Course of Exchange.

	Uncertain Prices.	Certain Prices.
Amsterdam	*rec.* 37 cents	*for* 1 florin current.
Hamburgh	*rec.* 33½ cents	*for* 1 marc lubs banco.

N. B. America exchanges with London at par, or at so much per cent. either above or under par. When the exchange is not at par, they reduce the sterling into dollars, and add, or deduct, according to the circumstance, the agio, that is, the difference between the par of exchange and the actual course.

Currencies, and their par in sterling.

A pound currency = 20 shillings or 240 pence.

In Georgia and South Carolina, a dollar is worth 4 shillings 6 pence currency; therefore

100 pounds currency = 100 pounds sterling.

In New England and Virginia, a dollar is worth 6 shillings currency; therefore

133⅓ pounds currency = 100 pounds sterling.

To reduce this currency into sterling, multiply by 3, and divide by 4.

In Delaware, Maryland, New Jersey, and Pennsylvania, a dollar is worth 7 shillings 6 pence currency; therefore

166⅔ pounds currency = 100 pounds sterling.

To reduce this currency into sterling, multiply by 3, and divide by 5.

In New York and North Carolina, a dollar is worth 8 shillings currency; therefore

177⅞ pounds currency = 100 pounds sterling.

To reduce this currency into sterling, multiply by 9, and divide by 16.

N. B. The several provincial currencies above mentioned are abolished in the United States of America, and the accounts kept in those moneys are not admitted in the courts of justice: they are still used, however, by the force of habit, in certain commercial transactions.

America on London.

Reduce 173 pounds 17 shillings 6 pence sterling into dollars and cents at par.

9 pounds = 40 dollars.

Rule.—Multiply 173 17 6 by 40 dollars, and divide the product by 9 pounds.

173 17 6
40

6920

for 10 shillings	20		
for 5 ditto	10		
for 2 ditto 6 pence	5		

9)6955(772 77⅞ result.

To prove this operation, multiply 772 77⅞ by 9, and divide the product by 40.

America on Amsterdam.

Reduce 839 florins 15 stivers current into dollars and cents, at the exchange of 37 cents per florin current.

1 florin = 37 cents
100 cents = 1 dollar.

Rule.—Multiply 839 15 by 37, price of exchange, and divide the product by 100 cents.

839 15
37

5873
2517

for 10 stivers	18	½
for 5 do.	9	¼

1,00)310,70¾(310 70¾ result.

To prove this operation, multiply 310 70¾ by 100 cents, and divide the product by 37, price of exchange.

America on Hamburgh.

Reduce 1236 marcs 12 shillings lubs banco into dollars and cents, at the exchange of 33½ cents per marc lubs banco.

1 marc = 33½ cents
100 cents = 1 dollar.

Rule.—Multiply 1236 12 by 33½, price of exchange, and divide the product by 100 cents.

1236 12
33½

3708
3708

for ½ -	618		
for 8 shillings	16	¾	
for 4 ditto -	8	⅜	

1,00)414,31⅛(414 31⅛ result.

To prove this operation, multiply 414 31⅛ by 100 cents, and divide the product by 33½, price of exchange.

EAST INDIES.

Moneys of Exchange.

Bombay.

A rupee = 4 quarters or 400 reis
A quarter = 100 reis.

Calcutta.

A rupee = 16 annas or 192 pices
An anna = 12 pices
100 sicca rupees = 116 current rupees.

Madras.

A pagoda = 36 fanams or 288 pices.
A fanam = 8 pices.

Course of Exchange
Ordered to be adopted for the adjustment of the Calcutta customs.

	Uncertain Prices.		Certain Prices.
			Exchange.
Bombay -	*rec.* 2 shillings 6 pence	*for*	10 sicca rupees.
Calcutta -	*rec.* 2 shillings 8 pence	*for*	24 ditto.
Madras -	*rec.* 8 shillings 9 pence	*for*	10 ditto.
Table of Exchange.			
	Coins.		
Great Britain	*giv.* 1 pound sterling	*for*	10 ditto.
Denmark -	*giv.* 1 rixdollar	*for*	24 ditto.
France - -	*giv.* 24 livres tournois	*for*	23 ditto.
Ditto - -	*giv.* 48 Mauritius livres	*for*	31 ditto.
Spain - -	*giv.* 1 hard dollar	*for*	34 ditto.
Portugal - -	*giv.* 1000 reis	*for*	24 ditto.
China - -	*giv.* 1 tale	*for*	36 ditto.
Madras - -	*giv.* 1 star pagoda	*for*	36 ditto.
America -	*giv.* 1 dollar	*for*	24 ditto.

WEST INDIES ON LONDON.

Moneys of Exchange.

A pound currency = 20 shillings or 240 pence.

Accounts are kept in pounds, shillings, and pence currency.

140 pounds currency = 100 pounds sterling.

Reduce 573 pounds 12 shillings 6 pence sterling into pounds, shillings, and pence currency, at the exchange of 140 pounds currency for 100 pounds sterling.

100 pounds sterling = 140 pounds currency.

Rule.—Multiply 573 12 6 by 140, price of exchange, and divide the product by 100 pounds.

573 12 6
140

22920
573

for 10 shillings	70		
for 2 do. 6 pence	17	10	

1,00)803,07 10(803 1 6 result.
20

1,50
12

6,00

To prove this operation, multiply 803 1 6 by 100 pounds, and divide the product by 140, price of exchange.

Arbitration of EXCHANGES is a calculation, by combining the rates of exchange of two or more places, to draw therefrom that which

shall be the most advantageous to remit or draw on. If bills remained always at par, or if the course of exchange was susceptible of being regulated with accuracy, there would be no such thing as an advantage to be obtained in one more than the other. The data to go upon are easily to be obtained, as the current prices are always published at short intervals.

The following examples will illustrate the nature of this subject.

London and Amsterdam.

Proportional Exchange.

	Quotation at London.	Quotation from Amsterdam.
On Amsterdam	37 3	
Genoa -	45	83½
Hamburgh	35	34
Leghorn -	48½	90
Lisbon -	62	44½
Madrid -	34½	88¼
Paris -	25 15	53½

Observation.—London gives the certain price to Amsterdam; that is, 1*l.* sterling for so many shillings Flemish banco, more or less; therefore, when London remits to Amsterdam, that place through which the highest course of exchange can be obtained is to be preferred, because more shillings Flemish will be received in exchange for one pound sterling. On the contrary, when London has to draw upon Amsterdam, that place should be chosen which furnishes the lowest course, because less shillings Flemish will be given in exchange for a pound sterling.

If you include the charges in the calculation, insert, for an indirect remittance, 100 in the divisor, and 100 less the charges in the dividend; and, for an indirect draft, place 100 in the divisor, and 100 more the charges in the dividend.

N. B. The above quotations are successively combined in the following arbitrations to ascertain the advantage which may be derived from the comparison of the different proportional exchanges.

London and Amsterdam through Genoa.

A bill on Genoa taken in London at 45 pence sterling per pezza of 5¾ lire fuori di banco is remitted to Amsterdam, and negotiated at 83½ grotes Flemish banco per pezza fuori di banco; what is the proportional exchange between London and Amsterdam?

1 pound sterling = 240 pence
45 pence = 1 pezza
1 pezza = 83½ grotes
12 grotes = 1 shilling Flemish.

Rule.—Multiply 20, fixed number, by the course of exchange between Amsterdam and Genoa; and divide the product by the course of London on Genoa, that is, $\frac{20 \times 83\frac{1}{2}}{45} =$ 37 1⅓.

London on Amsterdam through Hamburgh.

A bill on Hamburgh taken in London at 35 shillings Flemish banco per pound sterling is remitted to Amsterdam, and negotiated at 34 stivers banco for 2 marcs lubs banco: what is the proportional exchange between London and Amsterdam?

1 pound sterling = 35 shillings Flemish
8 shillings Flemish = 3 marcs
2 marcs banco = 34 stivers banco
6 stivers = 1 shilling Flemish.

Rule.—Multiply the course of exchange between London and Hamburgh by the course of Amsterdam on Hamburgh, and divide the product by 32, fixed number, that is, $\frac{35 \times 34}{32} = 37\ 2\frac{1}{4}$.

London and Amsterdam through Leghorn.

A bill on Leghorn taken in London at 48½ pence sterling per pezza of 8 reals is remitted to Amsterdam, and negotiated at 90 grotes Flemish banco per pezza of 8 reals: what is the proportional exchange between London and Amsterdam?

1 pound sterling = 240 pence
48½ pence = 1 pezza
1 pezza = 90 grotes
12 grotes = 1 shilling Flemish.

Rule.—Multiply 20, fixed number, by the course of exchange between Amsterdam and Leghorn; and divide the product by the course of London on Leghorn.

48½ 20
2 fraction 90

97 div. 1800
2 fraction

97)3600(37 1⅓

London and Amsterdam through Lisbon.

A bill on Lisbon taken in London at 62 pence sterling per milreis is remitted to Amsterdam, and negotiated at 44½ grotes Flemish banco per crusade of 400 reis: what is the proportional exchange between London and Amsterdam?

1 pound sterling = 240 pence.
62 pence = 1000 reis
400 reis = 44½ grotes
12 grotes = 1 shilling Flemish

Rule.—Multiply 50, fixed number, by the course of exchange between Amsterdam and Lisbon; and divide the product by the course of London on Lisbon, that is, $\frac{50 \times 44\frac{1}{2}}{62} = 35\ 10\frac{2}{3}$.

London and Amsterdam through Madrid.

A bill on Madrid taken in London at 34½ pence sterling per dollar of exchange is remitted to Amsterdam, and negotiated at 88¼ grotes Flemish banco per ducat of exchange: what is the proportional exchange between London and Amsterdam?

1 pound sterling = 240 pence
34½ pence = 1 dollar
375 dollars = 272 ducats
1 ducat = 88¼ grotes
12 grotes = 1 shilling Flemish.

Rule.—Multiply 1088, fixed number, by the course of exchange between Amsterdam and Madrid; and divide the product by 75, fixed number, multiplied by the course of London on Madrid.

75	1088
34½	88¼
300	8704
225	8704
37½	272
2587½	96016.
2 fraction	2 fraction
5175 div.	5175)192032(37 1$\frac{9}{16}$ result.

London and Amsterdam through Paris.

A bill on Paris taken in London at 25 livres 15 sols tournois per pound sterling is remitted to Amsterdam, and negotiated at 53½ grotes Flemish banco for 3 francs: what is the proportional exchange between London and Amsterdam?

1 pound sterling = 25¾ livres tournois
81 livres tournois = 80 francs
3 francs = 53½ grotes
12 grotes = 1 shilling Flemish.

Rule.—Multiply 20, fixed number, by the course of exchange between London and Paris, and by the course of Amsterdam on Paris; divide the product by 729, fixed number: that is $\frac{20 \times 25\frac{3}{4}}{729} = 37\ 9\frac{1}{2}$.

Recapitulation of the proportional exchange between London and Amsterdam.

Through Genoa it comes out at	37	1	1⅓
Hamburgh - -	37	2	2¼
Leghorn - - -	37	1	1⅓
Lisbon will answer to draw	35	10	10⅔
Madrid - -	37	1	1$\frac{5}{16}$
Paris will answer to remit	37	9	9½
Direct course between London and Amsterdam	37	3.	

Application to remit.—It appears by the comparison of the above-mentioned exchanges, that the proportional exchange upon Paris is the highest, and consequently, that it would be more advantageous to remit to Amsterdam by that place than by either of the others, or by a direct bill. Such remittance would establish an indirect course of 37 9½, instead of the direct, 37 3; so that a merchant would receive 37 shillings 9½ grotes Flemish in exchange for one pound sterling.

37 3 direct course: 37 9½ indirect course :: 100 :	101	9	1
Less for charges, at ¾ per cent. - - 0 15 0			
Advantage resulting from the arbitration - 0 14 1	1	9	1
	100	0	0

Application to draw.—If a merchant at London had to value on Amsterdam, instead of drawing directly, he would order his correspondent at Amsterdam to take a bill on Lisbon at 44½, and either to remit it thither to provide for drafts from London upon Lisbon at 62, or to remit it to London to be negotiated at the same price. Such operation would establish an indirect course of 35 10⅔, instead of the direct, 37 3; so that a merchant would give only 35 shillings 10⅔ grotes Flemish for one pound sterling.

37 3 direct course: 35 10⅔ indirect course :: 100*l.* :	96	6	10
Add for charges, at ¾ per cent. - 0 15 0			
Advantage resulting from the arbitration 2 18 2	3	13	2
	100	0	0

London and Genoa.

Proportional exchange.

	Quotation at London.	Quotation from Genoa.
On Genoa -	46	
Amsterdam	37 4	84$\frac{7}{8}$
Hamburgh	35 4	46¼
Leghorn	50	124$\frac{1}{2}$
Lisbon -	61½	765
Madrid -	34¾	660
Paris -	25 2	94$\frac{7}{8}$

Observation.—London gives the uncertain price to Genoa; that is, 46 pence sterling, more or less, for one pezza fuori di banco; therefore, when London remits to Genoa, that place through which the lowest course of exchange can be obtained is to be preferred, because less pence will be given in exchange for one pezza. On the contrary, when London has to draw upon Genoa, that place should be chosen which furnishes the highest course, because more pence will be received in exchange for a pezza.

If you include the charges in the operation, insert, for an indirect remittance, 100 less the charges in the divisor, and 100 in the dividend; and, for an indirect draft, place 100 more the charges in the divisor, and 100 in the dividend.

N. B. The above quotations are successively combined in the following arbitrations to ascertain the advantage which may be derived from the comparison of the different proportional exchanges.

London and Genoa through Amsterdam.

A bill on Amsterdam taken in London at 37 shillings 4 grotes Flemish banco per pound sterling is remitted to Genoa, and negotiated at 84⅞ grotes Flemish banco per pezza of 5¼ lire fuori di banco: what is the proportional exchange between London and Genoa?

1 pezza = 84⅞ grotes
12 grotes = 1 shilling Flemish
37⅓ shill. Flemish = 1 pound sterling
1 pound sterling = 240 pence.

Rule.—Multiply 20, fixed number, by the course of exchange between Genoa and Amsterdam; and divide the product by the course of London on Amsterdam.

37⅓ — 20
3 fraction — 84⅞
112 div. — 1680
17½
1697½
3 fraction

112)50921/2(45½ result.

London and Genoa through Hamburgh.

A bill on Hamburgh taken in London at 35 shillings 4 grotes Flemish banco per pound sterling is remitted to Genoa, and negotiated at 46¼ soldi fuori di banco per marc lubs banco: what is the proportional exchange between London and Genoa?

1 pezza = 115 soldi
46¼ soldi = 1 marc banco
3 marcs = 8 shillings Flemish
35⅔ shill. Flemish = 1 pound sterling
1 pound sterling = 240 pence sterling.

Rule.—Divide 73600, fixed number, by the course of exchange between London and Hamburgh, multiplied by the course of Genoa on Hamburgh.

35⅔ — 73600
6 fraction — 6 fraction
212 — 9805)441600(45 result.
46¼ — 49400
1272 — 375
848
53
9805 div.

London and Genoa through Leghorn.

A bill on Leghorn taken in London at 50 pence sterling per pezza of 8 reals is remitted to Genoa, and negotiated at 124½ soldi fuori di banco per pezza of 8 reals: what is the proportional exchange between London and Genoa?

1 pezza fuori di banco = 115 soldi ditto
124½ soldi ditto = 1 pezza of 8 reals
1 pezza of 8 reals = 50 pence sterl.

Rule.—Multiply 115, fixed number, by the course of exchange between London and Leghorn; and divide the product by the course of Genoa on Leghorn.

124½ — 115
2 fraction — 50
249 div. — 5750
2 fraction

249)11500(46 3/16 result.
1540
46

London and Genoa through Lisbon.

A bill on Lisbon taken in London at 61½ pence sterling per milreis is remitted to Genoa, and negotiated at 765 reis per pezza of 115 soldi fuori di banco: what is the proportional exchange between London and Genoa?

1 pezza = 765 reis
1000 reis = 61½ pence.

Rule.—Multiply the course of exchange between Genoa and Lisbon by the course of London on Lisbon; and divide the product by 1000, fixed number.

765
61½
765
4590
382½

1,000)47,047½(7 1/21 result.

London and Genoa through Madrid.

A bill on Madrid taken in London at 34¾ pence sterling per dollar of exchange is remitted to Genoa, and negotiated at 660 maravedis per gold crown: what is the proportional exchange between London and Genoa?

1 pezza = 115 soldi
214 soldi = 1 gold crown
1 gold crown = 660 maravedis
272 maravedis = 1 dollar
1 dollar = 34¾ pence.

Rule.—Multiply 115, fixed number, by the course of exchange between Genoa and Madrid, and by the course of London on Madrid; divide the product by 58208, fixed number.

115
660
6900
690
75900
34¾
303600
227700
56925

58208)2637525(45 9/16 result.
309205
18165

London and Genoa through Paris.

A bill on Paris taken in London at 25 livres 2 sols tournois per pound sterling is remitted to Genoa, and negotiated at 94⅞ sols in francs per pezza of 115 soldi fuori di banco: what is the proportional exchange between London and Genoa?

1 pezza = 94⅞ sols
20 sols = 1 franc
80 francs = 81 livres tournois
25 1/10 livres tournois = 1 pound sterling
1 pound sterling = 240 pence sterling.

Rule.—Multiply 243, fixed number, by the course of exchange between Genoa and Paris; and divide the product by 20, fixed number, multiplied by the course of London on Paris.

20 — 243
25 1/10 — 94⅞
502 div. — 972
2187
121⅝
60⅝
30⅜

502)23054⅜(45 15/16 result.
2974
464

Recapitulation of the proportional exchange between London and Genoa.

Through Amsterdam it comes out at 45½
Hamburgh will answer to remit 45
Leghorn - 46 3/16
Lisbon will answer to draw 47 1/21
Madrid - - - 45 5/16
Paris - - - 45 15/16
Direct course between London and Genoa - - 46.

Application to remit.—It appears by the comparison of the above-mentioned exchanges, that the proportional exchange upon Hamburgh is the lowest, and consequently, that it would be more advantageous to remit to Genoa by that place, than by either of the others, or by a direct bill. Such remittance would establish an indirect course of 45, instead of the direct 46; so that a merchant would give only 45 pence in exchange for one pezza fuori di banco.

46 direct course: 45 indirect course :: 100*l.* - - 97 16 6
Add for charges, at ¾ per cent. - - 0 15 0
Advantage resulting from the arbitration - 1 8 6
2 3 6
100 0 0.

Application to draw.—If a merchant at London had to value on Genoa, instead of drawing directly, he would order his correspondent at Genoa to take a bill on Lisbon at 765, and either to remit it thither to provide for drafts from London upon Lisbon at 61½, or to remit it to London to be negotiated at the same price. Such operation would establish an indirect course of 47 1/21, instead of the direct 46; so that a merchant would receive 47 1/21 pence in exchange for a pezza.

46 direct course: 47 1/21 indirect course :: 100*l.* - - 102 5 7.
Less for charges, at ¾ per cent. 0 15 0
Advantage resulting from the arbitration 1 10 7
2 5 7
100 0 0.

EXCHANGE signifies also a place in most considerable trading cities, wherein the merchants, negotiants, agents, bankers, brokers, interpreters, and other persons concerned in commerce, meet on certain days, and at certain times, to confer and treat together of matters relating to exchanges, remittances, payments, adventures, assurances, freightments, and other mercantile negotiations, both by sea and land. These assemblies are held with so much exactness, that the absence of a merchant, &c. makes him suspected of drawing to a failure or bankruptcy, as not being able to stand the Change. The most considerable exchanges in Europe, are those of Amsterdam, and that of London, called the Royal Exchange.

EXCHANGE OF CHURCH LIVINGS, is where two persons having procured licence from the ordinary to treat of and exchange, do, by one instrument in writing, agree to exchange their benefices, being both spiritual, and in order thereunto resign them into the hands of the ordinary: such exchange being executed, the resignations are good. Wats. c. 4. These exchanges are now seldom used.

EXCHEQUER. This, which is a court of law and equity, is a very ancient court of record, established by William the Conqueror, as a part of the aula regis, though regulated and reduced to its present state by Ed. I. and intended principally to order the revenues of the crown, and to recover the king's debts and duties.

The court consists of two divisions, viz. the receipt of the exchequer, which manages the royal revenue; and the judicial, which is again subdivided into a court of equity, and a court of common law.

The court of equity is held in the exchequer, before the lord treasurer, the chancellor of the exchequer, the chief baron, and three *puisné* barons. The primary and original business of this court was to call the king's debtors to account, by bill filed by the attorney general, and to recover any lands, tenements, or hereditaments, goods, chattels, or other profits or benefits, belonging to the crown.

This court, which was established merely for the benefit of the king's accountant, is thrown open; and now, by suggestion of privilege, any person may be admitted to sue here, as well as the king's accountant.

An appeal from the equity side of this court, lies immediately to the house of peers; but from the common law side, pursuant to 31 Ed. III. c. 12. a writ of error must first be brought into the court of exchequer chamber, whence, in the dernier ressort, there lies an appeal to the house of lords.

Chancellor of the EXCHEQUER. See CHANCELLOR.

EXCHEQUER CHAMBER has no original jurisdiction, but is merely a court of appeal, to correct the errors of other jurisdictions; and consists of the lord chancellor, the lord treasurer, with the justices of the king's-bench and common-pleas. In imitation of this, a second court of exchequer chamber was erected by 27 Eliz. c. 8. consisting of the justices of the common-pleas, and the barons of the exchequer; before whom writs of error may be brought, to reverse judgments in certain suits commenced originally in the court of king's-bench. Into the exchequer chamber, are sometimes adjourned from the other courts, such causes, as the judges upon argument find to be of great weight and difficulty, before any judgment is given upon them in the court.

EXCHEQUER BILLS. Bills of credit, issued by the authority of parliament, payable with interest out of the produce of a particular tax, or more frequently out of the supplies to be granted in a future session. The sum of £2,750,000 is usually raised in this manner on credit of the malt tax, and tax on personal estates, although it is well known that these taxes never produce so much, the deficiency being always made good out of the next supplies. The sum to be issued out of the produce of the consolidated fund is likewise usually raised by these bills, charged upon the growing produce of the surplus of the said fund; also other sums for ordinary and extraordinary expences, by bills charged upon the first supplies of the next session; so that of late years the total amount of outstanding exchequer bills has usually been about ten millions. The bank, since 1706, have contracted with government for the circulation of these bills at a certain premium. The interest they carry has been at various rates, from £7:12 to 3 per cent.; those at present in circulation bear interest at the rate of threepence halfpenny a day per cent. which is computed up to the day of sale, from the respective dates of the bills. They are generally for £100 each, but many of those issued on the vote of credit are for £1000, and they have sometimes been made out for much larger sums: they are numbered arithmetically, and registered accordingly, for the purpose of paying them off in a regular course. They are paid at the exchequer bill office, and the time of payment is notified by advertisement.

The daily transactions between the bank and the exchequer are chiefly carried on by bills of £1000 each, which are deposited by the bank in the exchequer to the amount of the sums received by them on government account; the bank notes and cash thus received by the bank being retained by them, as the detail part of the money-concerns of government is all transacted at the bank. The instalments on loans are paid into the receipt of the exchequer by these exchequer bills of £1000 each, which are received again by the bank as cash, either for the amount of dividends due, or in re-payments of advances; and as, while deposited in the exchequer, they are considered merely as a pledge or security, they of course continue to bear interest, till the advance on which the bank first received them is paid off.

In October, 1796, the 5 per cent. exchequer bills, issued on the vote of credit, being at a considerable discount, it was thought proper to fund them; and the terms agreed upon were as follows:—The holders to be entitled for every £100 to either of the following capitals:

£	s	d	
176	19	9¾	in the 3 per cents.
137	18	7¼	in the 4 per cents.
118	6	10¼	in the 5 per cents.

The amount of the bills thus funded was £1,433,870, and the capital stock created in the different funds, £2,374,333 14 8.

In November, 1801, it was again found necessary to fund a considerable part of the outstanding exchequer bills, which was effected on the following conditions: for each £100 principal to receive the under-mentioned proportions of stock:

£		Estimated value £	s	d
25	Three per cent. consols	17	1	10½
25	Three per cent. reduced	16	16	10½
50	Four per cent. consols	42	7	6
25	New 5 per cents.	24	15	0
	1s. 9d. Long annuity	1	14	4
		£102	15	7

And the proprietors to have the liberty of subscribing £50 additional in money for every £100 they held in bills, the money thus raised to be applied in paying off the sum of about £2,400,000 in exchequer bills in the possession of the bank. The amount of the bills funded and redeemed was £8,910,450.

As there is always a considerable sum outstanding in exchequer bills, the interest paid thereon forms a constant addition to the annual charge of the funded debt; the amount paid for interest on exchequer bills in the years 1803, 1804, and 1805, respectively, was as follows:

	£	s	d
1803 . .	801,787	10	5¼
1804 . .	624,859	18	10
1805 . .	1,478,316	3	3½

The premium or discount at which exchequer bills sell, depends on the proportion which the interest payable on them bears to the interest produced by the public funds according to their current prices.

Exchequer bills, though the same in their nature and solidity, differ in their origin from navy bills in this, that they are issued in anticipation of revenue, and circulated by the bank of England to raise money. During the recess of parliament, there is a sum left to the credit of the chancellor of the exchequer, to serve in cases of exigency. The bank makes advances to the amount voted, for which the exchequer issues bills. There is a standing contract between government and the bank for the trouble and expence attending the issue and circulation of these bills. Notice is given by public advertisement, and the payment is made at the exchequer-bill office Westminster.

EXCHEQUER, *black book of the*, a book containing a description of the court of England in 1175, and its officers, with their ranks, wages, privileges, perquisites, &c. also the revenues of the crown, both in money and cattle. Here we find that for one shilling as much bread might be bought as would serve 100 men a whole day; that the price of a fat bullock was only 12 shillings, and a sheep less than four.

EXCISE, one of the principal branches of the public revenue, consisting of inland duties, or taxes on articles manufactured or consumed, whereas the duties of customs are paid on goods brought into or carried out of the country. Excise duties are of very ancient date; they were numerous among

the Romans, and were established in Italy, Spain, France, and Holland, long before they were known in this country. The first attempt to introduce this species of taxation into England was in the year 1626, but it was not actually established till 1643, when the long parliament laid an excise duty on beer, ale, and other liquors, with a solemn declaration that at the end of the war all excises should be abolished. The example was immediately followed by the king and parliament of Oxford, who established similar excise duties, and the contest continuing longer than was expected, this mode of levying money was extended to bread, meat, salt, and many other necessary articles. The excise on bread and meat was afterwards repealed, but the duties on beer and ale were continued, and after the Restoration were granted to Charles 2d, during his life; from whose death they were continued, under the title of the *temporary excise*, to the different sovereigns, during their respective lives, as a part of the civil list revenue; but they are now placed on the same footing as all the other permanent taxes, being made perpetual, and the produce carried to the consolidated fund. The *hereditary excise* was a duty of fifteen pence per barrel upon beer and ale, and a proportionate sum upon other liquors sold in the kingdom, and was granted to Charles 2d, his heirs and successors for ever, as a compensation for the profits of the feudal privileges of wardship and purveyance then abolished by act of parliament. These two branches, which comprehended all the excise duties existing at the Revolution, produced on an average 610,486*l.* yearly. During the reign of William 3d, the excise was extended to salt, additional duties were laid on beer and ale, and an excise duty on malt, which has since been granted annually, was established. In the reign of queen Anne, candles, hides and skins, vellum and parchment, paper and pasteboards, soap, starch, hops, and some other articles, were subjected to excise duties. In the reign of George 1st, the excise duties, with all other taxes which had been granted for terms of years, were made perpetual, a duty was laid on wrought plate, and the principal part of the duties on tea, coffee, and chocolate, was transferred from the customs to the excise. During the reign of George 2d, considerable additions were made to the excise duties, by licences, a duty on glass, and new duties on spirituous liquors, coffee, chocolate, and malt; an attempt was made by sir R. Walpole to transfer the duties on wines and tobacco from the customs to the excise, but the measure being thought introductory to a general excise, it experienced great opposition, and was abandoned. Since that period, numerous additional duties have been imposed on all the articles subject to the excise, with which the increased consumption caused by the progress of population and luxury, has rendered this source of revenue so productive, that it is not surprising those who have had the management of the public finances should have become partial to it, though it has always been an obnoxious mode of taxation to the public. The total gross amount raised in England by excise duties, in the year ending 5th of January, 1805, will appear by the following account.

	£
Auctions — —	181,126
Beer — —	2,878,830
Bricks and tiles —	226,203
Candles — —	299,479
Coachmakers —	274
Cocoa nuts and coffee —	86,801
Cyder and perry —	19,868
Glass — —	293,640
Hides and skins —	281,210
Hops — —	432,178
Licences — —	290,094
Malt — —	1,147,937
Metheglin or mead —	189
Paper — —	317,380
Printed goods — —	686,971
Salt — —	1,097,151
Soap — —	526,028
Spirits, British —	1,267,423
Ditto, foreign — —	1,482,052
Starch — —	54,196
Sweets — —	26,985
Tea — —	968,199
Tobacco and snuff —	187,302
Verjuice — —	77
Vinegar — —	23,754
Wine — —	569,770
Wire — —	8,272
Total consolidated duties	£ 13,353,389

Temporary war taxes.

Malt — —	2,878,254
Wine — —	435,785
Sweets — —	4,039
Spirits, British — —	621,566
Ditto, foreign — —	736,451
Tea — —	1,010,842
Total war taxes —	£ 5,686,937

Annual duties.

Tobacco and snuff —	430,148
Malt, additional — —	927,534
Malt, old — —	587,635
Total annual duties —	£ 1,945,317

These sums, making together upwards of twenty millions, are, however, subject to several deductions, such as the expences of collection, the drawbacks allowed on exportation, bounties on beer, British spirits, and fish exported, pensions to the duke of Grafton and others charged on this particular branch of the public revenue, sundry allowances and repayments.

Abstract of the total receipt.

Balance remaining on the 5th of January, 1804	15,448
Received on consolidated duties	13,353,389
——— temporary war taxes	5,686,937
——— annual duties	1,945,317
	£ 21,001,092
By charges of management	545,256
— taxes repaid to officers	31,729
— exports — —	801,028
— allowances —	60,700
By bounties on fish exported, &c.	£ 20,082
— overcharges, repayments, &c.	38,180
— annual payment to officers of the late wine licence office, and of the late salt duties	12,214
— pensions — —	14,000
— payments into the exchequer —	19,448,143
— balance remaining on 5th January, 1805	29,837
	£ 21,001,092

The articles on which excise duties are collected in Scotland are nearly the same as in England, with some little variations in the rates at which the duties are imposed; the produce for the year ending 5th of January, 1805, was as follows:

Abstract of the total receipt.

Balance remaining on the 5th of January, 1804	62,889
Received on permanent duties	1,049,324
——— temporary war taxes	328,715
——— annual duties	106,629
	£ 1,547,557
By charges of management	126,070
— exports —	82,538
— allowances —	10,462
— disbursements out of the net produce	98,075
— remittances to London	1,158,000
— balance remaining on 5th January, 1805	72,412
	£ 1,547,557

Produce of the duties of excise in Ireland for the year ending 5th January, 1805.

On auctions — —	5,454
— glass bottles —	1,471
— coffee — —	487
— hides, leather, &c.	38,541
— malt — —	323,628
— paper-hangings —	1,376
— writing-paper & parchment	10,940
— wines, mead, and vinegar (home-made)	345
— wines, foreign —	48,895
— sugar — —	1,533
— strong waters —	736,757
— tobacco — —	144,122
— licences — —	71,324
	£ 1,384,873

In England the excise duties are collected at an expence of only £ 2 16*s.* 1*d.* per cent. on the gross revenue, or £ 3 4*d.* per cent. on the net produce; but the expence of collection in Scotland amounts to £ 7 8*s.* 6*d.* per cent. on the gross revenue, or £ 8 10*s.* 6*d.* per cent. on the net produce. In Ireland the management of the excise duties is united with the customs, and the expence of the whole amounts to £ 11 3*s.* 3*d.* per cent. on the net revenue.

Excise Laws. For more easily levying the revenue of the excise, the kingdom of England and Wales is divided into about fifty collections, some of which are called by the names of particular counties, others by the names of great towns; where one county is divided into several collections, or where a collection comprehends the contiguous parts of several counties, every such collection is subdivided into several districts, within which there is a supervisor; and each district is again subdivided into outrides and footwalks, within each of which there is a gauger or surveying officer.

The commissioners or sub-commissioners, in their respective circuits and divisions, shall constitute, under their hands and seals, so many gaugers as they shall find needful.

Arrears of duties.—By several acts of parliament, all articles in the possession of persons subject to the excise laws, together with all the materials and utensils of whatsoever description, are made liable for the arrears of duties, whether these be single or double duties; and if a trader, being in arrears for the single duties, becomes a bankrupt, and is convicted after the assignment of his effects, the double duties are a lien upon the exciseable commodities, utensils, and materials in the hands of his assignees, and the commissioners or magistrates may authorize the penalty to be levied upon all such commodities, and all the materials, preparations, utensils, and vessels for making thereof, in the custody of the bankrupt, or any person or persons in trust for him. 2 Doug. 411.

Bonds, for the exportation of exciseable commodities, are to be taken by officers of excise, and they are to be given generally upon all exciseable articles, at the place where exported.

Forgery of any stamps, licences, certificates, permits, or any other excise documents, is by various statutes made a capital felony.

Licences.—In all cases where licences are required, the licence will only sanction the business carried on in that particular place for which such licence was granted; but when the business is carried on by partners, one licence will be sufficient to cover the firm.

Officers of excise.—The officers of excise are to be appointed, and may be dismissed, replaced, or altered, by the commissioners, under their hands and seals; their salaries are allowed and established by the treasury; and by 1 W. & M. c. 24. s. 15. if it is proved by two witnesses, that any officer has demanded or taken any money, or other reward whatever, except of the king, such offender shall forfeit his office.

By several statutes, no process can be sued out against any officer of excise, for any act done in the execution of his office, until one month after notice given, specifying the cause of action, and the name and abode of the person who is to begin, and the attorney who is to conduct the action; and within one month after such notice, the officer may tender amends, and plead such tender in bar; and having tendered insufficient or no amends, he may, with leave of the court, before issue joined, pay money into court.

Officers of excise are empowered to search, at all times of the day, entered warehouses, or places for tea, coffee, &c. But private houses can only be searched upon oath of the suspicion before a commissioner or justice of peace, who can by their warrant authorize a search.

Permits. Persons dealing in exciseable commodities are entitled to permits for removing the same to different places in certain quantities, and under certain regulations. These permits are written upon a peculiar species of paper, manufactured expressly for the purpose; and by 23 Geo. III. c. 70. s. 11. no permit paper is to be delivered out before it shall be filled up agreeably to the request note of a trader; and officers knowingly granting any false permit, making false entries in the counterpart thereof, or receiving any commodities into stock with a false or forged permit, are to be transported for seven years.

Samples.—Officers of excise are, by various acts, empowered to take samples of exciseable commodities, paying the prices therein regulated for the same.

Seizures.—When an officer makes a seizure of any spirits, or other articles, he must lay his hand on the casks, vessels, &c. so seized, and declare that he seizes such spirits, &c. and the casks or vessels containing the same, for the use of his majesty and of himself; but if the officer happens to be alone when he makes such seizure, he must afterwards, in the presence of witnesses, again lay his hand on such cask, vessel, &c. and repeat the former declaration of seizure.

All informations on seizures must be laid in the names of the officers making the same.

By 41 Geo. III. c. 96. commissioners of excise are empowered to make restitution of exciseable goods.

Scales and weights.—By various acts of parliament, traders subject to the excise laws are to keep just and sufficient scales and weights, under penalty of £100 for every such offence, and the scales and weights may be seized by the officer.

Traders, manufacturers, and dealers liable to the excise duties, are to assist the officers in weighing stock; and forcibly obstructing, or using any art or contrivance to prevent or impede the officers from taking a true account incurs a penalty of £100.

EXCLAMATION, in rhetoric, a figure that expresses the violent and sudden breaking out, and vehemence of any passion. Such is that in the second book of Milton's Paradise Lost:

O unexpected stroke, worse than of death!
Must I thus leave thee, Paradise? Thus leave
Thee, native soil; these happy walks and shades,
Fit haunt of gods?

EXCLUSION, or *bill of exclusion*, a bill proposed about the close of the reign of king Charles II. for excluding the duke of York, the king's brother, from the throne, on account of his being a papist.

Exclusion, in mathematics, is a method of coming at the solution of numerical problems, by previously throwing out of our consideration such numbers as are of no use in solving the question.

EXCOECARIA, a genus of the triandria order, in the diœcia class of plants; and in the natural method ranking under the 38th order, tricoccæ. The male amentum is naked; there is no calyx nor corolla; there are three styles, and a tricoccous capsule. There are two species. The agallocha, or aloes-wood, is a native of China and some of the Indian islands, and is about the same height and form as the olive tree. Its trunk is of three colours, and contains three sorts of wood; the heart is that of tambac, or calombac, which is dearer in the Indies than even gold itself. It serves to perfume clothes and apartments; and is esteemed a sovereign cordial in fainting fits, a restorative in the palsy, and a cure for ascarides in children. It is burnt as incense in the Chinese and Indian temples; and it is also used to set the most precious jewels that are wrought in the Indies.

The aloes-wood is very highly valued; and strange fables were invented as to the origin of the tree that yields it; some pretending that it grew in Paradise, and was only conveyed to us by means of the rivers overflowing their banks and sweeping off the trees in their way; others affirming that it grew on inaccessible mountains, where it was guarded by certain wild beasts, &c. The Siamese ambassadors to the court of France in 1686, who brought a present of this wood from their emperor, first gave the Europeans any consistent account of it.

EXCOMMUNICATION, an ecclesiastical penalty or censure whereby such persons as are guilty of any notorious crime or offence, are separated from the communion of the church, and deprived of all spiritual advantages.

Excommunication among the Jews, according to Elias, a German rabbin, was distinguished into three kinds: 1. Niddui, which was a separation of but a few days. 2. Cherem, a separation attended with execration and malediction. And, 3. Shammatha, which was the last and greater excommunication. But Selden says, that niddui and shammatha are the same thing, and therefore that there were but two kinds of excommunication among the Jews, viz. the greater and the less. They made also another distinction in excommunication, into total or universal, by which a man was excommunicated with regard to all men; and partial, by which a man was excommunicated in one city, and with regard to certain persons, and not others.

It is observable, that not only the judges had the power of excommunicating, but that each particular person in conversation might excommunicate another, and himself likewise; and this excommunication, if well-grounded, was of force; nay, if a man dreamed that he was excommunicated by himself or by another, he was considered as an excommunicated person, because this dream was supposed to be sent from God.

As to the effects of the Jewish excommunication, the lesser excluded the excommunicated person from the society of men; that is, he was not to come nearer them than four cubits, neither he, his wife, children, or domestics, according to Buxtorf. The greater absolutely sequestered the person from the conversation of others; and sometimes he was shut up in a small chamber or prison, where he lived alone. Baronius and Beza pretend, that the greater excommunication excluded men from the use of sacred things. Selden, on the contrary, affirms, that they were allowed to be present in the temple, and partake of the public worship. Buxtorf, who is of the same opinion, adds, that whereas

others came into the temple at the right hand, and went out at the left, the excommunicated were obliged both to go in and out at the left.

Excommunication among the modern Jews, is attended with the most terrible consequences. The excommunicated person is refused all human assistance: if there is a corpse in his house, or a child to be circumcised, none must help him. He is cursed by the book of the law, by the curse of Joshua against Jericho, by that of Elisha against the children, by heaven and earth, and God is besought that a whirlwind may dash him to pieces. He is pelted with stones if he appears in the streets; and if he obtains absolution, it is upon the most mortifying conditions; for he is publicly tied to a post and whipped, after which he lays himself down at the door of the synagogue, and all those who go out, pass over him. This was the very case of the famous Jew Acosta. See Bayle, in the article Acosta.

In the antient christian church, the power of excommunication, as well as other acts of ecclesiastical discipline, was lodged in the hands of the clergy, who distinguished it into the greater and lesser. The lesser excommunication, simply called αφορισμος, separation or suspension, consisted in excluding men from the participation of the eucharist, and the prayers of the faithful. But they were not expelled the church; for they had the privilege of being present at the reading of the scriptures, the sermons, and the prayers of the catechumens and penitents. This excommunication was inflicted for lesser crimes, such as neglecting to attend the service of the church, and misbehaviour in it.

The greater excommunication, called παντελης αφορισμος, total separation and anathema, consisted in an absolute and entire exclusion from the church and the participation of all its rites. When any person was thus excommunicated, notice was given of it by circular letters to the most eminent churches all over the world, that they might all confirm this act of discipline, by refusing to admit the delinquent to their communion. The consequence of this latter excommunication was very terrible. The excommunicated person was avoided in civil commerce and outward conversation. No one was to receive him into his house, nor eat at the same table with him; and when dead, he was denied the solemn rites of burial. It has been a question, whether the antient church used to add execration to her censures. Grotius thinks this was done, though very seldom, as in the case of Julian the apostate, for whose destruction the antient christians absolutely prayed to God. St. Chrysostom was utterly against this practice, affirming that we ought not to pray against the sinner, but against his opinions or actions.

The Romish pontifical takes notice of three kinds of excommunication: 1. The minor, incurred by those who have any correspondence with an excommunicated person. 2. The major, which falls upon those who disobey the commands of the holy see, or refuse to submit to certain points of discipline; in consequence of which they are excluded from the church militant and triumphant, and delivered over to the devil and his angels. 3. Anathema, which is properly that pronounced by the pope against heretical princes and countries. In former ages, these papal fulminations were most terrible things; but at present, they are formidable to none but a few petty states of Italy.

Excommunication, in the Greek church, cuts the offender off from all communion with the 318 fathers of the first council of Nice, and with the saints; consigns him over to the devil and the traitor Judas; and condemns his body to remain after death as hard as a flint, or a piece of steel, unless he humbles himself and makes atonement for his sins by a sincere repentance. The form abounds with dreadful imprecations; and the Greeks assert, that if a person dies excommunicated, the devil enters into the lifeless corpse; and, therefore, in order to prevent it, the relations of the deceased cut his body in pieces, and boil them in wine. It is a custom for the patriarch of Jerusalem annually to excommunicate the pope and the church of Rome; on which occasion, together with a great deal of idle ceremony, he drives a nail into the ground with a hammer, as a mark of malediction.

Excommunication, among the pagans, excluded the person from the sacrifices and the temples, and delivered him over to the Furies, which was called execrare, and Diris devovere. When Marcus Crassus set out on his expedition against the Parthians, Atteius, tribune of the people, not being able to prevent him, ran to the gate of the city through which the general was to pass, and setting a chafing-dish in the middle of the way with fire in it, when Crassus drew near, he threw some perfumes into the chafing-dish, and pronounced curses against Crassus with great exclamation, and thus excommunicated him.

EXCOMMUNICATION, in the church of England, is the highest ecclesiastical censure which can be pronounced by a spiritual judge against a christian; for thereby he is excluded from the body of the church, and disabled to bring any action, or sue any person in the common law courts. Co. Lit. 133.

The sentence of excommunication was instituted originally for preserving the purity of the church; and it seems agreed, that wherever the spiritual court has jurisdiction in any cause, and the party refuses to appear to their citation, or after sentence, being admonished to obey their decree, that he may be excommunicated. 1 Rol. Abr. 883.

A person excommunicated is disabled to be a witness in any cause: he cannot be attorney or procurator for another; he is to be turned out of the church by the churchwardens, and not to be allowed christian burial. Gibs. Cod. 435.

The sentence of excommunication can only be pronounced by the bishop, or other person in holy orders, being a master of arts at least; also the priest's name pronouncing such sentence, is to be expressed in the instrument issuing under seal out of the court. Gibs. Cod. 1095.

EXCOMMUNICATO CAPIENDO, a writ directed to the sheriff, for apprehending him who stands obstinately excommunicated, forty days; for such an one not seeking absolution, has, or may have, his contempt certified into the chancery; whence issues this writ, for imprisoning him without bail or mainprize until he conforms. 5 Eliz. c. 23.

EXCOMMUNICATO DELIBERANDO, a writ to the sheriff, for the delivery of an excommunicated person out of prison, upon certificate of the ordinary, of his conformity to the jurisdiction ecclesiastical. F. N. B. 63.

EXCOMMUNICATO RECIPIENDO, a writ whereby persons excommunicated, being for their obstinacy committed to prison, and unlawfully delivered thence, before they have given caution to obey the authority of the church, are commanded to be sought for and imprisoned again.

EXCORIATION, in medicine and surgery, the galling or rubbing off of the cuticle.

EXCRESCENCE, in surgery, denotes every preternatural tumour which arises upon the skin, either in the form of a wart or tubercle. If they are born with a person, as they frequently are, they are called navi materni, or marks from the mother; but if the tumour is large, so as to depend from the skin like a fleshy mass, it is then called a sarcoma. See SURGERY.

EXCRETION, or SECRETION, in medicine, a separation of some fluid, mixed with the blood, by means of the glands. See PHYSIOLOGY.

EXCRETORY, in anatomy, a term applied to certain little ducts or vessels, destined for the reception of a fluid, secreted in certain glandules, and other viscera, for the excretion of it in the appropriated places. See ANATOMY.

EXECUTION is a judicial writ, grounded on the judgment of the court whence it issues; and is supposed to be granted by the court at the request of the party at whose suit it is issued, to give him satisfaction on the judgment which he has obtained: and therefore an execution cannot be sued out in one court, upon a judgment obtained in another. Impey, K. B.

Executions in actions where money is recovered, as a debt or damages, are of five sorts: 1. against the body of the defendant; 2. against his goods or chattels; 3. against his goods and the profits of his lands; 4. against the goods and the possession of his land; 5. against all three, his body, lands, and goods. 3 Black. 414. See CAPIAS AD SATISFACIENDUM, FIERI FACIAS, LEVARI FACIAS, and ELEGIT.

EXECUTION *of criminals*, must be according to the judgment; and the king cannot alter a judgment from hanging to beheading, because no execution can be warranted, unless it is pursuant to the judgment. 3 Inst. 52.

Execution of criminals is the completion of human punishment; and this in all cases, as well capital as otherwise, must be performed by the legal officer, the sheriff or his deputy. 4 Black. 405.

EXECUTIONE FACIENDA IN WITHERNAMIUM, a writ that lies for taking his cattle who formerly had conveyed out of the county the cattle of another: so that the bailiff, having authority from the sheriff to replevy the cattle so conveyed away, could not execute his charge.

EXECUTIONE JUDICII, a writ which lies where judgment is given in any court of record, and the sheriff or bailiff neglecting to do execution of the judgment, the party shall then have this writ directed to the said sheriff or bailiff; and if they shall not do execution, he shall have an alias, and pluries. And if upon this writ execution is

not done, or some reasonable cause returned why it is delayed, the judges of the court may amerce them.

EXECUTOR, is a person appointed by the testator, to carry into execution his will and testament after his decease. The regular mode of appointing an executor, is by naming him expressly in the will; but any words indicating an intention of the testator to appoint an executor will be deemed a sufficient appointment.

Any person capable of making a will, is also capable of being an executor: but in some cases, persons who are incapable of making a will, may nevertheless act as executors, as infants, or married women; to obviate, however, inconveniences which have occurred respecting the former, it is enacted by stat. 38 Geo. III. c. 89, that where an infant is sole executor, administration, with the will annexed, shall be granted to the guardian of such infant, or such other person as the spiritual court shall think fit, until such infant shall have attained the age of twenty-one; when, and not before, probate of the will shall be granted him.

An executor derives his authority from the will and not from the probate, and is therefore authorized to do many acts in execution of the will, even before it is proved, such as releasing, paying, or receiving of debts, assenting to licences, &c. but he cannot proceed until he has obtained probate.

If an executor dies before probate, administration must be taken out with the will annexed; but if an executor dies, his executor will be executor to the first testator, and no fresh probate will be needed. It will be sufficient if one only of the executors prove the will; but if all refuse to prove, they cannot afterwards administer, or in any respect act as executors.

If an executor becomes a bankrupt, the court of chancery will appoint a receiver of the testator's effects, as it will also upon the application of a creditor, if he appears to be wasting the assets.

If an executor once administers, he cannot afterwards renounce; and the ordinary may in such case issue process to compel him to prove the will. 1 Mod. 213.

If an executor refuses to take upon him the execution of the will, he shall lose the legacy therein contained.

If a creditor constitutes his debtor his executor, this is at law a discharge of the debt, whether the executor acts or not, provided however there be assets sufficient to discharge the debts of the testator.

The first duty of an executor or administrator is to bury the deceased in a suitable manner; and if the executor exceeds what is necessary in this respect, it will be a waste of the substance of the testator.

The next thing to be done by the executor is to prove the will, which may be done either in the common form, by taking the oath to make due distribution, &c. or in a more solemn mode, by witnesses to its execution.

By stat. 37 Geo. III. c. 9, s. 10, every person who shall administer the personal estate of any person dying without proving the will of the deceased, or taking out letters of administration within six calendar months after such person's decease, shall forfeit 50*l.*

Upon proving the will, the original is to be deposited in the registry of the ordinary, by whom a copy is made upon parchment under his seal, and delivered to the executor or administrator, together with a certificate of its having been proved before him, and this is termed the probate.

If all the goods of the deceased lie within the same jurisdiction, the probate is to be made before the ordinary or bishop of the diocese, where the deceased resided; but if he had goods and chattels to the value of 5*l.* in two distinct dioceses or jurisdictions, the will may be proved before the metropolitan or archbishop of the province in which the deceased died.

An executor, by virtue of the will of the testator, has an interest in all the goods and chattels, whether real or personal, in possession or in action of the deceased; and all goods and effects coming to his hands will be the assets to make him chargeable to creditors and legatees.

An executor or administrator stands personally responsible for the due discharge of his duty; if, therefore, the property of the deceased is lost, or through his wilful negligence becomes otherwise irrecoverable, he will be liable to make it good; and also where he retains money in his hands longer than is necessary, he will be chargeable not only with interest but costs, if any have been incurred.

But one executor shall not be answerable for money received, or detriment occasioned by the other, unless it has been by some act done between them jointly.

An executor or administrator has the same remedy for recovering debts and duties, as the deceased would have had if living.

Neither an executor nor administrator can maintain any action, for a personal injury done to the deceased, when such injury is of such a nature for which damages may be received; in actions however, which have their origin in breach of promise, although the suit may abate by the death of the party, yet it may be revived either by his executors or administrators, who may also sue for rent in arrear, and due to the deceased in his life-time.

By the custom of merchants, an executor or administrator may indorse over a bill of exchange or promissory note.

An executor or administrator may also, on the death of a lessee for years, assign over the lease, and shall not be answerable for rent after such assignment; nor shall he be liable for rent due after the lessee's death, from premises which in his life-time he had assigned to another.

An executor or administrator is bound only by such covenants in a lease as are said to run with the land.

The executor or administrator, previous to the distribution of the property of the deceased, must take an inventory of all his goods and chattels, which must, if required, be delivered to the ordinary upon oath.

He must then collect, with all possible convenience, all the goods and effects contained in such an inventory; and whatever is so recovered that is of a saleable nature, and can be converted into money, is termed assets, and makes him responsible to such amount to the creditors, legatees, and kindred of the deceased.

The executor or administrator having collected in the property, is to proceed to discharge the debts of the deceased, which he must do according to the following priorities, otherwise he will be personally responsible.

1. Funeral expences, charges of proving the will, and other expenditures incurred by the execution of his trust.

2. Debts due to the king on record, or by speciality.

3. Debts by particular statutes, as by 30 C. II. c. 23. Forfeitures for not burying in woollen, money due for poor-rates, and money due to the post-office.

4. Debts of record, as judgments, statutes, recognizances, and those recognized by a decree of a court of equity; and debts due on mortgage. 3 Peere Wms, 401.

5. Debts on special contracts, as bonds or other instruments under seal, and also rent in arrear.

6. Debts on simple contract, viz. such as debts arising by mere verbal promise, or by writing not under seal, as notes of hand, servants' wages, &c.

The executor is bound at his peril to take notice of debts on record, but not of other special contracts, unless he receives notice.

If no suit is actually commenced against an executor or administrator, he may pay one creditor in equal degree the whole debt, though there should be insufficient remaining to pay the rest; and even after the commencement of a suit, he may by confessing judgment to other creditors of the same degree, give them a preference.

Executors and administrators are also allowed, amongst debts of equal degree, to pay themselves first: but they are not allowed to retain their own debt, to the prejudice of others in a higher degree; neither shall they be permitted to retain their own debts, in preference to that of their co-executor or co-administrator of equal degree, but both shall be charged in equal proportion.

A mortgage made by the testator must be discharged by the representative out of the personal estate, if there is sufficient to pay the rest of the creditors and legatees. Where such mortgage, however, was not incurred by the deceased, it is not payable out of the personal estate. See LEGACIES, and ASSETS.

EXECUTOR *de son tort*, or an executor of his own wrong, a person that takes upon him the office of an executor by intrusion, without being so constituted by the testator, or appointed by the ordinary to administer. Such a person is chargeable to the rightful executor, as also to all the testator's creditors and legatees, so far as the goods amount to which he wrongfully possessed.

EXECUTORY ESTATE. Estates executory, are when they pass presently to the person to whom conveyed, without any after-act, 2 Inst. 513; and leases for years, rents, annuities, conditions, &c. are called inheritances executory. Id. 293.

EXECUTORY *devise*, is defined a future interest, which cannot vest at the death of a testator, but depends upon some contingency which must happen before it can vest. Abr. Eq. 186.

An executory devise differs from a remainder, in three very material points: 1. That it needs not any particular estate to support it. 2. That by it a fee-simple, or

ether less estate, may be limited after a fee-simple. 3. That hereby a remainder may be limited of a chattel interest, after a particular estate for life created in the same. 2 Black. 172.

Executory devises of terms for years.—If a farmer devises his term to A for life, the remainder to another, though A have the whole estate (for that is in him during his life) and so no remainder can be limited over, at common law, yet it is good by way of executory devise. 1 Rol. Abr. 610.

EXEDRÆ, in antiquity, a general name for such buildings as were distinct from the main body of the churches, and yet within the limits of the church taken in its largest sense. Among the exedræ the chief was the baptistery. Exedræ were also halls or little academies with several seats, upon which philosophers, rhetoricians, &c. sat when they met for conversation or disputation. Vitruvius speaks of them as places very open and exposed to the sun.

EXEGESIS, a discourse by way of explanation or comment upon any subject. In the Scotch universities there is an exercise among the students in divinity called an exegesis, in which a question is stated by the respondent, who is then opposed by two or three other students in their turns; during which time the professor moderates, and solves the difficulties which the respondent cannot overcome.

EXEMPLIFICATION *of letters patent*, a transcript or duplicate of them, made from the enrolment thereof, and sealed with the great seal. These exemplifications are by statute equally effectual, and may be pleaded as well as the originals. One may exemplify a patent under the great seal in chancery; also any record or judgment in any of the courts at Westminster, under the seal of each court; which exemplifications may be given in evidence to a jury. It is held, that nothing but matter of record ought to be exemplified.

EXEMPTION, in law, a privilege to be free from some service or appearance: thus, barons and peers of the realm are, on account of their dignity, exempted from being sworn upon inquests; and knights, clergymen, and others, from appearing at the sheriff's tourn. Persons of seventy years of age, apothecaries, &c. are also by law exempted from serving on juries; and justices of the peace, attorneys, &c. from parish-offices.

EXEMPTION, in the church of Rome, a privilege granted by the pope to the clergy, and sometimes to the laity, to exempt or free them from the jurisdiction of their respective ordinaries. Thus monasteries, and even private priests, for a small charge formerly procured exemptions from the jurisdiction of their bishops. In this, however, the council of Trent made a small reformation, by abolishing the exemption of particular priests, and monks not living in cloisters, and that of chapters in criminal matters.

EXERCISE, among physicians, such an agitation of the body as produces salutary effects in the animal œconomy. See MEDICINE.

EXERCISE, in military affairs, is the practice of all those motions and actions, together with the whole management of arms, which a soldier is to be perfect in, to render him fit for service, and make him understand how to attack and defend. Exercise is the first part of the military art; and the more it is considered, the more essential it will appear. It disengages the human frame from the stiff rusticity of simple nature, and forms men and horses to all the evolutions of war. The honour, merit, appearance, strength, and success of a corps, depend wholly upon the attention which has been paid to the drill and exercise of it, according to prescribed rules and regulations; while on the other hand we see the greatest armies, for want of being exercised, instantly disordered, and that disorder increasing in spite of command; the confusion oversets the art of skilful masters, and the valour of the men only serves to precipitate the defeat; for which reason it is the duty of every officer to take care that the recruits be drilled as soon as they join the corps.

The greatest advantage derived from exercise, is the expertness with which men become capable of loading and firing, and their learning an attention to act in conformity with those around them. It has always been lamented, that men have been brought on service, without being informed of the uses of the different manœuvres they have been practising; and that having no ideas of any thing but the uniformity of the parade, they instantly fall into disorder and confusion when they lose the step, or see a deviation from the straight lines they have been accustomed to at exercise. It is a pity to see so much attention confined to show, and so little given to instruct the troops in what may be of use to them on service. Though the parade is the place to form the characters of soldiers, and to teach them uniformity, yet when confined to that alone, it is too limited and mechanical for a true military genius.

The great loss which our troops sustained in Germany, America, and the West Indies, during a former war, from sickness, and not from the enemy, was chiefly owing to a neglect of exercise. An army whose numbers vanish after the first four months of a campaign, may be very ready to give battle in their existing period; but the fact is, that although fighting is one part of a soldier's business, yet bearing fatigue, and being in health, is another, and at least as essential as the first. A campaign may pass without a battle, but no part of a campaign can be gone through without fatigue, without marches, without an exposure to bad weather; all of which have exercise for their foundation; and if soldiers are not trained and inured to these casualties, but sink under them, they become inadequate to bodily fatigue, and eventually turn out a burthen to their country.

It is not from numbers, or from inconsiderate valour, that we are to expect victory; in battle it commonly follows capacity, and a knowledge of arms. We do not see that the Romans made use of any other means to conquer the world, than a continual practice of military exercises, an exact discipline in their camps, and a constant attention to cultivate the art of war. Hence, both antients and moderns agree, that there is no other way to form good soldiers but by exercise and discipline; and it is by a continual practice and attention to this, that the Prussians arrived at that point of perfection which has been so much admired in their evolutions, and manual exercise.

Formerly in the British service every commander in chief, or officer commanding a corps, adopted or invented such manœuvres as he judged proper, excepting in the instance of a few regulations for review; neither the manual exercise, nor quick and slow marching, were precisely defined by authority. In consequence, when regiments from different parts of the kingdom were brigaded, they were unable to act in line till the general officer commanding had established some temporary system to be observed by all under his command.

These inconveniences were at length obviated by the rules and regulations compiled by general Dundas on the system of the Prussian discipline, as established by Frederic the Great.

By his majesty's orders issued in 1792, this system is directed to be "strictly followed and adhered to, without any deviation whatsoever. And such orders before given, as are found to interfere with, or counteract their effect and operation, are to be considered as cancelled and annulled."

EXERCISE *of the infantry*, includes the use of the firelock and practice of the manœuvres for regiments of foot, according to the regulations issued by authority.

When a regiment of foot is drawn up, or paraded for exercise, the men are placed two, and sometimes three deep, which latter is the natural formation of a battalion. The grenadiers are on the right, and the light infantry on the left. In order to have the manual exercise well performed, it is in a particular manner requisite, that the ranks and files be even, well dressed, and the file-leaders well covered; this must be very strictly attended to both by the major and his adjutant; all officers also, on service in general, where men are drawn up under arms, or without, must be careful that the ranks and files are exactly even, and the soldiers must learn to dress themselves at once, without the necessity of being directed to do it. The beauty of all exercise and marching consists in seeing a soldier carry his arms well, keep his firelock steady and even in the hollow of his shoulder, the right hand hanging down, and the whole body without constraint. The musquets when shouldered, should be exactly dressed in rank and file; the men must keep their bodies upright, and in full front, not having one shoulder too forward, or the other too backward. The distances between the files must be equal, and not greater than from arm to arm, which gives the requisite room for the motions. The ranks are to be two paces distant from each other. Every motion must be done with life, and all facings, wheelings, and marchings, performed with the greatest exactness. Hence a regiment should never be under arms longer than two hours.

EXERCISE *of the cavalry*, is of two sorts, on horseback and on foot. The squadrons for exercise are sometimes drawn up three deep, though frequently two deep; the tallest men and horses in the front, and so on. When a regiment is formed in squadrons, the distance of 24 feet, as a common interval, is always to be left between the ranks, and the files must keep boot-top to boot-top. The officers commanding squadrons must,

above all things, be careful to form with great celerity, and during the whole time of exercise to preserve their several distances. In all wheelings, the flank which wheels must come about in full gallop. The men must keep a steady seat upon their horses, and have their stirrups at a fit length.

EXERCISE *of the artillery*, is the method of teaching the regiments of artillery the use and practice of all the various machines of war, viz.

EXERCISE *of the light field-pieces* teaches the men to load, ram, and sponge the guns well; to elevate them according to the distance, by the quadrant and screw; to judge of distances and elevations without the quadrant; how to use the portfire, match, and tubes for quick firing; how to fix the drag-ropes, and use them in advancing, retreating, and wheeling with the field-pieces; how to fix and unfix the trail of the carriage on the limbers, and how to fix and unfix the boxes for grape-shot on the carriages of each piece.

EXERCISE *of the garrison and battering artillery*, is to teach the men how to load, ram, and sponge; how to handle the hand-spikes in elevating and depressing the metal to given distances, and for ricochet; how to adjust the coins, and work the gun to its proper place; and how to point and fire with exactness, &c.

EXERCISE *for the mortar*, is of two different sorts, viz. with powder and shells unloaded, and with powder and shells loaded; each of which is to teach the men their duty, and to make them handy in using the implements for loading, pointing, traversing, and firing, &c.

EXERCISE *of the howitzer*, differs but little from the mortar, except that it is liable to various elevations; whereas that of the mortar is fixed to an angle of 45°; but the men should be taught the method of ricochet-firing, and how to practise with grape-shot; each method requiring a particular degree of elevation.

EXERCISES are also understood of what young gentlemen or cadets learn in the military academies and riding-schools; such as fencing, dancing, riding, the manual exercise, &c. The late establishment at High Wycomb is calculated to render young officers perfectly competent to all the duties of military service, provided they have been previously instructed in the first rudiments. Officers are there taught and exercised in the higher branches of tactics and manœuvres. We hope, for the sake of the army in general, that this institution will be extended in proportion to the service which a more enlarged scale would unquestionably render.

EX GRAVI QUERELA, in law, is a writ that lies for the person to whom any lands or tenements in fee are devised by will, and the heir of the devisor enters thereon, and detains them from the devisee. Also where a person devises such lands to another in tail with the remainder over in fee: here if the tenant in tail enters, and is seised by force of the intail, and afterwards he dies without issue, the person in remainder, or reversion, may bring this writ to execute the devise.

EXHALATION, a general term for all effluvia or steams, whether moist or dry, raised from the surface of the earth, in form of vapour. In the strict sense of the word, it applies to dry particles in opposition to EVAPORATION, which see.

Some indeed distinguish exhalations from vapours; expressing by the former all steams emitted from solid bodies, as earth, fire, sulphur, salts, minerals, &c. and by the latter, the steams raised from water and other fluids. Exhalations, therefore, according to them, are dry, subtile corpuscles, or effluvia, which are loosened and freed from hard earthy bodies, either by the heat of the sun, the agitation of the air, or the like causes; and being blended in the atmosphere with the moist vapours, help to constitute or form clouds and meteors. See METEOROLOGY.

EXHAUSTIONS, or *the method of Exhaustions*, a method of demonstration founded upon a kind of exhausting a quantity, by continually taking away certain parts of it.

The method of exhaustions was of frequent use among the antient mathematicians, as Euclid, Archimedes, &c. It is founded on what Euclid says in the 10th book of his Elements, viz. that those quantities are equal whose difference is less than any assignable quantity. Or thus: two quantities, A and B, are equal, when, if to or from one of them, as A, any other quantity, as d, be subtracted, however small it be, then the sum or difference is respectively greater or less than the other quantity B, viz. d being an indefinitely small quantity,

if $A + d$ be greater than B,
and $A - d$ less than B,
then is A equal to B.

This principle is used in the 1st prop. of the 10th book, which imports, that if from the greater of two quantities be taken more than its half, and from the remainder more than its half, and so on, there will at length remain a quantity less than either of those proposed. On this foundation it is demonstrated, that if a regular polygon of an infinite number of sides be inscribed in a circle, or circumscribed about it; then the space, which is the difference between the circle and the polygon, will by degrees be quite exhausted, and the circle become ultimately equal to the polygon. And in this way it is that Archimedes demonstrates that a circle is equal to a right-angled triangle, whose two sides about the right angle are equal, the one to the semidiameter, and the other to the perimeter of the circle.

Upon the method of exhaustions depends the method of indivisibles introduced by Cavalerius, which is but a shorter way of expressing the method of exhaustions; as also Wallis's Arithmetic of Infinites, which is a farther improvement of the method of indivisibles; and hence also the methods of increments, differentials, fluxions, and infinite series.

EXHEREDATION, in the civil law, the exclusion of a son by the father from inheriting his estate, termed among us disinheriting.

EXHIBIT, in law, is where a deed, or other writing, being produced in a chancery suit, to be proved by witnesses, the examiner or commissioner appointed after the examination of any such, certifies on the back of the deed, or writing, that the same was shewn to the witness, at the time of his examination, and by him sworn to.

EXHUMATION, the digging up of a body interred in holy ground, by the authority of a judge. By the French law the exhumation of a dead body is ordered, upon proof that he was killed in a duel; and a parson may demand the exhumation of any of his parishioners, when interred out of the parish without his consent.

EXIGENT, in law, a writ which lies where the defendant in a personal action cannot be found, nor any effects of his within the county, by which he may be attached or distrained. This writ is directed to the sheriff, to proclaim and call the defendant five county-court days, one day after another, charging him to appear under the pain of outlawry. Where a person indicted of felony, &c. absents himself so long, that the writ of exigent is awarded against him, such a withdrawing will be deemed a flight in law, whereby he is liable to forfeit his goods; and though he afterwards renders himself on the exigent, and is found not guilty, it is said the forfeiture shall stand; but if the party was in prison, or beyond the seas, he, or his executors, may reverse the award of the exigent, by writ of error. Upon all exigents a proclamation shall be issued out to make proclamations in the county where the defendant dwells, for him to yield himself, &c.

EXIGENTERS, four officers in the court of common-pleas, who make all exigents and proclamations, in all actions where process of outlawry lies. Writs of supersedeas, as well as the prothonotaries upon exigents, were likewise drawn up in their office.

EXILIUM, in law, signifies a spoiling, but seems to be restrained to the injury done to tenants by altering their tenure, ejecting them, &c.

EXIT, in law properly signifies issue or offspring; but is also applied to issues, annual rents, and profits of lands.

EX MERO MOTU, a formula used in the king's charters and letters patent, signifying that he grants them of his own will and motion. It is intended to bar all exceptions that might be taken to the charter or patent, by alleging the king, in granting them, was abused by false suggestions.

EXOACANTHA, a genus of the class and order pentandria digynia. The involucrum is spiny. The flowers all hermaphrodite, with equal inflexions; seeds ovate, striated. There is one species, of no note.

EXOCOETUS, or the *flying-fish*, in ichthyology, a genus belonging to the order of abdominales. See Plate Nat. Hist. fig. 190. The head is scaly, and it has no teeth; it has 10 radii in the branchiostege membrane; the body is whitish, and the belly is angular; the pectoral fins, the instruments of flight, are very large. When pursued by any other fish, it raises itself from the water by means of these long fins, and flies in the air to a considerable distance, till the fins dry, and then it falls down into the water. It is a fish that seems to lead a most miserable life. In its own element it is perpetually harassed by the dorados and other fish of prey. If it endeavours to avoid them by having recourse to the air, it either meets its fate from the gulls or the albatross, or is forced down again into the mouths of the inhabitants of the water, who below keep pace with its aerial excursions. This fish is caught in the Mediterranean and some other seas. It is most common between the tropics, and there its enemies are more particularly numerous. In these cli-

mates the flying-fishes spring out of the water by hundreds, to escape the rapacity of the dolphins, sharks, &c. When in the air, they have many formidable enemies to encounter within that element, viz. the pelican, eagle, diomeda, &c. and frequently throw themselves on board the ships to escape their pursuit. Their flesh is said to supply a palatable and nourishing food. There are two species.

EX OFFICIO, among lawyers, signifies the power a person has, by virtue of his office, to do certain acts without being applied to. Thus a justice of peace may ex officio at his discretion, take surety of the peace, without complaint made by any person whatsoever. There was formerly an oath ex officio, whereby a supposed offender was compelled in the ecclesiastical court to confess, accuse, or clear himself of a crime; but this law is repealed.

EXOMPHALUS, in surgery, called also omphalocele, and hernia umbilicalis, is a preternatural tumor of the abdomen at the navel from a rupture, or distension of the parts which invest that cavity. See SURGERY.

EXORCISM, among the ecclesiastical writers, the expelling devils from persons possessed, by means of conjurations and prayers.

EXORCISTS, in church-history, an order of men, in the antient church, whose employment it was to exorcise or cast out devils. See the preceding article.

EXORDIUM, in rhetoric, is the preamble or beginning, serving to prepare the audience for the rest of the discourse.

EXOTIC, an appellation denoting a thing to be the produce of foreign countries. Exotic plants of the hot climates are very numerous, and require the utmost attention of the gardener to make them thrive with us.

EXPANSION, as generally employed in science, denotes an increase of the bulk of any body by a power acting from within.

It may be laid down as a general rule, to which there is no known exception, that every addition or abstraction of caloric makes a corresponding change in the bulk of the body which has been subjected to this alteration in the quantity of its heat. In general, the addition of heat increases the bulk of a body, and the abstraction of it diminishes its bulk; but this is not uniformly the case, though the exceptions are not numerous. Indeed these exceptions are not only confined to a very small number of bodies, but even in them they do not hold, except at certain particular temperatures, while at all other temperatures these bodies are increased in bulk when heated, and diminished in bulk by being cooled. We may therefore consider expansion as one of the most general effects of heat. It is certainly one of the most important, as it has furnished us with the means of measuring all the others.

Though all bodies are expanded by heat and contracted by cold, and this expansion in the same body is always proportional to some function of the quantity of caloric added or abstracted; yet the absolute expansion, or contraction, has been found to differ exceedingly in different bodies. In general, the expansion of gaseous bodies is greatest of all; that of liquids is much smaller, and that of solids the smallest of all. Thus, 100 cubic inches of atmospheric air, by being heated from the temperature of 32° to that of 212°, are increased to 137.5 cubic inches; while the same augmentation of temperature only makes 100 cubic inches of water assume the bulk of 104.5 cubic inches; and 100 cubic inches of iron, when heated from 32° to 212°, assume a bulk scarcely exceeding 100.1 cubic inches. From this example, we see that the expansion of air is more than eight times greater than that of water, and the expansion of water about 45 times greater than that of iron.

An accurate knowledge of the expansion of gaseous bodies being frequently of great importance in chemical researches, many experiments have been made to ascertain it; yet, till lately, the problem was unsolved. The results of philosophers were so various and discordant, that it was impossible to form any opinion on the subject. This was owing to the want of sufficient care in excluding water from the vessels in which the expansion of the gases was measured. The heat which was applied converted portions of this water into vapour, which, mixing with the gas, totally disguised the real changes in bulk which it had undergone. To this circumstance we are to ascribe the difference in the determinations of de Luc, general Roy, Saussure, d'Ivernois, &c. Fortunately the problem has lately engaged the attention of Mr. Dalton of Manchester, and M. Gay Lussac; and their experiments, made with the proper precautions, have solved the problem. Mr. Dalton's experiments are distinguished by a simplicity of apparatus which adds greatly to their value, as it puts it in the power of others to repeat them without difficulty. It consists merely of a glass tube, open at one end, and divided into equal parts; the gas to be examined was introduced into it after being properly dried, and the tube is filled with mercury at the open end to a given point; heat is then applied, and the dilatation is observed by the quantity of mercury which is pushed out. M. Gay Lussac's apparatus is more complicated, but equally precise; and as his experiments were made on larger bulks of air, their coincidence with those of Mr. Dalton adds considerably to the confidence which may be placed in the results.

From the experiments of these philosophers it follows, that all gaseous bodies whatever undergo the same expansion by the same addition of heat, supposing them placed in the same circumstances. It is sufficient then to ascertain the law of expansion observed by any one gaseous body, in order to know the exact rate of dilatation of them all. Now, from the experiments of Gay Lussac we learn, that air, by being heated from 32° to 212°, expands from 100 to 137.5 parts; the increase of bulk for 180° is then 37.5 parts; or, supposing the bulk at 32° to be unity, the increase is equal to 0.375 parts; this gives us 0.00208, or $\frac{1}{480}$th part, for the expansion of air for 1° of the thermometer. Mr. Dalton found, that 100 parts of air, by being heated from 55° to 212°, expanded to 132.5 parts; this gives us an expansion of 0.00207, or $\frac{1}{483}$ part, for 1°; which differs as little from the determination of Lussac as can be expected in experiments of such delicacy.

From the experiments of Mr. Dalton, it appears that the expansion of air is almost perfectly equable; that is to say, that the same increase of bulk takes place by the same addition of caloric at all different temperatures. It is true, indeed, that the rate of diminution appears to diminish as the temperature increases. Thus the expansion from 55° to 133½°, or for the first 77½ degrees, was 167 parts; while the expansion from 133½ to 212°, or for the next 77°½, was only 158 parts, or 9 parts less than the first. But this difference, in all likelihood, is chiefly apparent; for de Luc has demonstrated that the thermometer is not an accurate measure of the increase of heat.

From the experiments of Gay Lussac, it appears that the steam of water, and the vapour of ether, undergo the same dilatation with air when the same addition is made to their temperature. We may conclude then that all elastic fluids expand equally and uniformly by heat; and that this expansion is nearly equable, though not perfectly so. The following table gives us the bulk of a given quantity of air at all temperatures from 32° to 212°.

Tem.	Bulk.	Tem.	Bulk.	Tem.	Bulk.
32°	100000	59°	105616	86°	111232
33	100208	60	105824	87	111440
34	100416	61	106032	88	111648
35	100624	62	106240	89	111856
36	100832	63	106448	90	112064
37	101040	64	106656	91	112272
38	101248	65	106864	92	112486
39	101456	66	107070	93	112688
44	101664	67	107280	94	112896
41	101872	68	107488	95	113104
42	102080	69	107696	96	113312
43	102288	70	107904	97	113520
44	102496	71	108112	98	113728
45	102764	72	108320	99	113936
46	102912	73	108528	100	114144
47	103120	74	108736	110	116224
48	103328	75	108944	120	118304
49	103536	76	109152	130	120384
50	103744	77	109360	140	122464
51	103952	78	109568	150	144544
52	104160	79	109776	160	126624
53	104268	80	109984	170	128704
54	104576	81	110192	180	130784
55	104784	82	110400	190	132864
56	104992	83	110608	200	134944
57	105220	84	110816	210	137024
58	105408	85	111024	212	137440

The expansion of liquid bodies differs from that of the elastic fluids, not only in quantity, but in the want of uniformity with which they expand when equal additions are made to the temperature of each. This difference seems to depend upon the fixity or volatility of the component parts of the liquid bodies; for in general those liquids expand most by a given addition of heat, whose boiling temperatures are lowest, or which contain in them an ingredient which readily assumes the gaseous form. Thus mercury expands less when heated to a given temperature than water, which boils at a heat much inferior to mercury; and alcohol is much more expanded than water, because its boiling temperature is lower. In like manner nitric acid is much more expanded than sulphuric acid; not only because its boiling point is lower, but because a portion of it has a tendency to assume the form of an elastic fluid. We may consider it therefore as a pretty general fact, that the higher the temperature neces-

sary to cause a liquid to boil, the smaller the expansion is which is produced by the addition of a degree of heat; or, in other words, the expansibility of liquids is nearly inversely as their boiling temperature.

Another circumstance respecting the expansion of liquids deserves particular attention. The expansibility of every one seems to increase with the temperature; or, in other words, the nearer a liquid is to the temperature at which it boils, the greater is the expansion produced by the addition of a degree of caloric; and, on the other hand, the farther it is from the boiling temperature, the smaller is the increase of bulk produced by the addition of a degree of caloric. Hence it happens, that the expansion of those liquids approaches nearest to equability whose boiling temperatures are highest; or, to speak more precisely, the ratio of the expansibility increases the more slowly, the higher the boiling temperature.

These observations are sufficient to show, that the expansion of liquids is altogether unconnected with their density. It depends upon the quantity of heat necessary to cause them to boil, and to convert them into elastic fluids. But we are altogether ignorant at present of the reason why different liquids require different temperatures to produce this change.

The following table will give the reader a precise notion of the rate of expansion of those liquids which have been hitherto examined by chemical philosophers.

Temp.	Mercury.	Linseed oil.	Sulphuric acid.	Nitric acid.	Water.	Oil of turpentine.	Alcohol.
30°	100000	100000	—	—	—	—	100000
40	100081	—	99752	99514	—	—	100539
50	100183	—	100000	100000	100023	100000	101105
60	100304	—	100279	100486	100091	100460	101688
70	100406	—	100558	100990	100197	100993	102281
80	100508	—	100806	101530	100332	101471	102890
90	100610	—	101054	102088	100694	101931	103517
100	100712	102760	101317	102620	100908	102446	104162
110	100813	—	101540	103196	—	102943	—
120	100915	—	101834	103776	101404	103421	—
130	101017	—	102097	104352	—	103954	—
140	101119	—	102320	105132	—	104573	—
150	101220	—	102614	—	102017	—	—
160	101322	—	102893	—	—	—	—
170	101424	—	103116	—	—	—	—
180	101526	—	103339	—	—	—	—
190	101628	—	103587	—	103617	—	—
200	101730	—	103911	—	—	—	—
212	101835	107250	—	—	104577	—	—

The expansion of solid bodies is so small, that a micrometer is necessary to detect the increase of bulk. As far as is known, the expansion is equable, at least the deviation from perfect equality is insensible. The following table exhibits the expansion of most of the solids which have been hitherto examined. Most of the experiments were made by Smeaton.

Temp.	Platinum.	Antimony	Steel.	Iron.	Cast-iron.	Bismuth.
32°	120000	120000	120000	120000	120000	120000
212	120104	120130	120147	120151		120167
White-heat			123428	121500	122571	

	Copper.	Cast-brass	Brass wire	Tin.	Lead.	Zinc.
32°	120000	120000	120000	120000	120000	120000
212	120204	120225	120232	120298	120344	120355

	Hammered zinc.	Zinc 8. Tin 1.	Lead 2. Tin 1.	Brass 2. Zinc 1.	Pewter.	Copper 3. Tin 1.
32°	120000	120000	120000	120000	120000	120000
212	120373	120323	120301	120247	120274	120218

The expansion of glass is a point of great importance, as it influences the result of most experiments on temperature. It has been examined with much precision by M. de Luc. The rate of its expansion, as settled by that philosopher, may be seen in the following table:

Temp.	Bulk.	Temp.	Bulk.	Temp.	Bulk.
32°	100000	100°	100023	167°	100056
50	100006	120	100033	190	100069
70	100014	150	100044	212	100083

From this table it appears, that when glass is heated one degree, it undergoes an expansion which amounts nearly to $\frac{1}{200000}$ of the whole bulk.

On the supposition that metals expand equably, the expansion of a mass of metal, by being heated a given number of degrees, is as follows: Let $a =$ the expansion of the mass in length for °, which must be found by experiment; $b =$ the number of degrees whose expansion is required; $s =$ the solid contents of the metallic mass; $x =$ the expansion sought; then $x = 3\,b\,a\,s$.

The property which bodies possess of expanding, when heat is applied to them, has furnished us with an instrument for measuring the relative temperature of bodies. See THERMOMETER.

Having considered the phenomena and laws of expansion as far as they are understood, it will be proper to state the exceptions to this general effect of heat, or the cases in which expansion is produced not by an increase, but by a diminution of temperature. These exceptions may be divided into two classes. The first class comprehends certain liquid bodies which have a maximum of density corresponding with a certain temperature; and which, if they are heated above that temperature, or cooled down below it, undergo in both cases an expansion or increase of bulk. The second class comprehends certain liquids which suddenly become solid when cooled down to a certain temperature; and this solidification is accompanied by an increase of bulk.

Water furnishes us with the most remarkable example of the first class of bodies. Its maximum of density corresponds with 42°.5 of Fahrenheit's thermometer, as has been lately ascertained by Mr. Dalton. If it is cooled down below 42°.5, it undergoes an expansion for every degree of temperature which it loses; and at 32° the expansion amounts, according to Mr. Dalton, to $\frac{1}{160}$ of the whole expansion which water undergoes when heated from 42°.5 to 212°. With this more recent experiments coincide very nearly; for by cooling 100000 parts in bulk of water from 42°.5 to 32°, they were converted to 100031 parts. We are indebted to the ingenuity of Mr. Dalton for the discovery of a very unexpected fact, that the expansion of water is the same for any number of degrees above or below the maximum of density. Thus if we heat water ten degrees above 42°.5, it occupies precisely the same bulk as it does when cooled down ten degrees below 42°.5. Therefore the density of water at 32° and at 53° is precisely the same. Mr. Dalton succeeded in cooling water down to the temperature of 5° without freezing, or 37°.5 below the maximum point of density; and during the whole of that range, its bulk precisely corresponds with the bulk of water the same number of degrees above 42°.5. Thus the bulk of water at 5° is the same as the bulk of water at 80°. The scale of expansion, therefore, which has been given for the expansion of water when heated, answers also for its expansion when cooled, provided the table begin at 42°.5, as is done in the table of the expansion of water. From this table it appears that the expansion of water, the original bulk being 10000, may be expressed pretty nearly by the following numbers:

Temp.	Expan.
82°.5	$6.^2$
102°.5	8^2
122°.5	10^2
142°.5	12^2
162°.5	14^2

The greatest deviation from these numbers is towards the beginning of the scale, when, owing to the smallness of the expansion, it is difficult to measure it with precision. It leads us to this remarkable conclusion, that the squares of the natural numbers beginning at 6 indicate the increase of bulk which 10000 parts of water experience for every ten degrees they are heated above 82°.5, or cooled below 12°.5. This rule will give the reader a more precise idea of the rate at which water expands when heated or cooled, than a bare inspection of the table could do.

A considerable number of liquids has been tried to ascertain whether any of them, like water, have a temperature in which their density is a maximum, and which expand when cooled below that temperature. Sulphuric acid has no such point, neither have the oily bodies; but some solutions of salt in water begin to expand before they become solid. These solutions, however, when cooled down sufficiently, crystallize with such rapidity, that it is extremely difficult to be certain of the fact, that they really do begin to expand before they crystallize.

That class of bodies which undergo an expansion when they change from a liquid to a solid body by the diminution of temperature, is very numerous. Not only water when converted into ice undergoes such an expansion, but all bodies which by cooling assume the form of crystals.

The prodigious force with which water expands in the act of freezing has been long known to philosophers. Glass bottles filled with water are commonly broken in pieces when the water freezes. The Florentine academicians burst a brass globe whose cavity was an inch in diameter, by filling it with water and freezing it. The force necessary for this effect was calculated by Muschenbroeck at 27720 lbs. But the most complete set of experiments on the expansive force of freezing water are those made by major Williams at Quebec, and published in the second volume of the Edinburgh Transactions. This expansion has been explained, by supposing it the consequence of a tendency which water, in consolidating, is observed to have to arrange its particles in one determinate manner, so as to form prismatic crystals, crossing each other at angles of 60° and 120°. The force with which they arrange themselves in this manner must be enormous, since it enables small quantities of water to overcome so great mechanical pressures. Various methods have been tried to ascertain the specific gravity of ice at 32°; that which succeeded best was to dilute spirits of wine with water till a mass of solid ice put into it remained in any part of the liquid without either sinking or rising. The specific gravity of such a liquid is 0.92, which of course is the specific gravity of ice, supposing the specific gravity of water at 60° to be 1. This is an expansion much greater than water experiences even when heated to 212°. We see from this, that water, when converted into ice, no longer observes that equable expansion measured by Mr. Dalton, but undergoes a very rapid and considerable augmentation of bulk.

The very same expansion is observed during the crystallization of most of the salts; all of them at least which shoot into prismatic forms. Hence the reason that the glass vessels in which such liquids are left, usually break to pieces when the crystals are formed.

This expansion of these bodies cannot be considered as an exception to the general fact, that bodies increase in bulk when heat is added to them; for the expansion is the consequence, not of the diminution of heat, but of the change in their state from liquids to solids, and the new arrangement of their particles which accompanies or constitutes that change.

It must be observed, however, that all bodies do not expand when they become solid. There are a considerable number which diminish in bulk; and in these the rate of diminution in most cases is rather increased by solidification. When liquid bodies are converted into solids, they either form prismatic crystals, or they form a mass in which no regularity of arrangement can be perceived. In the first case, expansion accompanies solidification; in the second place, contraction accompanies it. Water and all the salts furnish instances of the first, and tallow and oils are examples of the second. In these last bodies the solidification does not take place instantaneously, as in water and salts, but slowly and gradually; they first become viscid, and at last quite solid. Most of the oils, when they solidify, form very regular spheres. The same thing happens to honey, and to some metals. It has been thought that all combustible liquids contract, when they become solid, while incombustible liquids expand; but there are exceptions to this rule. Sulphuric acid does not by congelation alter its appearance; but cast iron, and perhaps sulphur also, expand in the act of congealing.

EX PARTE, a term used in the court of chancery, when a commission is taken out and executed by one side or party only, upon the other parties neglecting or refusing to join therein. When both the parties proceed together, it is called a joint commission.

EX PARTE TALIS, a writ that lies for a bailiff or receiver, that having auditors assigned to pass his accounts, cannot procure from them reasonable allowance, but is cast into prison; in which case the practice is to sue this writ out of the chancery, directed to the sheriff to take the four mainpernors to bring his body before the barons of the exchequer, at a certain day, and to warn the lord to appear at the same time.

EXPECTANT, in law, signifies having relation to, or depending on; thus, where land is given to a man and his wife, and to their heirs, they have a fee simple estate; but if it be given to them and the heirs of their bodies begotten, they have an estate tail, and a fee expectant, which is opposed to fee simple.

EXPECTATION, in the doctrine of chances, is applied to any contingent event, upon the happening of which some benefit, &c. is expected. This is capable of being reduced to the rules of computation; for a sum of money in expectation when a particular event happens, has a determinate value before that event happens. Thus, if a person is to receive any sum as 10*l.* when an event takes place which has an equal chance or probability of happening and failing, the value of the expectation is half that sum, or 5*l.*; but if there are three chances for failing, and only one for its happening, or one chance only in its favour out of all the four chances, then the probability of its happening is only one out of four, or $\frac{1}{4}$, and the value of the expectation is but $\frac{1}{4}$ of 10*l.* which is only 2*l.* 10*s.* or half the former sum. And in all cases, the value of the expectation of any sum is found by multiplying that sum by the fraction expressing the probability of obtaining it. So the value of the expectation on 100*l.* when there are three chances out of five for obtaining it, or when the probability of obtaining it is 3-fifths, is 3-fifths of 100*l.* which is 60*l.* And if s be any sum expected on the happening of an event, h the chances for that event happening, and f the chances for its failing; then, there being h chances out of $f + h$ for its happening, the probability will be $\frac{h}{f+h}$, and the value of the expectation is $\frac{h}{f+h} \times s$.

See CHANCES.

EXPECTATION *of Life*, the share of life due to a person of a given age, according to a table of mortality. The most obvious sense of the term, is certainly, "the particular number of years which a life of a given age has an equal chance of enjoying:" this is the time that a person may reasonably expect to live; for the chances against his living longer are greater than those for it; and therefore, he cannot entertain an expectation of living longer, consistently with probability: but this period does not coincide with what the writers on Life Annuities call the Expectation of Life, except on the supposition of an uniform decrease in the probabilities of life, as Mr. Simpson has observed in his Select Exercises; and Dr. Price adds, that even on this supposition, it does not coincide with what is called the expectation of life, in any case of joint lives; he therefore defines it more accurately to be, "The mean continuance of any given single, joint, or surviving lives, according to any given table of observations:" that is, the number of years which, taking them one with another, they actually enjoy, and may be considered as sure of enjoying; those who live or survive beyond that period, enjoying as much more time in proportion to their number, as those who fall short of it enjoy less.

The particular proportion that becomes extinct every year, out of the whole number constantly existing together of single or joint lives, must, wherever this number undergoes no variation, be the same with the expectation of those lives, at the time when their existence commenced. Thus, was it found in any town or district, where the number of births and burials are equal, that a 20th or a 30th part of the inhabitants die annually, it would appear, that 20 or 30 was the expectation of a child just born in that town or district; and if a 18th part of all the inhabitants of the age of 60 years and upwards die annually, the expectation of a person of 60 years of age is 13 years. These expectations, therefore, for all single lives, are easily found by a Table of Mortality, shewing the number that die annually at all ages, out of a given number alive at those ages; and the general rule for this purpose is, "to divide the sum of all the living in the Table, at the age whose expectation is required, and at all greater ages, by the sum of all that die annually at that age, and above it; or, which is the same, by the number in the table of the living at that age: and half unity subtracted from the quotient will be the required expectation." Thus the sum of all the living at the age of 60 and upwards, in Table I, is 27953, which divided by 2038, the number living at that age, and the quotient less half unity, gives 13,21, the expectation of 60, as in Table II.

TABLE I.

Shewing the Probabilities of the Duration of Human Life, deduced from the Register of Mortality at Northampton.

Age.	Persons living.	Decrem. of Life	Age.	Persons living.	Decrem. of Life.
0	11650	3000	49	2936	79
1	8650	1367	50	2857	81
2	7283	502	51	2776	82
3	6781	335	52	2694	82
4	6446	197	53	2612	82
5	6249	184	54	2530	82
6	6065	140	55	2448	82
7	5925	110	56	2366	82
8	5815	80	57	2284	82
9	5735	60	58	2202	82
10	5675	52	59	2120	82
11	5623	50	60	2038	82
12	5573	50	61	1956	82
13	5523	50	62	1874	81
14	5473	50	63	1793	81
15	5423	50	64	1712	80
16	5373	53	65	1632	80
17	5320	58	66	1552	80
18	5262	63	67	1472	80
19	5199	67	68	1392	80
20	5132	72	69	1312	80
21	5060	75	70	1232	80
22	4985	75	71	1152	80
23	4910	75	72	1072	80
24	4835	75	73	992	80
25	4760	75	74	912	80
26	4685	75	75	832	80
27	4610	75	76	752	77
28	4535	75	77	675	73
29	4460	75	78	602	68
30	4385	75	79	534	65
31	4310	75	80	469	63
32	4235	75	81	406	60
33	4160	75	82	346	57
34	4085	75	83	289	55
35	4010	75	84	234	48
36	3935	75	85	186	41
37	3860	75	86	145	34
38	3785	75	87	111	28
39	3710	75	88	83	21
40	3635	76	89	62	16
41	3559	77	90	46	12
42	3482	78	91	34	10
43	3404	78	92	24	8
44	3326	78	93	16	7
45	3248	78	94	9	5
46	3170	78	95	4	3
47	3092	78	96	1	1
48	3014	78			

The probability that a given life shall continue any number of years, or reach a given age, is the fraction, whose numerator is the number of the living in the Table opposite to the given age; and denominator, the number opposite to the present age of the given life. Thus, the probability that a life of 30 shall attain to 40, or live 10 years, is $\frac{3635}{4385}$. The difference between this fraction and unity gives the probability that the event will *not* happen; the probability that a life of 30 will not live 10 years, is therefore $\frac{750}{4385}$, consequently the odds of living to dying, in this period, are nearly 5 to 1. The probability that a person of 21 shall attain to 54, appears by the Table to be $\frac{2530}{5060}$, or an even chance.

TABLE II.

Shewing the Expectation of Human Life at every Age, according to the Probabilities in the preceding Table.

Age.	Expectation.	Age.	Expectation.	Age.	Expectation.
0	25,18	33	26,72	66	10,42
1	32,74	34	26,20	67	9,96
2	37,79	35	25,68	68	9,50
3	39,55	36	25,16	69	9,05
4	40,58	37	24,64	70	8,60
5	40,84	38	24,12	71	8,17
6	41,07	39	23,60	72	7,74
7	41,03	40	23,08	73	7,38
8	40,79	41	22,56	74	6,92
9	40,36	42	22,04	75	6,54
10	39,78	43	21,54	76	6,18
11	39,14	44	21,03	77	5,83
12	38,49	45	20,52	78	5,48
13	37,83	46	20,02	79	5,11
14	37,17	47	19,51	80	4,75
15	36,51	48	19,00	81	4,41
16	35,85	49	18,49	82	4,09
17	35,20	50	17,99	83	3,80
18	34,58	51	17,50	84	3,58
19	33,99	52	17,02	85	3,37
20	33,43	53	16,54	86	3,19
21	32,90	54	16,06	87	3,01
22	32,39	55	15,58	88	2,86
23	31,88	56	15,10	89	2,66
24	31,36	57	14,63	90	2,41
25	30,85	58	14,15	91	2,09
26	30,33	59	13,68	92	1,75
27	29,82	60	13,21	93	1,37
28	29,30	61	12,75	94	1,05
29	28,79	62	12,28	95	0,75
30	28,27	63	11,81	96	0,50
31	27,76	64	11,35		
32	27,24	65	10,88		

These tables are, for general use, the best that have been formed; but it is well known, that the duration of human life is much influenced by different situations; that it is greater in mountainous countries than in marshy districts; and that the country in general is much more favourable to the continuance of life than large towns. In proof of the latter assertion Dr. Price has observed, that in London the greater part of the natives die under three years of age, while in the country the greater part live to marry. The observations of Mr. Muret on the state of population in the Pays de Vaud, a district of the province of Bern in Switzerland, also confirm this remark, by shewing that the greater part of the inhabitants of that province live many years beyond maturity. A comparison of the expectations of life will exhibit this difference in a striking point of view.

	Holy Cross.	Swe-den.	Brand-enberg	Nor-wich.	Berlin.	Vien-na.	Lon-don.
At Birth	34	34½	30¼	23¼	18	16¼	18
Age 10	46	45	42¼	40¼	37¼	37	35
20	38¾	38	34½	34½	30¼	31¼	29
30	32¼	31½	28¼	29	25¼	25¾	23½
40	26¼	24½	22¾	23½	21	20¼	19½
50	20¼	18¼	16¼	17¼	16½	16	16
60	14¼	12½	11½	12¼	12¾	11¾	12¼
70	10	7½	7½	8¼	8¼	8¼	8
80	5¾	4¼	5	5¼	6	5¼	5

Ages at which 1000 Inhabitants die, in several principal Towns and Districts.

	Vaud in Switzerland.	Sweden.	Parish in Brandenberg.	Northampton.	Norwich.	London 1771 to 1780.	London 1728 to 1737.	Berlin.	Vienna.	Stockholm.
Under 10	347	388	423	513	560	593	590	519	673	653
10 to 20	43	42	50	47	46	46	50	26	40	39
20 to 30	47	51	41	64	53	56	59	80	40	56
30 to 40	57	60	54	64	52	66	72	86	48	64
40 to 50	75	74	58	67	57	72	70	73	52	61
50 to 60	117	92	92	70	65	61	57	80	52	50
60 to 70	146	118	116	69	74	51	48	63	48	41
70 to 80	122	119	122	66	62	38	31	50	32	29
80 and upwards	46	56	44	40	31	17	23	23	15	7

Proportion of Inhabitants dying annually

In London - - -	1 in 20¾
Edinburgh - - -	1 in 20⅘
Dublin - - -	1 in 22⅗
Stockholm - - -	1 in 19
Vienna - - -	1 in 19½
Rome - - - -	1 in 21½
Amsterdam - - -	1 in 24
Norwich - - -	1 in 24½
Northampton - -	1 in 26⅖
Liverpool - - -	1 in 27
Manchester - - -	1 in 28
Savannah in Georgia -	1 in 31 7/10
Wirtemburgh	1 in 32
Sweden - - -	1 in 35
Kingdom of Naples -	1 in 37⅓
Parish in Brandenberg -	1 in 45
Pays de Vaud - -	1 in 45
Philadelphia - -	1 in 45
Ackworth in Yorkshire	1 in 47
Salem in Massachusetts	1 in 47
Island of Madeira -	1 in 50
Corfe-castle, Dorset -	1 in 56⅓

These comparisons strongly shew the baleful influence of great cities in shortening human life. The irregular modes of life, the luxuries, debaucheries, and pernicious customs, which prevail much more in towns than in the country; and the foulness of the air, which is rendered in a great degree unfit for respiration; are undoubtedly the causes which produce this fatal effect.

EXPECTORANTS. See PHARMACY.

EXPECTORATION, the act of evacuating

or bringing up phlegm, or other matters, out of the trachea and lungs, by coughing, &c.

EXPENDITORS, the persons who disburse or expend the money collected by the tax for repairs of sewers, after the same is paid into their hands by the collectors, as ordered by the commissioners, and for which they are to render accounts when required.

EXPENSIS MILITUM LEVANDIS, a writ antiently directed to the sheriff for levying the allowance for knights of the shire; and expensis militum non levandis, was a writ to hinder the sheriff from levying such allowance upon lands that held in antient demesne.

EXPERIMENTAL PHILOSOPHY, that philosophy which proceeds on experiments; which deduces the laws of nature, and the properties and powers of bodies, and their actions upon each other, from sensible experiments and observations. The business of experimental philosophy is to enquire into and to investigate the reasons and causes of the various appearances or phænomena of nature; and to make the truth or probability of them obvious and evident to the senses, by plain, undeniable, and adequate experiments, representing the several parts of the grand machinery and agency of nature.

In our enquiries into nature, we are to be conducted by those rules and maxims which are found to be genuine, and consonant to a just method of physical reasoning; and these rules of philosophizing are by the greatest master in science, sir Isaac Newton, reckoned four, which are as follows:

1. More causes of natural things are not to be admitted, than are both true, and sufficient to explain the phænomena; for nature does nothing in vain, but is simple, and delights not in superfluous causes of things.

2. And, therefore, of natural effects of the same kind, the same causes are to be assigned, as far as it can be done; as of respiration in man and beasts, of the descent of stones in Europe and America, of light in a culinary fire and in the sun, and of the reflection of light in the earth and in the planets.

3. The qualities of natural bodies which cannot be increased or diminished, and agree to all bodies on which experiments can be made, are to be reckoned as the qualities of all bodies whatever; thus, because extension, divisibility, hardness, impenetrability, mobility, the vis inertiæ, and gravity, are found in all bodies which fall under our cognizance or inspection, we may justly conclude they belong to all bodies whatever, and are therefore to be esteemed the original and universal properties of all natural bodies.

4. In experimental philosophy, propositions collected from the phænomena by induction, are to be deemed (notwithstanding contrary hypotheses) either exactly or very nearly true, till other phænomena occur, by which they may be rendered either more accurate, or liable to exception. This ought to be done, lest arguments of induction should be destroyed by hypotheses.

These four rules of philosophizing are premised by sir Isaac Newton to his third book of the Principia; and more particularly explained by him in his Optics, where he exhibits the method of proceeding in philosophy, the first part of which is as follows:

As in mathematics, so in natural history, the investigation of difficult things, by way of analysis, ought always to precede the method of composition. This analysis consists in making experiments and observations, and in drawing general conclusions from them by induction (*i. e.* reasoning from the analogy of things by natural consequence); and admitting no objections against the conclusions, but what are taken from experiments or certain truths. And although the reasoning from experiments and observation, by induction, is no demonstration of general conclusions, yet it is the best mode of reasoning which the nature of things admits of, and may be looked on as so much the stronger, by how much the induction is more general; and if no exception occurs from phænomena, the conclusion may be pronounced generally; but if at any time afterwards, any exception shall occur from experiments, it may then be pronounced with such exceptions; by this way of analysis we may proceed from compounds to ingredients, and from motions to the causes producing them; and in general from effects to their causes, and from particular causes to more general ones, till the argument ends in the most general; this is the method of analysis. And that of synthesis, or composition, consists in assuming causes, discovered and established as principles, and by them explaining the phænomena proceeding from them, and proving the explanations. Though the whole history of nature is open to the researches of experimental philosophy, yet its principal branches may be accounted, attraction, gravitation, the laws of matter and motion, magnetism, optics, electricity, pneumatics, hydrostatics, hydraulics, and mechanics.

EXPERIMENTUM CRUCIS, a leading, or decisive experiment; thus termed, either on account of its being like a cross, or direction post, placed in the meeting of several roads, guiding men to the true knowledge of the nature of that thing they are enquiring after; or, on account of its being a kind of torture, whereby the nature of the thing is in a manner extorted by force.

EXPIATION, *great day of*, an annual solemnity of the Jews, upon the tenth day of the month Tisri, which answers to our September. On this occasion the high priest laid aside his breastplate and embroidered ephod, as being a day of humiliation. He first offered a bullock and a ram for his own sins, and those of the priests; then he received from the heads of the people two goats for a sin-offering, and a ram for a burnt-offering, to be offered in the name of the whole multitude. It was determined by lot which of the goats should be sacrificed, and which set at liberty. After this he perfumed the sanctuary with incense, and sprinkled it with blood; then, coming out, he sacrificed the goat upon which the lot had fallen. This done, the goat which was to be set at liberty, being brought to him, he laid his hands upon its head, confessed his sins and the sins of the people, and then sent him away into some desert place: it was called azazel, or the scape goat.

EXPILATION, among civilians, the carrying off or sequestering something belonging to an inheritance, before the heir had intermeddled with it.

EXPILATION also denoted a robbery committed by night, and was so called from the robbers stripping people of their clothes.

EXPLOSION, in natural philosophy, a sudden and violent expansion of an aerial or other elastic fluid, by which it instantly throws off any obstacle that happens to be in the way, sometimes with incredible force, and in such a manner as to produce the most astonishing effects upon the neighbouring objects. Explosion differs from expansion, in this: that the latter is a gradual and continued power, acting uniformly for some time; whereas the former is always sudden, and only of momentary duration. The expansions of solid substances do not terminate in violent explosions, on account of their slowness, and the small space through which the metal, or other expanding substance, moves, though their strength may be equally great with that of the most active aerial fluids. Thus we find, that though wedges of wood, when wetted, will cleave solid blocks of stone, they never throw them to any distance, as is the case with gunpowder. On the other hand, it is seldom that the expansion of any elastic fluid bursts a solid substance, without throwing the fragments of it to a considerable distance, the effects of which are often very terrible. The reasons of this may be comprised in the two following particulars. 1. The immense velocity with which the aerial fluids expand, when affected by a considerable degree of heat. 2. Their celerity in acquiring heat, and being affected by it, which is much superior to that of solid substances. Thus air, heated as much as iron when brought to a white heat, is expanded to four times its bulk; but the metal itself will not be expanded the 500th part of that space. In the case of gunpowder, which is a violent and well-known explosive substance, the velocity with which the flame moves is calculated by Mr. Robins, in his treatise upon Gunnery, to be no less than 7000 feet in a second, or little less than 79 miles per minute. Hence the impulse of the fluid is inconceivably great, and the obstacles on which it strikes are hurried off with vast velocity, though much less than that just mentioned; for a cannon-ball, with the greatest charge of powder that can be conveniently given, does not move at a greater rate than 2400 feet per second, or little more than 27 miles per minute. The velocity of the ball again is promoted by the sudden propagation of the heat through the whole body of the air, as soon as it is extricated from the materials of which the gunpowder is made, so that it is enabled to strike all at once, and thus greatly to augment the momentum of the ball. It is evident that this contributes very much to the force of the explosion, by what happens when powder is wetted or mixed with any substance, which prevents it from taking fire all at once. In this case the force of the explosion, even when the same quantity of powder is made use of, is not to be compared with that of dry powder.

We may conclude, upon these principles, that the force of an explosion depends, 1. on the quantity of elastic fluid to be expanded; 2. on the velocity it acquires by a certain degree of heat; and 3. on the celerity with which the degree of heat affects the whole of the expansile fluid. These three take place in the greatest perfection where the electric fluid is concerned, as in cases of lightning, earthquakes, and volcanoes. This fluid pervades the whole system of nature; its expan-

sion is nothing else than its motion from a centre towards a circumference, for it does not seem capable of any proper expansion by a separation of its parts like any other fluid. Hence, when it begins to expand in this manner, the motion is propagated through it, with a velocity far exceeding that of any other fluid whatever. Thus, even when the quantity is excessively small, as when an electric spark is sent through a glass full of water or of oil, the expansion is so violent as to dissipate the glass into innumerable fragments, with great danger to the by-standers. In violent lightning, when the electric fluid is much concentrated, the strength of the explosion is proportionable to the quantity. Every one has heard of the prodigious effects of lightning when it happens to strike buildings, trees, or even the most solid rocks; and in some cases, where the quantity of electricity is still greater than in any flash of lightning, we hear of still more tremendous consequences ensuing. Dr. Priestley gives an instance of a large fire-ball rolling on the surface of the sea, which, after rising up to the top-mast of a ship of war, burst with such violence, that the explosion resembled the discharge of hundreds of cannons fired at once. Great damage was done by it; but there is not the least doubt that most of its force was spent on the air, or carried down to the sea by the mast and iron-work of the ship. Indeed, considering that in all cases a great part of the force of electric explosions is dissipated in this manner, it may justly be doubted whether they can be measured by any method applicable to the mensuration of other forces. Even in artificial electricity the force is prodigiously great, insomuch that Dr. Van Marum calculated that of the great battery belonging to the machine in Teyler's museum to be upwards of 900 pounds.

Whenever the electrical fluid acts like common fire, the force of the explosions, though exceedingly great, is capable of mensuration, by comparing the distances to which the bodies are thrown with their weight. This is most evident in volcanoes, where the projections of the burning rocks and lava manifest the greatness of the power, at the same time that they afford a method of measuring it. By means of the fire which kindles the volcanoes, the aerial fluids are suddenly restored to their elastic state; and not only so, but their natural elasticity is greatly augmented, so that the explosions take place with great violence. The case is the same with gunpowder. The reason of the extreme quickness of the explosion of gunpowder is, that it takes fire so readily by the intimate mixture and combustibility of all the materials. In volcanoes the explosions likewise follow one another very quickly, and are by no means inferior in strength to those of gunpowder; but here the quantity of vapour makes up for the comparative slowness with which it is affected by the heat. Thus, though we could not by any other means contrive to fire cannon in such quick succession as we can do with gunpowder, yet in the huge furnace of a volcano the elastic matter is supplied in such quantities, that the explosions are in a manner unremitting; and even in ordinary experiments the confinement of aerial vapours has often occasioned violent explosions in chemical vessels. Carbonic acid gas though heavier than most of the other aerial fluids, yet by its expansion contributes equally to the force of the explosion, as is evident, in that of pulvis fulminans. This is compounded of sulphur, saltpetre, and salt of tartar. The latter we know contains much carbonic acid gas; and it is probable that the violence of the explosion is occasioned by this air; for it is said that the greater quantity of it the alkaline salt contains, the greater force does it explode with.

Next in strength to the aerial vapours are those of aqueous and other liquids. The most remarkable effects of these are observed in steam-engines; but there is one particular case from which it has been inferred that aqueous steam is vastly stronger than the flame of gunpowder. This is when water is thrown upon melted copper; for here the explosion is so strong as almost to exceed imagination; and the most terrible accidents have been known to happen from such a slight cause as one of the workmen spitting in the furnace where copper was melting. Here, however, it is most probable that a decomposition of the water takes place, and on this supposition, the phænomenon is easily solved. The water being thrown in substance upon the melted copper, is decomposed by the violent heat; and one part of it adheres to the metal, thus converting it into a kind of calx, while the other is converted into inflammable air, which expanding suddenly, throws the melted metal about with the greatest violence by means of its reaction.

In order to understand the manner in which this is accomplished, we must consider some of the principles of gunnery laid down by Mr. Robins. One of these is, that though the air, in cases of ordinary velocity, makes no great resistance, it is far otherwise where the velocity of the moving body becomes very great. In all cases of explosion also there is in the first instance a vacuum made by the exploding fluid; and consequently the weight of the atmosphere is to be overcome, which amounts to about 15 pounds on every square inch of surface. Supposing the surface of the exploding fluid then, on that of melted copper, to contain an area of four square inches, it meets with a resistance of 60 pounds from the atmosphere, and consequently communicates an equal pressure to the fluid metal. Even this must of consequence throw it about, unless the same pressure was exactly diffused over every part of the surface. But much more must this effect be increased by the immense velocity with which the fluid moves, and by which the resistance of the atmosphere is augmented in a prodigious degree. The elastic fluid generated is then confined not only by the fluid metal and sides of the furnace, but by the air itself, which cannot get out of the way, so that the whole resembles a cannon closed at the mouth, and filled with inflamed gunpowder. Hence not only the melted metal, but the furnace itself, and the adjacent walls of the building, are hurried off as they would be by the firing of a great quantity of gunpowder in a small space, and which is well known to produce analogous effects.

Dr. Black, in explaining the phænomenon in question, supposes that the mere heat of the metal applied to the aqueous steam produces the explosion; and in proof of this, alleges that copper imbibes a greater quantity of heat during fusion than any other metal. Aqueous steam, however, seems to be too slow for producing such sudden and violent effects. Explosions, it is true, will be occasioned by it, but then it must be confined for a very considerable time, whereas the effects of water thrown upon melted copper are instantaneous.

It must be observed, that in all cases where a very hot body is thrown upon a small quantity of water in substance, an explosion will follow; but here the water is confined, and suddenly rarefied into steam, which cannot get away without throwing off the body which confines it. Examples of this kind frequently occur where masons, or other mechanics, are employed in fastening cramps of iron into stones; where, if there happens to be a little water in the hole into which the lead is poured, the latter will fly out in such a manner as sometimes to burn them severely. Terrible accidents of this kind have sometimes happened in foundries, when large quantities of melted metal have been poured into wet moulds. In these cases, the sudden expansion of the aqueous steam has thrown out the metal with violence; and if any decomposition has taken place at the same time, so as to convert the aqueous into an aerial vapour, the explosion must be still greater.

To this last kind of explosion we must refer that which takes place on pouring cold water into boiling or burning oil or tallow. Here the case is much the same whether we pour the oil on the water, or the water on the oil. In the former case, the water which lies at the bottom is rarefied into steam, and explodes; in the latter, it sinks down through the oil by its superior specific gravity, and explodes as it passes along. In either case, however, the quantity of aqueous fluid must be but small in proportion to that of the oil; a very great quantity would put out the flame, or destroy the heat, in whatever way we applied it.

Another kind of explosion is that which takes place in solid substances, where we can scarcely suppose either aqueous or aerial vapours to be concerned. The most remarkable of these are the volcanic bombs mentioned by sir William Hamilton in the great eruption of Vesuvius in 1779. They were large pieces of lava, which burst in pieces like bombs as they fell to the ground; but he does not inform us whether their bursting was attended with any great violence or not. Indeed, amidst such scenes of horror, and the continual tremendous explosions of the volcano, smaller phænomena of this kind would probably be overlooked.

The only other kind of explosion we have to take notice of, is that produced by hydrogen and oxygen gases, when mixed together and set on fire. This differs from any of those hitherto considered, because in reality there is an absolute condensation, rather than an expansion, throughout the whole of the operation; and could the airs be made to take fire throughout their whole substance absolutely at the same instant, there would be no explosion, but only a sudden production of heat. From this cause also is derived a very singular phenomenon, taken notice of by Dr. Priestley in his experiments on that subject. Having inclosed several quantities of these gases in a copper vessel, firing them

afterwards by the electric spark, he found that the force of the explosion was directed more towards one part of the vessel than another; least on that part where the electrical discharge was made, and most upon that which was farthest from it. This inequality was very considerable; insomuch that he could not repeat his experiments any number of times without injuring the vessel in that part which was farthest from the discharge. The reason he gives for this is, that the mixture was not fired at the same instant, but first at the place where the discharge was made. This first explosion would have acted equally upon all parts of the vessel, had it not been for the intervention of the air. By the first momentary explosion, however, the air in the farthest part of the vessel was condensed, so that the next explosion was made stronger, while the copper in the fore part of the vessel had the whole of this strong explosion to resist, the hinder part being but little concerned, as the air in it was condensed and reduced almost to a vacuum.

Though the phenomena of explosions are sometimes very destructive, they are likewise of considerable use in life, by removing obstacles which could scarcely be got the better of by any mechanical power whatever. The principal of these are the blowing up of rocks, the separating of stones in quarries, and other purposes of that kind. The destruction occasioned by them in times of war, and the machines formed upon the principle of explosion for the destruction of the human race, are well known; and if we cannot call these useful, some take them at least to be necessary evils. For the production of explosions, gunpowder is the only substance that has yet been found to answer; nevertheless, as its use is attended with considerable expence, several attempts have been made to find out a cheap substitute for it. One of the most remarkable of these was by mixing small quantities of water inclosed in little bladders, or some easily destructible vehicles, along with a charge of powder. By this contrivance it was hoped that the water, being converted into vapour when the powder was inflamed, would augment the force of the explosion; but instead of this, it was found greatly to diminish it. The reason was evident, viz. that the conversion of the water into steam required so much of the latent heat of the inflamed gunpowder, that enough was not left to give the necessary expansion to the aerial fluid produced.

The effects of explosions, when violent, are felt at a considerable distance, by reason of the concussions they give to the atmosphere; for, as it has been already hinted, all of them act upon the atmospherical fluid with the very same force they exert upon terrestrial substances subjected to their action. Sir William Hamilton relates, that at the explosions of Vesuvius in 1767, the doors and windows of the houses at Naples flew open if unbolted, and one door was burst open, though it had been locked. A great quantity of gunpowder being put into the ditch of a fortified city, and set on fire, destroyed part of the wall, and broke down one of the gates. The blowing up of powder-magazines or powder-mills will destroy buildings and kill people, though certainly without the reach of the flame, and untouched by any part of the shattered magazine or mill. But the most curious effect is, that they electrify the air, and even glass-windows, at a considerable distance. This is always observable in firing the guns of the Tower at London; and some years ago, after an explosion of some powder-mills in the neighbourhood of that city, a great number of people were alarmed by a rattling and breaking of their china-ware, which by the vulgar was taken for a supernatural phenomenon, but undoubtedly was owing to some commotion in the electrical fluid, from the violent concussion of the atmosphere. In this respect, however, the effects of electrical explosions themselves are most remarkable, though not in the uncommon way just mentioned; but it is certain, that the influence of a flash of lightning is diffused for a great way round the place where the explosion happens, producing many very perceptible changes both on the animal and vegetable creation.

EXPONENT, in algebra, is a number placed over any power or involved quantity, to shew to what height the root is raised: thus, 2 is the exponent of x^2, and 4 the exponent of x^4, or $xxxx$. See ALGEBRA.

EXPONENT *of a ratio*, is the quotient arising from the division of the antecedent by the consequent: thus, in the ratio of 5 to 4, the exponent is $1\frac{1}{4}$; but the exponent of 4 : 5, is 4-5ths.

EXPONENTIAL CURVE, is that the nature of which is expressed by an exponential equation. The area of any exponential curve whose nature is expressed by this exponential equation $x^x = y$ (making $1 + v = x$), will be

$$\frac{1}{0.1.2}v^2 + \frac{1}{0.1.2.3}v^3 - \frac{1}{0.1.2.3.4}v^4 + \frac{1}{0.1.2.3.4.5}v^5 - \frac{1}{0.1.2.3.4.5.6}v^6, \text{ &c.}$$

EXPONENTIAL EQUATION is that wherein there is an exponential quantity. See the next article.

EXPONENTIAL QUANTITY is a quantity whose power is a variable quantity, as x^x, a^x. Exponential quantities are of several degrees and orders, according as the exponents themselves are more or less involved. If the exponent be a simple quantity, as z^y, it is called an exponential of the first or lowest degree; but when the exponent itself is an exponential of the first degree, as z^{y^x}, it is called an exponential of the second degree. In like manner, if the exponent itself be an exponential of the second degree, as $x^{y^{x^0}}$, it is called an exponential of the third degree, &c.

EXPORTATION, the act of sending goods out of one country into another. In modern times it has been the principal object of commercial policy, in almost every country, to encourage exportation, except with respect to a few particular articles; the export of manufactured goods has been promoted with the view of encouraging the internal industry of the country, and the export of foreign produce, as a means of drawing wealth from other countries by the profits of the carrying-trade. The excess of the value of goods exported, beyond that of the imports, has usually been considered as a criterion of the profits which a country derives from foreign trade; but this is a very fallacious mode of determining a point of great importance; advantageous foreign trade might long exist, even if the imports constantly exceeded the value of the exports. See POLITICAL ARITHMETIC.

The laws in force relating to exportation consist principally of prohibitory or restrictive regulations respecting bullion, corn, wool, machinery, and tools used in various branches of manufactures, the exportation of which it is thought might diminish the necessary supply of provisions for the consumption of the country, or enable foreigners to rival valuable branches of its manufactures. The acts relative to the exportation of wool prohibit the exportation not only of the article itself, but also of live sheep, rams, or lambs, from Great Britain, Ireland, Jersey, Guernsey, Alderney, Sark, or Man, on penalty of the forfeiture thereof, and of the ships conveying the same; also 3*l*. for every sheep, &c. and the offender to suffer three months solitary imprisonment; for a second offence 5*l*. per sheep, &c. and six months imprisonment: except wether sheep for ships' use only, put on board by licence of the port-officer of the customs. A limited quantity of wool is, however, permitted to be exported from the port of Southampton to Jersey, Guernsey, Alderney, and Sark.

The duties on exportation, payable in Great Britain and Ireland, which were formerly the principal branch of the revenue derived from foreign trade, are now of small amount in comparison with the duties payable on goods brought into the country. See CUSTOMS.

For the extent of the several branches of the export trade of Great Britain, and the articles of which they consist, see COMMERCE.

Total official value of the exports of Great Britain in the year 1800.

	£.	s.	d.
From London — — —	25,428,922	16	7
Outports — — —	15,377,027	1	3
England — — —	40,805,949	17	10
Scotland — — —	2,346,069	7	8
	43,152,019	5	6

Proportion of British manufactures and foreign merchandise exported in the year 1800.

	British manufactures. £.	s.	d.	Foreign merchandise. £.	s.	d.
From London —	13,272,494	0	5	12,156,428	16	2
Outports —	9,183,066	9	11	6,193,960	11	4
England — —	22,455,560	10	4	18,350,389	7	6
Scotland — —	1,848,723	3	2	497,346	4	6
	24,304,283	13	6	18,847,735	12	0

It is well known that the official value of British manufactures exported is much below their real marketable value, in consequence of the great improvement which has taken place in almost every branch of manufacture since the rates, according to which these accounts are formed, were established; and the following is as nearly as can be ascertained, the real value of the exports of Great Britain in the year 1800. The reduction of the amount of foreign merchandise proceeds from an old established error in rating the article of coffee for exportation very much above its real value.

	£.	s.	d.
Exports of British manufactures — —	39,471,203	0	0
Foreign merchandise — — —	16,359,640	13	0
Total real value — — —	55,830,843	13	0

The following account of the export trade of France is on the authority of an official report made to the government of that country, for the year ending 22d September, 1800. The value, which is given in livres, may be converted into pounds sterling with sufficient exactness, by allowing twenty-four livres to the pound; but it may be proper to remark, that the account appears defective in some particulars; and from the values being given almost entirely in round numbers, it may be presumed that much of it is formed on estimates. Considering the deranged state of the foreign trade of France since the revolution in that country, it may not however be possible to obtain more accurate particulars.

Total official value of the exports of France in the year 1800.

	Livres.	Livres
Live stock — — —	13,654,000	
Brandy — — — —	16,669,000	
Wine of Bordeaux — — —	11,488,000	
Other wines — — —	21,339,000	
Salt — — — —	5,386,000	
Corn and flour — — —	5,527,000	
Cheese and dried fruits — — —	3,875,000	
Total of provisions, &c. — — — —		87,562,500
Copper, iron, &c. — — — —		4,530,800
Cotton yarn — — —	2,263,000	
Dressed leather — — —	7,552,000	
Cochineal — — — —	5,604,000	
Tobacco — — —	4,963,000	
Total of raw materials — — —		33,694,500
Mules — — — — —		2,244,000
Silk goods — — —	41,222,000	
Woollen drapery — —	23,146,000	
Cotton stuffs — — —	12,335,000	
Linen and coarse cloths — —	34,866,000	
Millinery, furniture, watches, jewellery, skins, porcelain, hardware, soap, glass, &c. — —	22,000,000	
Total of French manufactures — —		140,854,200
Gold and silver — — — — —		490,500
Sundries — — — — —		2,199,100
Total —		271,575,600

The countries to which the above goods were exported were as follows:

	Livres.
To Spain — — — — —	62,441,400
Batavian republic — — — —	37,751,600
Ligurian republic — — — —	23,010,700
Helvetian republic — — — —	38,809,100
Denmark, Sweden, Prussia, and the Hans towns — —	32,969,700
The United States of America — — — —	557,700
The Levant, Sardinia, Italy, Portugal, Germany, and other states then at war with France — — — —	76,035,400
Total —	271,575,600

The commerce of the United States of America has already advanced to an extent which rivals that of some of the principal states of Europe, and, in all probability, will materially affect many of the long-established channels of trade. The destination of the exports of the United States is principally to the West Indies, Great Britain, France, Holland, and Spain; but some smaller branches of their commerce begin to appear in all the trading parts of the world. The following statement shews the proportions of the exports of 1804 to the dominions of each power:

	Dollars.
To Great Britain and Ireland	12,206,501
the British colonies —	9,623,301
Holland and the Dutch colonies —	16,447,417
France and colonies —	12,776,111
Spain and colonies —	6,728,125
Hamburgh, Bremen, &c.	4,475,007
Denmark and colonies —	3,346,623
Sweden — —	691,975
Prussia — —	1,186,116
Portugal and colonies —	2,496,858
Italy — —	1,671,149
Trieste, and other Austrian ports — —	333,798
Europe generally —	620,891
Turkey, the Levant, and Egypt	44,646
Morocco and the Barbary states	9,333
Cape of Good Hope —	167,917
Africa generally —	349,036
China — —	198,601
East Indies generally —	796,316
South Seas — —	10,000
North-west coast of America	196,059
West Indies generally —	3,324,294
Total	77,699,074

This total is more than double the amount of the exports of America ten years prior to the above period; and the whole increase of the trade of the States since they ceased to be British colonies, has been such as never before took place in any country. The proportion of the exports, consisting of produce or manufactures of the United States, and of foreign merchandise, was as follows:

	Dollars.
Domestic produce —	41,467,477
Foreign — — —	36,231,597
Total	77,699,074.

On converting the totals of the accounts of the exports of France and America into British money, their respective amounts will stand thus:

	£.
Exports of Great Britain in 1800 — —	43,152,019
Exports of France in 1800 —	11,315,650
Exports of the American States in 1804 — —	17,482,291

Had the comparison been made with the real value of the exports of Great Britain instead of the custom-house value, the superior extent of our foreign trade would have appeared still more striking.

EXPOSITION, in general, denotes the setting a thing open to public view: thus it is the Romanists say, the host is exposed, when shewn to the people.

EX POST FACTO, in law, something done after another: thus an estate granted may be good by matter ex post facto, that was not so at first, as in case of election.

A law is said to be ex post facto when it is enacted to punish an offence committed before the passing of the law. Such a proceeding is held to be against the constitution of England.

EXPRESSED OILS, in chemistry, such oils as are obtained from bodies only by pressing. See OIL.

EXPRESSION, in chemistry, or pharmacy, denotes the act of pressing out the juices or oils of vegetables, which is one of the three ways of obtaining them; the other two being by infusion and decoction. See PHARMACY.

EXPRESSION, in painting, is the distinct exhibition of character in the general object of the work, or of sentiment in the characters or persons represented.

In the latter case it consists either in representing the body in general and all its parts severally, in actions most peculiarly suitable to the design of the picture, and marking thereby the emotions of the soul in the various figures, or in pourtraying in the face the appearances of the passions. In this sense the term expression has been frequently confounded with passion; but the former implies a representation of its object agreeably to its nature and character, and to the office it holds on the picture; while the latter denotes merely a particular turn or motion of the body, or of the muscles and features of the face, which marks any violent agitation of the soul: so that every passion is an expression, but not every expression a passion.

Expression, says Le Brun, is a lively and natural resemblance of the objects which we are to represent. It is a necessary ingredient in every part of painting, and without it no picture can be perfect, as it is that which describes the true characters of things. It is by expression that the different natures of bodies are distinguished, that the figures seem to have motion, and that every thing counterfeited appears to be real.

Expression subsists as well in the colouring as in the design; it is to be observed in the representation of landscapes, as well as in the general composition of figures.

All substances, whether animate or inanimate, are capable of expression. The skill of the painter exhibits the hardness of one substance and the softness of another, its smoothness or roughness, its dryness or moistness, clearness or opaqueness, &c. in characters which cannot be mistaken.

Expression being therefore a representation of things according to their character, may be considered either with respect to the subject in general, or to the passions peculiarly relative to it.

1st. With regard to the subject; it is first requisite that all and every part of the composition should be so adapted to the general character of the subjects that they should conspire to impress at the same moment one distinct sentiment or idea. Thus, for example, in a picture designed to give the representation of a joyful or peaceful event, every object that is introduced should be of a pleasing or tranquil kind. If the subject be taken from history, its particular nature and character must be diffused through every part of the work; but wherever any circumstance occurs, which counteracts or diminishes the general sentiment raised by the event represented, the insertion of such circumstance will, proportionably to its magnitude, destroy the general expression of the picture.

Extraneous incidents are frequently introduced for the purpose of diversifying and giving variety to the expression; but they must be such as are neither contrary to the truth of the history, nor to the principal design of the subject.

Expression, in a picture, will then be perfect when every part of the picture is not only fit and appropriate to the subject, but when no one part of it could without evident impropriety be transferred to any other subject.

The agreement of the whole ought to be particularly regarded, not only in the actions of the figures, but in the back-ground, light and shade, and colouring. Whatever is the general character of the subject, whether serene, joyous, melancholy, grave, solemn, or terrible, the picture should discover that character to the first glance of the spectator. The nativity of a Saviour, his resurrection or ascension, must be distinguished from his crucifixion or his interment, as much by the general hue of the picture, the accessory ornaments, back-ground, &c. as by the action of the figures. In viewing some of the finest religious subjects of the Italian school, sentiments of awe and devotion have been often experienced to be amongst the first impressions made on the spectator, previous to his examination of the particular actions or countenances of the figures, and therefore evidently produced by the general distribution of the composition, or the general tone of the colouring. The works of Ludovico Caracci are justly celebrated by sir J. Reynolds in his academic discourses, for their powerful effect in the latter point.

In the admirable cartoon by Raffaelle, of St. Paul preaching at Athens, the expression of the whole work is just and strong. The dignified air of the apostle impresses the spectator with reverence. His action is awful and authoritative without excess or extravagance: it is an action which assures us that he, who uses it, speaks with a power of conviction. The different sentiments of his audience are exhibited with equal skill and good sense. Some of his hearers appear angry, some malicious, some attentive, some reasoning within themselves on his doctrines, some disputing their truth, and some convinced. The very back-ground has its meaning; it contributes to the demonstration or expression of that superstition, against which the inspired orator directed his eloquence. In the power of distinct, peculiar, and appropriate expression, no one has ever raised himself above Raffaelle, scarcely any one has ever equalled him.

There are often certain little circumstances which contribute to the expression of the general subject, and of these also no painter ever availed himself more than Raffaelle; witness the burning lamps, in the cartoon of the Apostles healing at the beautiful Gate of the Temple, where they have the effect of expressing the holy uses, no less than the magnificence, of the building in which they are hung.

The robes or other habits of the figures, their attendants, their ensigns of authority, crowns, maces, swords; or, in humble life, their various implements of labour, crooks, scythes, &c. all contribute to the expression of character.

There are also various kinds of accessory aids, which form a mode of artificial expression, indulged to painters, and practised by them. To express the sensations of the mind of Christ, when in agony a short while previous to his crucifixion, Baroccio has not only represented the angel offering him the cup of bitterness, but has painted in the back-ground the cross encircled with flames.

In the same manner in the cartoon where the people of Lycaonia are going to offer sacrifices to St. Paul and Barnabas, Raffaelle has shewn the cause of their offerings, by adventitious figures. In the fore-ground, the man who had been healed of lameness by those apostles, is the most eager to express his sense of the miraculous power exercised by them, and the individuality of this character is marked not only by a crutch on the ground under his feet, but by the more singular circumstance of an old man taking up the skirt of his garment, looking on the limb which he may be supposed to have remembered in its former crippled state, and expressing his admiration and devotion.

Of the same kind was the artifice used by the Greek painter Timanthes (and so much admired by the antients), to express the prodigous bulk of a cyclops. He placed round the sleeping monster several satyrs, supposed to be of the ordinary size of the human form, one of whom was measuring the thumb of the giant with his thyrsus, apparently with great caution, lest he should awake; others were running away, as if frightened; others gazing on him from a distance, as not daring to approach him.

Another artificial mode of expression, practised by painters, is the use of allegorical figures, representative of certain points of the subject. This art has also been derived from the antients, who have left abundant examples of it; as in the bas-reliefs on the Antonine column at Rome, where the figure of Jupiter Pluvius is introduced to express the rain which fell when the Roman army was preserved by the prayers of the Theban legion. Raffaelle, in this manner, has personified the river Jordan in his design of the children of Israel passing across the river of that name: and has represented him as pushing back and restraining the course of the waters with his arm.

2dly. With regard to the passions and affections peculiar to the subject, the general rules consist in the proper division and distinction of them, as shewn in brute or rational animals, in young or old, in male or female, in cultivated or savage.

The passions of brutes are few and simple; those of the rational animal many and various. The powers of expression in the one are more confined than in the other. A man can move his eyebrows more readily than the brutes, and can give greater variety to the direction of the eyes, &c.

Children and savages, less accustomed to the use of reason, express their passions more directly than cultivated men; the first necessarily, without habitual modes of disclosure or disguise.

Respecting the difference of age and sex, the expressions of vigorous manhood wear a freer, bolder, and more resolute appearance; those of women, and age, are more tender, reserved and feeble.

Condition or rank of life also demands a difference of expression. The demeanour of a magistrate, or other person invested with public honours, is more grave and reserved than that of the populace, whose external motions are, for the most part, rude and disorderly.

The several expressions of action, in running, striking, pointing, asking, forbidding, affirming, idling, avoiding, pursuing, starting, and many other modes, are obviously various, and require a fitness of attitude, and a proper delineation of the corresponding and assisting parts of the body, and other accessories.

For the painter of animals nothing is more necessary than the study of the characteristic expressions of the brute creation, which are severally as various as their species; not only on account of the singular diversity of qualities and instincts with which they are endowed, but of the different modes in which they exhibit passions of a similar nature. Expression in brute animals is, generally speaking, more displayed by attitude than by the features of the face, although, in part, this probably arises from our imperfect acquaintance with them.

As it is therefore in the human figure, and still more particularly in the human countenance, that expression is most effectually and exquisitely displayed, it is to man that our observations must be principally directed in this part of the subject, for the study of which there is no perfect school but that of nature. If the rules of expression generally given are found to agree with the experience of a careful observer of nature, they are good and useful; if not, they are to be followed with caution, or rejected wholly, as occasion shall dictate.

The affections of the soul may be expressed by attitude, and by countenance. There are few strong emotions of our minds which may not, in a great measure, be shewn by the former. Fear, surprise, horror, admiration, humility, pride, and many other affections, are visible in the air and turn of the body; but as this mode of expression admits of a very extensive range, it is next to impossible to define the precise rules by which it is to be governed.

Next to the general action of the body, and turn or air of the head, the hands claim a principal share in the expression of our sentiments. It is by them we approve, condemn, admit, refuse, entreat, admonish. The hands raised together towards heaven express devotion; folded they denote idleness, and sometimes despair; wringing the hands denotes grief; waving one hand from us, prohibition; extending it towards any one, acceptance and benevolent intentions; laying the fore-finger on the mouth enjoins silence; the same finger extended while the others are closed in the hand, shews and points to a particular object.

That by the countenance the particular and immediate disposition of our minds is indicated, is indisputable; and not this only, but our general qualities and capacities are to be found by the same index. Let two men, a wise man and a fool, be placed together, dressed and disguised as you please, one will never be mistaken for the other; nay, the distinction between them will be discernible at the first glance of the eye: and as these characters are most strongly stamped upon the face so as to be read by every spectator, when they are in the utmost extremes, they are proportionably impressed as they exist in a greater or less degree, and are legible accordingly, in proportion to the skill and sagacity of the reader.

In the same manner our good or ill-nature, our gentleness, ferocity, humility, pride, are discoverable in the countenance in all their various degrees. The lines and forms by which these general tendencies, or settled habits of our minds, are expressed, are, of all others, the most difficult to be defined. The reader will find many curious hints and essays concerning them in the works of Lavater.

With regard to the temporary affections of the mind, the following rules of expression are ordinarily given:

Although the passions of the soul may be expressed by the actions of the body, it is in the face that they are principally shewn, and particularly in the turn of the eye, and motion of the eyebrows.

There are two ways of elevating the eyebrows; the one at the middle, which likewise draws up the corners of the mouth, and argues pleasurable emotions; the other at the point next the nose, which likewise draws up the middle of the mouth, and is the mark of grief and painful sensations.

The passions are all reducible to joy and sadness, either mixed or simple.

Joy causes a dilatation of all the parts of the face; the eyebrows rise in the middle, the eyes are half-open and smiling, the pupils sparkling and moist, the nostrils a little open, the cheeks full, the corners of the mouth drawn upwards, the lips red, the complexion lively, the forehead serene.

Passionate joy, proceeding from love, is shown by the forehead smooth and even, the eyebrows a little elevated on the side to which the pupil is turned, the eyes sparkling and open, the head inclined towards the object, the air of the face smiling, and the complexion ruddy.

Joy proceeding from desire, is expressed by the air and action of the body, the arms extending towards the object in uncertain and unquiet motions.

Sadness is expressed by the body being bent downwards, the head neglectfully reclined, the forehead wrinkled, the eyebrows raised to the middle of the forehead, the eyes half-shut, the mouth a little open, the corners tending downwards, the under lip pointing and drawn back, the nostrils swelled and drawn downwards.

Sadness, mixed with fear, causes the parts to contract and palpitate, the members to tremble and fold up, the visage to be pale and livid, the point of the nostrils elevated, the pupil in the middle of the eye, the mouth opened at the sides, and the under-lip drawn back.

In sadness, mixed with anger, the motions are more violent, the parts all agitated, the muscles swelled, the pupil wild and sparkling, the point of the eyebrows fixed toward the nose, the nostrils open, the lips swelled and pressed down, the corners of the mouth a little open and foaming, the veins swelled and full, and the hair erect.

Sadness, mixed with despair, has a similar appearance to the last mentioned, only more excessive and disordered.

But, added to these general observations, every passion has its distinct form of expression, for which see the article PASSIONS.

It is remarkable that Leonardo da Vinci, in his Treatise on Painting, has observed, that between the expression of laughing, and that of weeping, there is no difference in the motion of the features, either in the eyes, mouth, or cheeks, but in the brows only; those who weep, raising the brows and bringing them close together above the nose, and forming many wrinkles on the forehead, while those who laugh have them elevated and extended.

Of expression in sculpture, sir Joshua Reynolds has given it as his opinion that it is necessarily of a much more confined kind than in painting; an assertion which cannot be disputed, inasmuch as the materials of sculpture are more limited. He instances the celebrated group of Laocoon and his sons, in which he says the whole expression consists in the representation of bodily pain in general, and asserts that sculpture is incapable of admitting the mixed delineation of pain and parental affection.

This doctrine, if not highy questionable, certainly demands a greater degree of elucidation.

EXTASY, in medicine, a species of catalepsy, when a person perfectly remembers, after the paroxysm is over, the ideas he conceived during the time it lasted.

EXTEND, in law, signifies to value the lands or tenements of a person bound by a statute, &c. who has forfeited the same, at such an indifferent rate, that by the yearly rent the creditor in time may be paid his debt. See EXTENT.

EXTENSION, in philosophy, one of the common and essential properties of body, or that by which it possesses or takes up some part of universal space, which is called the place of that body.

EXTENSOR, an appellation given to several muscles, from their extending or stretching the parts to which they belong.

EXTENT, in law, is used in a double sense: sometimes it signifies a writ or command to the sheriff for the valuing of lands or tenements; and sometimes the act of the sheriff, or other commissioner, upon this writ; but most commonly it denotes an estimate or valuation of lands, and hence come our extended or rack rents. Every extent ought to be made on inquisition and verdict, without which the sheriff cannot legally execute the writ.

The cognisee, or party to whom the lands are delivered, has no absolute property in them, but is accountable to the cognisor according to the extended value only, not the real value. No seisin can be on an extent, nor may lands or goods be sold thereon.

EXTERMINATION, in general, the extirpating or destroying something. In algebra surds, fractions, and unknown quanti-

fies, are exterminated by the rules for reducing equations. See ALGEBRA.

EXTINGUISHMENT, in law: wherever a right, title, or interest is destroyed, or taken away by the act of God, operation of law, or act of the party, this is called an extinguishment.

Of the extinguishment of rents.—If a lessor purchases the tenantcy from his lessee, he cannot have both the rent and the land; nor can the tenant be under any obligation to pay the rent when the land, which was the consideration thereof, is returned by the lessor into his own hands; and this resumption or purchase of the tenantcy makes what is properly called an extinguishment of the rent.

As to the extinguishment of copyholds, it is laid down as a general rule, that any act of the copyholder, which denotes his intention to hold no longer of his lord, amounting to a determination of his will, is an extinguishment of his copyhold. Hutt. 81.

Of the extinguishment of common.—If a commoner release his common in one acre, it is an extinguishment of the whole common. Show. 350.

Of the extinguishment of debts.—A creditor's accepting a higher security than he had before is an extinguishment of the first debt; as if a creditor by simple contract accepts an obligation, this extinguishes the simple-contract debt. 1 Rol. Abr. 470 and 471.

EXTINGUISHMENT OF SERVICES. The lord purchases or accepts parcel of the tenantcy, out of which an entire service is to be paid or done; by this the whole service will be extinct: but if the service is pro bono publico, then no part of it shall be extinguished: and homage and fealty are not subject to extinguishment by the lord's purchasing part of the land. 6 Rep. 105.

EXTINGUISHMENT OF WAYS. If a man has a highway as appendant, and after purchases the land wherein this way is, the way is extinct: though a way of necessity, to market, or to church, or to arable land, &c. is not extinguished by purchase of grounds, or unity of possession. 1 Inst. 155.

EXTORTION, signifies any oppression by colour or pretence of right; and in this respect it is said to be more heinous than robbery itself, as also that it is usually attended with the aggravating sin of perjury. Co. Lit. 368.

At common law extortion is severely punishable at the king's suit by fine and imprisonment, and by a removal from the office in the execution whereof it was committed. 31 Eliz. c. 5. And this statute adds a greater penalty than the common law gave; for hereby the plaintiff shall recover his double damages. 2 Inst. 210. See COLOUR OF OFFICE.

EXTRACT, in pharmacy, is a solution of the purer parts of a mixed body inspissated, by distillation or evaporation, nearly to the consistence of honey. See PHARMACY.

EXTRACTION, in surgery, is the drawing any foreign matter out of the body by the hand, or by the help of instruments. See SURGERY.

EXTRACTION OF ROOTS, in algebra and arithmetic, the method of finding the root of any power or number. See ALGEBRA, and ARITHMETIC.

EXTRACTOR, in midwifery, an instrument, or forceps, for extracting children by the head. See MIDWIFERY.

EXTRA-JUDICIAL, is when judgment is given in a cause or case not depending in that court where such judgment is given, or wherein the judge has no jurisdiction.

EXTRA-PAROCHIAL, out of any parish; privileged or exempted from the duties of a parish. If a place is extra-parochial, and has not the face of a parish, the justices have no authority to send any poor person thither: possibly a place extra-parochial may be taxed in aid of a parish, but a parish shall not in aid of that. 2 Salk. 486.

EXTRAVAGANTES, those decretal epistles which were published after the Clementines. They were so called because, at first, they were not digested or ranged with the other papal constitutions, but seemed to be detached from the canon law. They continued to be called by the same name when they were afterwards inserted in the body of the canon law. The first extravagantes are those of John XXII. successor of Clement V.: the last collection was brought down to the year 1483, and was called the common extravagantes, notwithstanding that they were likewise incorporated with the rest of the canon law.

EXTRAVASATION, in contusions, fissures, depressions, fractures, and other accidents of the cranium, is when one or more of the blood-vessels that are distributed on the dura mater, are broken or divided, whereby there is such a discharge of blood as greatly oppresses the brain, and disturbs its offices; frequently bringing on violent pains and other mischiefs, and at length death itself, unless the patient is timely relieved. See SURGERY.

EXTREMES, in logic, the terms expressing the two ideas whose relation we enquire after in a syllogism.

EXTREME *and mean proportion*, in geometry, is when a line AB (Plate Miscell. fig. 88) is so divided in F, that the rectangle under the whole line AB, and the lesser segment FB, is equal to the square of the greater segment AF.

Let a square be formed upon the line AB, and one of its sides AC be equally divided in the point D; draw DB, and take the line DG equal to the line BD; then the square AGHF will be equal to the rectangle FE.

For since the line AC is equally divided in the point D, and is lengthened by the line AG, the rectangle CH, together with the square of the line AD, will (by 6. 2. El.) be equal to the square of the line DG or DB. But the square AE, with the square of the line AD, is also equal (47.1.) to the square of the line DB. Therefore the square AE is equal to the rectangle CH. Taking then away from both the rectangle CF, the rectangle FE will be equal to the square FG.

But no number can be so divided into two parts, as is demonstrated by Clavius, in his commentaries upon lib. 9. of Euclid; which is evident enough thus: Let a be the number, and x the greater part; then the lesser part will be $a - x$, and so $aa - ax = xx$, and thence $x = \frac{a + a\sqrt{5}}{2}$; and since the square root of 5 cannot be had in numbers exactly, it is plain that the value of x partly consisting of the square root, multiplied by a, cannot be had exactly in numbers neither.

EXTREMES, *conjunct and disjunct.* See TRIGONOMETRY, *spherical.*

EXUVIÆ, among naturalists, denote the cast-off parts or coverings of animals, as the skins of serpents, caterpillars, and other insects. See ERUCA.

EYE, in anatomy, the organ of sight, or that part of the body whereby visible objects are represented to the mind. See ANATOMY, OPTICS, and PHYSIOLOGY.

Motions of the eye are either external or internal. The external motion is that performed by its four straight and two oblique muscles, whereby the whole globe of the eye changes its situation or direction. The spherical figure of our eyes, and their loose connection to the edge of the orbit by the tunica conjunctiva, which is soft, flexible, and yielding, does excellently dispose them to be moved this or the other way, according to the situation of the object we would view. By the membranes the eye is connected to the edge of the orbit, which being soft and flexible, they do in such a manner as not in the least to impede its necessary motions; and that great quantity of fat placed all round the globe, betwixt it and the orbit, lubricates and softens the eye, and renders its motions more easy: hence arise the three following remarkable observations:

I. When nature has denied the head any motion, it is observable that she has, with great care and industry, provided for this defect. To this purpose belongs the surprising beautiful and curious mechanism observable in the immoveable eyes of flies, wasps, &c. They nearly resemble two protuberant hemispheres, each consisting of a prodigious number of other little segments of a sphere, all which segments are perforated by a hole, which may be called their pupil, in which this is remarkable; that every foramen, or pupil, is of a lenticular nature, so that we see objects through them topsy-turvy, as through so many convex glasses: they even become a small telescope, when there is a due focal distance between them, and the lens of the microscope by which they are viewed. Leuwenhoek's observations make it probable that every lens of the cornea supplies the place of the crystalline humour, which seems to be wanting in those creatures; and that each has a distinct branch of the optic nerve answering to it, upon which the images are painted: so that as most animals are binocular, and spiders for the most part octonocular, so flies, &c. are multocular, having in effect as many eyes as there are perforations in the cornea, by which means (as other creatures with but two eyes are obliged, by the contraction of the muscles above-enumerated, to turn their eyes to objects) these have some or other of their pupils always ready placed towards objects nearly all around them: whence they are so far from being denied any benefit of this noble and most necessary sense of sight, that they have probably more of it than other creatures, answering to their necessities and ways of living.

II. As in man and most other creatures, the eyes are situated in the head, because, among other reasons, it is the most convenient place for their defence and security, being composed of hard bones, wherein are formed two large strong sinuses, or sockets, commonly called orbits, for the convenient lodging of these tender organs, and securing

them against external injuries; so in those creatures whose head, like their eyes and the rest of their body, is soft and without bones, nature has provided for this necessary and tender organ a wonderful kind of guard, by enduing the creature with a faculty of withdrawing his eyes into his head, and lodging them in the same safety within his body. We have a very beautiful example of this in snails, whose eyes are lodged in four horns, like atramentous spots, one at the end of each horn, which they can retract at pleasure, when in any danger. Here it may be also observed, that the cornea in all animals that want eyelids, as fishes, exeactly resembles in hardness the horn of a lanthorn; and therefore is not hurt by such particles as their eyes are commonly exposed to. And in the mole, because this animal lives under ground, it was necessary its eyes should be well guarded and defended against the many dangers and inconveniences to which its manner of living exposes it: this is the reason why its eyes are so small, and that they are situated so far in the head, and covered so strongly with hair; and besides they can protrude and retract them at pleasure. See COMPARATIVE ANATOMY.

III. The third and last reflection we shall make upon the external motion of our eyes, is what regards a problem which has very much perplexed both physicians and philosophers, viz. What is the cause of the uniform motion of both eyes?

In some creatures, such as fishes, birds, and among quadrupeds, the hare, cameleon, &c. the eyes are moved differently; the one towards one object, and the other towards another. But in man, sheep, oxen, and dogs, the motions are so uniform that they never fail to turn both towards the same place: hence in operations upon the eye that require it to be kept immoveable, sometimes it is necessary to tie up the sound eye with a compress, by which means the other is easier kept fixed and immoveable.

The final cause of this uniform motion is, 1. That the sight may be thence rendered more strong and perfect: for since each eye apart impresses the mind with an idea of the same object, the impression must be more strong and lively when both eyes concur; and that both may concur, it is necessary that they move uniformly; for though the retina, or immediate organ of vision, is expanded upon the whole bottom of the eye, as far as the ligamentum ciliare, yet nothing is clearly and distinctly seen but what the eye is directed to. 2. A second advantage we reap from the uniform motion of the eyes, which is more considerable than the former, consists in our being thereby enabled to judge with more certainty of the distance of objects. See OPTICS.

There is yet another advantage, full as considerable as any of the former, that is thought to arise from the uniform motion of our eyes, and that is, the single appearance of objects seen with both our eyes; which, though at first view it does not appear probable, is true: for if in looking at an object you turn one of your eyes aside with your finger, and alter its direction, every thing will be seen double.

By the internal motions of the eye we understand those motions which only happen to some of its internal parts, such as the crystalline and iris; or to the whole eye when it changes its spherical figure, and becomes oblong or flat. The internal motions of our eyes are either such as respect the change of conformation that is necessary for seeing distinctly at different distances, or such as only respect the dilatation and contraction of the pupil.

That our eyes change their conformation, and accommodate themselves to the various distances of objects, will be evident to any person, who but reflects on the manner and most obvious phenomena of vision.

Authors are very much divided in their opinions with regard to the mechanism by which this change is introduced, as well as what parts it consists in: for some are of opinion that the whole globe changes its form, by being lengthened into an oblong figure when objects are near, and by becoming flat when they are removed to a greater distance; and others are of a quite contrary opinion.

With regard to the change of the crystalline, and the mechanism by which it is produced, some maintain, that according as objects are at different distances this humour becomes more or less convex, which does indeed very well account for distinct vision at all distances; for objects painted on a sheet of white paper, by means of a lens placed in the hole of a window-shutter, in a dark room, have their images always distinct, at whatever distance they may be from the window, provided the lens is of a convexity answerable to that distance.

EYE, in architecture, is used to signify any round window, made in a pediment, an attic, the reins of a vault, &c.

EYE *of a dome*, an aperture at the top of a dome, as that of the Pantheon at Rome, or of St. Paul's at London: it is usually covered with a lanthorn.

EYE *of the volute*, in architecture, is the centre of the volute, or that point in which the helix, or spiral of which it is formed, commences: or it is the little circle in the middle of the volute, in which are found the thirteen centres for describing the circumvolutions of it.

EYE, in agriculture and gardening, signifies a little bud or shoot inserted into a tree by way of graft.

EYE-BRIGHT. See EUPHRASIA.

EYE *of the anchor*, on board a ship, the hole in which the ring of the anchor is put into the shank.

EYE *of the strap*, on board a ship, the ring or round which is left to the strap to which any block is seized.

EYE, in printing, is sometimes used for the thickness of the types; or, more properly, it signifies the graving in relievo on the top of the letter, otherwise called its face: the eye of the *e* is the small opening at the head of that letter, which distinguishes it from the *c*.

EYE-GLASS, in the microscope. See MICROSCOPE.

EYRE, or *eire*, in law, the court of itinerant justices. See JUSTICES.

EZAN, in the Mahometan theology, a hymn containing the profession of their faith, which is repeated five times a day, to call the people to prayers.

EZEKIEL'S REED, or ROD, a measure of length mentioned by that prophet, and computed to be nearly equal to two English feet.

F.

F, the sixth letter of the alphabet. As a numeral it denotes 40, and with a dash over it thus $\overline{F}$, denotes 40,000: in music it stands for the bass-clef; and frequently for forte, as *ff* does for forte forte.

F, in medicine, stands for fiat, let it be done: thus F. S. A. stands for fiat secundum artem, let it be done according to art.

As an abbreviation, F stands for filius, fellow, &c.: thus F. R. S. signifies Fellow of the Royal Society.

FA, in music, one of the syllables invented by Guido Aretine, to mark the fourth note of the modern scale, which rises thus, ut, re, mi, fa. Musicians distinguish two fa's, viz. the flat, marked with a *b*, or ; and the sharp or natural, marked thus , and called biquadro.

FA FINTO, a feigned F, or a feint upon that note: this is the case of every note that has the mark ♭ before it; but more especially mi and si, or our E and B, and is what we commonly call the flat of any note.

FABA, the *bean*. See VICIA.

FABLE, *fabula*, a tale or feigned narration, designed either to instruct or amuse, disguised under the allegory of an action, &c. Fables were the first pieces of wit that made their appearance in the world, and have been still highly valued, not only in times of the greatest simplicity, but among the most polite ages of the world. Jotham's fable of the trees is the oldest that is extant, and as beautiful as any that has been made since. Nathan's fable of the poor man is next in antiquity, and had so good an effect as to convey instruction to the ear of a king. We find Æsop in the most distant ages of Greece; and in the early days of the Roman commonwealth, we read of a mutiny appeased by the fable of the belly and the members. There is scarcely a book in the whole compass of profane literature which contains a greater store of moral wisdom, frequently seasoned with no small share of wit, than Æsop's fables. It is injudiciously put into the hands of children who cannot understand it: its object is to instruct men.

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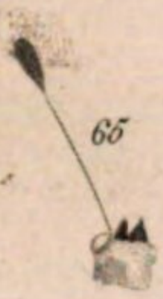

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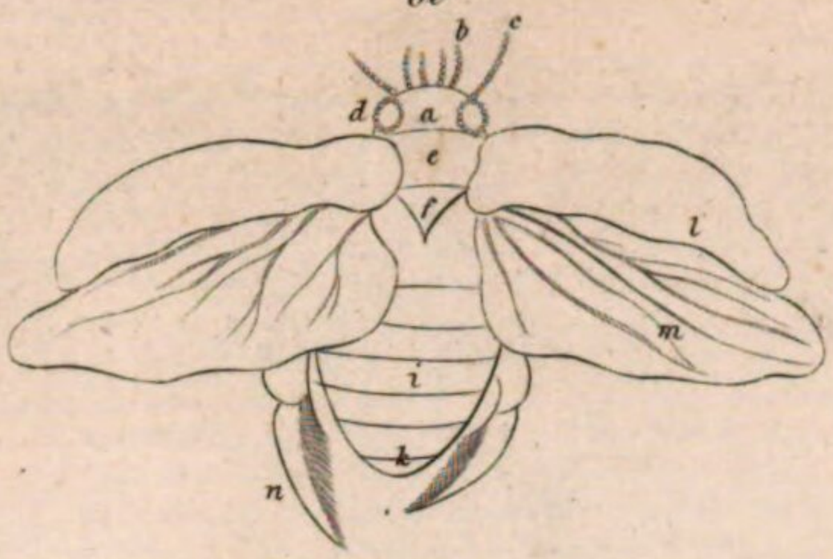

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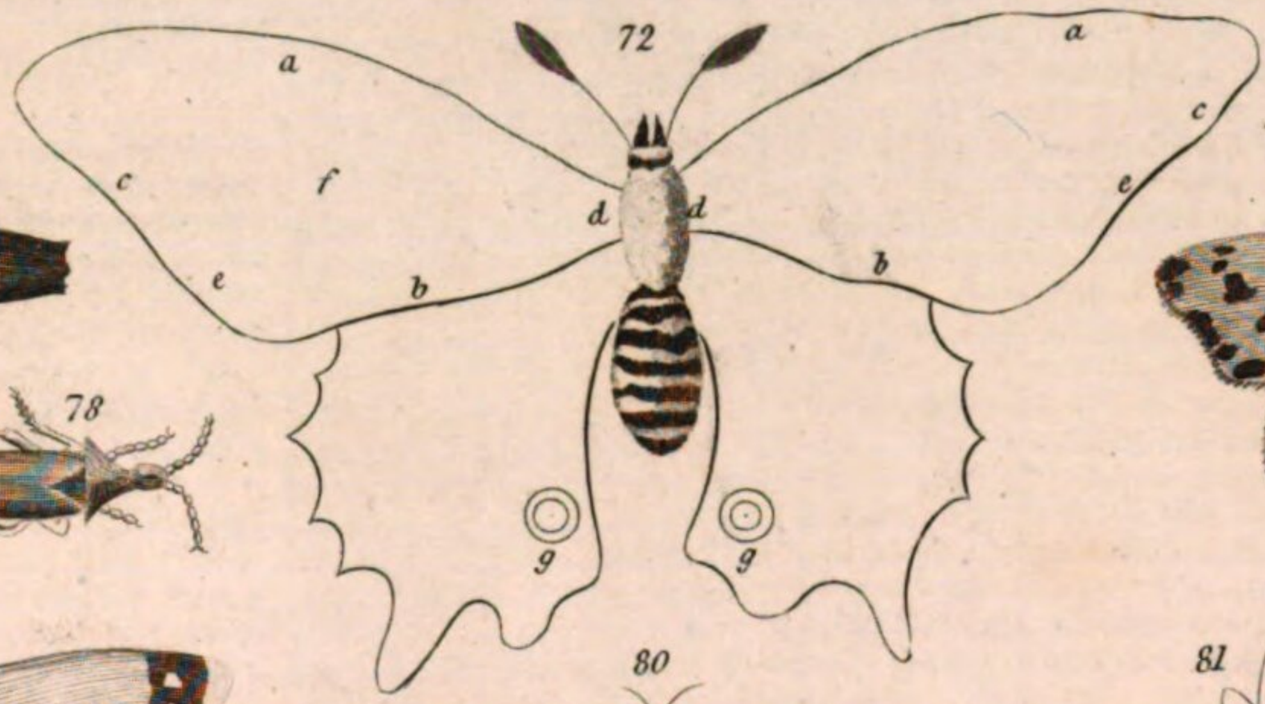

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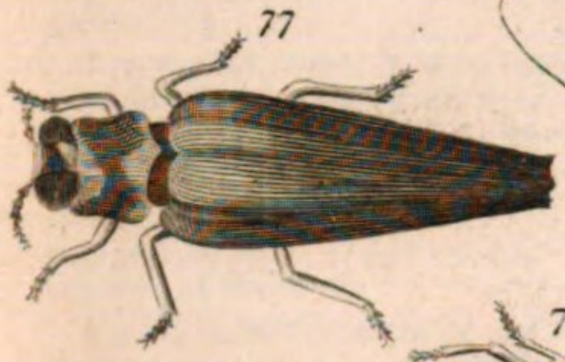

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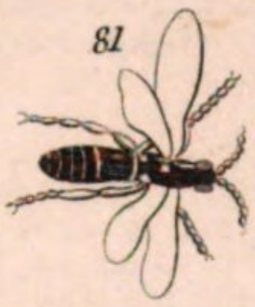

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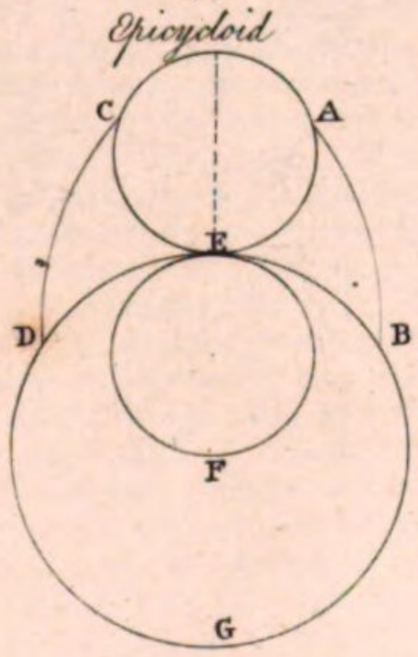
Epicycloid



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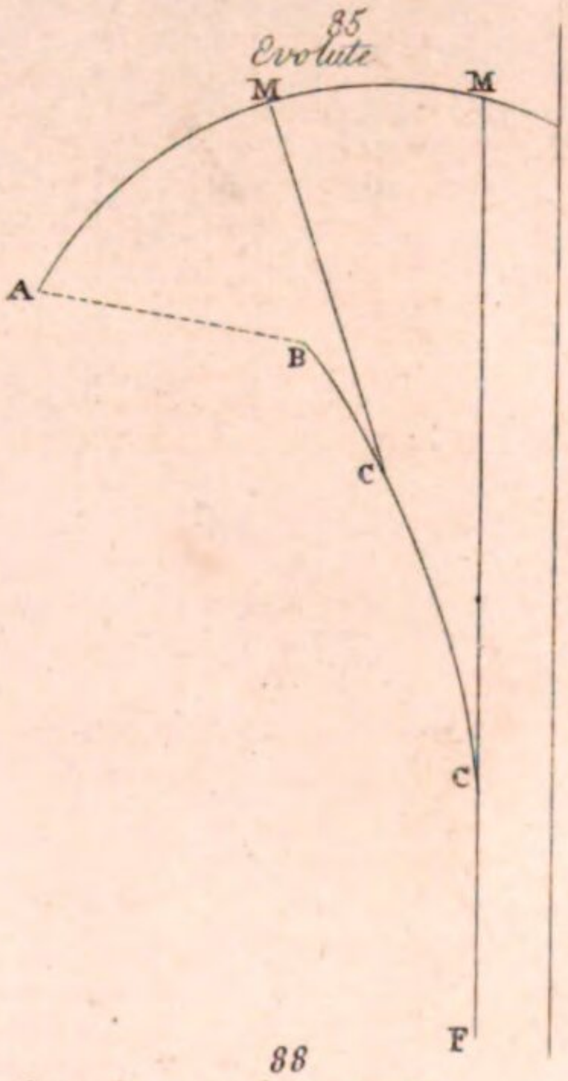
Evolute



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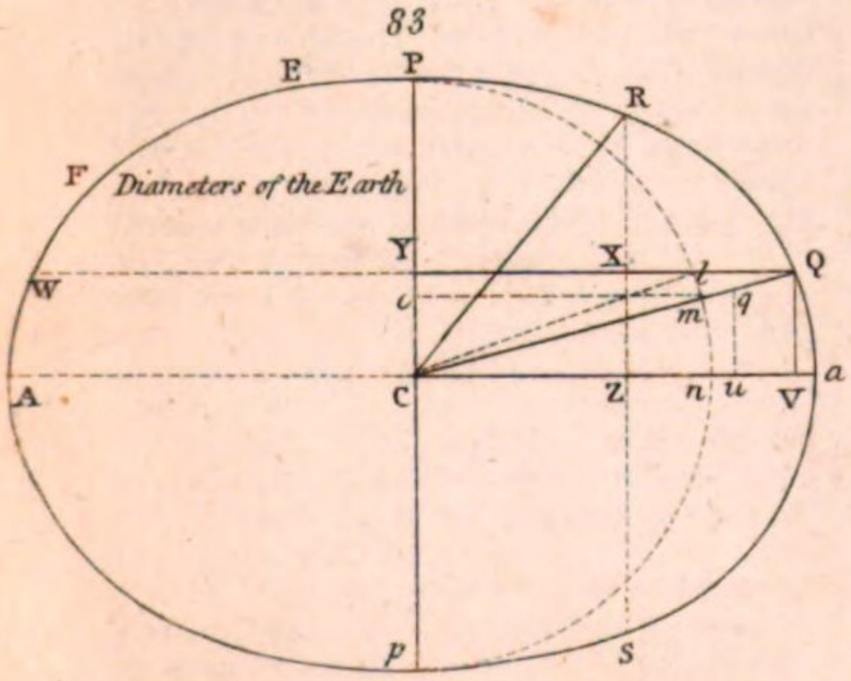

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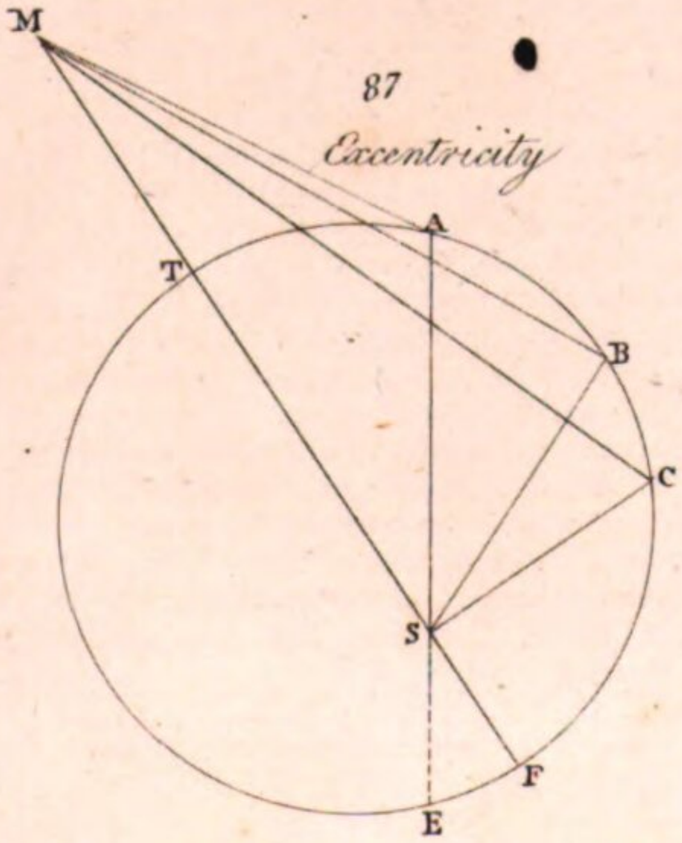
Excentricity



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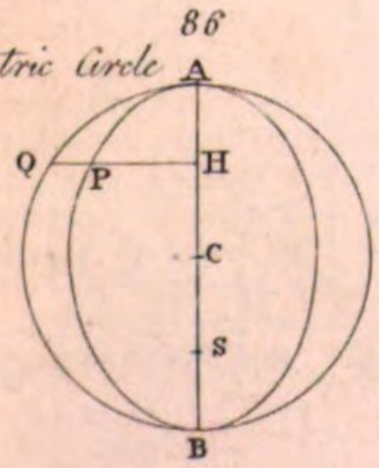
Excentric Circle



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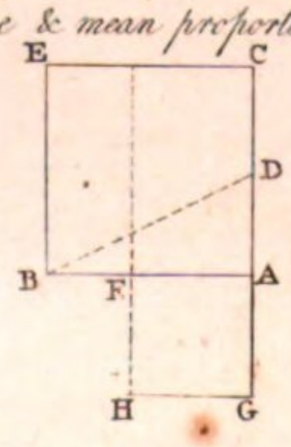
Extreme & mean proportion



Printed June 1 1806, for Richard Phillips, New Bridge St. Blackfriars.

FABLE is also used for the plot of an epic or dramatic poem; and is, according to Aristotle, the principal part, and the soul of a poem. See POETRY.

FABRIC-LANDS, those formerly given towards rebuilding or repairing of cathedrals and other churches; for antiently almost every body gave more or less, by his will, to the fabric of the parish-church where he dwelt.

FACE, or *façade*, in architecture, the front of a building, or the side which contains the chief entrance. Sometimes, however, it is used for whatever side presents to the street, garden, court, &c. or is opposite to the eye.

FACE *of a stone*, in masonry, that superficies of it which lies in the front of the work. The workmen generally choose to make one of those sides the face, which, when in the quarry, lay perpendicularly to the horizon, and consequently the breaking, not the cleaving way of the stone.

FACE, in fortification, an appellation given to several parts of a fortress, as the face of a bastion, &c. See FORTIFICATION.

FACE, in the military art, a word of command, intimating to turn about: thus, "Face to the right," is to turn upon the left heel a quarter-round to the right; and "Face to the left," is to turn upon the right heel a quarter-round to the left.

FACET, or *facette*, among jewellers, the name of the little faces or planes to be found in brilliant and rose diamonds.

FACTION, in antiquity, a name given to the different companies of combatants or racers in the circus. They were four, viz. the white, the red, the green, and the blue; to which Domitian added another of purple colour. They were so denominated from the colour of the liveries they wore, and were dedicated to the four seasons of the year, the green being consecrated to spring, the blue to winter, the red to summer, and the white to autumn. It appears from antient inscriptions that each faction had its procurators and physician; and from history, that party rage ran so high among them, that in a dissension between two factions, in the time of Justinian, almost forty thousand men lost their lives in the quarrel. See Gibbon's Decline and Fall, &c.

FACTITIOUS, any thing made by art, in opposition to what is the produce of nature. Thus, factitious cinnabar is opposed to native cinnabar.

FACTOR, in commerce, is an agent or correspondent residing beyond the seas, or in some remote part, commissioned by merchants to buy or sell goods on their account, or assist them in carrying on their trade.

A factor receives from the merchants, his constituents, in lieu of wages, a commission or factorage, according to the usage of the place where he resides, or the business he transacts, this being various in different countries, and on the purchases and sales of different commodities. He ought to keep strictly to the tenor of his orders; as a deviation from them, even in the most minute particular, exposes him to make ample satisfaction for any loss that may accrue from his nonobservance of them; and it is very reasonable it should be so, as the distance of his situation renders him unable to judge of his principal's views and intention. When unlimited orders are given to factors, and they are left to sell or buy on the best conditions they can, whatever detriment occurs to their constituents, they are excused, as it is to be presumed they acted for the best, and were governed by the dictates of prudence. But a bare commission to sell is not sufficient authority for the factor to trust any person, wherefore he ought to receive the money on the delivery of the goods; and, by the general power, he may not trust beyond one, two, or three months, &c. the usual time allowed in sales, otherwise he shall be answerable out of his own estate. If a factor sells on the usual trust to a person of good credit, who afterwards becomes insolvent, he is discharged; but not if the man's credit was bad at the time of sale. If a factor gives a man time for payment of money contracted on sale of his principal's goods, and, after that time is elapsed, sells him goods of his own for ready money, and the man becomes insolvent, the factor in equity ought to indemnify his principal, but he is not compellable by the common law. A factor should always be punctual in the advices of his transactions, in sales, purchases, freights, and more especially in draughts by exchange: he should never deviate from the orders he receives in the execution of a commission for purchasing goods, either in price, quality, or kind; and if, after goods are bought, he sends them to a different place from what he was directed to, they must remain for his own account, except the merchant, on advice of his proceedings, admits them according to his first intention. A factor that sells a commodity under the price he is ordered, shall be obliged to make good the difference: and if he purchases goods for another at a price limited, and afterwards they rise, and he fraudulently takes them for his own account, and sends them to another part, in order to secure an advantage that seemingly offers, he will, on proof, be obliged, by the custom of merchants, to satisfy his principal for damages. If a factor, in conformity with a merchant's orders, buys with his money, or on his credit, a commodity he shall be directed to purchase; and, without giving advice of the transaction, sells it again to profit, and appropriates to himself the advantage; the merchant shall recover it from him, and besides have him amerced for his fraud. When factors have obtained a profit for their principal, they must be cautious how they dispose of it; for if they act without commission they are responsible: and if a merchant remits goods to his factor, and about a month after draws a bill on him, the factor, having effects in his hands, accepts the bill, then the principal breaks, and the goods are seized in the factor's hands for the behalf of the creditors, it has been conceived the factor must answer the bill notwithstanding, and come in as a creditor for so much as he was obliged, by reason of his acceptance, to pay. A factor who enters into a charterparty with a master for freight, is obliged by the contract; but if he loads aboard generally, the principal and the lading are liable for the freight, and not the factor. If a factor, having money in his hands belonging to his principal, neglects to insure a ship and goods, according to order, if the ship miscarry, the factor, by the custom of merchants, shall make good the damage; and if he makes any composition with the insurers after insurance without orders so to do, he is answerable for the whole insurance.

As fidelity and diligence are expected from the factor, so the law requires the like from the principal; if, therefore, a merchant remits counterfeit jewels to his factor, who sells them as if true; if he receives loss or prejudice by imprisonment or other punishment, the principal shall not only make full satisfaction to the factor, but to the party who bought the jewels.

What is here said of factors, is meant of such as reside abroad to act for merchants; and may be applied to supercargoes, who go a voyage to dispose of a cargo, and afterwards return with another to their principals; but it is also the custom of the merchants of the highest credit throughout the world to act mutually in the capacity of factors for each other. The business so executed is called commission-business, and is generally desirable by all merchants, provided they have always effects in their hands, as a security for all the affairs which they transact for the account of others. And this class of traders of established reputation, have current as well as commission accounts, constantly between them; and draw on, remit to, and send commissions to each other only by the intercourse of letters, which, among men of honour, are as obligatory and authoritative as all the bonds and ties of law.

FACTOR, in multiplication, a name given to the multiplier and multiplicand, because they constitute the product.

FACTORAGE, called also commission, is the allowance given to factors by the merchant who employs them. A factor's commission in Britain, on most kinds of goods, is two and a half per cent.: on lead, and some other articles, two per cent.; in Italy, two and a half per cent.; in France, Holland, Spain, Portugal, Hamburgh, and Dantzic, two per cent.; in Turkey three per cent.; in North America five per cent. on sales, and five per cent. in returns; in the West Indies eight per cent. for commission and storage. In some places it is customary for the factors to insure the debts for an additional allowance, generally one and a half per cent. In that case they are accountable for the debt when the usual term of credit is expired. Factorage on goods is sometimes charged at a certain rate per cask, or other package, measure, or weight, especially when the factor is only employed to receive or deliver them.

FACTORY is a place where a considerable number of factors reside, to negotiate for their masters or employers. The most considerable factories belonging to the British are those established in the East Indies, Portugal, Turkey, &c.

FACULÆ, in astronomy, certain bright and shining parts, which the modern astronomers have, by means of telescopes, observed upon or about the surface of the sun: they are but very seldom seen.

Hevelius assures us that, on July 20, 1634, he observed a facula, whose breadth was equal to a third part of the sun's diameter. He says too that the maculæ often change into faculæ, but these seldom or never into maculæ. And some authors even contend

that all the maculæ degenerate into faculæ before they quite disappear. Many authors, after Kircher and Scheiner, have represented the sun's body full of bright, fiery spots, which they conceive to be a sort of volcanoes in the body of the sun; but Huygens, and others of the latest and best observers, finding that the best telescopes discover nothing of the matter, agree entirely to explode the phenomena of faculæ. All the foundation he could see for the notion of faculæ, he says, was, that in the darkish clouds which frequently surround the maculæ, there are sometimes seen little points or sparks brighter than the rest.

FACULTY, in law, a privilege granted to a person, by favour and indulgence, of doing what, by law, he ought not to do. For granting these privileges there is a court under the archbishop of Canterbury, called the court of the faculties, the chief officer of which is styled master of the faculties, who has a power of granting dispensations in divers cases: as to marry without the bans being first published; to ordain a deacon under age; for a son to succeed his father in his benefice; a clerk to hold two or more livings, &c.

FACULTY, in the schools, a term applied to the different members of an university, divided according to the arts and sciences taught there: thus in most universities there are four faculties, viz. 1. Of arts, which include humanity and philosophy. 2. Of theology. 3. Of physic. And, 4. Of civil law. The degrees in the several faculties in our universities are those of bachelor, master, and doctor.

FACULTY OF ADVOCATES, a term applied to the college or society of advocates in Scotland, who plead in all actions before the court of session. They meet in the beginning of every year, and choose the annual officers of the society, viz. dean, treasurer, clerks, private and public examinators, and a curator of their library. The manner of admission into the faculty of advocates is by a trial in the civil law, and Scotch law: the person desiring to be admitted having, upon petition, obtained a recommendation to the dean of the faculty, he gives a remit to the private examinators, who are nine in number, and who, after their election, having divided the body of the civil law into nine parts, each taking one, appoint a diet for examination: in this diet there must be at least seven present, each of whom examines the candidate; and the question being afterwards put, Qualified, yea or no? they give their opinion by balloting, upon which the candidate is either admitted by signing his petition, or remitted to his studies. After the private trial the dean of the faculty assigns the candidate a title of the civil law, for the subject of a thesis; which being distributed among the advocates, the faculty meet on a day appointed, when three at least of fifteen public examinators dispute against the thesis; and afterwards the faculty give their opinions by balloting, as in the private trial. If the candidate is found qualified, the dean assigns him a law for an harangue before the lords; which harangue being made, he is admitted a member of the faculty, upon paying the fees, taking the oaths to the government, and an oath to be faithful in his office.

FACULTY is also used to denote the powers of the human mind, viz. understanding, will, memory, and imagination.

FÆCES, in chemistry, the gross matter, or sediment, that settles at the bottom after distillation, fermentation, &c.

FÆCULA. See GLUTEN.

FAGARA, *iron wood*, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 43d order, dumosæ. The calyx is quadrifid, the corolla tetrapetalous, and the capsule bivalved and monospermous. There are 10 species, all natives of the warm parts of America, rising with woody stems more than 20 feet high. They are propagated by seeds; but in this country must be kept continually in a stove.

FAGG, in the sea language, a term given to the end of those strands which do not go through the tops, when a cable or rope is closed.

FAGONIA, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 14th order, gruinales. The calyx is pentaphyllous; the petals are five, and heart-shaped; the capsule is quinquelocular, ten-valved, with the cells monospermous. There are three species, herbaceous plants of Spain, Crete, and Arabia.

FAGRÆA, a genus of the class and order pentandria monogynia. The calyx is bell-shaped; corolla funnel-shaped; berry two-celled, fleshy, seeds globular; stigma peltate. There is one species, a shrub of Ceylon.

FAGUS, the *beech-tree*, a genus of the polyandria order, in the monœcia class of plants; and in the natural method ranking under the 50th order, amentaceæ. The male calyx is quinquefid and campanulated; there is no corolla; the stamina are 12; the female calyx is quinquedentated; there is no corolla; there are three styles; the capsule (formerly the calyx) is muricated and quadrivalved; the seeds two in number. There are five species. The most remarkable are,

1. The sylvatica, or beech-tree, rises 60 or 70 feet high, and has a proportionable thickness, branching upward into a fine regular head, with oval serrated leaves, with flowers in globular catkins, succeeded by angular fruit called mast.

2. The castanea, or chesnut-tree, has a large upright trunk growing 40 or 50 feet high, branching regularly round into a fine spreading head, with large spear-shaped acutely serrated leaves, naked on the under side, having flowers in long amentums, succeeded by round prickly fruit, containing two or more nuts.

3. The pumila, dwarf chesnut-tree, or chinkapin, rises eight or ten feet high, with a branching shrubby stem, and oval spear-shaped and acutely serrated leaves, hoary on the under side.

The first species is very easily raised from the mast or seed. "For woods (says Evelyn) the beech must be governed as the oak; in nurseries as the ash: sowing the masts in autumn, or later, even after January, or rather nearer the spring, to preserve them from vermin, which are very great devourers of them. But they are likewise to be planted of young seedlings, to be drawn out of the places where the fruitful trees abound. Millar says, the season for sowing the masts "is any time from October to February, only observing to secure the seeds from vermin when early sowed; which, if carefully done, the sooner they are sown the better after they are fully ripe." Hanbury orders a sufficient quantity of masts to be gathered about the middle of September, when they begin to fall: these are to be "spread upon a mat in an airy place six days to dry; and after that you may either proceed to sow them immediately, or you may put them up in bags in order to sow them nearer the spring: as they will keep very well, and there will be less danger of having them destroyed by mice or other vermin, by which kinds of animals they are greatly relished." They must be sown in beds properly prepared, about an inch deep. In the first spring many of the young plants will appear, whilst others will not come up till the spring following. Having stood two years in the seminary, they should be removed to the nursery, where they may remain till wanted.

The propagation of the second species is also chiefly from seeds. Evelyn says, "Let the nuts be first spread to sweat, then cover them in sand; a month being past, plunge them in water, and reject the swimmers; being dried for 30 days more, sand them again, and to the water-ordeal as before. Being thus treated until the beginning of spring or in November, set them as you would beans; and, as some practise it, drenched for a night or more in new milk; but with half this preparation they need only to be put into the holes with the point upwards, as you plant tulips. If you design to set them in winter or autumn, I counsel you to inter them in their husks, which being every way armed, are a good protection against the mouse, and a providential integument."—"Being come up, they thrive best unremoved, making a great stand for at least two years upon every transplanting; yet if you must alter their station, let it be done about November." Millar cautions us against purchasing foreign nuts that have been kiln-dried, which (he says) is generally done to prevent their sprouting in their passage; therefore he adds, "If they cannot be procured fresh from the tree, it will be much better to use those of the growth of England, which are full as good to sow for timber or beauty as any of the foreign nuts, though their fruit is much smaller." He also recommends preserving them in sand, and proving them in water. In setting these seeds or nuts, he says, "The best way is to make a drill with a hoe (as is commonly practised for kidney-beans), about four inches deep, in which you should place the nuts, at about four inches distance, with their eye uppermost; then draw the earth over them with a rake, and make a second drill at about a foot distance from the former, proceeding as before, allowing three or four rows in each bed. In April (he does not mention the time of sowing) these nuts will appear above ground; you must therefore observe to keep them clear from weeds, especially while young: in these beds they may remain for two years, when you should remove them into a nursery at a wider distance. The best time for transplanting these trees is either in October, or the end of February, but October is the best season: the distance these should have in the nursery is three feet row from row, and one foot in the

rows. If these trees have a downright tap-root, it should be cut off, especially if they are intended to be removed again: this will occasion their putting out lateral shoots, and render them less subject to miscarry when they are removed for good. The time generally allowed them in the nursery is three or four years, according to their growth; but the younger they are transplanted the better they will succeed. Young trees of this sort are very apt to have crooked stems; but when they are transplanted out, and have room to grow, as they increase in bulk they will grow more upright, and their stems will become straight, as I have frequently observed where there have been great plantations." Hanbury follows Millar almost literally, except that he mentions February as the time of sowing; and recommends that the young plants, a year after they have been planted in the nursery, be cut down to within an inch of the ground; which (he says) "will cause them to shoot vigorously with one strong and straight stem." There is one material objection against sowing chesnuts in drills, which are well known to serve as guides or conductors to the field-mouse, who will run from one end to the other of a drill without letting a single nut escape her: we rather recommend setting them with a dibble, either promiscuously or in quincunx, at about six inches distance. Evelyn says, that coppices of chesnuts may be thickened by layering the tender young shoots; but adds, that "such as spring from the nuts and marrons are best of all." There is a striped-leaved variegation which is continued by budding; and the French are said to graft chesnuts for their fruit; but Millar says, such grafted trees are unfit for timber. The chesnut will thrive upon almost any soil which lies out of the water's way; but dislikes wet moory land.

The method of propagating the dwarf-chesnut is from seeds, which we receive from America. These should be planted in drills, as soon as they arrive, in a moist bed of rich garden-mould. If the seeds are good they will come up pretty soon in the spring. After they appear they will require no trouble, except keeping them clean from weeds, and watering them in dry weather. They may stand in the seed-bed two years, and be afterwards planted in the nursery ground, at a foot asunder, and two feet distance in the rows; and here when they are got strong plants they will be fit for any purpose.

In stateliness and grandeur of outline the beech excels the oak. Its foliage is peculiarly soft and pleasing to the eye; its branches are numerous and spreading; and its stem grows to a great size. The bark of the beech is remarkably smooth, and of a silvery cast: this, added to the splendour and smoothness of its foliage, gives a striking neatness and delicacy to its general appearance. The beech therefore, standing singly, and suffered to form its own natural head, is highly ornamental: and its leaves varying their hue as the autumn approaches, renders it in this point of view still more desirable. In respect of actual use the beech follows next to the oak and the ash: it is almost as necessary to the cabinet-maker and turner as the oak is to the shipbuilder, or the ash to the plough and cart-wright. Evelyn nevertheless condemns it in pointed and general terms; because "where it lies dry, or wet and dry, it is exceedingly obnoxious to the worm." He adds, however, "but being put ten days in water it will exceedingly resist the worm." The natural soil and situation of the beech are upon dry, chalky, or limestone heights: it grows to a great size upon the hills of Surry and Kent; as also upon the declivities of the Cotswold and Stroudwater hills of Gloucestershire, and flourishes exceedingly upon the bleak banks of the Wye, in Hereford and Monmouth shires; where it is much used in making charcoal. In situations like those, and where it is not already prevalent, the beech, whether as a timber-tree or as an underwood, is an object worthy the planter's attention.

The mast, or seeds, yield a good oil for lamps; and are a very agreeable food to squirrels, mice, and swine. The fat of swine fed with them, however, is soft, and boils away, unless hardened by some other food. The leaves gathered in autumn, before they are much injured by the frosts, make much better mattrasses than straw or chaff, and last for seven or eight years. The nuts, when eaten by the human species, occasion giddiness and headache; but when well dried and powdered they make wholesome bread. They are sometimes roasted, and substituted for coffee. The poor people in Silesia use the expressed oil instead of butter.

The chesnut-tree sometimes grows to an immense size. The largest in the known world are those which grow upon mount Ætna in Sicily. At Tortworth in Gloucestershire is a chesnut-tree 52 feet round. It is proved to have stood there ever since the year 1150, and was then so remarkable that it was called the great chesnut of Tortworth. It fixes the boundary of the manor, and is probably near 1000 years old. As an ornamental, the chesnut, though unequal to the oak and beech, has a degree of grandeur belonging to it which recommends it strongly to the planter's attention. Its uses have been highly extolled, and it may deserve a considerable share of the praise which has been given it. As a substitute for the oak it is preferable to the elm for door-jambs, window-frames, and some other purposes of the house-carpenter: it is nearly equal to oak itself; but it is very apt to be shaky, and there is a deceitful brittleness in it which renders it unsafe to be used as beams, or in any other situation where an uncertain load is required to be borne. It is universally allowed to be excellent for liquor-casks; as not being liable to shrink, nor to change the colour of the liquor it contains: it is also strongly recommended as an underwood for hop-poles, stakes, &c. Its fruit too is valuable, not only for swine and deer, but as human food: bread is said to have been made of it. Upon the whole, the chesnut, whether in the light of ornament or use, is undoubtedly an object of the planter's notice.

FAILLIS, in heraldry, a French term denoting some failure or fraction in an ordinary, as if it was broken, or a splinter taken from it.

FAIR, a greater kind of market, granted to a town, by privilege, for the more speedy and commodious providing of such things as the place stands in need of.

It is incident to a fair, that persons shall be free from being arrested in it for any other debt or contract than what was contracted in the same, or at least promised to be paid there. Also proclamation is to be made, how long they are to continue; and no person shall sell any goods after the time of the fair is ended, on forfeiture of double the value, one fourth to the prosecutor, and the rest to the king. There is a toll usually paid in fairs, on the sale of things, and for stallage, picage, &c.

Fairs abroad are either free, or charged with toll and imposition. The privileges of free fairs consist chiefly, first, in that all traders, &c. whether natives or foreigners, are allowed to enter the kingdom, and are under the royal protection, exempt from duties, impositions, tolls, &c. Secondly, that merchants, in going or returning, cannot be molested or arrested, or their goods stopped. They are established by letters-patent from the prince. Fairs, particularly free fairs, make a very considerable article in the commerce of Europe, especially that of the Mediteranean, and inland parts of Germany, &c.

The principal British fairs are, 1. Sturbridge-fair, near Cambridge, by far the greatest in Britain, and perhaps in the world. 2. Bristol has two fairs, very near as great as that of Sturbridge. 3. Exeter. 4. West Chester. 5. Edinburgh. 6. Wheyhill; and, 7. Burford-fair, both for sheep. 8. Pancras-fair, in Staffordshire, for saddle-horses. 9. Bartholomew-fair, at London, for lean and Welsh black cattle. 10. St. Faith's, in Norfolk, for Scotch runts. 11. Yarmouth fishing-fair for herrings, the only fishing-fair in Great Britain. 12. Ipswich butter-fair. 13. Woodborough-hill, in Dorsetshire, for west-country manufactures, as kerseys, druggets, &c. 14. Two cheese-fairs at Chipping Norton: with innumerable other fairs, besides weekly markets, for all sorts of goods, as well our own as of foreign growth.

Among the principal free fairs in France were those of St. Germains, Lyons, Rheims, Chartres, Rouen, Bourdeaux, Troyes, Bayonne, Dieppe, &c.

The most noted fairs in Germany are those of Francfort, Leipsic, and Nurenburg; not only on account of the great trade, but the vast concourse of princes of the empire, nobility, and people, who come to them from all parts of Germany to partake of the diversions.

FAIRY-CIRCLE, or *ring*, a phenomenon frequent in the fields, &c. supposed by the vulgar to be traced by the fairies in their dances: there are two kinds of it; one of about seven yards in diameter, containing a round bare path, a foot broad, with green grass in the middle of it. The other is of different bigness, encompassed with a circumference of grass, greener and fresher than that in the middle. Mess. Jessop and Walker, in the Philosophical Transact. ascribed them to lightning: we have however examined them ourselves, and are convinced they are produced by a kind of fungus which breaks and pulverizes the soil; why this vegetable should put forth its offsets in this kind of circular direction we cannot rightly account. The circles however are seldom complete, and often very irregular.

FAKE, among sailors, signifies one round or circle of a cable or hawser, coiled up out of the way.

FALCATED, something in the form of a

sickle: thus the moon is said to be falcated when she appears horned.

FALCO, in ornithology, a genus belonging to the order of accipitres, the characters of which are these: the beak is crooked, and furnished with wax at the base; the head is thick-set with feathers, and the tongue is cloven. The eagle, kite, and hawk, form this genus. There are 32 species, of which the following are the most remarkable.

1. The leucocephalus, bald, or white-headed eagle of Catesby, is ash-coloured, with head and tail white; the iris of the eye is white, over which is a prominence covered with a yellow skin; the bill and the cere or wax are yellow, as are likewise the legs and feet; and the talons are black. Though it is an eagle of small size, it weighs nine pounds, is strong and full of spirit, preying on lambs, pigs, and fawns. They always make their nests near the sea or great rivers, and usually upon old dead pine or cypress trees, continuing to build annually on the same tree till it falls. Though he is so formidable to all birds, yet he suffers them to build near his royal nest without molestation; particularly the fishing-hawk, herons, &c. which all build on high trees, and in some places are so near one another that they appear like a rookery. The nests are very large and very fetid, owing to the relics of their prey. Lawson says they breed very often, laying again under their callow young, whose warmth hatches the eggs. In Bering's isle they make their nests on the cliffs near six feet wide and one thick; and lay two eggs in the beginning of July. This species inhabits both Europe and America; but is more common in the latter. Besides flesh, it feeds also on fish. This, however, it does not procure for itself; but sitting in a convenient spot, watches the diving of the fishing-hawk into the water after a fish; which the moment it has seized, the bald eagle follows close after, when the hawk is glad to escape by dropping the fish from his bill; and such is the dexterity of the former, that it often seizes the prey before it can fall to the ground. Catesby says the male and female are much alike.

2. The ossifragus, sea-eagle, or osprey with yellow wax, and half-feathered legs: it is about the size of a peacock; the feathers are white at the base, iron-coloured in the middle, and black at the points; and the legs are yellow. It is found in several parts of Great Britain and Ireland. Mr. Willughby tells us, that there was an eyrie of them in Whinfield-park, Westmoreland; and the bird soaring in the air with a cat in its talons (which Barlow drew from the very fact which he saw in Scotland) is of this kind. The cat's resistance brought both animals to the ground, when Barlow took them up; and afterwards caused the fact to be engraved in the 36th plate of his collection of prints. Turner says, that in his days this bird was too well known in England; for it made horrible destruction among the fish. All authors indeed agree, that it feeds principally on fish, which it takes as they are swimming near the surface, by darting down upon them; not by diving or swimming, as some authors have pretended, who furnish it for that purpose with one webbed foot to swim with, and another divided foot to take its prey. Martin, speaking of what he calls the great eagles of the Western isles, says, that they fasten their talons in the back of the fish, commonly of salmon, which are often above the water, or very near the surface. Those of Greenland will even take a young seal out of the water.

3. The chrysaëtos, or golden eagle (See Pl. Nat. Hist. fig. 191), weighs about twelve pounds, and is in length about three feet, the wings when extended measuring about seven feet four inches. The sight and sense of smelling are very acute: the head and neck are clothed with narrow sharp-pointed feathers, of a deep-brown colour bordered with tawny; the hind part of the head in particular is of a bright rust-colour. These birds are very destructive to fawns, lambs, kids, and all kinds of game; particularly in the breeding season, when they bring a vast quantity of prey to their young. Smith, in his History of Kerry, relates, that a poor man in that county got a comfortable subsistence for his family, during a summer of famine, out of an eagle's nest, by robbing the eaglets of the food which the old one brought; whose attendance he protracted beyond the natural time, by clipping the wings and retarding the flight of the former. It is very unsafe to leave infants in places where eagles frequent, there being instances in Scotland of two being carried off by them; but, fortunately, the theft was discovered in time, and the children were restored unhurt out of the eagles' nests. In order to extirpate these pernicious birds, there is a law in the Orkney isles, which intitles every person that kills an eagle to a hen out of every house in the parish where it was killed. Eagles seem to give the preference to the carcases of dogs and cats. People who make it their business to kill those birds, lay one or other of these carcases by way of bait; and then conceal themselves within gunshot. They fire the instant the eagle alights; for she, that moment, looks about before she begins to prey. Yet, quick as her sight may be, her sense of hearing seems still more exquisite. If hooded crows or ravens happen to be nearer the carrion, and resort to it first, and give a single croak, the eagle is certain instantly to repair to the spot.

Eagles are remarkable for their longevity, and for their power of sustaining a long abstinence from food. Mr. Keysler relates, that an eagle died at Vienna after a confinement of 104 years. This pre-eminent length of days probably gave occasion to the saying of the Psalmist, "Thy youth is renewed like the eagle's." One of this species, which was nine years in the possession of Owen Holland, esq. of Conway, lived 32 years with the gentleman who made him a present of it; but what its age was when the latter received it from Ireland is unknown. The same bird also furnishes us with a proof of the truth of the other remark; having once, through the neglect of servants, endured hunger for 21 days without any sustenance whatever.

4. The fulvus, or white-tailed eagle of Edwards, has the whole plumage of a dusky-brown: the breast marked with triangular spots of white, but which are wanting in the British kind: the tail is white, tipt with black; but in young birds dusky, blotched with white: the legs are covered to the toes with soft rust-coloured feathers. These birds inhabit Hudson's-bay and northern Europe as far as Drontheim. They are found on the highest rocks of the Uralian chain, where it is not covered with wood; but are most frequent on the Siberian, where they make their nests on the loftiest rocks. They are rather inferior in size to the sea-eagle; but are generous, spirited, and docile. The Independant Tartars train them for the chase of hares, foxes, antelopes, and even wolves. This practice is of considerable antiquity; for Marco Polo, the great traveller of 1269, observed and admired the diversion of the great cham of Tartary, who had several eagles which were applied to the purposes we have here described. The Tartars also esteem the feathers of the tail as the best they have for pluming their arrows. This species is frequent in Scotland; where it is called the black eagle, from the dark colour of its plumage. It is very destructive to deer, which it will seize between the horns; and by incessantly beating it about the eyes with its wings, soon makes a prey of the harassed animal. The eagles in the isle of Rum have nearly extirpated the stags that used to abound there. They generally build in cliffs or rocks near the deer-forests; and make great havock not only among them, but also among the white hares and ptarmigans. Mr. Willughby gives the following curious account of the nest of this species. "In the year of our Lord 1668, in the woodlands near the river Darwent, in the peak of Derbyshire, was found an eagle's nest made of great sticks, resting one end on the edge of a rock, the other on two birch-trees; upon which was a layer of rushes, and over them a layer of heath, and upon the heath rushes again; upon which lay one young one and an addle egg; and by them a lamb, a hare, and three heath-poults. The nest was about two yards square, and had no hollow in it. The young eagle was as black as a hobby, of the shape of a gos-hawk, almost of the weight of a goose, rough-footed, or feathered down to the foot: having a white ring about the tail."

5. The cyaneus, or hen-harrier, with white wax, yellow legs, a whitish-blue body, and a white ring round the eyes and throat. It is the blue hawk of Edwards, and is a native of Europe and Africa. These birds are extremely destructive to young poultry and to the feathered game: they fly near the ground, skimming the surface in search of prey. They breed on the ground, and are never observed to settle on trees.

6. The albicilla, or cinereous eagle, is inferior in size to the golden eagle; the head and neck are of a pale ash-colour; the body and wings cinereous, clouded with brown; the quill feathers very dark; the tail white; the legs feathered but little below the knees, and of a very bright yellow. The male is of a darker colour than the female. The bill of this species is rather straighter than is usual in the eagle, which seems to have induced Linnæus to place it among the vultures. But Mr. Pennant observes, that it can have no title to be ranked with that genus, the characteristical mark of which is, that the head and neck are either quite bare, or only covered with down; whereas this bird is wholly feathered. This species is in size equal to the black eagle, and inhabits Europe as high as Iceland and Lapmark. It is common in Greenland, but does not extend to America; or, according to Mr. Pennant, if it does, it varies into the white-headed eagle, to which it has great affinity,

particularly in its feeding much on fish: the Danes therefore call it fiské-orn. It is common in the south of Russia, and about the Volga, as far as trees will grow; but is very scarce in Siberia. It inhabits Greenland the whole year, sitting on the rocks with flagging wing, and flies slowly. It makes its nest on the lofty cliffs, with twigs, lining the middle with mosses and feathers; lays two eggs; and sits in the latter part of May or beginning of June. These birds prey on young seals, which they seize as they are floating on the water; but frequently, by fixing their talons in an old one, they are overmatched, and drawn down to the bottom, screaming horribly. They feed also on fish, especially the lumpfish, and a sort of trout; on ptarmigans, auks, and eider ducks. They sit on the tops of rocks, attentive to the motion of the diving birds, and with quick eyes observe their course by the bubbles which rise to the surface of the water, and catch the fowls as they rise for breath. The Greenlanders use their skins for clothing next to their bodies; eat the flesh; and keep the bill and feet for amulets. They kill them with the bow; or take them in nets placed in the snow properly baited; or tempt them by the fat of seals, which the eagles eat to an excess which occasions such a torpidity as to make them an easy prey. They are common in Scotland and the Orkneys; where they feed on fish, as well as on land-animals.

7. The maculatus, or the crying eagle, with a dusky bill and yellow cere; the colour of the plumage is a ferruginous brown; the coverts of the wings and scapulars are elegantly varied with oval white spots; the primaries dusky, the ends of the greater, white; the breast and belly are of a deeper colour than the rest of the plumage, streaked downwards with dull yellow; the tail is dark brown, tipt with dirty white; the legs are feathered to the feet, which are yellow. The length of the bird is two feet. This species is found in many parts of Europe, but not in Scandinavia; is frequent in Russia and Siberia; and extends even to Kamtschatka. It is less generous and spirited than other eagles, and is perpetually making a plaintive noise; from which it was styled by the antients planga et clanga; and anataria, from its preying on ducks, which Pliny describes with great elegance. The Arabs used to train it for the chase; but its quarry was cranes and other birds, the more generous eagle being flown at antelopes and other quadrupeds. This species was itself an object of diversion, and made the game of even so small a bird as the sparrowhawk; which would pursue it with great eagerness, soar above, then fall on it, and fastening with its talons, keep beating it about the head with its wings, till they both fell together to the ground. This sir John Chardin has seen practised about Tauris.

8. The milvus, or kite, is a native of Europe, Asia, and Africa. This species generally breeds in large forests or woody mountainous countries. Its nest is composed of sticks, lined with several odd materials, such as rags, bits of flannel, rope, and paper. It lays two, or at most three, eggs; which, like those of other birds of prey, are much rounded and blunt at the smaller end. They are white spotted with dirty yellow. Its motion in the air distinguishes it from all other birds, being so smooth and even that it is scarcely perceptible. Sometimes it will remain quite motionless for a considerable space; at others glide through the sky without the least apparent action of its wings; thence deriving the old name of glead, or glede, from the Saxon glida. They inhabit the north of Europe, as high as Jalsberg, in the very south of Norway; but do not extend farther. They quit Sweden in flocks at the approach of winter, and return in spring. Some of them winter about Astrakan, in lat. 46. 30: but the far greater part are supposed to retire into Egypt, being seen in September passing by Constantinople in their way from the north; and again in April returning to Europe, to shun the great heats of the East. They are observed in vast numbers about Cairo, where they are extremely tame, and feed even on dates, probably for want of other food. They also breed there; so that, contrary to the nature of other rapacious birds, they increase and multiply twice in the year; once in the mild winters of Egypt, and a second time in the summers of the north. It makes its appearance in Greece in the spring; and in the early ages, says Aristophanes, "it governed that country; and men fell on their knees when they were first blessed with the sight of it, because it announced the flight of winter, and told them to begin to shear their vernal fleeces." In Britain they are found the whole year. Lord Bacon observes, that when kites fly high, it portends fair and dry weather. See Plate Nat. Hist. fig. 197.

9. The gentilis, or gentil falcon, inhabits the north of Scotland, and was in high esteem as a bold and spirited bird in the days of falconry. It makes its nest in rocks: it is larger than the gos-hawk; the head of a light rust-colour, with oblong black spots; the whole under side from chin to tail white, tinged with yellow; the back of a brown colour; the tail barred with four or five bars of black, and as many of ash-colour; the very tips of all the tail feathers white.

10. The subbuteo, or hobby, was used like the kestrel in the humbler kind of falconry; particularly in what was called daring of larks: the hawk was cast off; the larks, aware of their most inveterate enemy, were fixed to the ground for fear; by which means they became a ready prey to the fowler, who drew a net over them. The back of the bird is brown: the nape of the neck white: and the belly pale, with oblong brown spots. It is a bird of passage; but breeds in Britain, and migrates in October.

11. The buteo, or buzzard, is the most common of the hawk kind in England. It breeds in large woods; and usually builds on an old crow's nest, which it enlarges, and lines with wool and other soft materials. It lays two or three eggs, which are sometimes perfectly white, sometimes spotted with yellow. The cock-buzzard will hatch and bring up the young if the hen is killed. The young keep company with the old ones for some little time after they quit the nest; which is not usual with other birds of prey, who always drive away their brood as soon as they can fly. The buzzard is very sluggish and inactive, and is much less in motion than other hawks; remaining perched on the same bough for the greatest part of the day, and dwelling at most times near the same place. It feeds on birds, rabbits, moles, and mice; it will also eat frogs, earthworms, and insects. This bird is subject to some variety in its colour. Some have the breast and belly of a brown colour, and are only marked across the craw with a large white crescent; but usually the breast is of a yellowish white, spotted with oblong rust-coloured spots, pointing downwards; the back of the head, neck, and coverts of the wings, are of a deep brown, edged with a pale rust-colour: the middle of the back covered only with a thick white down. The tail is barred with black and ash-colour, and sometimes ferruginous.

12. The tinnunculus, or kestrel, breeds in the hollows of trees, in the holes of high rocks, towers, and ruined buildings. It feeds on field-mice, small birds, and insects; which it will discover at a great distance. This is the hawk that we so frequently see in the air fixed in one place; and, as it were, fanning with its wings; at which time it is watching for its prey. When falconry was in use in Great Britain, this bird was trained for catching of small birds and young partridges. It is easily distinguished from all other hawks by its colours. The crown of the head and the greater part of the tail are of a fine light grey; the back and coverts of the wing of a brick-red, elegantly spotted with black; the whole under side of the bird of a pale rust-colour spotted with black.

13. The sufflator, with yellowish wax and legs; the body is of a brownish-white colour; and the covers of the eyes are bony. He has a fleshy lobe between the nostrils; which, when angry or terrified, he inflates till his head becomes as big as his whole body. He is a native of Surinam.

14. The cachinnans, or laughing hawk, has yellowish legs and wax, and white eyebrows; the body is variegated with brown and white; and it has a black ring round the top of the head. It makes a laughing kind of noise when it observes any person, and is a native of America.

15. The columbarius, or pigeon-hawk of Catesby, weighs about six ounces. The bill is black at the point, and whitish at the base: the iris of the eye is yellow; the base of the upper mandible is covered with a yellow cere of wax: all the upper part of the body, wings, and tail, are brown. The anterior vanes of the quill-feathers have large red spots. The tail is marked with large regular transverse white lines; the throat, breast, and belly, are white, mixed with brown; the small feathers that cover the thighs reach within half an inch of the feet, and are white, with a tincture of red, beset with long spots of brown; the legs and feet are yellow. It inhabits America, from Hudson's-bay as low as South Carolina. In the last it attains to a larger size. In Hudson's-bay it appears in May on the banks of the river Severn, breeds, and retires south in autumn. It feeds on small birds; and, on the approach of any person, flies in circles, and makes a great shrieking. It forms its nest in a rock, or some hollow tree, with sticks and grass; and lines it with feathers; and lays from two to four eggs, white spotted with red. In Carolina it preys on pigeons, and the young of the wild turkeys.

16. The furcatus, or swallow-tailed hawk, has a black bill, less hooked than usual with rapacious birds: the eyes are large and black,

and with a red iris: the head, neck, breast, and belly, are white; the upper part of the back and wings a dark purple; but more dusky towards the lower parts, with a tincture of green. The wings are long in proportion to the body, and when extended, measure four feet. The tail is dark purple mixed with green, and remarkably forked. This most elegant species inhabits the southern parts of North America only during summer. Like swallows, they feed chiefly flying; for they are much on wing, and prey on various sorts of insects. They also feed on lizards and serpents; and will kill the largest of the regions it frequents with the utmost ease. They quit North America before winter, and are supposed to retreat to Peru.

17. Haliætus, the fishing-hawk of Catesby, sometimes called the osprey, weighs 3 pounds and a quarter; it measures, from one end of the wing to the other, five feet and a half. The bill is black, with a blue cere or wax; the iris of the eye is yellow, and the crown of the head brown, with a mixture of white feathers; from each eye, backwards, runs a brown stripe: the back, wings, and tail, are of a dark brown; the throat, neck, and belly, white; the legs and feet are rough and scaly, and of a pale blue colour; the talons are black, and nearly of an equal size: the feathers of the thighs are short, and adhere close to them, contrary to others of the hawk kind, which nature seems to have designed for the more easily penetrating the water. Notwithstanding this bird is so persecuted by the bald eagle, yet it always keeps near its haunts. It is a species of vast quickness of sight; and will see a fish near the surface from a great distance, descend with prodigous rapidity, and carry the prey with an exulting scream high into the air. The eagle hears the note, and instantly attacks the fishing-hawk: who drops the fish, which the former catches before it can reach the ground or water. The lower parts of the rivers and creeks near the sea, in America, abound with these eagles and hawks, where such diverting contests are often seen. It sometimes happens that this bird perishes in taking its prey; for if it chances to fix its talons in an overgrown fish it is drawn under water before it can disengage itself, and is drowned. See Plate Nat. Hist. fig. 194.

18. The gyrfalco, or Iceland falcon, has a strong bill, much hooked, the upper mandible sharply angulated on the lower edges, with a blueish wax: the head is of a very pale rust-colour, streaked downwards with dusky lines: the neck, breast, and belly, are white, marked with cordated spots; the thighs white, crossed with short bars of deep brown: the back and coverts of the wings are dusky, spotted, and edged with white; the exterior webs of the primaries dusky mottled with reddish-white, the inner barred with white; the feathers of the tail are crossed with 14 or more narrow bars of dusky and white, the dusky bars regularly opposing those of white: the wings, when closed, reach almost to the end of the train: the legs are strong and yellow. The length of the wing, from the pinion to the tip, is sixteen inches. This species is an inhabitant of Iceland, and is the most esteemed of any for the sport of falconry.

19. The fuscus, or Greenland eagle, has dusky irides; lead-coloured wax and feet; brown crown, marked with irregular oblong white spots; whitish forehead; blackish cheeks; the hind part of the head and throat white; breast and belly of a yellowish white, striped downwards with dusky streaks; the back dusky, tinged with blue, the ends of the feathers lightest, and sprinkled over with a few white spots, especially towards the rump; the wings of the same colours, variegated beneath with white and black; the upper part of the tail dusky, crossed very faintly with paler bars, the under side whitish. It inhabits all parts of Greenland, from the remotest hills to those which impend over the sea. They are even seen on the islands of ice remote from shore. They retire in the breeding-season to the farthest part of the country, and return in autumn with their young. They breed in the same manner as the cinereous eagle, but in more distant places; and lay from three to five eggs. The tail of the young is black, with great brown spots on the exterior webs. They prey on ptarmigans, auks, and all the small birds of the country. They have frequent disputes with the raven, but seldom come off victors; for the raven will, on being attacked, fling itself on its back; and either by defending itself with its claws, or by calling, with its croaking, numbers of others to its help, oblige the falcon to retire. The Greenlanders use the skin, among others, for their inner garments; the wings for brushes; the feet for amulets; but seldom eat the flesh, unless compelled by hunger.

20. The candicans, or white gyrfalcon of Pennant, has the wax and bill blueish, the latter greatly hooked; the eye dark-blue; the throat of a pure white; the whole body, wings, and tail, of the same colour, most elegantly marked with dusky bars, lines, or spots, leaving the white the far prevailing colour. There are instances, but rare, of its being found entirely white. In some, the whole tail is crossed by remote bars of black or brown; in others, they appear only very faintly on the middle feathers; the feathers of the thighs are very long and unspotted; the legs strong, and of a light blue. Its weight is 45 ounces troy; length near two feet, extent four feet two. This species has the same manners and haunts with the former. It is very frequent in Iceland; is found in Lapmark and Norway, and rarely in the Orkneys and North Britain. In Asia, it dwells in the highest points of the Uralian and other Siberian mountains, and dares the coldest climates throughout the year. It is kept in the latitude of Petersburgh, uninjured in the open air during the severest winters. This species is pre-eminent in courage as well as beauty, and is the terror of the other hawks. It was flown at all kinds of fowl, how great soever they were: but its chief game used to be herons and cranes.

The last three species are in high esteem for sport. They are reserved for the kings of Denmark; who send their falconer with two attendants annually into Iceland to purchase them. They are caught by the natives, a certain number of whom in every district are licensed for that purpose. The Iceland falcons will last ten or twelve years; whereas those of Norway, and other countries, seldom are fit for sport after two or three years. Yet the Norwegian hawks were in old times in great repute in this kingdom, and even thought bribes worthy of a king.

21. The aviporus, with black wax, yellow legs half-naked, the head of an ash-colour, and having an ash-coloured stripe on the tail, which is white at the end. It is the honey-buzzard of Ray, and had that name from the combs of bees or wasps being found in its nest. It is a native of Europe, and feeds on mice, lizards, frogs, bees, &c. It runs very swiftly, like a hen.

22. The æruginosus, or moor-buzzard, with greenish wax, a greyish body, the top of the head, nape of the neck, and legs, yellowish; is a native of Europe, and frequents moors, marshy places, and heaths: t never soars like other hawks; but commonly sits on the ground, or on small bushes. It makes its nest in the midst of a tuft of grass, or rushes. It is a very fierce and voracious bird; and is a great destroyer of rabbits, young wild ducks, and other water-fowl. It also preys, like the fishing-hawk, on fish.

23. The palumbarius, with black wax edged with yellow, yellow legs, a brown body, the prime feathers of the tail marked with pale streaks, and the eyebrows white. It is the gos-hawk of Ray; and was formerly in high esteem among falconers, being flown at cranes, geese, pheasants, and partridges. It breeds in Scotland, and builds its nest in trees. It is destructive to game, and dashes through the woods after its quarry with vast impetuosity; but if it cannot catch the object of its pursuit almost immediately, desists, and perches on a bough till some new game presents itself. This species is common in Muscovy and Siberia. They extend to the river Amur; and are used by the emperor of China in his sporting progresses, attended by his grand falconer, and 1000 of the subordinate. Every bird has a silver plate fastened to its foot, with the name of the falconer who has the charge of it; that, in case it should be lost, it might be brought to the proper person: but if he could not be found, the bird is delivered to another officer, called the guardian of lost birds; who keeps it till it is demanded by the falconer to whom it belonged. That this great officer may the more readily be found among the army of hunters who attend the emperor, he erects a standard in the most conspicuous place.

24. The nisus, or sparrowhawk, with green wax, yellow legs, a white belly undulated with grey, and the tail marked with blackish belts. This is the most pernicious hawk we have, and makes great havock among pigeons as well as partridges. It builds in hollow trees, in old nests of crows, large ruins, and high rocks: it lays four white eggs, encircled near the blunter end with red specks.

25. The minutus, with white wax, yellow legs, and the body white underneath. It is the least hawk of Brisson, being about the size of a thrush: and is found on the island of Melita.

Besides these we may mention the lithofalco, or stone falcon, which inhabits many parts of Europe, and is about a foot long; the bill blueish-ash; irids yellow; two middle tail-feathers uniform, the rest barred with brown: the gallicus or French eagle, so called from its being found chiefly in France, about two feet long, feeds on rats, mice, and frogs; it builds its nest mostly on the ground;

the irids yellow; tail-feathers white with brown transverse stripes, brown at the tips and edges; claws grey: the lacer inhabits Europe, Tartary in Asia, and many parts of North America; it is two feet long, patient of cold; used in hunting the white heron: the head pale brown; wing-coverts and primary quill feathers with transverse white lines; tail brown, with oval transverse red spots on the sides; legs feathered to the toes: and the magnirostris, or great billed falcon, found in Cayenne, a little larger than the sparrowhawk; legs shorter; bill longer, thicker, black; irids orange; feathers above and on the breast brown edged with rusty; claws black. See Plate Nat. Hist. figs. 192, 193, 195, and 196.

There are some other species distinguished by ornithologists. Among these are two described by Mr. Bruce; of which one deserves particular notice, as being not only the largest of the eagle kind, but supposed to be the largest bird that flies. He calls it the golden eagle; by the natives it is vulgarly called abon duchn, or father long-beard.

FALCONRY, the exercise of taking wild-fowl by means of hawks. There are only two countries in the world where we have any evidence that the exercise of hawking was very antiently in vogue. These are Thrace and Britain. In the former it was pursued merely as the diversion of a particular district, if we may believe Pliny (b. x. 8.), whose account is rendered obscure by the darkness of his own ideas of the matter. The primæval Britons, with a fondness for the exercise of hunting, had also a taste for that of hawking; and every chief among them maintained a considerable number of birds for that sport. To the Romans this diversion was scarcely known in the days of Vespasian; yet it was introduced immediately afterwards. Most probably they adopted it from the Britons; but we certainly know that they greatly improved it by the introduction of spaniels into the island. In this state it appears among the Roman Britons in the sixth century. Gildas, in a remarkable passage in his first epistle, speaks of Maglocunus, on his relinquishing the sphere of ambition, and taking refuge in a monastery; and proverbially compares him to a dove, that hastens away at the noisy approach of the dogs, and with various turns and windings takes her flight from the talons of the hawk.

In after-times, hawking was the principal amusement of the English: a person of rank scarcely stirred out without his hawk on his hand; which, in old paintings, is almost the criterion of nobility. Harold, afterwards king of England, when he went on a most important embassy into Normandy, is painted embarking with a bird on his finger, and a dog under his arm: and in an antient picture of the nuptials of Henry VI. a nobleman is represented in much the same manner; for in those days, "it was thought sufficient for noblemen to winde their horn, and to carry their hawk fair, and leave study and learning to the children of mean people."

The expence was great that sometimes attended this sport. In the reign of James I. sir Thomas Monson is said to have given 1000*l.* for a cast of hawks: we are not then to wonder at the rigour of the laws that tended to preserve a pleasure which was carried to such an extravagant pitch. In the 34th of Edward III. it was made felony to steal a hawk; to take its eggs, even in a person's own ground, was punishable with imprisonment for a year and a day, besides a fine at the king's pleasure: in queen Elizabeth's reign, the imprisonment was reduced to three months; but the offender was to find security for his good behaviour for seven years, or lie in prison till he did.

The falcons or hawks that were in use in these kingdoms are now found to breed in Wales, and in North Britain and its isles. The peregrine-falcon inhabits the rocks of Caernarvonshire. The same species, with the gyr-falcon, the gentil, and the gos-hawk, are found in Scotland, and the lanner in Ireland.

We may here take notice, that the Norwegian breed was, in old times, in high esteem in England: they were thought bribes worthy a king. Jeoffrey Fitzpierre gave two good Norway hawks to king John, to obtain for his friend the liberty of exporting 100 cwt. of cheese; and Nicholas the Dane was to give the king a hawk every time he came into England, that he might have free liberty to traffic throughout the king's dominions.

They were also made the tenures that some of the nobility held their estates by, from the crown. Thus sir John Stanley had a grant of the isle of Man from Henry IV. to be held of the king, his heirs, and successors, by homage and the service of two falcons, payable on the day of his or their coronation. And Philip de Hastang held his manor of Combertoun, in Cambridgeshire, by the service of keeping the king's falcons.

Falconry, though an exercise now much disused among us, in comparison with what it antiently was, does yet furnish a great variety of significant terms, which still obtain in our language. Thus, the parts of a hawk have their proper names. The legs from the thigh to the foot, are called *arms*; the toes the *petty singles*; the claws the *pounces*. The wings are called the *sails*; the long feathers the *beams*; the two longest, the *principal feathers*; those next, the *flags*. The tail is called the *train*; the breast-feathers the *mails*; those behind the thigh the *pendant feathers*. When the feathers are not yet full-grown she is said to be *unsummed*; when they are complete, she is *summed*: the craw, or crop, is called the *gorge*; the pipe next the fundament, where the fæces are drawn down, is called the *pannel*: the slimy substance lying in the pannel is called the *glut*: the upper and crooked part of the bill is called the *beak*; the nether part, the *clap*; the yellow part between the beak and the eyes, the *sear* or *sere*; the two small holes therein, the *nares*.

As to her furniture: the leathers with bells buttoned on her legs, are called *bewits*. The leathern thong, whereby the falconer holds the hawk, is called the *lease* or *lash*; the little straps, by which the lease is fastened to the legs, *jesses*; and a line or packthread fastened to the lease, in disciplining her, a *creance*. A cover for her head, to keep her in the dark, is called a *hood*; a large wide hood, open behind, to be worn at first, is called a *rufter-hood*: to draw the strings, that the hood may be in readiness to be pulled off, is called *unstriking the hood*. The blinding a hawk just taken, by running a thread through her eye-lids, and thus drawing them over the eyes, to prepare her for being hooded, is called *seeling*. A figure or resemblance of a fowl, made of leather and feathers, is called a *lure*. Her resting-place, when off the falconer's hand, is called the *perch*. The place where her meat is laid, is called the *hack*; and that wherein she is set while her feathers fall and come again, the *mew*.

Something given a hawk to cleanse and purge her gorge, is called *casting*. Small feathers given her to make her cast, are called *plumage*. Gravel given her to help to bring down her stomach is called *rangle*. Her throwing up filth from the gorge after casting is called *gleaming*. The purging of her grease, &c. *enseaming*. Her being stuffed is called *gurgiting*. The inserting a feather in her wing in lieu of a broken one is called *imping*. The giving her a leg, wing, or pinion of a fowl to pull at is called *tiring*. The neck of a bird the hawk preys on is called the *inke*. What the hawk leaves of her prey is called the *pill* or *pelf*.

There are also proper terms used for several actions. When she flutters with her wings, as if striving to get away, either from the perch or fist, she is said to *bate*. When, standing too near, they fight with each other, it is called *crabbing*. When the young ones quiver, and shake their wings in obedience to the elder, it is called *cowring*. When she wipes her beak after feeding, she is said to *feak*. When she sleeps, she is said to *jouk*. From the time of exchanging her coat till she turn white again, is called her *intermewing*. Treading is called *cawking*. When she stretches one of her wings after her legs, and then the other, it is called *mantling*. Her dung is called *muting*; when she mutes a good way from her, she is said to *slice*; when she does it directly down, instead of yerking backwards, she is said to *slime*; and if it be in drops, it is called *dropping*. When she sneezes it is called *sniting*. When she raises and shakes herself she is said to *rouze*. When, after mantling, she crosses her wings together over her back, she is said to *warble*.

When a hawk seizes she is said to *bind*. When, after seizing, she pulls off the feathers she is said to *plume*. When she raises a fowl aloft, and at length descends with it to the ground, it is called *trussing*. When, being aloft, she descends to strike her prey, it is called *stooping*. When she flies out too far from game she is said to *rake*. When, forsaking her proper game, she flies at pyes, crows, &c. that chance to cross her, it is called the *check*. When, missing the fowl, she betakes herself to the next check, she is said to *fly on head*. The fowl or game she flies at is called the *quarry*. The dead body of a fowl killed by the hawk is called a *pelt*. When she flies away with the quarry she is said to *carry*. When in stooping she turns two or three times on the wing, to recover herself ere she seizes, it is called *cancelliering*. When she hits the prey, yet does not truss it, it is called *ruff*. The making a hawk tame and gentle is called *reclaiming*. The bringing her to endure company, *manning* her. An old staunch hawk, used to fly and set example to a young one, is called a *make-hawk*.

The reclaiming, manning, and bringing

up a hawk to the sport, is not easy to be brought to any precise set of rules. It consists in a number of little practices and observances, calculated to familiarize the falconer to his bird, to procure the love of it, &c.

When your hawk comes readily to the lure, a large pair of luring bells are to be put upon her; and the more giddy-headed and apt to rake out your hawk is, the larger must the bells be. Having done this, and she being sharp-set, ride out in a fair morning, into some large field unencumbered with trees or wood, with your hawk on your hand; then having loosened her hood, whistle softly to provoke her to fly; unhood her, and let her fly with her head into the wind; for by that means she will be the better able to get upon the wing, and will naturally climb upwards, flying a circle. After she has flown three or four turns, then lure her with your voice, casting the lure about your head, having first tied a pullet to it; and if your falcon come in and approach near you, cast out the lure into the wind, and if she stoop to it reward her.

You will often find, that when she flies from the fist, she will take stand on the ground: this is a fault which is very common with soar-falcons. To remedy this, fright her up with your wand; and when you have forced her to take a turn or two, take her down to the lure and feed her. But if this does not do; then you must have in readiness a duck sealed, so that she may see no way but backwards, and that will make her mount the higher. Hold this duck in your hand, by one of the wings near the body; then lure with the voice, to make the falcon turn her head; and when she is at a reasonable pitch, cast your duck up just under her; when, if she strikes, stoops, or trusses the duck, permit her to kill it, and reward her by giving her a reasonable gorge. After you have practised this two or three times, your hawk will leave the stand, and, delighted to be on the wing, will be very obedient.

It is not convenient, for the first or second time, to shew your hawk a large fowl; for it frequently happens, that they escape from the hawk, and she, not recovering them, rakes after them: this gives the falconer trouble, and frequently occasions the loss of the hawk. But if she happens to pursue a fowl, and being unable to recover it, gives it over, and comes in again directly, then cast out a sealed duck: and if she stoops and trusses it across the wings, permit her to take her pleasure, rewarding her also with the heart, brains, tongue, and liver. But if you have not a quick duck, take her down with a dry lure, and let her plume a pullet and feed upon it. By this means a hawk will learn to give over a fowl that rakes out, and, on hearing the falconer's lure, will make back again, and know the better how to hold in the head.

Some hawks have a disdainful coyness, proceeding from their being high-fed; such a hawk must not be rewarded though she should kill: but you may give her leave to plume a little; and then taking a sheep's heart cold, or the leg of a pullet, when the hawk is busy in pluming, let either of them be conveyed into the body of the fowl, that it may savour of it; and when the hawk has eaten the heart, brains, and tongue of the fowl, take out what is inclosed, call her to your fist, and feed her with it; afterwards give her some of the feathers of the fowl's neck, to scour her, and make her cast.

If your hawk is a stately high-flying one, she ought not to take more than one flight in a morning; and if she is made for the river let her not fly more than twice: when she is at the highest, take her down with your lure; and when she has plumed and broken the fowl a little, feed her, by which means you will keep her a high-flier, and fond of the lure.

FALDFEY, or FALDFEE, a rent or fee paid by some customary tenants, for liberty to fold their sheep on their own lands.

FALL, is the name of a measure of length used in Scotland, and containing six ells of that country.

FALL, in the sea language, that part of the rope of a tackle, which is hauled upon. Also when a ship is under sail, and keeps not so near the wind as she should do, they say she falls off; or when a ship is not flush, but has risings of some parts of her decks more than others, it is called falls.

FALLOPIAN TUBES. See ANATOMY.

FALLOWING *of land*. See HUSBANDRY.

FALSE, in music, an epithet applied to theorists to certain chords, called false, because they do not contain all the intervals appertaining to those chords in their perfect state: as a fifth, consisting of only six semitonic degrees, is denominated a false fifth. Those intonations of the voice which do not truly express the intended interval are also called false, as well as all ill-adjusted combinations; and those strings, pipes, and other sonorous bodies, which, from the ill-disposition of their parts, cannot be accurately tuned. Certain closes are likewise termed false, in contradistinction to the full or final close. See CLOSE.

FALSETTO. (Ital.) That species of voice in a man, the compass of which lies above his natural voice, and is produced by artificial constraint.

FALSIFYING, in law, the proving a thing to be false.

The falsifying a record, is where a person purchases land of another, who is afterwards outlawed for felony; in this case, he may falsify the record as to the time when the felony is supposed to have been committed, and also as to the point of the offence. But in the case where a person is found guilty by verdict, such purchaser shall only falsify the time. To falsify a recovery may be done by the issue in tail, where it is suffered by a tenant for life.

FALSO RETURNO BREVIUM, a writ that lies against a sheriff for false returning of writs he had got to execute.

FALSO BORDONE, in music, a term applied in the early days of descant to such counterpoint as had either a drone bass, or some part constantly moving in the same interval with it.

FALX, in anatomy, a process of the dura mater placed between the two hemispheres of the brain, and resembling a reaper's sickle.

FAMILIARS *of the inquisition*, are people that assist in the apprehending of such persons as are accused, and carrying them to prison; upon which occasion, the unhappy person is surrounded by such a number of these officious gentlemen, that there is no possibility of escaping out of their hands. As a reward of this base employ, the familiars are allowed to commit the most atrocious actions, to debauch, assassinate, and kill, with impunity.

FAN, an instrument used in husbandry. See HUSBANDRY.

FANDANGO, a dance much practised in Spain, and of which the natives of that country are particularly fond. Its air is lively, and much resembles the English hornpipe.

FANTASIA. (Ital.) The name generally given to a species of composition, supposed to be struck off in the heat of imagination, and in which the composer is allowed to give free range to his ideas, and to disregard those restrictions by which other productions are confined. Some writers limit the application of this term to certain extemporaneous flights of fancy; and say, that the moment they are written, or repeated, they cease to be fantasias. This, they add, forms the only distinction between the fantasia and the capricio. The capricio, though wild, is the result of premeditation, committed to paper, and becomes permanent: but the fantasia is an impromptu, transitive, and evanescent; exists but while it is executing, and when finished, is no more. Fantasias being, however, daily written and published, it is evident in which of the above senses the word is now to be understood.

FARINA FŒCUNDANS, among botanists, the impregnating meal or dust on the apices or antheræ of flowers; which being received into the pistil, or seed-vessel of plants, fecundates the rudiments of the seeds in the ovary, which otherwise would decay and come to nothing.

The manner of gathering the farina of plants for microscopical observation is this: Gather the flowers in the midst of a dry sunshiny day when the dew is perfectly off; then gently shake off the farina, or lightly brush it off with a soft hair-pencil, upon a piece of white paper; then take a single talc of isinglass between the nippers, and, breathing on it, apply it instantly to the farina, and the moisture of the breath will make that light powder stick to it. If too great a quantity is found adhering to the talc, blow a little of it off; and if there is too little, breathe upon it again, and take up more. When this is done, put the talc into the hole of a slider, and applying it to the microscope, see whether the little grains are laid as you desire; and if they are, cover them up with another talc, and fix the ring, but care must be taken that the talcs do not press upon the farinæ in such a manner as to alter the form.

FARLEY, or FARLIEU, money paid by tenants in the west of England, in lieu of a heriot. See HERIOT.

FARM, or FERM, signifies the chief messuage in a village, or any large messuage on which land belongs, meadow, pasture, wood, common, &c. and which has been used to let for term of life or years, under a certain yearly rent payable by the tenant for the same. See HUSBANDRY.

FARMER, among miners, signifies the lord of the field, or the person who farms the lot and cope of the king.

FARRIERY, the art and profession of the farrier, which have comprehended, from the earliest even to the present period, the medical and surgical care of the horse, as well as that of manufacturing and fitting him with shoes.

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Equus Caballus
Wild Horse

188

Erinaceus ecaudata
Madagascar hedgehog

180

Ephemera vulgata

189

Euphorbia officinalis

190

Exocoetus volitans
Flying fish

191

Falco chrysaetos
Golden Eagle

193

Falco Gallicus
French Eagle

192

Falco lithofalco
Stone Falcon

194

Falco haliaetus
Bald Buzzard

Printed June 1 [illegible] by Richard Ph[illegible] Bridge St Blackfriars

These men, as labourers of iron, were originally termed ferrers, or ferriers, from the Latin word *ferrum*, iron, and their craft ferriery; which word has since, either by a very usual corruption or improvement of language, been changed to farriery. This term remains yet in general use to its fullest extent, and not inaptly; since notwithstanding the laudable attempts of many enlightened men at various periods, our blacksmiths form a very large majority of horse surgeons and physicians. Nor is such defect peculiar to this country, but prevails in an equal degree throughout Europe; even in Italy and France, countries which preceded us many centuries in veterinary science, and from which indeed we have derived its elements.

On the establishment of a college, about fourteen years since, for the instruction of pupils in animal medicine and surgery, under a French professor, (Saintbel) we imported also from France the term *veterinary*, and the veterinary art has been since substituted for farriery by practitioners of liberal education. The supposed derivation of the term veterinary is from the participle *vectum*, of the Latin verb *veho*, to carry; *quasi* vecterinary, thence applied to the care of animals which carry, or beasts of burden. The change to veterinary was easy and in course; and if, according to the opinions of some, we ought to revert to the radical orthography, and write ferriery instead of farriery, a parity of reasoning, and desire of close adherence to the root, would induce us to retain the *c*, and pronounce the word vecterinary. It is easy to conceive what revolutions in language such attempts would occasion if generally put in practice; but by no means easy to discover the utility of a capricious and partial adoption of such changes in particular words.

The term veterinary was originally used by the Latins, (Vegetius) and has a more extensive import than our farriery, which relates to the horse solely; whereas the former comprehends the care, both in health and in a state of disease, of all those animals domesticated for the laborious service or food of man. In a history of the general science those branches may, however, be properly considered together.

From the manifest great consequence of the services of the domestic animals to man, in a state of civilization, they have, from a very remote period of antiquity, been the objects of his study and attention, both as to their ordinary management, and that which was requisite for them in a state of disease: for the latter a peculiar system was formed, including a materia medica and general mode of treatment considerably distinct from those in use with human patients. Of the authors of this system, whether Greek or Roman, nothing worth notice has been handed down beyond an occasional citation of names, to be found in Columella the Roman writer, who lived in the reign of Tiberius, and treated at large on the general management of cattle; and in Vegetius Renatus, who lived two centuries afterwards, and wrote more professedly on animal diseases. Both these authors have treated their subject in elegant and classical Latin; and the latter most particularly has urged, in very eloquent and forcible language, the necessity of a liberal cultivation of the veterinary art, as well on the score of profit as of humanity. It ought to be remembered however, that neither of these authors had the benefit of any professional acquaintance with medicine or surgery, obscure and imperfect as were those sciences in their days; and that no ancient treatise on the diseases of animals, written by a professional man, has descended to posterity. Nor is this in the smallest degree to be regretted, since we not only find in the authors abovementioned a sufficient field for the satisfaction of our curiosity, but also the most ample proofs of the irrationality of ancient principles and practice, and their total inapplicability to modern occasions. (Lawrence's General Treatise on Cattle.) On veterinary anatomy and physiology no attempts at discovery or improvement are to be traced in those writers, a singular defect considering the progress which had been made in Egypt and Greece, in both the human and comparative anatomy. Celsus is the only physician of eminence among the antients who is reported to have written on veterinary medicine, a part of his works which has not survived; nor is probably the loss we have thereby suffered very considerable. Xenophon is the oldest veterinary writer on record; but his treatise is confined to the training and the management of the horse for war and the chace. With respect to the fragments of antient Greek and Latin veterinary writers, collected and published by Ruellius, chief marshal, or farrier to Francis I. king of France, they appear to have been generally the works of military men, or other lovers of the horse; perhaps none of them were of medical education. We learn from the works of one of them, (Theomnestus) which is confirmed also by others, that the antients had a knowledge of the disease called the glanders in horses and other cattle, which was denominated in those days the moist malady. The chief merit of the antient veterinary writers consists in their dietetic rules and domestic management; they were in the habit of purging their animals, but in other respects their medical prescriptions appear to us an inconsistent and often discordant jumble of numerous articles, devoid either of rational aim, or probable efficacy. In the operations of surgery, particularly in phlebotomy, and indeed in the various methods of manual treatment and controul of their animals, the antients were far more skilful; and what they have left on the symptoms of diseases, if of no consequence in the present advanced state of science, still serves to demonstrate that they had not been inattentive observers of animal diseases, however inferior they might be in their methods of cure. These antient writers are yet to be esteemed superior, not only in learning and eloquence, but in professional utility, to the majority of their pupils of the fifteenth, sixteenth, and seventeenth centuries.

On the revival of learning in Europe, at the above periods, the works of the antient veterinary writers were eagerly sought and translated in Italy and France. At the same dawn of opening light and enthusiasm for the resuscitation and enlargement of the bounds of useful science, the anatomy and physiology of the human body became the grand objects of pursuit in the Italian schools. Veterinary anatomy followed in course; and the descriptive labours of Ruini and others on the body of the horse, have not only served for a groundwork and model to all the schools of Europe since; but succeeding discoveries and improvements, notwithstanding the vast advantage of a general diffusion of light, have not been hitherto sufficiently considerable to detract in any eminent degree from the well-earned fame of those early and original anatomists. Veterinary medicine was now generally cultivated, and in some instances, under regular medical professors. We find the following names in a list of those who had written on the *res veterinaria* in Italy during that period:—Laurentius Russius, Camerarius, Apollonius, Horatio, Albeterio, Grilli, Cæsar Fiaschi, Evangelista; and afterwards in Germany and France, Gresson, Libal, Wickerus, La Brove, Vinet. Every branch of the equine economy, whether relative to harness and trappings, equitation and military menage, or riding the great horse, the methodical treatment of the hoof, with the invention of various forms of iron shoes, and their scientific adaptation, were pursued with general assiduity and success. In this latter department Cæsar Fiaschi distinguished himself; and either invented or recommended the welted shoe, proposing a substitute for calkens and frost-nails, which it appears were then in use, as well as the *lunette*, or short half-moon shoe. Those horse-nails of peculiar form, of late years recommended as a new and useful invention, under the name of concave nails, were well known in those times of which we now speak. In fact, considerable progress was made towards a perfect system of horse-shoeing, which however declined and retrograded during a long interval, until its revival in France and England within the last fifty years. Evangelista, of Milan, distinguished himself in the breaking or education of the horse, and to him is attributed the invention of the martingale.

The new veterinary science having diffused itself over a great part of the continent, could scarcely fail of occasional communication with this country, where the care of diseased animals had been committed immemorially to leeches and farriers, persons generally belonging to the most illiterate class of society. It is probable that such communications became frequent during the reign of the first Tudors; for we learn from Blundeville, who wrote in the time of Elizabeth, that French and German farriers and riding-masters were not only employed by the queen, but in general by the nobility and gentry of the country. Yet our improvements in this country, in consequence of foreign aid, with regard to the medical and surgical branches at least, were by no means great, extending our view from the period of which we now speak, to the early part of the eighteenth century. No medical name appears during that long interval upon our veterinary list, nor any one of the smallest scientific pretension, we mean as far as respects the medical, anatomical, or surgical branches, that of Snape excepted, who was farrier to Charles II. and whose family, it appears by his book, had served the crown in that capacity upwards of two hundred years. Snape's anatomy of the horse proves him to have been a well-informed farrier. His anatomical system, arrangements, and nomenclature, were in course drawn from the Italian school; but he dissected, and his descriptions were confirmed by his own observation. His numerous plates are bold, accurate, and handsomely executed. Whether or not he pub-

lished the book of cures which he promised, we are uninformed, but he was doubtless far better qualified for that task than those of his profession upon whom that branch of the veterinary art unfortunately devolved. Stevens, Martin, Clifford, Morgan, were very early writers among the leeches and farriers. The book of Mascal, farrier to James I. is most laughably illiterate, and we cannot help wondering with a late author how such a book could possibly pass through numerous editions in a learned age, and which even possessed learned and rational books on the same subject. The above list may be concluded with De Grey and the celebrated Gervase Markham, a contemporary of Blundeville, who continued to publish perhaps until after the Restoration, and whose works were stuffed with every absurd, barbarous, and abominable juggling trick, as well as with every useful invention which had issued from the brains of either antients or moderns. As a specimen of the medical part of the horse leech-craft of Markham, he prescribes human ordure in certain cases for the horse, both externally and internally. Yet this man's works had a most rapid and universal sale, and continued in repute until the days of Gibson, and even long afterwards among the country leeches and farriers. It must be allowed that Markham's book contained the fullest detail of the practice of the farrier, with a delineation of his instruments, not materially different from those in present use.

Blundeville wrote sensibly and respectably on the general subject of the horse, according to the continental, the then fashionable practice. Baret in the succeeding reign, that of James I. wrote a learned treatise, entitled an Hipponomie, or the Vineyard of Horsemanship, in which he ably, and from obvious great experience, discusses all the relative branches, including the principles and practice of the race-course, and of that system of equitation peculiar to, and so generally prevalent in, this country. The huge folio of the duke of Newcastle gives us the regular manege of the horse from the continental schools, with an account of the different races of the animal, in which his grace was a connoisseur of high celebrity. Throughout the same interval veterinary science in France seems to have remained almost exclusively in the hands of the marshals or farriers, amongst whom Solleysel was the most celebrated writer of the seventeenth century; his works were afterwards abridged and translated into English by sir William Hope.

Until the reign of George I. the medical care of horses and other domestic animals was confided entirely to the classes of farriers, leeches, and cow-doctors. Considering the superior value of animals in this country, the former neglect of them would appear astonishing, did it not subsist at this moment in so considerable a degree; and that from causes easily ascertainable, but with difficulty to be surmounted. The medical system of the farriers, as delivered in their books, formed a strange medley of antient metaphysical notions, blended with deductions from the vague and uncertain experience of illiterate men. Much of it seemed the result of mere ignorance and caprice; no little, of pure distraction. For example, in a case of farcy, De Grey orders the medicine to be administered to the ears of the horse, and stiched up therein. In case of lameness a turf was to be cut and secreted; and in proportion as the turf decayed and wasted, so would the lameness! Various of their operations, in which no shadow of reason or possible utility seems discernible, were pursued with measures of horrible barbarity; for example, in Markham, the cure by the fire or knife for the falling of the crest! These men seem to have exhausted their wits in the discovery of ingenious and knowing feats of cruelty; and it is a phrase with Markham, 'other torments there are.' The art of shoeing the horse had retrograded from the original practice of the Italian farriers, which, however imperfect, yet formed a sufficient outline for a rational system. It had become the universal practice to pare away the frog and soles of the horse's foot; and by way of making amends for such loss of substance, to substitute a shoe of massive iron, so long as to project beyond the heels. It must however be acknowledged, that far more rational practice obtained amongst those who had the superintendance of that peculiar species of horses appropriated to the business of the turf, not only with respect to shoeing, but every other branch of management; and as the foreign and racing species has been the grand source of improvement for our British saddle and coach breeds; so the jockey system of equitation and general treatment of the horse, allowing its progressively amending defects, has ever possessed a characteristic and acknowledged superiority in this country.

Such was the state of farriery and veterinary practice in the early part of the eighteenth century, when the former, or horse medicine and surgery, attracted the attention of Wm. Gibson, who had acted in queen Anne's wars as an army-surgeon, and appears by his writings to have been a man of much practical knowledge and sound judgment. He was the first regular professional man who attempted to improve veterinary science, which he effected in a plain and popular way, grounded on the analogy between the human and brute physiology, in course between human and animal medicine. The appearance of Gibson's book on farriery forms an era in veterinary annals; and his system in fundamentals has ever been, and is at this moment, the basis of our superior veterinary practice. He lived to publish a new edition of his chief work, about the middle of the eighteenth century. Dr. Bracken, a physician of Lancaster, a vulgar, desultory, captious, and petulant writer, yet a profound and enlightened reasoner, and of great ability in his profession, in a few years followed the laudable example of Gibson, and turned his attention to veterinary medicine. He was an exquisite practical judge of the animal on which he treated; and his work on farriery is a standard with respect to the jockey or peculiar English system, a branch which had been left untouched by Gibson. Bartlet, a surgeon in Bow-street, Covent-garden, was a most respectable, intelligent, and useful compiler from Gibson and Bracken, whose labours he circumscribed and improved. He also first introduced the new, but hypothetical and impracticable, system of short shoeing, which had then lately been promulgated in France by the sieur La Fosse, a farrier of considerable science, and a great practical veterinary anatomist. Bartlet candidly gave the rules of La Fosse for shoeing horses, without pretending to any great practical knowledge of the subject; and these rules, speculative as they were, had yet the beneficial effect of operating a considerable improvement on English practice. Fortunately the affair was soon after taken in hand by William Osmer, a surgeon and a sportsman, who had great practical knowledge of the horse, and particularly of the race-horse, that species which, whilst it improves every other, requires the greatest attention, and in an especial manner with regard to shoeing and the treatment of the feet. Osmer commenced veterinary surgeon, and published an excellent and practical, although whimsically written book on horse-shoeing, in which he reduced the speculative rules of La Fosse to the standard of his own and of English experience. His book has not probably been hitherto excelled in point of utility; and being written in a plain and popular way, is adapted to the capacities of shoeing-smiths. The earl of Pembroke also wrote a short and excellent treatise on the same subject, practical horse-shoeing and case of the feet, and on the education of the military horse. Berenger, about the same time, published a respectable work on the grand manege. Mr. Clarke, the king's farrier for Scotland, has published two valuable treatises on shoeing, and on prevention of the diseases of horses.

To revert to the commencement of the Gibsonian era. It is to be lamented that the success with which Gibson's and Bracken's improved farriery was attended did not stimulate the attempts of some regular medical men to undertake the improvement of veterinary practice in favour of our other domestic animals, and to deliver them and their proprietors from barbarous and illiterate leech-craft. Doubtless a want of encouragement must be looked upon as one of the chief causes of this defect. A book indeed appeared about the middle of the eighteenth century, under the name of Topham, treating of the disease of horned cattle, but it proved to be merely a compilation, in which however were collected some useful hints with respect to management. As Gibson's Farriery had given rise to a great number of compilations, so Topham's book served the same purpose to the cow-doctors, many of whom copied Topham word for word, and boldly published these excerpts as the result of their own long experience and practice. Such has proved to be almost invariably the deceptive practice of this description of writers; whence the great number of similar publications, and the constant well-founded complaints against them. Mr. Lawrence, in his late General Treatise on Cattle, has taken the pains to ascertain various facts of this kind, and has given the outline of a national system of veterinary practice, calculated for cattle and sheep, recommending the pursuit to medical men, and the liberal encouragement of such to the proprietors of cattle, and particularly to the agricultural societies.

The eighteenth century was abundantly fruitful in veterinary pursuits and publications. France took the lead; but a zeal for the improvement of this branch of science also pervaded Germany and the northern states, and colleges were established in various countries, wherein the science has been since regularly cultivated. Baron Haller

collated the various continental writers on black cattle and sheep; another catalogue of them may also be found in the Giournal di Literati of Italy. Since these collections, the number of veterinary writers has been immense on the continent, not improbably for a reason already assigned. Few or none of them have been translated into our language, excepting detached parts of the works of the eminent French writers, La Fosse and Bourgelat. Our late professor Saintbel was a disciple of these celebrated veterinarians, and drew his geometrical proportions of the race-horse Eclipse from the tables of the latter. The truth and correctness of these geometrical principles have been since controverted by Mr. Wilkinson. Indeed, several speculative positions laid down in these tables do not accord with English practical experience; nor is the continental veterinary system, it is said, altogether calculated for the practice of this country, one great proof of which presents itself in the failure of the celebrated method of shoeing by La Fosse. The French have improved the anatomical and surgical branches of the veterinary art, rather than the medical; the English have made the greatest improvements in the latter: it is not improbably a parallel case with respect to human medicine.

Since the establishment of a veterinary college at St. Pancras, near London, in 1792, a great number of veterinary surgeons, receiving their diploma from thence, have been dispersed in the army and throughout the country, to our great national advantage, in the surgical and medical treatment of horses. A number of farriers also annually take the advantage of improving themselves at this seminary; but it is to be lamented that the light of veterinary science has hitherto shined but dimly and imperfectly on the other domestic animals. A great number of veterinary publications have issued from the press within this last period; and the two professors Saintbel and Coleman, with Messrs. White, Boardman, Blane, and many others, have laudably and usefully distinguished themselves in this way. Mr. Blane appears to have taken great pains in a new branch of veterinary science, as it relates to that useful domestic the dog. He has also published the anatomy of the horse. But the anatomical drawings and engravings of the bones, muscles, and many of the blood-vessels of the horse, of our justly celebrated horse-painter Stubbs, are held superior to any thing we possess of this kind.

The objects of farriery we have shewn, are the anatomy, physiology, pathology, medical and surgical care, and shoeing, of the horse. Dr. Crooke, quoted by Snape, affirms, that the motions of the heart, the arteries, the midriff, the brain, and guts, are the same in beasts as in men. Mr. Bracey Clarke observes, that "to describe each part of the horse individually and separately, would be often only repeating the more elaborate descriptions of the human anatomy, more frequently than those but little conversant with this subject would suspect. Many of the viscera, and even the myology of the trunk and extremities, often correspond in their principal circumstances." Snape further says, that "in some regards anatomy is more necessary to farriers than to physicians, in order to find out disorders; for besides the pulse and the urine, and the pathognomonic signs of each distemper, they (the latter) are assisted in their enquiries, moreover not to say chiefly, by the complaints and relations of the patients themselves; whereas a farrier, having to do with a dumb creature, must be very curious in his knowledge of the parts, with their offices, and of the sympathy or consent that one part hath with another; or else, seeing all his information must be of his own hammering out, he is like to make but a short discovery of the distemper." Add to the above observations, the analogy which modern experience has found to subsist between human and animal medicine, so far as our domesticated animals are concerned; and it will appear to whom veterinary science must necessarily be confined; and that an illiterate and ignorant class, whose laborious occupation must for ever preclude study and reflection, are totally incapable of the practice of medicine, whether human or animal. Thus the countenance and encouragement of so gross a deviation from rectitude and common sense must be constantly attended with loss and disappointment to the proprietors, and cruelty to their animals, exclusive of the moral breach of holding out to a numerous set of men the arts of imposition and legerdemain as a livelihood. The branches of the veterinary art, justly appropriate to the farrier and the cow-leech, are shoeing the horse and the labouring-ox, administering drenches, obstetric practice, bleeding, firing, and common surgical operations, under the guidance of a scientific veterinarian. Even shoeing, which seems most to appertain to the province of the common operator, has never been, in a single instance, improved by that class, but invariably by men of science: on the contrary, every improvement has met the strenuous opposition of the common farrier, until he has been gradually drawn into it, and almost imperceptibly to himself. Nor is the province we have assigned to these people, by any means, narrow or confined, but most ample, and affording a fair scope for both industry and good natural talents. Yet far be it from our intention to exclude them from the benefits either of attending the veterinary college or of consulting useful and practical books, which, in fact, are the true and only means to accomplish them in the fair and proper objects of their profession. We neither counsel nor desire any thing farther, than that such men, who may be much more suitably and advantageously employed, be as little as possible permitted to dabble in medicine.

It has of late been averred, in a sense far too general, that analogies fail, as well in anatomy as in the effects of medicine, between the human and those animals of which we treat. It is true the latter are quadrupeds, and their structure is of greater magnitude, and necessarily varies from ours; their integuments are thicker, and their general substance more solid. It requires, therefore, and the proportion has been long ascertained with sufficient accuracy, the application of a more powerful stimulus, in all given cases; in many, peculiar modes of administration. Certain common articles of the materia medica, namely, rhubarb, jalap, and the purging salts, it has been said of late, have no perceptible effects on the body of the horse, an assertion which ought to be received with a degree of caution. It is true, jalap and rhubarb, which were formerly, and particularly by Gibson, recommended as ingredients in purgative formulæ, will scarcely have any purgative effect if used by themselves; the latter, however, at least is certainly capable of answering many beneficial intentions in veterinary medicine; but its high price is doubtless a strong objection. Purging salts, it is acknowledged, will not often excite liquid dejections in horses, although they will in cows; but in the former, judiciously administered, they evacuate great loads of softened excrement, have excellent cooling and diuretic properties, and are well calculated for horses much confined in hot stables, and for those of delicate constitutions. All, or the far greater part, of the most powerful and efficacious medicines, both of the tonic and debilitating class, have a signal and analogical effect on the constitution of the horse. Nor is the common opinion, that the horse, living upon plain and simple food, has very little or no occasion for medicines, deserving of the smallest attention, any otherwise than as applied to the horse ranging at large in a state of nature. Labouring in the service of man, and confined to the dense and foul air of the stables, often in a constant state of luxurious repletion, exposed also to perpetual alternations of heat and cold, his body becomes subject to a variety of diseases, some of them of a most malignant type; and with respect to accidents, he must, from the nature of his severe services, be necessarily subject to a greater variety than any other animal. The above common-place opinion has ever been brought particularly to bear against the practice of purging horses, by which nevertheless they receive the most obvious and important benefits, and of which they seldom fail to have occasional need, whilst kept at hard meat in the stable. In fact, considering the obstruction and heat to which they are liable from the vast volume of their intestines, and the dryness and solidity of the food with which they are fed, it should seem probable that no animals stand more in need of artificial evacuants. The very circumstance of the length of their intestines has indeed been adduced as a proof of the impropriety and even danger of administering to them purgative medicines; and various instances of fatal effects therefrom have been proved. Sotteysel, the French writer, argued in this way; and advised the substitution of perspirants and diuretics; and notwithstanding the eminent success which every one accustomed to the superior management of horses, has experienced from purging them, the above superficial and groundless notion is occasionally revived even at present. The grand object is the removal of visceral infraction and obstruction, the common parent of almost every morbid evil in the horse; and this can at no rate be effected by diuretics, although they gave a partial, but illusory, and thence dangerous relief.

Nor are alteratives, in a general view, so advantageous as mild and well apportioned purges, which seem, in a particular manner, adapted and friendly to the constitution of the horse, filling him with renovated spirit and vigour, and increasing his appetite and strength. Purging the horse is perhaps to be considered as an English practice, alteratives and diuretics being in more general use

on the continent; and with respect to the danger of purging, the experience of a century has proved that to consist merely in the abuse and the use of bad drugs. Purging composes a material branch of our celebrated jockey or Newmarket system, which, with its imitations, have produced a perfection of habit and condition in the horse, universally admired by foreigners, and peculiar to this country. There is yet another opinion occasionally delivered, which we trust may not be unsuccessfully controverted: we advert to the pretended infant and imperfect state of veterinary science. The science of farriery has long been in a respectable and even mature state in this country, however generally deficient the practice; and we surely have at this time an undoubted right to expect a general and practical improvement.

Horses are particularly subject to catarrhal fever, pneumonia, influenzal and epidemic colds, rheumatism, asthmatic complaints, affections of the liver, colic, and blindness. They also share in common with human nature the maladies of apoplexy, spasm and convulsions, affections of the kidneys and urinary bladder, diabetes, dropsy, fever, and cutaneous affections.

The peculiar diseases of the horse are glanders, farcy, grease, strangles, poll evil or abscess, and they are particularly liable to injury and lameness in the lower extremities.

With respect to their diseases, the glanders, it is well known, has ever been the veterinary opprobrium, nor have we yet, after an infinity of attempts at various periods, advanced one step towards a probability of cure, speaking of the chronic species; nor is such an attainment perhaps an object of much consequence or interest from the length of time the cure must necessarily require, and the little subsequent use to be expected from the patient. The acute or incipient glanders will generally submit to proper remedies and care. The disease is atmospheric and catarrhal, and occasionally, but perhaps not so frequently as in common supposed, caught by contagion of other horses. Oxen and sheep are affected by the glanders; the latter particularly, on being early shorn in cold springs, under the influence of easterly winds. Broken wind in the horse, as its designation would seem to intimate, is irreparable; and there is a relative circumstance for which perhaps it is not easy to account, namely, that if a horse of this description be turned to grass for any length of time, on taking him back to the stable his malady shall be considerably increased, although, perhaps, if continued constantly abroad, he might remain as at first, or experience some amendment. In general, the diseases of horses, supposing skill in the practitioner, and an acquaintance with our best written authorities, may be treated very successfully, and upon a very near level in that respect with the human patient. Amongst, or rather the chief of, those irreparable injuries which the horse, from his hard services, is liable to sustain, must be reckoned repeated strains of the tendons. For a chronic case of that kind it is seldom possible to obtain a cure; and although the only remedy to be depended on is a long run at grass, yet, as has already been observed of broken wind, a horse in a confirmed case of injured tendons, frequently returns worse from grass than he was whilst in the stable. (Lawrence on Horses.) These injuries are commonly seated about the well-known back sinew of the leg, and among that multitude of tendons (in Snape's language) that descend into the coffin-joint. It has been said that our knowledge in that most important branch, tendinous lameness, has been on the decline since our late unreserved adoption of the principles of the French veterinary school, and accession to the hypothesis of the inelasticity and immobility of tendons, on which it is asserted, that there can exist no such malady as a strained tendon, producing morbid laxity subsequent to inflammation. The new opinion seems to confine the disease to inflammation simply, and the cure to the dispersion of the inflammatory symptoms. Now constant experience has proved, that those merely attendant symptoms may be soon ridded, and yet the strain or lameness continue. (See Bracken on the nature of strain.) This is a most material point of the veterinary art, and involves the great and necessary qualification of detecting the seats of lameness in horses. English horses in general are extremely subject to tendinous lamenesses, both from their natures, as being so much mixed with the delicate racing breed, and from their being forced to more speedy and severe exertions than the horses of any other country. Hence it is said that the best continental veterinarians, as defective in practical experience, are imperfectly skilled in the lamenesses in question, and their proper treatment; and that in order to attain considerable knowledge in this branch, and to be able to ascertain the seats of lameness, it is absolutely necessary for the veterinarian to experiment and practise with the living as well as the dead subject, and to advance far beyond the limits of the riding-school and parade. On this disputed subject, on the turf, on the theory and practice of humanity to animals, and on the purchase, qualifications, and performances of horses, Mr. Lawrence's Philosophical and Practical Treatise may be consulted with much advantage.

The grease.—This discharge seems peculiar to the horse, as in the disorder properly so called, and in molten-grease or the body-founder. The grease in the legs is an extravasation, or bursting from the vessels, and afterwards through the skin, of serum, or simple humour, either from defect of exercise, or any cause of obstructed circulation in those depending parts. Round, fleshy-legged horses, like those, for example, of the old Suffolk cart breed, are constitutionally liable to grease; on the contrary, the flat, sinewy-legged, and in general as horses approach the thorough-bred or racing-kind, they are the least liable to this defect. Want of good grooming, however, the legs remaining in their dirt in the stall, or the horse not lying down, will grease any species of horses. This malady never affects the horse at grass, which points out the readiest cure; and with respect to such as are constitutionally liable, the only way to preserve them sound is to keep them abroad. A slight case in the stable gives way to thorough cleansing and ablution with soap and water, the discharge being afterwards dried up with astringent poultices, lotions, or powders. Purges or alterants may be exhibited according to the nature of the case. A confirmed and inveterate case is extremely difficult of cure, requiring powerful escarotic applications.

Oslets, splents, spavins, ringbone, curb, thoroughpin, &c. are bony excrescences differently posited, originating in an extravasation by pressure of weight or over-exertion, of the mucilage or oil of the joints, which gradually condenses and becomes ossified. Splents and oslets upon the shank, not affecting the joint, may not occasion lameness, and even admit of dispersion and cure by friction, blistering, and repellents, if taken early, and before their substance is become too solid. The ringbone is an ossification or bony swelling, surrounding, as its name expresses, like a ring, the coronet or summit of the hoof; it proceeds from the contiguous small pastern bones. Being suffered to come to maturity, it is incurable by any possible remedy which can leave the horse sound. The spavin is also a preternatural bone, situated on the inside beneath the hock, and extending in its course to the joint. It is generally a hopeless case. Removing the part with a chisel was formerly attempted; but blistering and caustics are the more usual modes of attempt at cure. A very powerful caustic method, recommended by Osmer, was within these few years tried upon a celebrated trotter; but it killed the horse in three days. Perhaps Gibson's cure of a confirmed spavin is the most successful one on record. See his Farriery. The thoroughpin is posited withoutside, and between the bones of the hock. An incipient case may admit a remedy; and we lately witnessed a perfect cure of this malady in about three months by a perpetual blister. The curb is found on the back part of the hock. The bog-spavin withinside, in the cavity of the hock, is a tumour frequently of considerable bulk, of the nature of the windgall. It produces lameness; and that part of the horse, although generally forgotten, should be examined in purchase.

Windgalls are well-known distinct tumours on the pastern-joints, filled with extravasated fluid, which either forms capsules or bags for itself, or such bags are an enlargement of the natural bursæ mucosæ, or mucous capsules, which are found wherever tendons pass over each other, or over any solid part, and serve the purpose of lubricating with their mucus those tendons. Horses are in general subject to this infirmity in proportion to the racing blood they have; and we have seen common bred hacks, in which no labour would produce a windgall. Work will generally bring them more or less; but bandage and astringent lotions, with runs abroad, and the loose stable, are the only preventives. The general palliative remedies are as above, and blistering. When they feel tense and elastic, they may not be an immediate occasion of lameness; but if flabby and inelastic, and of considerable bulk, the tendons are debilitated, and there can be little expectation of soundness. Bracken made a successful experiment of opening, and discharged the fluid of the bog-spavin; and after him, Lawrence that of the windgall. See their accounts.

Corns are bruises or compressions of the horny sole near the quarters; if dry, to be pared out with the knife, and treated with spirituous and healing applications, applying

the bat-shoe, if it is necessary to work the horse.

The sand-crack is a cleft in the external part of the hoof, either vertical or with the grain, occasioned by too great dryness in course, and to be prevented by the opposite. Rest the horse, bind the hoof, pare and dress the part. Gibson, in some cases, used the cautery moderately heated.

The quittor, in French *javart*, is a hard round lump or excrescence on the coronet, between hair and hoof, on the one or the other, but usually on the inside quarter of the foot; confirmed, it is a very bad case, generally inducing in the cure the ill consequence of a false quarter or seam adown the foot, from loss of substance; subsequently to which the horse is seldom, perhaps never, rightly sound. The founder of the foot is probably rheumatic, or at least often originates in a similar cause.

Mallenders are chinks or clefts behind the knees of the fore-legs; sallenders are the same defect in the hinder legs. They discharge matter, which must be treated with thorough ablution, repellents, and mercurial washes or unguents, internal alteratives or purges being also administered. Wash thoroughly with a linen rag and soap-suds warm the wound of the broken knee, in order to discharge the gravel or dirt which may have intruded. Bathe with brandy, or bind upon the part tow dipped in tincture of myrrh and brandy. In case of swelling, it may be useful to poultice, and afterwards bathe with brandy and vinegar warm. Sheet-lead bandaged on the part may make the hair grow smooth.

Lameness in the shoulder is comparatively a very rare occurrence, notwithstanding which grooms and farriers in general, from a deceptio visus, and not being skilled in a manual detection of affections of the parts, generally imagine every lameness to exist in the shoulder. In an obvious and real lameness of the shoulder, during the tension and inflammation, rowelling is necessary, with spirituous and astringent fomentations; but that which is of far the greatest consequenee, sufficient time to repose at grass.

Strains in the loins and couplings.—A strengthening charge and embrocation may have some good effect; but remaining at rest abroad, for a considerable length of time, is the only cure when the case is curable.

Lameness of the hip or whirlbone, and of the stifle-bone, similar to the small crampbone in a leg of mutton.—In the former case the symptoms are, swinging of the limb, or its being longer than naturally: in trotting, the horse drops backward upon the heel. Time and rest, with applications as above, cure a recent case of this kind; but from neglect it becomes incurable. The whirlbone, or hip, is sometimes depressed or beat down by violence, and so remains the horse, yet continuing useful. A mare in this state, thence called slip, even-raced. On lameness of the stifle, Snape says, "It is worth the dissector's taking notice of these three last muscles, how they are joined all in one, just at their crossing the stifle, where they make one broad and very strong tendon, which spreads over and involves the patella, or little bone of the stifle, and ties it so fast in its place, upon the jointing of the thighbone with the tibia, that it is very seldom displaced, or indeed never. For although by distensions or strains we often have this part affected, yet never did I see an absolute dislocation in it. The patella indeed may be, and often is, wrenched either to one side or the other, as the accident may happen." Cure consists in rest, and the usual treatment of strains: the tumour will sometimes, but rarely, suppurate, which is a present remedy.

Teeth and age of the horse.—The horse has forty teeth: twenty-four double teeth or grinders, four tushes or single teeth, and twelve front teeth or gatherers. Mares in general have no tushes. The black marks or cavities, which denote the age, are to be found in the corner front teeth, adjoining the tushes. Horned cattle have similar marks in the teeth. At four years and a half old, the mark-teeth are just visible above the gum, and the cavity is very conspicuous. At five, the horse sheds his remaining colt's teeth, and his tushes appear. At six, his tushes are up, and appear white, small, and sharp; near which is observable a small circle of young, growing, flesh: the horse's mouth is then complete, and the corner teeth filled up. At seven years old, the two middle teeth fill up. At eight, the black marks vanish, and the horse's mouth is said to be full, and himself aged. The French farriers aver that the marks remain in the teeth of the upper jaw until the horse is twelve years of age; but we believe this to be fortuitous.

The lampas, from the Latin lampascus, is an inflammation and tumour of the first bar of the young horse's mouth, adjoining the upper fore teeth, which prevent his chewing. If scalded mashes, warm gruel, Glauber's salts in the water, and bleeding, do not remove the inconvenience in a week, lightly cauterize the tumid parts, without penetrating deep enough to scale off the thin bone beneath the upper bars. Wash with salt and water first, afterwards heal with a mixture of honey and brandy or port wine. La Fosse and others have denied the existence of this slight malady; but we have witnessed it repeatedly. We have also seen the haw in the eye, and the probability of its obstructing the sight, with its successful excision, a very small part of the substance being extirpated; the proper rule, should excision ever be recurred to, in truth a matter of doubt, as a painful operation. The haw is a preternatural enlargement and sponginess of the caruncle, a fleshy substance in the inner corner of the eye, causing the ligament which runs along the verge of the membrane to compress the eye-ball like a hoop.

Shoeing.—The veterinarian who is ambitious of being thoroughly grounded in this important branch of his art, should study attentively the principles and rules of La Fosse, Bourgelat, and Osmer, comparing them with what has been since written by Mr. Clarke, and the professors Saintbel and Coleman. One or two of the antients have mentioned the iron shoe, but it did not probably come into general use in Europe until the fifteenth century. It has been often hinted that horses might be accustomed to labour without shoes, and that exposure to the hard ground would render their soles obdurate, a consequence which is also pretended to result from their standing upon a hard, unlittered pavement, with abundance of similar and futile sophistry. The distressing accidents which have happened from the loss of a shoe, in consequence of which, from a few hours speedy travel by night, the hoof has been worn away to the very bones of the foot, are a full and lamentable answer to such follies. Indeed, in hot and dry countries, where the hoof is naturally hard, and the exertions of the horse very limited, compared with those he undergoes in this country, he is perhaps generally ridden without shoes. In the Welsh mountains this is also occasionally practised: but upon our roads, particularly in wet weather and in winter, the walls, sole, and frog, would be rubbed away and totally destroyed, granting the practice was used with a young and perfect foot, which never knew the protection of a shoe; nor have we any horses but would flinch under such an exposure of their feet.

A young and perfect foot has a firm and level bearing upon the circular crust or wall, and the frog, which however is an elastic substance, and the fulcrum or rather cushion of the main tendon. The frog is yet not a solid and steady support, but springs or contracts on touching the ground. In some very concave feet, of bred cattle particularly, the frog is not of sufficient bulk to reach the ground; and in thousands of horses shod by common farriers, the case is similar, from the part being reduced by constant wear and paring, and by the improper height of the shoe-heels: yet the frog does its office, although surely not in so perfect a way. In general, the foot should be suffered to retain its natural form and substance on applying the shoe, the toe only being shortened, the walls or crust pared even, the sole, bars or binders, and frog, being left intire, bating a little trimming away of loose and decaying substance: instead of which, the common farriers pare the sole without mercy, almost extirpate the frog to make it appear neat, and cut away at every shoeing half the substance of the bars in order to open the heels, the direct way to shut them up, or narrow them; since one great use of the frog and bars is that of an interposing substance to keep the heels open and spreading. It must yet be acknowledged, that some naturally tough, thick, and quick-growing soles may require paring, or they otherwise are inconvenient, and produce uneasy sensations in the horse; but this is perhaps never the case with respect to the frog, which, coming in constant contact with the ground, would always be thereby sufficiently reduced. As there are too many hoofs with thin and weak walls or crusts, in which it is difficult for the smith to find nail-hold, and from which by consequence scarcely an atom can be spared to the paring-knife, so there are others of the concave and deep kinds, in which the surrounding edges or crusts are so high and tough, that it is absolutely necessary and salutary to the foot to soften it by paring them down occasionally, bringing the pittance of a frog nearer to the ground, disposing it to enlarge and thereby expand the narrow and wiry heels.

A shoe should be so formed, that the horse may stand steady and firm upon his natural level, namely to bear equally upon the toe and the surrounding wall or crust; the frog, i in its perfect and natural state, touching the ground. The shoe-heels may be reduced in substance, in order to enable a frog, de-

fective in size, to touch the ground, provided a too great tenderness and sensibility in the frog, a very common case even in a colt, do not forbid it. In that circumstance, attended by a soreness or defect in the quarters also, the shoe-heels must be of sufficient thickness to do the office of the frog, and preserve the just level of the foot; for with reduced quarters and shoe-heels, and no frog to support the tendon, the latter must suffer great distension even from the mere natural weight of the horse; and in this way, from a forced attempt at improvement of the frog, by certain speculators, great numbers of horses were instantly lamed. Our common farriers, however, have usually run into the opposite defect, and by extremely thick shoe-heels, and even the addition of calkins to the fore-shoes, have thrown the weight of the horse chiefly upon his toes. They are doubtless much improved in their practice in most parts of England, but in some, the old dangerous and destructive form of shoe is still retained; long, broad, and convex in the external surface, and concave next the foot. Such is precisely the common shoe of the draught-horse even in the metropolis, where one would suppose common sense, in the course of more than fifty years, must have had time to operate. Yet we lately witnessed the heart-rending exertions of four noble animals to draw up Holborn-hill a most ponderous load, the stones presenting a surface of glass, to the slippery convex, or rather globular surfaces of the horse-shoes. It is impossible but these willing animals must have ineffectually wasted more than half their powers, that is to say, the strength of the four was reduced to less than that of two, by the senseless form of their shoes; and we represented to the driver, the strong probability that a quarter of an hour of such excessive exertion, might injure the horses in a greater degree, than six months of fair and regular although hard labour. Shoes should be made of the best iron well hammer-hardened, but not too much softened by the fire. Of such stuff, the shoe should be as light as the horse could bear; but it must be remembered, there must be a sufficient substance of iron in proportion to the weight of the horse, or in travelling, he will suffer from jarring or concussion of the bones of the foot. Narrowness of the web of the shoe is indubitably an advantage, but some feet require and must have more cover. The length of the shoe in general, should approach, never exceed, the extremity of the heel, and should decrease in width at the heel, excepting a need to defend weak quarters. The surface of the shoe presented to the earth should ever and without exception be flat, and even when practicable, hammered somewhat concave or hollow, which gives a firmer tread on slippery surfaces. This is a very old idea, and although professor Saintbel did not succeed in reducing it to practice with thin shoes, it can meet with no obstruction in the heavy shoes of cart-horses, which are however always made far heavier than necessary, from being forged of inferior materials, a consideration for the opulent proprietors of draught-horses. The shoe must rest entirely on the wall or crust, never on the sole, on which the pressure would occasion lameness. To this end, that part of the shoe applied to the crust must be flat, consisting of a rim or margin according in breadth, with the crust, and of equal thickness around the outside of the rim, in the middle of which exactly the nail-holes are to be made; from this margin internally, towards the sole, the shoe must be formed gradually thinner, that it may not press upon the sole. Osmer farther directed, and it has been invariably followed by the best practitioners, that the shoe should be made to stand somewhat wider at the extremity of each heel, than the foot itself; otherwise, as the foot grows in length, the heel of the shoe, in a short time, gets within the heel of the horse; which pressure often breaks the crust, and produces lameness, perhaps a corn. The practice of fitting the shoes red-hot upon the horse's foot, is by no means so harmless as smiths represent, when they are reproved for it: it is highly injurious to thin weak feet. The bar or circular shoe, lightly and judiciously formed, is a most excellent protection to weak heels and frogs; such feet will grow and increase in substance under the bar-shoe; and probably, light and tender-footed horses, used in quick draught upon the roads, should always have therefore feet shod in that mode.

The running thrush is a discharge issuing from the cleft of the frog, either natural or accidental. Our late writers are generally in an error in supposing this defect to be always occasioned by improper treatment of the part; since some horses with their frogs untouched, and of the full size, are liable always to the discharge when full-fed and standing long in stable without due exercise; moreover others, with the frog constantly cut away and treated in the mode supposed to be productive of the complaint, are yet entirely free from it. Ablutions, cleansing, and drying remedies are generally proper, and in the constitutional case, purges and also alteratives. Interfering, knocking, the speedy-cut, or crossing the legs or interfering in the gallop particularly, arise from naturally faulty conformation. Knocking is applied to striking the pastern-joints; the speedy-cut to the knees, against and beneath which the hoof strikes in action, particularly in a speedy trot. The shoeing-smith is generally supposed able to effect far more by his art, in this case, than he really can; and we meet in the French writers, and in those who have copied them without the benefit of practical information, much flourish, and a multiplicity of scientific rules which are totally to obviate the defects in question; to which one simple practical answer will be quite sufficient:—a horse irregularly formed in his lower extremities will wound his joints in action, unshod and with his bare hoofs, even were they reduced. A horse with the toe irregularly turned out or in, will strike the opposite joint, in one case, with the heel, in the other with the toe. Assuredly the defect may be palliated, never thoroughly remedied, by certain well-known methods of forming and fixing on the shoes. The ingenious Osmer considering this defect radically proposed measures to counteract the common crookedness of the pastern-joints in colts, a speculation to which we refer the curious. Improvement in shoeing the labouring ox also claims the attention of the veterinarian.

Phlebotomy or blood-letting.—The old writers enumerate thirty-one veins in the body of the horse, in which he may be let blood, but the neck and plate-veins are most commonly opened for that purpose. It has been lately disputed to which method of operation the preference is due, the common one of the fleam and blood-stick, or that of the lancet. The latter method was known to the old farriers, although as rarely practised by them as by the modern. The frequent accidents consequent on striking with the blood-stick, and perhaps dividing the vein, and causing a dangerous tumour in the neck, are notorious. But in opposition to the use of the lancet, it is said to require more skill; and that the horse, on first feeling the point, unless the desired effect be instantaneous, shifts the position of his neck and prevents success in the operation. Thus adroitness in the use of the lancet and instant execution, seem the only *desiderata*, by which to obtain a most beneficial improvement in practice. By some this advantage has been obtained, and they prefer the common lancet used in human phlebotomy. The horse, from past experience of perhaps repeated strokes, is ever shy of the farrier and the blood-stick. Surely even the prick of the lancet must occasion less alarm; and were the horse moderately twitched, or even his head made fast, he might be held sufficiently steady. Mr. Clark (see his book), shews the danger in making the ligature round the horse's neck, previously to sticking and cutting the orifice; but in the use of the lancet, this is not so material, and the ligature may be slackened, upon the completion of the orifice. Should it be necessary to pin the wound as usual, care should be taken not to raise the skin from the vein, whence the blood may flow into the cellular substance between the vein and the skin, and form a lump or tumour, commonly called a swelled neck. Animals should never be bled at random, as is too often the case at this day, but by measure; nor is the practice lately introduced of drawing such large quantities, amounting to upwards of a gallon of blood, from a horse at one time, either rational or ultimately beneficial, in any case. The most proper place for making the opening in the jugular veins, is where the teguments are thinnest, which is about a hand-breadth from the head, and about one inch below the branching, or joining of the vein which comes from the lower jaw, and which may be distinctly seen when any pressure is made on the main branch of the vein. In general, blood-letting should be reserved for inflammatory and critical cases, and nothing can be more absurd than the custom of regular periodical bleeding, whether in man or horse; neither bleeding nor diuretics can be the sufficient substitute of purgatives, when the plain intent is to remove obstruction and inflammation by unlading the bowels.

The use of rowels, setons, and blisters, to promote discharges from the body of the horse, has been long established. The cautery is also an instrument of prime consequence in veterinary practice; but the firing the legs of horses is yet performed by the generality of common farriers in a heavy-handed, rough, and barbarous way; the old method of drawing cross lines ought to be abolished. Indeed the general rude and unfeeling modes of treating this animal, by whose services mankind are so much benefited, form a pro-

per subject of instant enquiry, and attempts at gradual improvement. Common farriers and grooms, from inveterate habit and total absence of reflection, look upon the animal, placed by stratagem and force within their power, as a mere piece of machinery, the feelings of which never disturb the straightforward aim of the operator, for indeed they never come within his contemplation: on the contrary, he generally views his victim, bound down to the most infernal and exquisite tortures, with a kind of triumph, or even strongly-marked features of revenge, if the wretched beast has given him much trouble. The heavy and bungling methods of common operators increase tenfold the necessary sufferings of the horse. Thus an author, whom we have repeatedly quoted, relates that he saw a mare's lip twitched with such violent force, that it burst asunder; and the agony of the twitch being so exalted, its intent was frustrated, and the mare threw herself upon the ground. The burning off with a lighted candle the hair of the horse's lips, beneath the jaw, and within his ears, is generally a most terrifying process, and renders many horses dangerously shy about the head; besides, the robbing that delicate organ the ear of the natural protection of its inner part, is most improper, unnecessary, and cruel. Such practice should never be permitted for a moment; the scissars will do every thing in the case which neatness and symmetry require. The cruel operation of nicking the tails of horses it is almost useless to declaim against, from its present general adoption; but we really can discover no reason why an erected tail should be deemed essential to beauty of figure on the road or field, more than on the turf, for which purpose horses are never nicked. Yet it seems necessary to dock or abridge the tail of the horse destined for the saddle at least; but as it is always a severe, and often a dangerous, operation to a full-grown horse, we recommend Mr. Lawrence's practice of taking off a hand's-breadth of the colt's tail while it sucks, at a month or two old. He says he has repeatedly performed this trifling operation with a sharp knife; the patients being so little disturbed by it as to continue feeding on the same spot: nor was it always necessary to bind up the wound. Although no friend to cropping, he has been tempted to crop a large, heavy, lopping, ear in a yearling; judging it best to crop early if at all. As Mr. Lawrence's treatise contains hints of peculiar utility, we will quote certain of them in this place: He strongly recommends that all cart-colts may be taught to back when they are first taken in hand; as a preventive of much future misery and barbarity. That the keepers of post-horses would, as far as lies in their power, be careful to select postilions of light weight; and that they would attach a convenient seat to the splinter-bar of their post-chaises, for the use of the postilion, whenever he can obtain leave of humane passengers to ease his horse, by seating himself on the bar. Mr. Lawrence also recommends a covering for the knees, to preserve them in case of an accidental fall, or in the case of a recent wound by a fall: this is of particular use to race-horses and hunters, or sale-horses on travel. He farther counsels, that saddle colts, in their breaking, be taught and accustomed to a steady canter, a thing generally unthought of.

In fine, to obtain a thorough knowledge of the habitudes, dispositions, likings, defects, and diseases of animals, with their proper management, requires long experience and much reflection. The want of such knowledge is productive of animal misery in a thousand shapes. We have spoken fully of the deficiency in farriers, and the necessity for their gradual improvement. It is a well-known fact, of two famous contemporary farriers, that the one doctored the sound leg of a horse during many months, leaving the unsound one untouched; whilst the other, who warmly recommended a patten-shoe, on being questioned, could not describe its use; and it is by no means uncommon for a farrier to turn off a lame horse with the patten-shoe applied to the wrong foot. As to stable care, the horse cannot be kept in full working condition without a considerable allowance of solid corn; and constant dressing of his body by an experienced groom, who should be reminded, if necessary, not to irritate and wound the fine skin of a well-dressed horse with too sharp a currycomb. As has already been remarked, occasional purges will be necessary to the well-fed horse; and the aloe seems to answer every purpose. Nor is any other ingredient necessary in the dose if the best, or succotrine, aloes are used, from one ounce to fourteen drams of which may be safely given to the horse, either balled up with soap, or flour and treacle. The usual greasing and stopping the feet is generally pernicious, and contributes to harden and contract the hoof; the real stable preventive of which is frequent soaking in water. But the grand and effectual remedy is an annual run at grass, without which no horse can be preserved in his most perfect state.

We have referred those who are desirous of a thorough investigation to Mr. Stubbs's anatomy of the horse; and shall conclude with a few anatomical selections from Mr. Burke's elegant and useful compendium recently published.

The shoulders (of the horse) enclose the whole breast on both sides, beginning from the withers, and reaching downwards to the fore-legs or arms.

The arms commence at the shoulders; and the hind-part pointing posteriorly is called the elbow. Each fore-leg or arm reaches to the knee.

The shank is that part which reaches from the knee to the pastern; where these parts meet is called the great pastern, or fetlock joint. The pastern has another joint, distinguished by the title of the lesser pastern-joint, and then extends to the foot; its junction here is termed the coffin-joint.

The foot consists of the external and internal parts; the former comprises all the outside horny and insensible portions, covering and inclosing as in a case the internal sensible foot; and it is distinguished into the crust, sole, bars, and frog. The internal sensible foot is composed of several parts; it is contained within, and defended by, the former.

Belonging to the hind-parts of a horse are his haunches; they commence at the termination of the loins, and descend at each side to the hock.

The stifle is that part of the thigh which projects towards the horse's belly, when he is in the act of bending his leg; it is the knee-pan of a horse.

The whirl-bone is the upper extremity of the thigh bone, articulated with the bones of the pelvis.

The thigh begins at the stifle, and reaches to the bending of the ham or hock.

The ham is the bending of the hind-leg; the round knob, or point, behind is termed the heel of the hock, and is the part into which the tendon of Achilles (vulgò back-sinew) is inserted.

The small of the fore-leg being called the shank, the small of the hind-leg is termed the instep.

The pasterns and feet behind have also the same names as before.

The right side of a horse is always called his off-side, and the left his near-side; the latter being that we approach when we go to mount, or handle a horse.

DESCRIPTION OF THE PLATE.

FIGURE 1.

Shewing the Skeleton of the Horse.

A. The head, including all its parts as articulated with the neck.
BB. The blade-bone or scapula.
C. The humerus, or shoulder-bone.
DD. The bones of the leg, or fore-arm, consisting in each of the radius and ulna.
EE. The joints of the knees, with the small ranges of bones.
FF. The posterior parts of the knee-joints.
GG. The shank-bones, consisting in each of the cannon bone, and the two metacarpal, or splent-bones.
HH. The great pastern bones, with the two sesamoid bones of each fetlock.
II. The lesser pastern bones.
KK. The bones of the feet, consisting in each of the coffin and navicular bones, with the lateral cartilages.
LL. The bones of the pelvis, called ossa innominata.
MM. The thigh-bones.
NN. The bones of the hind-legs, consisting in each of the tibia and the fibula.
OO. The points of the hocks.
PP. The small bones of the hocks.
QQ. The bones of the instep; consisting in each of the cannon bone and two metatarsal bones.
RR. The great pastern and sesamoid bones of the hind-legs.
SS. The little pastern bones of the hind-legs.
TT. The coffin and navicular bones of each hind-foot, with the lateral cartilages.
V. The sternum, or breast-bone.
X. The point of the sternum.
YY. The ribs.
Z. The cartilaginous ends of the ribs on the breast and abdomen.
I. II. III. IV. V. VI. VII. The seven vertebræ of the neck.
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. The eighteen vertebræ of the thorax and back.
1. 2. 3. 4. 5. 6. The six vertebræ of the loins.
1. 2. 3. 4. 5. The five spines of the os sacrum.
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. The eighteen joints of the coxendix and tail.

FIGURE 2.—Representing the intestines of a horse as they appear in their natural situation when the abdomen is laid open.

AAAAAA. The colon, with its various circumvolutions and windings, together with its numerous folds, and under which lie the small intestines.

B. The cœcum, or blind gut.

C. The rectum.

FIGURE 3.—Shews the horny sole *a* raised from the fleshy sole *c c c*; round which is the enchannelled flesh *y*, placed in the fulcus of the inner surface of the hoof, the horny part of which is soft and white.

FIGURE 4.—Represents the under part of the fleshy sole *c*, raised from the foot-bone, or coffin-bone, *d d d*; *g* the covering or sheath of the tendo Achillis; *z* the cartilage; *y* the edge of the fleshy sole confined in the furrow of the channelled horny substance.

FIGURES 5 and 6.—Give the bottom or base of the foot; *a a a* the horny sole; *b* the frog; *z* the hoof towards its lower edge, called the crust or wall of the foot.

FIGURES 7 and 8. Modern shoes.

FARTHING *of gold*, a coin used in antient times, containing in value the fourth part of a noble, or 20*d*. silver. It is mentioned in the stat. 9 Hen. V. cap. 7. where it is enacted, that there shall be good and just weight of the noble, half-noble, and farthing of gold.

FARTHING *of land*, seems to differ from FARDING-*deal*; for in a survey-book of the manor of West-Hapton, in Devonshire, there is an entry thus: A. B. holds six farthings of land at 12*d*. per ann. So that the farthing of land must have been a considerable quantity, far more than a rood.

FASCES, in Roman antiquity, axes bound up together with rods or staves, and carried before the Roman magistrates as a badge of their authority and office. The use of the fasces was introduced by the elder Tarquin, as a mark of sovereign authority: in aftertimes they were borne before the consuls, but by turns only, each his day. They had twelve of them carried by so many lictors. After the consuls, the prætors assumed them, and Censorinus observes they had only two, though Plutarch and Polybius give them six. In the government of the decemviri, it was the practice at first for only two of them to have the fasces. Afterwards each of them had twelve, in the same manner as the kings.

FASCETS, in the art of making glass, are the irons thrust into the mouths of bottles, in order to convey them into the annealing tower.

FASCIÆ, in astronomy, certain parts on Jupiter's body resembling belts or swaths. They are more lucid than the rest of that planet, and are terminated by parallel lines, sometimes broader, and sometimes narrower. Mr. Huygens observed a fascia in Mars much broader than those in Jupiter, and possessing the middle part of his disk, but very obscure.

FASCINES, in fortification, faggots of small wood of about a foot diameter, and six feet long, bound in the middle, and at both ends. See FORTIFICATION.

FASCIOLA, in zoology, the FLUKE or GOURD WORM: a genus of insects of the order of vermes intestina; of which the characters are these: The body is flattish, and has a vent-hole at the extremity and on the belly. There are several species. 1. The hepatica, or liver-fluke, grows to two-thirds of an inch in length, though it is more usually met with not half that size; and its breadth is nearly equal to two-thirds of its length. It is flattish, but somewhat rounded on the back, and has about eight deep longitudinal furrows in two series; its skin is soft and whitish, with a tinge of brown. The hinder part is rounded, the fore part is furnished with a large mouth. It bears some resemblance to the seed of the common gourd, whence it has acquired the name of the gourd worm. It is found in fresh waters, in ditches, at the roots of stones, sometimes in the intestines, and often in the substance of the other viscera in quadrupeds. It often infests the liver of sheep, and on that account is called hepatica. Bags with salt in them should be placed in the fold, that sheep might lick them, which is a good remedy. 2. The intestinalis, or intestinal fluke, is of a long slender form, if extended; when contracted, of a suboval form; inhabits the intestines of fresh-water fish, especially the bream. 3. The barbata, is white, with transverse papillæ in the mouth. It is of an oblong shape, and about the size of a cucumber-seed.

FASHION-PIECES, in the sea language, are two compassing pieces of timber, into which is fixed on each side the transom.

FASTERMANS, among our Saxon ancestors, were pledges or bondsmen, who were answerable for each others' good behaviour.

FASTI, in Roman antiquity, the calendar wherein were expressed the several days of the year, with their feasts, games, and other ceremonies. There were two sorts of fasti, the greater and less; the former being distinguished by the appellation of fasti magistrales, and the latter by that of fasti calendares. The greater fasti contained the feasts, with every thing relating to religion and the magistrates. The lesser were again distinguished into the city and country fasti, each adapted to the people for whom they were designed. In all these fasti, the court-days, or those whereon causes might be heard and determined, were marked with the letter F; these days were called fasti, from fari, to speak or pronounce; and the other days, not marked with this letter, were called nefasti.

FASTI CONSULARES, was also a tablet, or chronicle, wherein the several years were denoted by the respective consuls, with the principal events that happened during their consulship. And hence, the term fasti is still applied to the archives and public registers of a nation.

FAT, in anatomy, an oleaginous or butyraceous matter, secreted from the blood, and filling up the cavity of the adipose cells.

FAT, in chemistry. See OIL.

FAT, in the sea language, signifies the same with broad. Thus a ship is said to have a fat quarter, if the trussing in or tuck of her quarter is deep.

FAT, perhaps properly vat (vas or vessel), denotes likewise an uncertain measure of capacity. Thus a fat of isinglass contains from $3\frac{1}{4}$ hundred-weight to four hundred-weight; a fat of unbound books, half a maund, or four bales; of wire, from 20 to 25 hundred-weight; and of yarn, from 220 to 221 bundles.

FATA MORGANA, a very remarkable aerial phenomenon, which is sometimes observed from the harbour of Messina and adjacent places, at a certain height in the atmosphere. The name, which signifies the Fairy Morgana, is derived from an opinion of the superstitious Sicilians, that the whole spectacle is produced by fairies, or such-like visionary invisible beings. The populace are delighted whenever it appears; and run about the streets shouting for joy, calling every body out to partake of the glorious sight.

This singular meteor has been described by various authors; but the first who mentioned it with any degree of precision was father Angelucci, whose account is thus quoted by Mr. Swinburne in his Tour through Sicily: "On the 15th of August, 1643, as I stood at my window, I was surprised with a most wonderful delectable vision. The sea that washes the Sicilian shore swelled up and became, for ten miles in length, like a chain of dark mountains; while the waters near our Calabrian coast grew quite smooth, and in an instant appeared as one clear polished mirror, reclining against the ridge. On this glass was depicted, in chiaro-scuro, a string of several thousand of pilasters, all equal in altitude, distance, and degree of light and shade. In a moment they lost half their height, and bent into arcades, like Roman aqueducts. A long cornice was next formed on the top, and above it rose castles innumerable, all perfectly alike. These soon split into towers, which were shortly after lost in colonnades, then windows, and at last ended in pines, cypresses, and other trees, even and similar. This is the Fata Morgana, which for twenty-six years I had thought a mere fable."

To produce this pleasing deception, many circumstances must concur, which are not known to exist in any other situation. The spectator must stand with his back to the east, in some elevated place behind the city, that he may command a view of the whole bay; beyond which the mountains of Messina rise like a wall, and darken the back-ground of the picture. The winds must be hushed, the surface quite smooth, the tide at its height, and the waters pressed up by currents to a great elevation in the middle of the channel. All these events coinciding, as soon as the sun surmounts the eastern hills behind Reggio, and rises high enough to form an angle of 45 degrees on the water before the city, every object existing or moving at Reggio will be repeated a thousandfold upon this marine looking-glass; which, by its tremulous motion, is in a manner cut into facets. Each image will pass rapidly off in succession as the day advances, and the stream carries down the wave on which it appeared. Thus the parts of this moving picture will vanish in the twinkling of an eye. Sometimes the air is at that moment so impregnated with vapours, and undisturbed by winds, as to reflect objects in a kind of aerial screen, rising about 30 feet above the level of the sea. In cloudy heavy weather they are drawn on the surface of the water, bordered with fine prismatical colours.

To the above account we shall add the following, by another observer: "In fine summer days, when the weather is calm, there rises above the great current a vapour, which acquires a certain density, so as to form in the atmosphere horizontal prisms, whose sides are disposed in such a manner, that when they come to their proper degree of perfection, they reflect and represent successively, for some time, (like a moveable mirror) the

Fig.1.

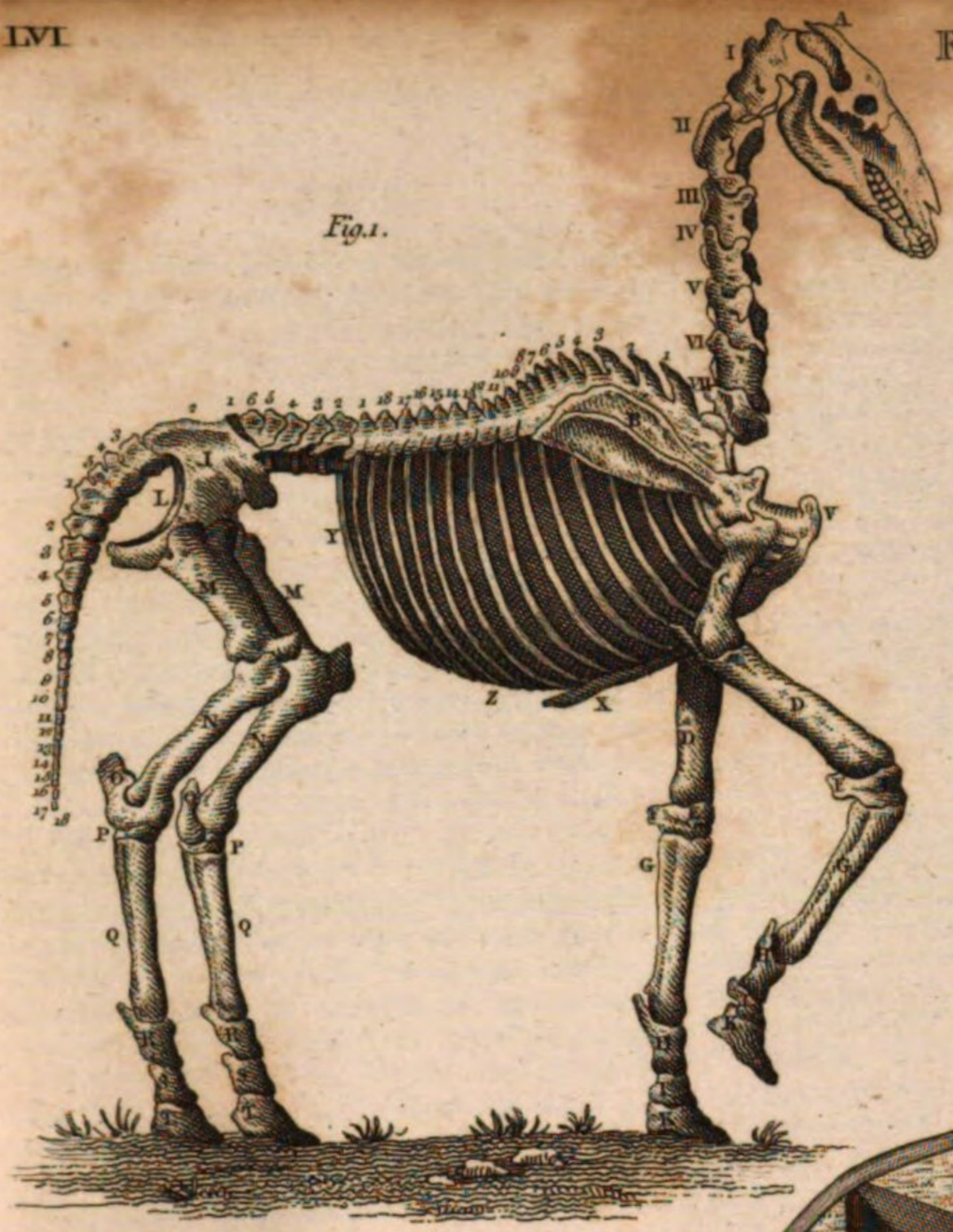


Fig.2.

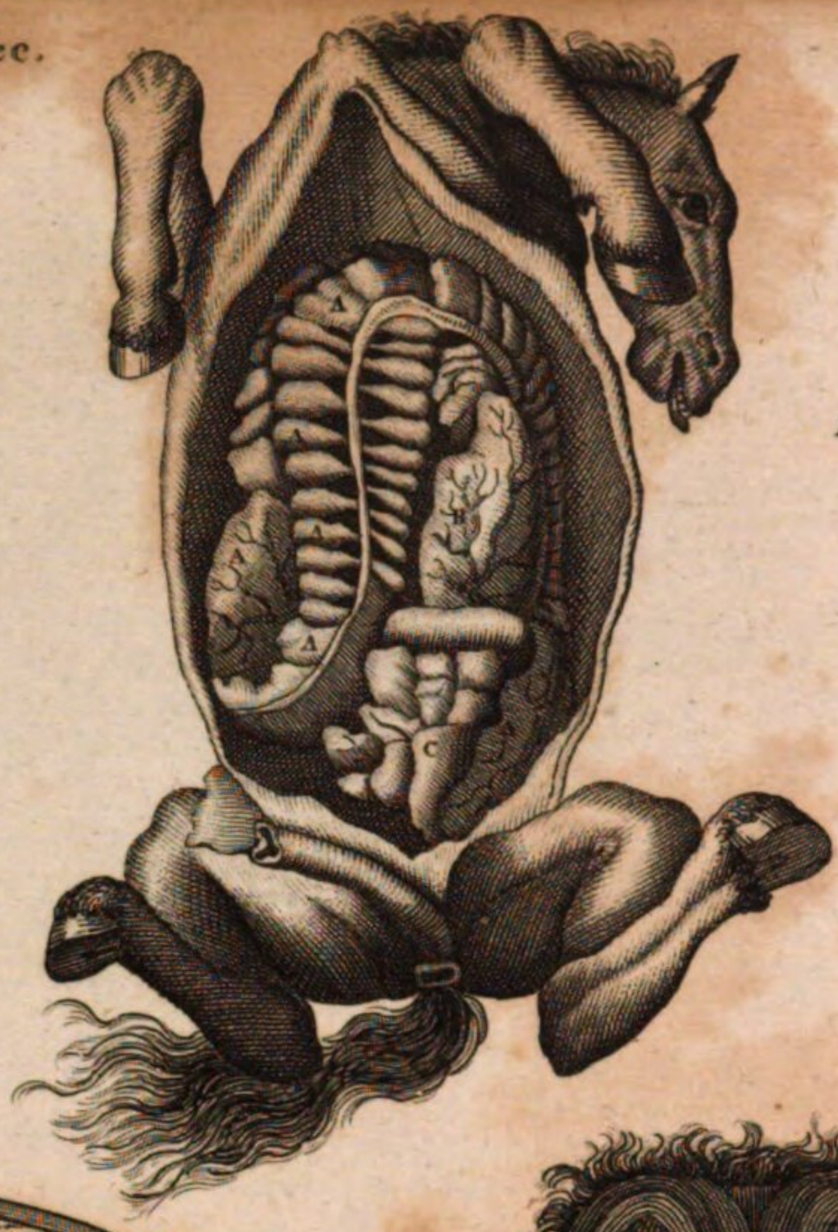


Fig.5.

Fig.3.

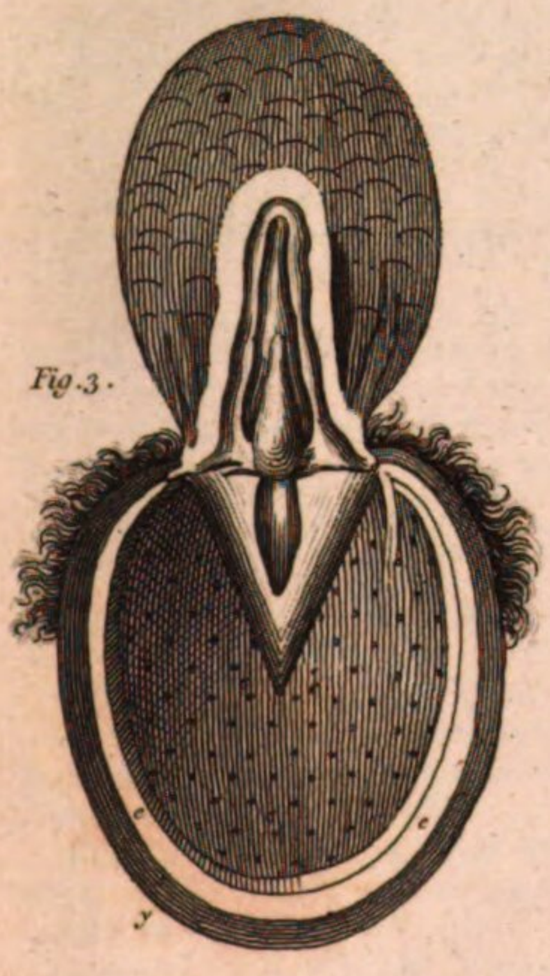


Fig.10.

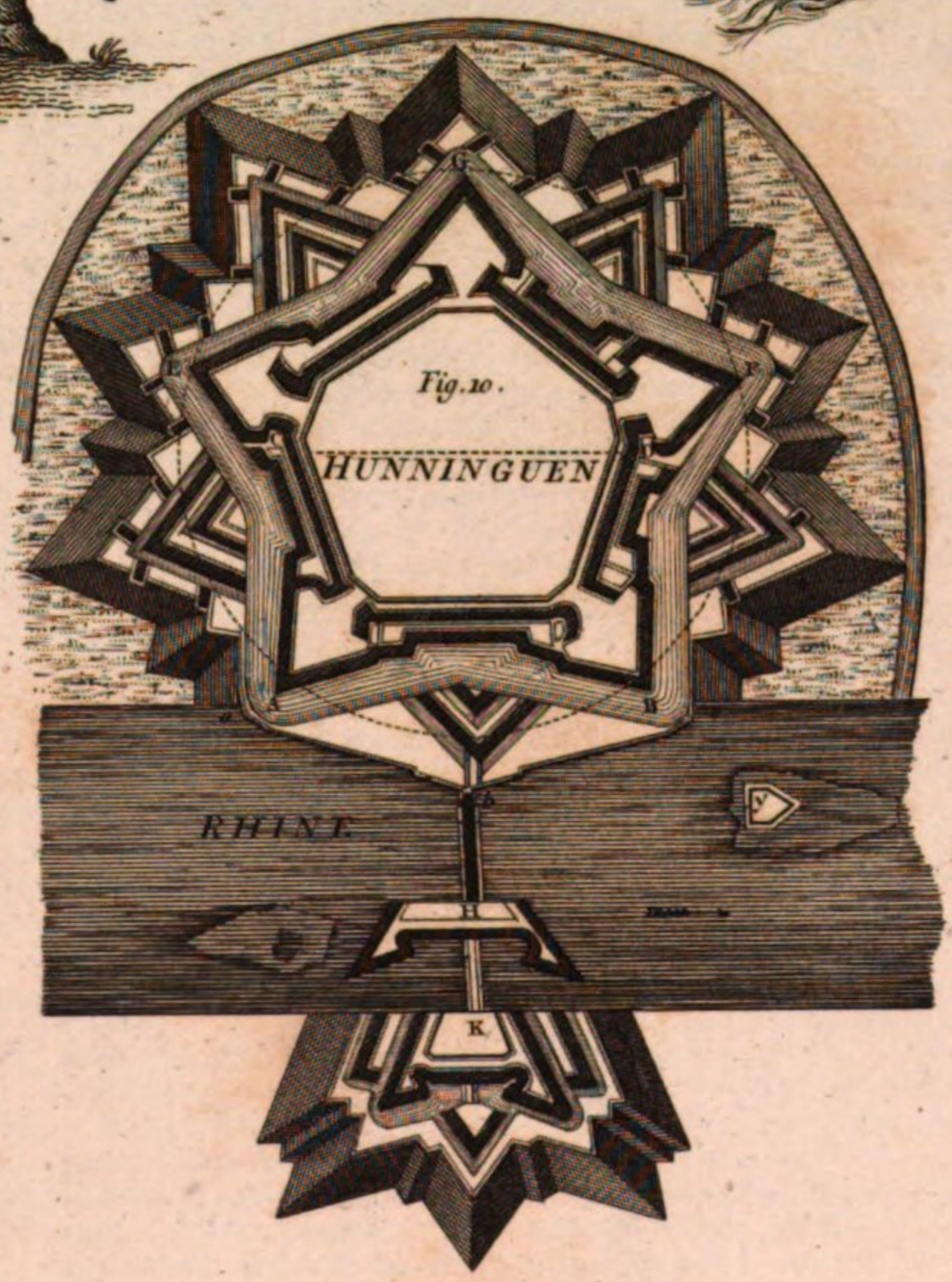


Fig.6

Fig.4.

Fig.9.

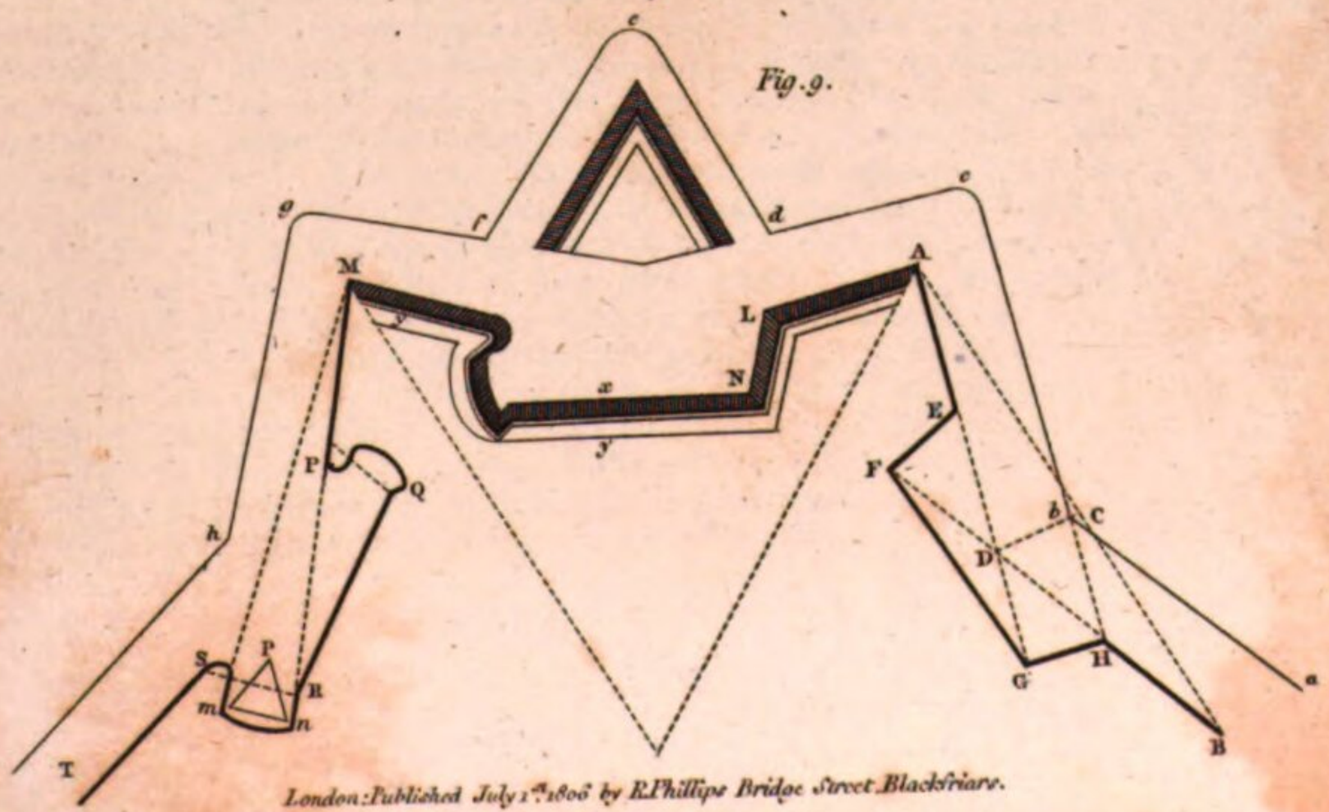


Fig.7.

Fig.8.

London: Published July 1st 1806 by R. Phillips Bridge Street Blackfriars.

objects on the coast or in the adjacent country. They exhibit by turns the city and suburbs of Messina, trees, animals, men, and mountains. They are certainly beautiful aerial moving pictures. There are sometimes two or three prisms, equally perfect; and they continue in this state eight or ten minutes. After this some shining inequalities are observed upon the surface of the prism, which render confused to the eye the objects which had been before so accurately delineated, and the picture vanishes. The vapour forms other combinations, and is dispersed in air. Different accounts have been given of this singular appearance; which for my part I attribute to a bitumen that issues from certain rocks at the bottom of the sea, and which is often seen to cover a part of its surface in the canal of Messina. The subtle parts of this bitumen being attenuated, combined, and exhaled with the aqueous globules that are raised by the air, and formed into bodies of vapour, give to this condensed vapour more consistence; and contribute, by their smooth and polished particles, to the formation of a kind of aerial crystal, which receives the light, reflects it to the eye, and transmits to it all the luminous points which colour the objects exhibited in this phenomenon, and render them visible."

FATHER, in church history, is applied to antient authors who have preserved in their writings the traditions of the church. Thus St. Chrysostom, St. Basil, &c. are called Greek fathers, and St. Augustine and St. Ambrose Latin fathers. No author who wrote later than the twelfth century is dignified with the title of Father.

FATHER AND SON. In law the father shall not have action for taking any of his children, except his heir; and that is, because the marriage of his heir belongs to the father, but not of any other of his sons or daughters. And the father has no property or interest in the other children, which the law accounts may be taken from him. Cro. Eliz. 770.

The father is obliged by the common law to provide for his children. Lord Raym. 41.

Justices cannot order a maintenance for a child to be paid by the father, without adjudging that the child is poor, or likely to become chargeable. Id. 669.

FATHOM, a long measure containing six feet, chiefly used at sea for measuring the length of cables and cordage.

FAVORITO, in music, as choro favorito, a chorus in which are employed the best voices and instruments, to sing the recitatives, play the ritornellas, &c.; this is otherwise called the little chorus, or choro recitante.

FAUSSE-BRAYE, in fortification, a small rampart without the true one, about three or four fathom wide, and bordered with a parapet and banquet. See FORTIFICATION.

FEAL-DIKES, a cheap sort of fence common in Scotland, built with feal or sod dug up by the spade from the surface of grass-ground, consisting of the upper mould rendered tough and coherent by the matted roots of the grass thickly interwoven with it. If only a very thin bit of the upper surface is pared off with a paring-spade, the pieces are called divots. These being of a firmer consistence, are more durable when built into dikes than feal, but much more expensive also.

FEALTY, in law, an oath taken on the admittance of any tenant, to be true to the lord of whom he holds his land; by this oath the tenant holds in the freest manner, on account, that all who have fee, hold per fidem et fiduciam, that is, by fealty at the least. This fealty, at the first creation of it, bound the tenant to fidelity, the breach of which was the loss of his fee. It has been divided into general and special; general, that which is to be performed by every subject to his prince; and special, required only of such as, in respect of their fee, are tied by oath to their lords. To all manner of tenures, except tenantcy at will and frank-almoign, fealty is incident, though it chiefly belongs to copyhold estates, held in fee and for life. The form of this oath by stat. 17 Ed. II. is to run as follows. "I, A. B. will be to you my lord D. true and faithful, and bear to you faith for the lands and tenements which I hold of you, and I will truly do and perform the customs and services that I ought to do to you. So help me God."

FEAST, or FESTIVAL, in a religious sense, is a day of feasting and thanksgiving.

The four quarterly feasts, or stated times whereon rent on leases is usually reserved to be paid, are Lady-day, or the annunciation of the blessed virgin Mary, or 25th of March; the nativity of St. John the Baptist, held on the 24th of June; the feast of St. Michael the archangel, on the 29th of September; and Christmas, or rather St. Thomas the apostle, on the 21st of December.

FEATHER, in physiology, a general name for the covering of birds: it being common to all the animals of this class to have their whole body, or at least the greatest part of it, covered with feathers or plumage.

There are two sorts of feathers found on birds, viz. the strong and hard kind, called quills, found in the wings and tail; and the other plumage, or soft feathers, serving for the defence and ornament of the whole body. All birds, so far as yet known, moult the feathers of their whole body yearly. Feathers make a considerable article of commerce, particularly those of the ostrich, heron, swan, peacock, goose, &c. for plumes, ornaments of the head, filling of beds, writing-pens, &c. Geese are plucked in some parts of Great Britain five times in the year; and in cold seasons many of them die by this barbarous custom. Those feathers that are brought from Somersetshire are esteemed the best, and those from Ireland the worst.

Eider down is imported from Denmark; the ducks that supply it being inhabitants of Hudson's-bay, Greenland, Iceland, and Norway. All the islands west of Scotland breed numbers of these birds, which turn out a profitable branch of trade to the poor inhabitants. Hudson's-bay also furhishes very fine feathers, supposed to be of the goose kind. The down of the swan is brought from Dantzic. The same place also sends us great quantities of the feathers of the cock and hen. The London poulterers sell a great quantity of the feathers of those birds, and of ducks and turkeys; those of ducks, being a weaker feather, are inferior to those of the goose; and turkey's feathers are the worst of any. The best method of curing feathers is to lay them in a room, exposed to the air and sun; and when dried, to put them in bags, and beat them well with poles to get off the dirt.

Feathers, when chemically analysed, seem to possess very nearly the same properties with hair. According to Mr. Hatchett, the quill is composed chiefly of coagulated albumen, without any traces of gelatine. See HAIR.

FEATHER-MILL, in the salt-works, the partition in the middle of the furnace, which it divides into two chambers. See the article SALT-MAKING.

FEATHER-EDGED, among carpenters, an appellation given to planks or boards which have one side thicker than the other.

FECIALES, or FÆCIALES, a college of priests instituted at Rome by Numa, consisting of twenty persons, selected out of the best families. Their business was to be arbitrators of all matters relating to war and peace, and to be the guardians of the public faith. It is probable that they were ranked among the officers of religion, to procure them the more deference and authority, and to render their persons more sacred among the people. If the commonwealth had received any injury from a foreign state, they immediately dispatched these officers to demand satisfaction, who, if they could not procure it, were to attest the Gods against the people and country, and to denounce war: otherwise they confirmed the alliance, or contracted a new one, which they ratified by sacrificing a hog.

FECULA. See GLUTEN.

FEE, in law. All our land here in England (the crown-lands being in the king's own hands, in right of his crown, excepted) is in the nature of feudum or fee; for though many have land by descent from their ancestors, and others have clearly purchased land with their money, yet is the land of such a nature, that it cannot come to any, either by descent or purchase, but with the burthen that was laid upon him who had novel fee, or first of all received it as a benefit from his lord to him, and to all such to whom it might descend, or any way be conveyed from him; so that in truth, no man has directum dominium, the very property or demesne, in any land, but only the prince in right of his crown. Cam. Brit. 93. See FEODAL SYSTEM.

FEE SIMPLE, is an estate of inheritance whereby a person is seised of lands, tenements, or hereditaments, to hold to him and his heirs for ever, generally, absolutely, and entirely; without mentioning what heirs, but referring that to his own pleasure, or the disposition of the law. It is the most perfect tenure of any, when unincumbered; but although the greatest interest which by our law a subject can possess, yet it may be forfeited for treason or felony. To constitute an estate in fee, or of inheritance, the word heir is necessary in the grant or donation. Co. Lit. 1. Plowd. 498. 2 Black. 48.

FEE QUALIFIED, is such a freehold estate, as has a qualification subjoined to it, and which therefore must determine whenever the qualification is at an end. Co. Lit. 27.

FEE CONDITIONAL. This estate was, at the common law, a fee restrained to some particular heirs, exclusive of others; as to the heirs of a man's body, or to the heirs male of his body: in which cases it was held, that as soon as the grantee had issue born, the estate was thereby converted into fee simple, at

least so far as to enable him to sell it, to forfeit it by treason, or to charge it with incumbrances. But the statute de donis having enacted, that such estates so given, to a man and the heirs of his body, should at all events go to the issue, if there were any, or if none, should revert to the donor; this was by the judges denominated an estate in tail. Plowd. 251. See ESTATE.

FEE also signifies a certain allowance to physicians, barristers, attorneys, and other officers, as a reward for their pains and labour. If a person refuse to pay an officer his due fees, the court will grant an attachment against him, to be committed till the fees are paid; and an attorney may bring an action on the case for his fees, against the client that retained him in his cause.

FEE also denotes a settled perquisite of public officers, payable by those who employ them. The fees due to the officers of the custom-house, are expressly mentioned in a schedule, or table, which is hung up in public view in the said office, and in all other places where the said fees are to be paid or received. And if any officer shall offend, by acting contrary to the regulations therein contained, he shall forfeit his office and place, and be for ever after incapable of any office in the custom-house. The other public offices have likewise their settled fees, for the several branches of business transacted in them.

FEE FARM, is when the lord, upon the creation of the tenantcy, reserves to himself and his heirs, either the rent for which it was before let to farm, or at least a fourth part of that farm rent.

FEE FARM RENT, so called, because a farm rent is reserved upon a grant in fee.

FEELERS, in natural history a name used by some for the horns of insects. See ENTOMOLOGY.

FEELING, one of the five external senses, by which we obtain the ideas of solid, hard, soft, rough, hot, cold, wet, dry, and other tangible qualities.

This sense is the coarsest, but at the same time the surest of all others; it is besides the most universal. We see and hear with small portions of our body, but we feel with all. Nature has bestowed that general sensation wherever there are nerves, and they are every where, where there is life. Was it otherwise, the parts divested of it might be destroyed without our knowledge. It seems on this account nature has provided, that this sensation should not require a particular organization. The structure of the nervous papillæ is not absolutely necessary to it. The lips of a fresh wound, the periosteum, and the tendons, when uncovered, are extremely sensible without them. These nervous extremities serve only to the perfection of feeling, and to diversify sensation. Feeling is the basis of all other sensations.

The object of feeling is every body that has consistency or solidity enough to move the surface of our skin. It was necessary to perfect feeling, that the nerves should form small eminences, because they are more easily moved by the impression of bodies, than an uniform surface. It is by means of this structure, that we are enabled to distinguish not only the size and figure of bodies, their hardness and softness, but also their heat and cold. Feeling is so useful a sensation, that to the blind it supplies the office of eyes, and in some sense indemnifies them for their loss. See PHYSIOLOGY.

FEIGNED ISSUE, is that whereby an action is feigned to be brought by consent of the parties, to determine some disputed right, without the formality of pleading; and thereby to save much time and expence in the decision of a cause. 3 Black. 452.

FELAPTON, in logic, one of the six moods of the third figure of syllogisms, wherein the first proposition is an universal negative, the second an universal affirmative, and the third a particular negative.

FELIS, *cat*, in zoology, a genus of the mammalia class, belonging to the order of feræ. The generic character is: front-teeth six, the intermediate ones equal; grinders three on each side; tongue aculeated backwards; claws retractile.

1. Felis leo, lion. The lion is principally an inhabitant of Africa, but is also found, though far less plentifully, in the hotter regions of Asia. It is, however, in the interior of Africa that he exerts his greatest ravages, and reigns superior among the weaker quadrupeds. A lion of the largest size has been found to measure about eight feet from the nose to the tail, and the tail itself about four feet; the general colour is a pale tawny, still paler or more inclining to white beneath; the head is very large, the ears rounded, the face covered with short or close hair, the upper part of the head, the neck, and shoulders, coated with long shaggy hair, forming a pendent mane; on the body the hair is short and smooth; the tail is terminated by a tuft of blackish hair. The lioness, which is smaller than the lion, is destitute of the mane, and is of a whiter cast beneath. The lion, like the tiger, frequently conceals himself in order to spring on his prey, bounding to the distance of a great many feet, and seizing it with his claws. His strength is prodigious: it has even been affirmed, that a single stroke of his paw is sufficient to break the back of a horse; and that he carries off with ease a middle-sized ox or buffalo. He does not often prey in open sunshine, but commences his depredations at the close of day. The roaring of the lion, when in quest of prey, resembles the sound of distant thunder; and, being re-echoed by the rocks and mountains, appals the whole race of animals, and puts them to sudden flight; but he frequently varies his voice into a hideous scream or yell: he is supposed to be destitute of a fine scent, and to hunt by the eye alone. The lion is commonly said to devour as much as will serve him for two or three days, and when satiated with food, to remain in a state of retirement in his den, which he seldom leaves, except for the purpose of prowling about for his prey. His teeth are so strong, that he breaks the bones with perfect ease, and often swallows them together with the flesh; his tongue, as in other animals of this genus, is furnished with reversed prickles; but they are so large and strong in the lion, as to be capable of lacerating the skin. The lioness is said to bring forth in the spring, in the most sequestered places, and to produce but one brood in the year. The young are four or five in number, which the parent nurses with great assiduity, and attends in their first excursions for prey. When brought into Europe, lions have been known to breed even in a state of confinement; instances of which are recorded by some of the older naturalists. In the Tower of London also, examples of a similar nature have occurred. The young animals are scarcely so large as small pug dogs, and are said to continue at the teat about the space of a year, and to be five years in coming to maturity. If we may judge from some specimens of young lions in the Leverian Museum, which are said to have been whelped in the Tower, their size seems scarcely to exceed that of a half-grown kitten. Indeed, some of the antient writers have affirmed, that the young lions are hardly larger than weasels.

The count de Buffon, reasoning from the size and constitution of the lion, and the time required for his arriving at full growth, concludes that he "ought to live about seven times three or four years, or nearly to the age of twenty-five." He adds, that those which have been kept at Paris have lived sixteen or seventeen years. If, however, we might depend on the commonly received accounts of those which have been kept in the Tower of London, we might mention the lion known by the name of Pompey, which is said to have lived no less than 70 years in his state of captivity; and another in the same receptacle, which is reported to have lived 63 years. It must be acknowledged, however, that, from the general constitution of the lion, one would not suppose him to be a very long-lived animal.

Lions have sometimes constituted a part of the established pomp of royalty in the eastern world. The monarch of Persia, as we are informed by Mr. Bell, in his Travels, had, on days of audience, two large lions chained on each side the passages of the hall of state, being led thither, by proper officers, in chains of gold.

The Romans, struck with the magnificent appearance of these animals, imported them in vast numbers from Africa, for their public spectacles. Quintus Scævola, according to Pliny, was the first in Rome who exhibited a combat of lions; but Sylla the dictator, during his prætorship, exhibited a hundred lions; and after him Pompey the Great exhibited no less than 600 in the grand circus, viz. 315 males, and the rest females; and Cæsar the dictator 400. Pliny also tells us, that the first person in Rome who caused them to be yoked so as to draw a carriage, was Mark Antony, who appeared in the streets in Rome in a chariot drawn by lions, accompanied by his mistress Cytheris, an actress from the theatre; a sight, says Pliny, that surpassed in enormity even all the calamities of the times!

In modern times, the lion is said to be often hunted with dogs by the colonists about the Cape of Good Hope, and it is added that twelve or fifteen dogs are sufficient for the purpose. The lion, after being roused, runs for some time, then stops and shakes his mane, as if in defiance of the dogs, who, rushing all at once upon him, soon destroy him; two or three of the pack, however, generally falling victims to the first strokes of his paws. See Plate Nat. Hist. fig. 200 & 201.

2. Felis tigris, tiger, is a native of the warmer parts of Asia, and is principally found in India and the Indian islands. The species extends, however, as far as China and Chinese Tartary, the lake Ural, and the Altaic

mountains. Its colour is a deep tawny, or orange-yellow, the face, throat, and under side of the belly, being nearly white; the whole is traversed by numerous long black stripes, forming a bold and striking contrast with the ground-colour. About the face and breast the stripes are proportionally smaller than on other parts; the tail is annulated with black, and is shorter than the body. There seems to be some variation in the proportion and number of the stripes in different individuals; and the ground-colour is more or less bright, according to various circumstances of age and health in the respective animals. Linnæus calls the tiger "*pulcherrimus quadrupedum.*" We must not judge of the elegance of this animal's robe from the specimens which are sometimes seen in museums, or even from such living ones as by long confinement, and an alteration of climate, have lost the native brilliancy of their colours. When seen in perfection, and before its health has been impaired by confinement, it is scarcely possible to conceive a more elegantly variegated animal than the tiger: the bright and intense orange-yellow which constitutes the ground-colour; the deep and well-defined stripes of black, in some parts double, in others single; the pure white of the cheeks and lower part of the sides, over which a part of the black striping is continued; form all together an appearance far superior in beauty to the skin of the zebra, or that of any other regularly marked quadruped, not excepting even the panther itself.

In its general size the tiger is inferior only to the lion, and has been seen even larger, viz. of the length of 15 feet from the nose to the tip of the tail. The largest are those of India, and are termed royal tigers; but this distinction is supposed to relate merely to the size of the animal, there being only one species of tiger, though there may perhaps be some races larger than others.

Of so fierce and sanguinary a disposition is the tiger, as to surpass in rapacity every other wild beast, and it is therefore considered as the most dreadful scourge of the hotter regions of Asia. The lion is commonly supposed to prey in a less malignant and cruel manner. He is also, when taken into a state of confinement, capable of being tamed, and rendered mild and placid to his keepers; but the tiger is not to be divested of his natural ferocity of character, and in confinement he generally exhibits all the symptoms of malignity. His method of seizing his prey is by concealing himself from view, and springing with a horrible roar on his victim, which he carries off and tears in pieces, after having first sucked out the blood. The voice of the tiger, in the act of springing on his prey, is said to be hideous beyond conception. Even a buffalo has been thus seized by a tiger, and carried off with such seeming ease, as to appear scarcely an impediment to the animal's flight. It is affirmed, that if the tiger happens to miss his aim, he does not pursue his prey, but, as if ashamed of his disappointment, runs off. In the beginning of the last century (says Mr. Pennant), a company, seated under the shade of some trees near the banks of a river in Bengal, were surprised by the unexpected sight of a tiger preparing for its fatal spring; when a lady, with almost unexampled presence of mind, furled a large umbrella in the animal's face, which instantly retired, and thus gave an opportunity of escaping from so terrible a neighbour. Another party had not the same good fortune; but in the height of their entertainment lost in an instant one of their companions, who was seized and carried off by a tiger. But the fatal accident which occurred in 1792, in the East Indies, must be still fresh in the memory of all who read the dreadful description given by an eye-witness of the scene. "We went (says the narrator) on shore on Sangar island to shoot deer, of which we saw innumerable traces, as well as of tigers; notwithstanding which we continued our diversion till near three o'clock, when, sitting down by the side of a jungle to refresh ourselves, a roar like thunder was heard, and an immense tiger seized on our unfortunate friend Mr. Monro, son of sir Hector Monro, and rushed again into the jungle, dragging him through the thickest bushes and trees, every thing giving way to his monstrous strength: a tigress accompanied his progress. The united agonies of horror, regret, and fear, rushed at once upon us. I fired on the tiger: he seemed agitated. My companion fired also; and in a few moments after this, our unfortunate friend came up to us, bathed in blood. Every medical assistance was vain, and he expired in the space of 24 hours, having received such deep wounds from the teeth and claws of the animal as rendered his recovery hopeless. A large fire, consisting of 10 or 12 whole trees, was blazing by us at the time this accident took place, and ten or more of the natives were with us. The human mind can scarcely form any idea of this scene of horror. We had hardly pushed our boat from that accursed shore, when the tigress made her appearance, almost raging mad, and remained on the sand all the while we continued in sight."

The tiger has been known to attack even a lion, and both animals have perished in the conflict. The tigress, like the lioness, produces four or five young at a litter: she is at all times furious, but her rage rises to the utmost extremity when robbed of her young. She then braves every danger, and pursues her plunderers, who are often obliged to release one in order to retard her motion. She stops, takes it up, and carries it to the nearest cover, but instantly returns, and renews her pursuit, even to the very gates of buildings or the edge of the sea; and when her hope of recovering them is lost, she expresses her agony by hideous howlings, which excite terror wherever they reach. See Plate Nat. Hist. fig. 204.

3. Felis pardus, panther. Next to the tiger, the panther is the most conspicuous species in this genus, measuring about six feet and a half, and sometimes nearly seven feet from nose to tail, which is itself about three feet long. The colour of the panther is a bright and beautiful tawny yellow, thickly marked all over the upper parts of the body, shoulders, and thighs, with roundish black spots, disposed into circles, consisting of four or five separate spots; and there is commonly, but not always, a central spot in each circle, in which particular, as well as in its superior size and deeper colour, the panther differs from the leopard, which has very rarely any central spots in its circular markings. On the face and legs the spots are single, and along the top of the back is a row of oblong spots, which are still longer as they approach the tail. The breast and belly are white; the former marked with transverse dusky stripes, the latter and the tail with large irregular black spots.

The panther is principally found in Africa, and is to that country what the tiger is to Asia, with this alleviating circumstance, that it is supposed to prefer the destruction of other animals to that of man. Its manner of seizing its prey resembles that of the tiger, lurking near the sides of woods, &c. and darting forward with a sudden spring. It is of a highly ferocious nature, and scarcely to be tamed. These animals and the leopard were the varii and pardi of the antients; and one would think (says Mr. Pennant) that the Romans would have exhausted the deserts of Africa by the numbers they drew thence for their public spectacles. Scaurus exhibited at one time 150 panthers; Pompey the Great, 410; and Augustus, 420. It has been doubted whether the panther and the leopard were natives of America as well as of the old continent; but this question seems now to be decided in the negative.

4. Felis leopardus, the leopard, is best distinguished from the panther by its paler yellow colour, its smaller size, and the somewhat closer disposition of the spots which form its ocellated markings; but to a mere general observer, the two animals are so extremely alike as to be frequently mistaken for each other. A true distinctive mark between the leopard and panther is by no means easy to communicate either by description or even by figure. The principal difference is in size, the leopard being considerably the smallest of the two: the colour of the panther is richer or more fulvous than that of the leopard; but this too is liable to a degree of uncertainty: the ocelli or rounded marks on the panther are larger and more distinctly formed; but the character given by Mr. Pennant of the panther, viz. a central spot in the middle of each, is by no means a permanent or truly distinctive mark; since the spots in some specimens (perhaps the males) are quite plain in the middle; while, in some specimens of the leopard, one or more small central spots are visible. As to the subtransverse marks about the neck or breast, they seem to be full as distinct in the leopard as in the panther, and perhaps, upon the whole, we must be content with distinguishing the two species by the size, and by the fulvous yellow of the panther, and the clearer or paler yellow of the leopard. The general length of this species from nose to tail, is four feet, of the tail two and a half. It is a native of Senegal and Guinea, as well as of many other parts of Africa: it also occurs in several parts of Asia, viz. in Persia, India, China, &c. In its manners it resembles the panther.

A variety of this species, of a dusky black, marked with spots of a deeper or more glossy black, and perfectly resembling in disposition those of the common leopard, is found in Bengal. In one of this kind brought to England some years ago, the fur, when a little turned aside, exhibited a slight tinge of the natural or general colour.

5. Felis jubata, the hunting leopard, is about

the size of a large greyhound, and of a long make, with narrow chest, and long legs. It is a native of India, where it is said to be tamed, and used for the chase of antelopes and other animals; being carried into the field chained and hooded, and at the proper time loosed; when it is said to steal along the ground at first, concealing itself till it gains a proper advantage, and then to dart on the animal it pursues with several repeated springs. If it happens to miss its prey, it returns to the call of its master.

6. Felis uncia, the ounce, is scarcely inferior in size to the leopard. Its colour is dull white, with a slight yellowish or tawny cast, and the whole is scattered over with differently-sized spots and markings of black. About the head these spots are small, numerous, and roundish; along the back they form a kind of abrupt or irregularly interrupted stripes, while on the sides and limbs they are variously shaped, forming in some places angular and in others somewhat round or oval marks, with a central space included, and on the legs and tail they are black and scattered. In its general form the animal seems much allied to the leopard. It seems not to have been distinctly described by any modern author till the time of Buffon; but it is supposed to have been known to the antients, and to have been the smaller panther of Oppian, and the panthera of Pliny. It is a native of several parts of Africa and Asia.

7. Felis onca, the Brasilian tiger, is a native of the hotter parts of South America, and is considered as a very fierce and destructive animal. Its manners are said to resemble those of the tiger, lying in ambush for its prey. See Plate Nat. Hist. fig. 198. It is about the size of a wolf, or even larger. Its ground-colour is a pale brownish-yellow, variegated on the upper parts with streaks and open oblong spots or markings of black, the top of the back being marked with long interrupted stripes, and the sides with rows of regular open marks; the thighs and legs are also variegated with black spots, but without central spaces; the breast and belly are whitish; the tail not so long as the body; the upper part marked with large black spots in an irregular manner, the lower with smaller spots.

8. Felis pardalis, ocelot. The ocelot or pardalis is certainly one of the most beautiful of the present genus. In size it is almost equal to the jaguar. Mr. Pennant describes it as about four times the size of a large cat. The ground-colour of the male is a bright reddish-tawny above, nearly white on the lower part of the sides, breast, limbs, and belly. Several large, long, and variously inflected broad stripes, of a deeper or richer tinge than the ground-colour, are disposed over the upper parts of the body: these stripes are edged with black, and have also several differently-shaped black spots in the middle part. The head is streaked and spotted with black, and the upper as well as under parts of the limbs and the belly marked in a beautiful manner with small and numerous round spots; the tail is patched or spotted also. The colours of the female are less vivid, and more inclining to ash-colour. This is an extremely ferocious animal, and inhabits the hotter parts of South America, where it is said to commit great ravages among cattle, &c. It is also said to be untameable in a state of captivity. See Plate Nat. Hist. fig. 203.

9. Felis puma. The puma is the largest of the American beasts of prey, measuring five feet or more from nose to tail, the tail itself about two feet eight inches. It is a long-bodied animal, and stands high on its legs. Its colour is a pale brownish-red, with a slight dusky cast on some parts; the chin is white; the breast and belly ash-coloured; and the insides of the legs are of the same colour; the tail of a dusky-ferruginous tinge, with a black tip. It is a native of many parts of America, both north and south, occurring from Canada to Brasil. The puma is an animal of great strength and fierceness, preying on cattle, deer, &c. Sometimes it is said to climb trees, and watch the opportunity of springing on such animals as happen to pass beneath.

10. Felis discolor, black tiger. This, like the former species, is a native of America, and is considered as a very destructive and ferocious animal. It is about the size of a large dog, and is entirely of a deep brownish-black colour on the upper parts, and pale-grey or whitish beneath; the upper lip and the paws are also whitish; the tail is of the same colour with the body. See Plate Nat. Hist. fig. 205.

11. Felis tigrina, margay. The margay is a native of South America, and is about the size of a common cat. The ground-colour is a bright tawny; the face striped downwards with black; the shoulders and body marked both with stripes and large oblong black spots; on the legs the spots are small; the breast, belly, and insides of the limbs, are whitish; the tail is long, and marked with black, grey, and fulvous. It resides principally on trees, preying on birds: it is said to breed in the hollows of trees, and to bring but two young at a birth. It is very fierce and untamable.

12. Felis capensis, the Cape cat, inhabits the neighbourhood of the Cape of Good Hope, and is described in the Philosophical Transactions, vol. 71, by Dr. Forster. In its manners it seems extremely to resemble the common cat, frequenting trees, and preying on the smaller animals. The specimen described by Dr. Forster was not more than nine months old, and had been taken quite young. It was perfectly tame and gentle, and had all the actions and manners of a domestic cat. Dr. Forster imagines it to be the same species with the 'nnussi described by Labat, who calls it a sort of wild cat of the size of a dog, with a coat striped and varied like that of a tiger. The length of a skin measured by Mr. Pennant was near three feet from nose to tail; but Dr. Forster's specimen seems to have been much smaller.

13. Felis manul. This species inhabits the middle part of northern Asia, and was first described by Dr. Pallas. It is of the size of a fox, and is of a strong and robust make. Its colour is tawny, but the crown of the head is speckled with black, and the cheeks are marked by two dusky lines running obliquely from the eyes; the feet are striped obscurely with dark lines; the tail is longer than that of a domestic cat, and is thickly beset with hair, and encircled with ten black rings, of which the three next to the tip are placed so near as almost to touch each other.

14. Felis catus. The cat, in a state of natural wildness, and from which are supposed to have proceeded all the varieties of the domestic cat, is a native of the northern regions of Europe and Asia. In this its natural state it differs in some slight particulars from the domestic animal, having a somewhat shorter tail in proportion, a flatter and larger head, and stronger limbs; and, from an exact anatomical inspection of its interior parts, it appears that the intestines are somewhat shorter than those of the domestic cat. The colour of the wild cat is commonly a pale yellowish-grey, with dusky stripes and variegations, those on the back running lengthwise, those on the sides transversely and with a curved direction: the tail is annulated with several alternate circles of blackish-brown and dull white; the tip of the nose and the lips are black. Even wild cats, however, appear to differ in their shades of colour in different parts of Europe. Mr. Schreber, in his plate of quadrupeds, figures a specimen of a pretty deep tawny colour, varied with black or deep-brown streaks, so that the animal has very much the appearance of a tiger in miniature; while on another plate he has exhibited one, communicated by Dr. Pallas, of a pale grey with black or dark-brown variegations.

The manners of the wild cat resemble those of the lynx, and several others of this genus, living in woods, and preying on young hares, on birds, and a variety of other animals, which it seizes by surprise. It breeds in the hollows of trees, and produces about four at a birth. "The wild cat (says Mr. Pennant) may be called the British tiger: it is the fiercest and most destructive beast we have; making dreadful havoc among our poultry, lambs, and kids. It inhabits the most mountainous and woody parts of these islands, living mostly in trees, and feeding only by night. It multiplies as fast as our common cats; and often the females of the latter will quit their domestic mates, and return home pregnant by the former."

The varieties of this animal, in a domestic state, are very numerous: it is either entirely black; black and white; black, fulvous, and white (called the tortoise-shell or Spanish cat); white without any variegation; fulvous and white; dun-colour or tawny, either plain or with deeper stripes; tabby, or of a similar colour to the wild cat, but with much bolder or more vivid variegations; slate-coloured or blue grey (called the Chartreux cat); slate-coloured with very long fur, especially on the neck and tail (the Persian cat); white with hair of a similar length (called the Angora cat); or, lastly, with penciled or tufted ears, like a lynx, which sometimes, though rarely, takes place. Of all the above varieties, the Persian and the Angora are the most remarkable: the latter variety has one eye blue, the other yellow; a particularity which takes place in some specimens of the common white cat. It is also observable, that the white variety of the cat is sometimes perfectly deaf.

The cat, when well educated, possesses qualities which will entitle her to the regard and protection of mankind; and if she does not exhibit the vivid and animated attachment of the dog, she is still of an affectionate and gentle disposition, and grateful to her benefactors.

A singular instance of attachment in the

cat is recorded in Mr. Pennant's Account of London. Henry Wriothsly, earl of Southampton, the friend and companion of the earl of Essex in his fatal insurrection, having been confined some time in the Tower, was surprised by a visit from his favourite cat, which, says tradition, reached its master by descending the chimney of his apartment.

No animal, whose habits and manners we have the opportunity of accurately observing, exhibits a greater degree of maternal tenderness than the cat. The extreme assiduity with which she attends her young, and the fondness which she shews for them, afford the most pleasing entertainment to a philosophic observer. She even possesses a propensity to nurse with tenderness the young of a different individual; and it is a general observation, that a domestic cat will commonly suckle and nurse any young kitten that is newly introduced to her.

Nothing can be more beautiful than the experiment of setting a young cat, for the first time, before a looking-glass. The animal appears surprised and pleased with the resemblance, and makes several attempts at touching its new acquaintance; and at length, finding its efforts fruitless, it looks behind the glass, and appears highly surprised at the absence of the figure: it again views itself, tries to touch with its foot, suddenly looking at intervals behind the glass. It then becomes more accurate in its observations, and begins, as it were, to make experiments, by stretching out its hand in different directions; and when it finds that these motions are answered in every respect by the figure in the glass, it seems at length to be convinced of the real nature of the image. The same is the case with the dog at an early age.

The cat generally lives in habits of friendship with the other domestic animals; the contrary instances arising entirely from neglect of early education.

The fur of the cat, being generally clean and dry, readily yields electric sparks when rubbed; and if a clean and perfectly dry domestic cat is placed, in frosty weather, on a stool with glass feet, or insulated by any other means, and rubbed for a certain space in contact with the wire of a coated vial, it will be effectually charged by this method. See Plate Nat. Hist. fig. 202.

15. Felis serval. The serval is a native of India and Tibet, and is an extremely fierce and rapacious animal. It resides principally among trees, leaping with great agility from one tree to another, and pursuing birds, &c. This species appears to have been first described by the French academicians in their work entitled Mémoires pour servir à l'Histoire des Animaux. The specimen there described measured two feet and a half from the nose to the tail, which was eight inches long. Its shape was thick and strong; its general colour was fox-red or ferruginous, with the throat, abdomen, and insides of the legs, yellowish-white; it was spotted almost all over with black, the spots being of a long form on the back, and round on the sides, belly, and legs, where they were proportionally smaller and more numerous. The specimen described and figured in the count de Buffon's Natural History differed only in a very few particulars, so slight as to leave no doubt of the identity of the species. It was excessively fierce and untamable. There is also an American serval, which differs chiefly from the above in being mild and gentle.

16. Felis chaus, is an inhabitant of the woody and marshy tracts that border on the western side of the Caspian Sea, and in the Persian provinces of Ghilan and Masenderan, and is frequent about the mouth of the Kur, the ancient Cyrus. In manners, voice, and food, it agrees with the wild cat. Its general length is about two feet six inches from the nose to the tail; but it has been known to mea ure three feet: the tail reaches only to the flexure of the legs. The colour of this species is a dusky yellowish-brown; the breast and belly much brighter or more inclining to orange-colour; the tail is tipped with black, and has three obscure black bars at some distance from the tip; and on the inside of the legs, near the bend of the knee, are two dusky bars; the ears are tufted with black hairs.

17. Felis rufa, bay lynx. This species is about twice the size of a large cat, and is a native of North America. Its colour is a bright bay, obscurely marked with small dusky spots; the upper and under lip, throat, and whole under sides of the body and limbs, are white. From beneath each eye three curved blackish stripes pass down the cheeks; the upper part of the inside of the fore legs is marked by two black bars; the upper part of the tail is marked with four or five dusky bars, and that next the tip is black; the ears are sharp-pointed, and tufted with long black hairs. This animal was first described by Guldenstedt. The hair is shorter and smoother than that of the common lynx.

18. Felis caracal. The caracal or Persian lynx is a native both of Asia and Africa; and it is said that in some parts of Persia it is tamed and made use of in the chace. It is an animal of great strength and fierceness. Dr. Charleton mentions one which killed a hound and tore it in pieces in an instant, notwithstanding the vigorous defence made by the dog. It is used not only in the chace of the smaller quadrupeds, but of the larger kinds of birds, such as herons, cranes, pelicans, &c. which it is said to surprise with great address. When it has seized its prey, it lies motionless for some time upon it, holding it in its mouth. The caracal is about the size of a fox, but of a much stronger make; its colour is a pale reddish-brown, whitish beneath; the head is small, the face longish, the ears sharp and slender, of a blackish colour, and terminated by a tuft or pencil of long black hairs.

19. Felis lynx, the common lynx, with some slight varieties as to size and colour, appears to be found in all the colder regions of Europe, Asia, and America, residing in thick woods, and preying on hares, deer, birds, and almost every kind of animal inhabitant. The general size of the lynx is that of a middling dog: the measure given by Mr. Pennant of the skin of a Russian lynx is four feet six inches from head to tail, the tail measuring six inches. But the generality of lynxes seem to be somewhat smaller than this. In colour the lynx varies, but is generally of a pale-grey, with a very slight reddish tinge; the back and whole upper parts are obscurely spotted with small dusky or blackish marks. The throat, breast, and belly, are white; the tail white, with a black tip; the ears tipped with pencils of long black hair. The lynx is said to howl almost in the manner of a wolf. In a state of captivity it seems extremely ferocious, and is not to be tamed. See Plate Nat. Hist. fig. 199.

FELIS VOLANS, the flying-cat, an animal supposed to be the same with the flying squirrel.

FELLOES, in fortification, are six pieces of wood, each whereof form a piece of an arch of sixty degrees, and joined all together by dulleges, make an entire circle; which, with the addition of a nave and twelve spokes, make the wheel of a gun carriage. Their thickness usually is the diameter of the ball of the gun they serve for, and their breadth something more.

FELLOWSHIP, or COMPANY, in arithmetic, is when two or more join their stocks, and trade together, dividing their gain or loss proportionably.

Fellowship is either with or without time. Questions without time, or in the single rule of fellowship, as it is frequently called, are wrought by the following proportion:

As the whole stock, to the whole gain or loss, so is each man's particular stock, to his particular gain or loss.

Example I. A, B, and C, make a joint stock: A puts in 460*l.*, B 510*l.*, and C 480*l.*; they gain 340*l.*; what part of it belongs to each?

In order to the solution of this question, find the total of their joint stock, viz.

A's stock 460*l.* + B's stock 510*l.* + C's stock 480*l.* = 1450*l.* the total stock.

Then 1. To find A's share of the gain, state as follows: If 1450*l.* : 340*l.* :: 460*l.*, which being worked by the rule of three, the answer will be 107*l.* 17*s.* 2¾*d.* for A's share of the profit.

2. B's share of the gain, by stating thus: if 1450*l.* : 340*l.* :: 510*l.* and working by the rule of three, will be found to be 119*l.* 11*s.* 8½*d.*

3. C's share will appear 112*l.* 11*s.* 0¼*d.* when worked as before, after having stated thus: If 1450*l.* : 340*l.* :: 480*l.*

Example II. Suppose three partners, A, B, and C, make a joint stock in this manner: A puts in 24*l.*, B 32*l.*, and C 40*l.*, in all 96*l.*, with which they trade, and gain 12*l.*; required each man's true share of that gain? The first operation for A's part of the gain will stand thus:

96*l.* : 12*l.* :: 24*l.* : 3*l.* = A's gain.
96*l.* : 12*l.* :: 32*l.* : 4*l.* = B's gain.
96*l.* : 12*l.* :: 40*l.* : 5*l.* = C's gain.

Proof 3*l.* + 4*l.* + 5*l.* = 12*l.* the whole gain.

That is, if the total of all their particular gains amounts to the whole gain, the work is true; if not, some mistake has been committed.

FELLOWSHIP *with time*, usually called the *double rule of fellowship*, because every man's money is to be considered with relation to the time of its continuance in the joint stock. It is worked thus: multiply each man's stock by the respective time he puts it in for, and add all the products; the total of which must be your first number through all the statings; the gain or loss the second, as before; and each man's particular stock, multiplied by its time, the third.

Example I. A put into company 560*l.* for eight months, B 279*l.* for ten months, and C 735*l.* for six months; they gained 1000*l.* What share of it must each have?

For the solution of this question, proceed as follows: A's stock 560*l.* × 8 its time = 4480; B's stock 279*l.* × 10 its time = 2790; C's stock 735*l.* × 6 its time = 4410. Then 4480 + 2790 + 4410 = 11680.

Now, 1. To find A's share of the profit, state thus: If 11680*l.* : 1000*l.* :: 4480*l.* which being worked by the rule of three, the answer will be 383*l.* 11*s.* $2\frac{3}{4}$*d.* for A's share of the gain.

2. For finding B's share state thus: If 11680*l.* : 1000*l.* :: 2790*l.* and working as before directed, the answer will be 238*l.* 17*s.* $4\frac{3}{4}$*d.*

3. To find C's proportion of the gain, say, if 11680*l.* : 1000*l.* :: 4410*l.* then working it by the rule of three, the true amount of his share will appear to be 377*l.* 11*s.* $4\frac{1}{4}$.

FELO DE SE, a felon of himself, is a person who, being of sound mind, and of the age of discretion, voluntarily kills himself: for if a person is insane at the time, it is no crime. But this ought not to be extended so far as the coroner's juries sometimes carry it, who suppose that the very act of self-murder is an evidence of insanity; as if every man who acts contrary to reason had no reason at all; for the same argument would prove every other criminal non compos, as well as the self-murderer. 3 Inst. 54.

All inquisitions of the offence, being in the nature of indictments, ought particularly and certainly to set forth the circumstances of the fact; as the particular manner of the wound, and that it was mortal, &c. and in conclusion add, that the party in such manner murdered himself. 1 Salk. 377.

A felo de se forfeits all chattels real and personal, which he has in his own right; and also all such chattels real whereof he is possessed, either jointly with his wife, or in her right; and also all bonds and other personal things in action, belonging solely to himself; and also all personal things in action, and entire chattels in possession, to which he was entitled jointly with another, on any account, except that of merchandize; but it is said that he shall forfeit a moiety only of such joint chattels as may be severed, and nothing at all of what he was possessed of as executor or administrator. Stamdf. P. C. 188, 189. Plow. 243, 262. 3 Inst. 55.

FELONY, in the general acceptation of law, comprises every species of crime which occasioned at common law the forfeiture of lands or goods. This most frequently happens in those for which a capital punishment either was or is liable to be inflicted; for those felonies which are called clergyble, or to which the benefit of clergy extends, were antiently punished with death in lay or unlearned offenders; though now, by the statute law, that punishment is for the first offence universally remitted.

Felony is always accompanied with an evil intention, and therefore shall not be imputed to a mere mistake or misanimadversion; as where persons break open a door to execute a warrant, which will not justify such a proceeding. But the bare intention to commit a felony is so very criminal, that at the common law it was punishable as felony, where it missed its effect through some accident, which no way lessened the guilt of the offender; but it seems agreed at this day, that felony shall not be imputed to a bare intention to commit it, yet it is certain that the party may be very severely fined for such an intention. 1 Haw. 65.

The punishment of a person for felony, by our antient books, is, 1st, to lose his life; 2dly, to lose his blood, as to his ancestry, and so to have neither heir nor posterity; 3dly, to lose his goods; 4thly, to lose his lands, and the king shall have year, day, and waste, to the intent that his wife and children be cast out of the house, his house pulled down, and all that he had for his comfort and delight destroyed. 4 Rep. 124. A felony by statute incidentally implies, that the offender shall be subject to the like attainder and forfeiture, &c. as is incident to a felon at common law. 3 Inst. 47. See BURGLARY, FORGERY, HOMICIDE, PETIT TREASON, RAPE, ROBBERY, &c.

Felon's goods are not forfeited till it is found by indictment that he fled for the felony, and therefore they cannot be claimed by prescription. See ESTRAYS, and WAIFS.

FELONY *under colour of law*: such is coming into a house by colour of writ of execution, and carrying away the goods. A special trust prevents the felony, until such special trust is determined. 8 Mod. 76.

FELT, in commerce, a sort of stuff, deriving all its consistence merely from being fulled or wrought with lees and size, without either spinning or weaving. Felt is made either of wool alone, or of wool and hair.

FELSPAR. See LEPIDOLITE.

FELUCCA, in sea affairs, a little vessel with six oars, frequent in the Mediterranean, which has this peculiarity, that its helm may be applied either in the head or stern as occasion requires.

FEME COVERT, a married woman, so called from being under the cover, protection, and influence of her husband. See HUSBAND AND WIFE.

FEME SOLE, a single or unmarried woman. A feme sole is liable to perform parish offices, the act only requiring the person to be a substantial householder, without reference to sex.

FEME SOLE TRADER, a married woman, who, by the custom of London, trades on her own account, independant of her husband. See BANKRUPTCY.

FEMININE, or FŒMININE, in grammar, one of the genders of nouns.

FEMUR, *os femoris*, the thigh-bone. See ANATOMY.

FEN, a place overflowed with water, or abounding with bogs. See DRAINING.

Fens are either made up of a congeries of bogs, or consist of a multitude of pools or lakes with dry spots of land intermixed, like so many little islands.

Several statutes have been made for the draining of fens, chiefly in Kent, Cambridgeshire, Bedfordshire, Lincolnshire; by 11 Geo. II. commissioners shall be appointed for the effectually draining and preserving of the fens in the isle of Ely, who are authorized to make drains, dams, and proper works thereon; and they may charge the landholders therein with a yearly acre-tax, and in default of payment sell the defaulters' lands.

FENCE, in country affairs, a hedge, wall, ditch, bank, or other inclosure, made around gardens, woods, corn-fields, &c. See HUSBANDRY.

Where a hedge and ditch join together, in whose ground or side the ditch is, to the owner of that land belongs the keeping of the same hedge or fence, and the ditch belonging to it on the other side, in repair and scoured. P. Off. 188.

An action on the case or trespass lies for not repairing fences, whereby cattle come into the ground of another, and so damage it. Also it is presentable in the court-baron. 1 Salk. 335.

FENCE MONTH, a month wherein it is unlawful to hunt in the forest, because the female deer fawn in that time: it being always, according to the charter of the forest, 15 days before, and ending 15 days after Midsummer.

FENCING, the art of making a proper use of the sword, as well for attacking an enemy, as for defending one's self.

FEND, in the sea language, imports the same as defend: thus, fending the boat is saving it from being dashed to pieces against the rock, shore, and ship's side. And hence,

FENDERS are pieces of old hawsers, cable-ropes, or billets of wood, hung over the ship's sides, to keep other ships from rubbing against and injuring her.

FENDUE *en pal*, in heraldry, a cross cloven down in pale, that is, from top to bottom, and the two parts set at some distance from each other.

FENESTRA, in anatomy, a term applied to two openings or foramina within the ear, distinguished by the names of the oval and the round fenestra. The fenestra ovalis leads to the vestibule, on which stands the stapes. The fenestra rotunda leads to the cochlea, and is closed by a membrane.

FENNEL. See ANETHUM.

FENS. Any person convicted of maliciously cutting or destroying any bank, mill, engine, floodgate, or sluice for draining fens, shall be guilty of felony, without benefit of clergy. 27 Geo. II. c. 19.

FEODAL SYSTEM, the constitution of fiefs or feuds. It is about twelve centuries ago since this system was so universally received in Europe, that sir Henry Spelman calls it the law of nations in our western world. Hence it deserves our attention in a particular manner; a knowledge of the different feuds being indispensably requisite for a proper understanding either of the civil government of our own country, or the laws by which its landed property is regulated.

The military policy of the Celtic or northern nations, known by the names of Goths, Vandals, Franks, Huns, and Lombards, furnished the original constitution or system of feuds. These people pouring out in vast multitudes from the officina gentium or storehouse of nations, overran all the European nations on the decline of the Roman empire. They brought the feudal system along with them from the countries out of which they emigrated; and, supposing it to be the most proper method of securing their new conquests, they introduced it into their more southerly colonies.

According to this system, the victorious general allotted considerable tracts of land to his principal officers; while they, in like manner, divided their possessions among the inferior officers, and even those common soldiers who were thought to be the most deserving. Allotments of this kind were named

195

Falco sacer
Sacre

196

Falco magnirostris
Great billed Falcon

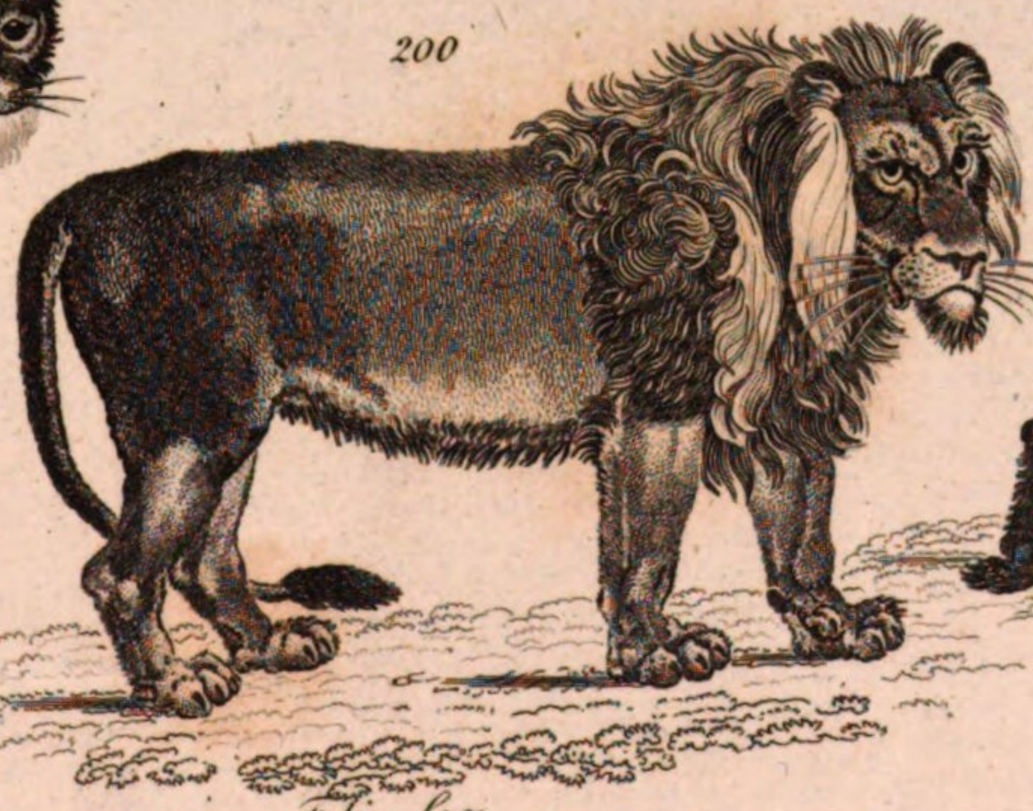
197

Falco milvus
Kite

199

Felis Lynx

200



Felis Leo
Lion

201

Felis Leo
Lioness

203

Felis pardalis
Marian cat

198

Felis Onca
Ocelot

202

Felis catus
Domestic cat

Heath Sc

Printed June 1-1806, for Richard Phillips, New Bridge St. Blackfriars.

feoda, fiefs, fees, or feuds, form a combination of words, in the language of these barbarians, signifying a reward or stipend bestowed on certain conditions. The condition upon which these rewards were given was, that the possessors should faithfully serve the person from whom they were received, both at home and abroad, in a military capacity. To this they engaged themselves by a juramentum fidelitatis, or oath of fealty; in the event of a breach of which, either by not performing the service agreed upon, by deserting their lord in time of battle, &c. the lands were to return to their original possessor.

Thus the possessors of feodal allotments became interested in the defence of them; and not only the receivers, but those who gave them, were equally and mutually bound to defend their possessions, none of them being able to pretend any right but that of conquest. For this purpose, government and subordination were absolutely necessary; it being impossible to conduct any system of defence where every thing was tumultuous and irregular. Every person, therefore, who was a feudatory, *i. e.* who had received lands, was bound to do every thing in his power to defend the lord of his fee; while, on the other hand, the latter was no less subordinate to his immediate superior; and so in succession to the prince himself. In like manner a reciprocal bond of defence existed down from the prince to the lowest feodists.

Such were the foundations on which the feodal system was properly established; and the natural consequence was, a military subjection throughout the whole community. The prince could always collect an army of feudatories ready to defend not only the kingdom in general, but the particular possessions of each person; and the propriety of this constitution was soon apparent in the strength which these newly-erected kingdoms acquired, and the valour with which their conquests were defended.

Besides these feodal grants, however, which were held only on the terms of military service, there were others called allodial, which were given upon more enlarged principles. To these every free man had a title, and could not only claim his territory as well as the rest, but dispose of it at his pleasure; and this freedom was denominated allodiality. These allodials, however, were not exempted from military service. A part of their freedom consisted in liberty to go to the wars; for this, in the barbarous times we speak of, was the only way to acquire any degree of renown. Only the slaves were destined to follow the arts of peace; while every free person was not only at liberty to defend his country, but under an obligation to do it in case of any urgent necessity.

Thus there was a feodal and a national militia. The free people only were allowed to possess property; the feudal vassals constituted the army, properly so called; while the national militia was composed of the allodial proprietors. This allodiality, however, was not confined to landed property, but included likewise moveable estates or money; so that proprietors of the latter kind were obliged also in times of danger to bear arms and appear in the field. Between the feodal and allodial proprietors, however, there was this farther difference, that the latter had no concern with any private quarrels which might take place among the lords themselves; so that they were never obliged to appear in the field unless when called forth by the sovereign against the enemies of the nation at large. This circumstance we might suppose to be an advantage, but it ultimately operated otherwise; becoming the means of changing the allodial right into a feodal tenure. For some time the holders of fiefs had an eminent advantage over the allodial proprietors. This was owing to the imperfection of government in those days; so that the nobles had it in their power to revenge their own quarrels, while the weak were equally exposed to the insults of both parties. The lord and his vassals, therefore, were always formidable; but the allodial proprietors had scarcely any means of defending themselves. The reason of this was, in the first place, that the law did not allow them to commit any hostilities; and in the next, they were too distant and unconnected to form any proper league for mutual defence; and hence proceeded the necessity already hinted at, of converting allodial property into feudal tenure. This was indeed owing in a great measure to the absurdity and violence of the times, by which gifts of property, burthened with service, and which might return to the person who granted them, were rendered superior in value to the absolute and unconditional possession of a subject. Other considerations, however, contributed to produce the same effect. As in those dark ages no right existed but what had its origin in conquest, it thence followed that the greatest conqueror or warrior was the most honourable person. The king, in whom the whole exploits of the community centred, as being their head, was the most honourable person; and all others derived from him that portion of honour which they enjoyed, and which was most nicely adjusted in proportion as they approached him. Allodial proprietors, therefore, having no pretensions of this kind, were treated with contempt. From this disagreeable situation they wished to free themselves, by converting their allodial property into feudal tenures; while the princes, supposing it their interest to extend those tenures as much as possible, discouraged the allodial possessions. As the feodists supported the importance of the nation and dignity of the monarch, it was not thought proper to allow the allodial proprietors any greater compensations than what were given to vassals in similar cases. Thus they were exposed to continual mortifications in the courts of justice; they were neglected by the king; denied sufficient protection from the laws; exposed not only to continual insults, but to have their property on all occasions destroyed by the great; so that they were without resource except from the feodal tenures, and were obliged even to solicit the privileges which were bestowed in other cases on vassals. In these unhappy circumstances, they were glad to yield up their lands to any superior whom they thought most agreeable, and to receive them back from him as a feudal gift. Thus the landed property was every where changed into feudal tenures, and fiefs became universal.

For some time the feodal system was not only useful in itself, but honourable in its principles; but this continued no longer than while the importers of it into Europe adhered to their original simple and noble maxims. During that period, the lord exercised his bounty to the vassal, which the latter repaid by acts of gratitude; so that the intercourse betwixt them was of the most tender and affectionate kind; and this gave rise to what are called the feodal incidents.

The expectants of fiefs were educated in the hall of the superior, while the tenures were precarious or only for life: and even when they became hereditary, the lord took care of the son and estate of his deceased vassal, not only protecting his person, but taking charge of his education, and directing the management of his affairs. He took pleasure in observing his approach to maturity; and when he came of age, never failed to deliver to him the lands, with the care of which he had been entrusted, and which he had been careful to improve. This was called the incident of wardship.

The incident of relief was founded upon the gratitude of the vassal, who, upon entering on his fief, brought a present to his lord, as an acknowledgment of his care of him during the early part of his life, and in order to conciliate his future regard.

The incident of marriage proceeded also upon the principle of gratitude on the part of the vassal. The latter, conscious of the favours he had received, did not choose to ally himself with a family inimical to his chief; while the superior himself, ambitious to aggrandise and augment the importance of his family, sought how to find the most advantageous match for his vassal.

Sometimes the superior himself was reduced in his circumstances by war or other accidents; but from whatever cause his distress proceeded, even though it had arisen from his own extravagance or prodigality, or when only destitute of means to support his ambition or grandeur, his vassals were bound to support and relieve him according to their circumstances; and this was called the incident of aid.

The incident of escheat took place on the part of the vassal, when, through cowardice, treachery, or any remarkable misbehaviour, he rendered himself unworthy of his fief. In that case, the taking it from him, and giving it to one more worthy, was called an escheat.

While the lords and vassals thus vied with one another in mutual acts of friendship and benevolence, happiness, liberty, and activity, were diffused through the society. The vassals behaved courteously towards the retainers, who were immediately below them; while they again were courted by the lords, as constituting their importance and strength: the lords, lastly, giving a like importance and dignity to the sovereign himself. Thus a regular, powerful, and compact system of government took place, an unanimity and attention pervaded the various departments of state; so that while the subjects were free, the nation at large was formidable.

During this state of affairs, the members of the national assembly in every country of Europe appeared there in arms, whether they came personally or by their representatives. Such particularly was the case under the Anglo-Saxon government; and the happiness they at that time enjoyed made the oppression and tyranny of the Normans appear the more intolerable. In process of

time, however, the state of society began to suffer a remarkable alteration. The high and disinterested notions from which the happiness above-mentioned took its origin, declined; the romantic ideas of chivalry ceased; and much more interested notions of property came in their stead. The separation of the interests of the lords from their vassals was the first step towards the destruction of the feodal system. Thus the incidents, which, as has just now been mentioned, promoted their happiness, did the very reverse. Property, being now looked upon as a distinction superior to personal merit, naturally introduced the most mercenary views. In consequence of these, the infant ward, the care of whom was wont to be considered as a sacred and honorary trust, was now only looked upon as a means of procuring emolument to the superior. The latter now regarded the profits of his vassals as so many diminutions of his own wealth. Instead of taking care to improve the estate of his ward as formerly, he impoverished it; not only neglecting the education of the heir, but offering insults to himself; insomuch that the relations of the unfortunate vassal were frequently obliged to ransom from the avaricious superior both his person and effects. By merchandise of this kind the coffers of princes were filled, and wardships let out to strangers, who might exercise their rapacity with greater freedom. When the vassal at last attained the years of maturity, he came to the possession of his lands without any of that joy and festivity which usually took place on the occasion. He received an inheritance wasted and destroyed, while new grievances daily presented themselves to augment the horrors of his situation. All the incidents, which in former times were so many expressions of gratitude on the part of the vassal, were now changed into taxes which might be exacted at the pleasure of the lord. Before the vassal was invested in his land, the superior exacted from him a certain sum or other gift, to be measured only by his own rapacity; and in case of delay or inability to pay this demand, the superior continued in possession of the estate. Such scandalous oppression could not but produce the greatest discontent and clamour. Applications were made to the law without success; nor were even the laws regarded which were fabricated on purpose for their relief. The incident of marriage now proved a source of the most dreadful oppression. The lord assumed a right of marrying his vassal to whom he pleased; and he not only exerted this right himself, but would sell it to a stranger, or allow the vassal to buy it himself; while the penalty annexed to a marriage without the consent of the superior involved no less punishment than the loss of the estate itself, or some grievous infliction as for a crime of the first magnitude. The case was still worse with a female ward, whose beauty and accomplishments became a source of gain to the superior, or were sacrificed to please his whim or caprice; so that her relations were frequently obliged to buy from him the privilege of marrying her to the person she or they thought most proper. In like manner the aid, which was formerly a voluntary gift from the vassal in cases of distress happening to his lord, now became an unavoidable tax. An aid formerly was demanded, when the eldest daughter of the superior was married, when his eldest son was knighted, or when the superior himself was taken prisoner in battle. These were the only legal causes of making a demand of this kind; but, in the subsequent times of degeneracy, the most frivolous pretences were every day made use of by the prince to oppress the lords, and by the lords to oppress their vassals; demanding subsidies at pleasure, which their inferiors were always obliged to comply with. Lastly, the escheat, which in former times took place only in cases of cowardice, treachery, or some other heinous crime, was now inflicted on the most trifling occasions. If the vassal happened to be too long in attending the court of his superior to take the oath of fealty; if he committed any action which could in the least be construed an infringement of the oath; if he neglected to give his lord warning of any misfortune which he might suppose was about to befal him; revealed any thing concerning him; made love to his sister or daughter, &c; or even if he should grant a tenure of land to another person in form different from that in which he held his own; all these, nay others still more ridiculous, were judged sufficient reasons for the superior to seize on the estate of the vassal, and involve him and his family in ruin.

Notwithstanding these oppressions, however, the vassal was still obliged to submit to his lord, to own him as his superior, and even in appearance to pay him the same respect as formerly, when the greatest unanimity and cordial affection subsisted between them. Still he was obliged to perform the same military service; because a failure in that respect would have subjected him to a forfeiture of lands according to the original agreement. A vast difference, however, now took place in the valour and activity which inspired the army. The vassals, forced into the field with desponding hearts, were indifferent as to the success of the cause in which they were engaged, and frequently obstructed instead of forwarding the operations of the field. Hence the sovereign found himself embarrassed; and, though nominally at the head of a martial and powerful people, was frequently unable to effect any thing on account of the mutual hatred and dissension which every where prevailed.

Thus the feodal states of Europe became unnaturally weak; a remedy was necessary; and it is remarkable, that the same remedy was applied all over the continent. This was, in short, the making fiefs hereditary, which till now had only been granted for a long term of years; and, in return, burdening the lands with a certain number of soldiers, which were not to be refused on any pretence whatever. Hence was derived the tenure of knight-service. A certain portion of land, burdened with the service of one horse-soldier or knight, was called a knight's fee; and thus an estate, furnishing any number of soldiers, was said to contain as many knight's fees; so that now the manors, baronies, &c. became powerful according to the number of soldiers they were bound to furnish. In the grants from the crown, the nobility were obliged to furnish a certain number of soldiers for the service of the sovereign; and in those from the nobility to their vassals the like service was required. Even the commons who had grants from the crown furnished a certain proportion of knights or cavalry. The force of the nation was called into action by grants in capite, or from the sovereign and nobility. A numerous and powerful army was instantly assembled, and at once ready for action. Of this army the king was the general, the nobility were the officers, and the vassals soldiers, the whole being exactly arranged, and capable of entering upon any expedition without the least delay.

Thus a remedy was found in some measure for the weakness of the feodal sovereigns; but, though the knight's-tenure could accomplish this, it could not bring back the former affection and cordiality which subsisted between the various ranks of people. On the contrary, by uniting them more firmly to one another by legal ties, it rendered matters rather worse. The oppression originating from the operation of the feodal incidents still continued with unremitting violence. The grants of knight's-tenure were attended with the same oaths of homage and fealty; the same incidents of relief, wardship, marriage, aid, and escheat; with the feodal tenures. The princes promised to abate somewhat of their rigour in demanding the feodal perquisites, but did not keep their word. Laws were occasionally promulgated, and for some time had an effect; but palliatives soon became ineffectual, and a new state of weakness commenced.

The two remarkable eras in the feodal history are, the time before the invention of knight's-service, and that during which it continued. Fiefs were in a state of fluctuation from the destruction of the Roman empire till the ninth century; but they were rendered perpetual in France about the year 877, and were generally become so in every country in Europe about the beginning of the tenth. Du Cange, *voce Militia*, gives us an example of a knight's fee in the year 880. By the year 987, when Hugh Capet was raised to the throne of France, knight-service was become general all over Europe, and was introduced into England, after having made its appearance in other countries. In England, however, there have been several doubts and difficulties among the learned concerning the introduction of the feodal laws. Many are of opinion, that they were first introduced by William the Conqueror; and, consequently, that they were entirely unknown to the Anglo-Saxons: but others think that they existed among the latter in the same form under which they were continued by the Normans. Dr. Stuart is of opinion, that the Saxons who settled in England could not be strangers to fiefs. He supposes the conformity of manners, which undoubtedly prevailed between the Saxons and other barbarians, a sufficient proof that the hereditary grant of land, as well as the fluctuating state of feodal tenures which preceded it, were known to the former. Collateral proofs are derived from the spirit and tenure of the Anglo-Saxon laws, but especially from the grants of hereditary estates on condition of military service. The condition of fiefs, however, under the Anglo-Saxons, was very different from what it was afterwards. In their times, we find no mention made of those oppressions of which so much notice has already been taken; and this may easily be accounted for from the alteration of the feodal spirit in different ages. During the

time that a warm and generous affection subsisted between the feodal superiors and vassals, the incidents were marks of generosity on the one part and gratitude on the other; but as soon as a variance had taken place, from the interested disposition which the introduction of luxury produced, the same incidents became sources of the most flagrant oppression. This was remarkably the case in the time of William the Conqueror; and during the reign of king John matters were come to such a crisis, that the people every where complained loudly, and demanded the restoration of the laws of Edward the Confessor. "What these laws of Edward the Confessor were (says Mr. Hume) which the English, every reign during a century and a half, desired so passionately to have restored, is much disputed by antiquarians; and our ignorance of them seems one of the greatest defects of the antient English history." Dr. Stuart has offered an explanation; but this is in fact no more than a conjecture, that "by the laws or customs of the Confessor, that condition of felicity was expressed which had been enjoyed during the fortunate state of the feodal association. The cordiality, equality, and independance, which then prevailed among all ranks in society, continued to be remembered in less prosperous times, and occasioned an ardent desire for the revival of those laws and usages which were the sources of so much happiness."

Besides the great distinction (of which an account has already been given) between the state of fiefs under the Anglo-Saxons and under the Normans, they were no less distinguished by the introduction of knight's-service. Hitherto the refinement of the English had been obstructed by the invasion of the Danes, and the insular situation of the kingdom; but after the Norman conquest the fiefs were made perpetual. Still, however, the knight's-fee and knight's-service were altogether unknown. William, the sixth prince who enjoyed the duchy of Normandy, was well acquainted with every thing relating to fiefs; for that duchy had experienced all the variety incidental to them, from the time of its being granted to Rollo by Charles the Simple, in the year 912, to the year 1066, when William was put in possession of England by the battle of Hastings.

On his accession to the throne, a number of forfeitures took place among those who had followed the fortunes of Harold. Their estates were to be disposed of at the pleasure of the conqueror; and it was natural to suppose that he would follow the method practised in his own country. Hence the origin of knight's-service in England. A grant of land to any person whatever, was estimated at a certain number of knight's-fees; and each of these required the service of a knight. The grants of lands were even renewed to the old tenants under this tenure; so that by degrees the whole military people in the kingdom acquiesced in it. To accomplish this, Domesday-book is supposed to have been compiled, which contained an exact account of all the landed property in the kingdom. Hence it is to be concluded, not that William introduced fiefs into England, as some have imagined, but that he brought them to their ultimate state of perfection by the introduction of knight's-service. This is evident from the laws enacted during his reign. In these it is not only mentioned that knight's-service was enacted, but that it was done expressly with the consent of the common council of the nation; which at that time was equivalent to an act of parliament.

The invention of knight's-service proved generally agreeable: for, as few of the Anglo-Saxon fiefs were hereditary, the advancement of the rest to perpetuity, under the tenure of knight's-service, must have been accounted an acquisition of some importance, as not only augmenting the grandeur and dignity of the sovereign, but securing the independance of the subject, and improving his property. In the happy state of the feodal association, there was indeed no necessity for the knight's-fee; but when the discordance and oppression so often mentioned began to take place, it became then necessary to point out particularly every duty of the vassal as well as of the lord; and this was fully done by the invention of knight's-service. The nobles possessed duchies, baronies, and earldoms, which extensive possessions were divided into as many fees, each of them to furnish a knight for the service of the king or of the superior; so that every feodal state could command a numerous army and militia, to support and defend it in case of any emergency. The knights were also bound to assemble in complete armour whenever the superior thought proper to call, and to hold themselves in readiness for action whenever the king or superior found it convenient to take the field; so that thus the militia might be marched at the shortest notice to defend or support the honour of the nation.

The knights were usually armed with an helmet, sword, lance, and shield; and each was besides obliged to keep a horse. This last requisite was owing to the contempt into which the infantry had fallen, through the prevalence of tournaments and luxuries of various kinds, though it was by means of the infantry that the barbarians had originally distinguished themselves in their wars with the Romans, and become able to cope with those celebrated warriors. All proprietors of fees or tenants by knight's-service fought on horseback; the cavalry were distinguished by the name of battle, and the success of every encounter was supposed to depend on them alone. They only were completely armed; the infantry, being furnished by the villages under the jurisdiction of the barons, had at first only bows and slings, though afterwards they were found worthy of much greater attention.

While the feodal association remained in perfection, the superior could at any time command the military service of his vassals; but, in the subsequent degeneracy, this service could neither be depended upon when wanted, nor was it of the same advantage when obtained as formerly. The invention of knight's-service tended in a great degree to remedy this inconvenience. Those who were possessed of knight's-fees were now obliged to remain 40 days in the field at their own expence; and this without exception, from the great crown vassals to the smallest feudatories; but if longer service was required, the prince was obliged to pay his troops. In those times, however, when the fate of nations was frequently decided by a single battle, a continuance in the field for 40 days was sufficient for ordinary occasions.

Thus matters seemed once more to be restored nearly to their former state. It was now, as much as ever, the interest of the nation to act with unanimity in its defence, not only against foreign enemies, but against the tyranny of the prince over his subjects, or of one part of the subjects over the other. New inconveniences, however, soon began to take place, owing to the gradual improvements in life and the refinement of manners. From the first institution of military service, a fine had been accepted instead of actual appearance in the field. In the times of barbarity, however, when men accounted rapine and bloodshed their only glory, there were but few who made an offer of this compensation; but as wealth and luxury increased, and the manners of people became softer, a general unwillingness of following the army into the field became also prevalent. A new tenure, called *escuage*, was therefore introduced, by which the vassal was only obliged to pay his superior a sum of money annually instead of attending him into the field. Hence originated taxes and their misapplication; for as the king was lord paramount of the whole kingdom, it thence happened that the whole escuage-money collected throughout the nation centred in him. The princes, then, instead of recruiting their armies, filled their coffers with the money, or dissipated it otherwise, hiring mercenaries to defend their territories when threatened with any danger. These being composed of the dregs of the people, and disbanded at the end of every campaign, filled all Europe with a disorderly banditti, who frequently proved very dangerous to society. To avoid such inconveniences, standing armies were introduced, and taxations began to be raised in every European kingdom. New inconveniences arose. The sovereigns in most of these kingdoms, having acquired the right of taxation, as well as the command of the military power, became completely despotic; but in England the sovereign was deprived of this right by Magna Charta, which was extorted from him, as related in our English histories; so that, though allowed to command his armies, he could only pay them by the voluntary contributions of the people, or their submitting to such taxations as were virtually imposed by themselves.

The tenure by knight's-service was continued in Great Britain (nominally at least), with all the incidents, homage, fealty, escuage, wardship, marriage, &c. till the time of the civil wars, when it was abolished by the Long Parliament, and the abolition was confirmed by 12 Car. II. c. 24.

FEOFFMENT, may be defined to be the gift of any corporeal hereditament to another. He that so gives or enfeoffs, is called the feoffor, and the person enfeoffed is denominated the feoffee. 2 Black. 20. But by the mere words of the deed, the feoffment is by no means perfected. There remains a very material ceremony to be performed, called livery of seisin, without which the feoffee has but a mere estate at will. Id.

The end and design of this institution was, by this sort of ceremony or solemnity, to

give notice of the translation of the feud from one hand to another; because if the possession might be changed by the private agreement of the parties, such secret contracts would make it difficult and uncertain to discover in whom the estate was lodged, and consequently the lord would be at a loss of whom to demand his services, and strangers equally perplexed to discover against whom to commence their actions for the prosecution and recovery of their right. To prevent, therefore, this uncertainty, the ceremony of livery and seisin was instituted. 2 Bac. Abr. 482.

Of the several sorts of livery.—The livery in deed is the actual tradition of the land, and is made either by the delivery of a branch of a tree or a turf of the land, or some other thing, in the name of all the lands and tenements contained in the deed; and it may be made by words only, without the delivery of any thing: as if the feoffor upon the land, or at the door of the house, says to the feoffee, "I am content that you should enjoy this land according to the deed." This is a good livery to pass the freehold. Co. Lit. 48. *a.*

The livery within view, or the livery in law, is when the feoffor is not actually on the land or in the house, but being in sight of it, says to the feoffee, "I give you yonder house or land; go and enter into the same, and take possession of it accordingly." This livery in law cannot be given or received by an attorney, but only by the parties themselves. Pollex, 47.

But this sort of livery is not perfect to carry the freehold, till an actual entry made by the feoffee, because the possession is not actually delivered to him, but only a licence or power given him by the feoffor to take possession of it; and therefore if either the feoffor or feoffee dies before livery, and entry made by the feoffee, the livery within the view becomes ineffectual and void; for if the feoffor dies before entry, the feoffee cannot afterwards enter, because then the land immediately descends upon his heir, and consequently no person can take possession of his land without an authority delegated from him who is the proprietor; nor can the heir of the feoffee enter, because he is not the person to whom the feoffor intended to convey his land, nor had he an authority from the feoffor to take the possession: besides, if the heir of the feoffee was admitted to take possession after his father's death, he would come in as a purchaser; whereas he was mentioned in the feoffment to take as the representative of his ancestor, which he cannot do, since the estate was never vested in his ancestor. Co. Lit. 48. b.

A feoffment cannot be made of a thing of which livery cannot be given, as of incorporeal inheritances, such as rent, advowson, common, &c. 2 Rol. 1. *l.* 20.; though it be an advowson, &c. in gross. 21 Id.

A man may either give or receive livery in deed, by letter of attorney; for since a contract is no more than the consent of a man's mind to a thing, where that consent or concurrence appears, it would be most unreasonable to oblige each person to be present at the execution of the contract, since it may as well be performed by any other person delegated for that purpose by the parties to the contract. Co. Lit. 52.

There are few or no persons excluded from exercising this power of delivering seisin; for monks, infants, femes covert, persons attainted, outlawed, excommunicated, villains, aliens, &c. may be attorneys; for this being only a naked authority, the execution of it can be attended with no manner of prejudice to the persons under these incapacities or disabilities, or to any other person who by law may claim any interest of such disabled persons after their death. Co. Lit. 52. *a.* See FINE.

FEOFFOR and FEOFFEE. Feoffor is he who infeoffs or makes a feoffment to another of lands or tenements in fee simple; and feoffee is the person infeoffed, or to whom the feoffment is made. See FEOFFMENT.

FERÆ, in zoology, an order of quadrupeds, the distinguishing characters of which are, that all the animals belonging to it have fore-teeth conic, usually six in each jaw; tusks longer; grinders with conical projections; feet with claws; claws subulate; food, carcases, and preying on other animals. See NATURAL HISTORY, ZOOLOGY, &c.

FERÆ NATURÆ. Animals of a wild nature are those in which a man has not an absolute but only a qualified and limited property, which sometimes subsists, and at other times does not subsist. And this qualified property is obtained either by the art and industry of man, or the impotence of the animals themselves, or by special privilege.

A qualified property may subsist in animals *feræ naturæ*, by the art and industry of man, either by his reclaiming and making them tame, or by so confining them that they cannot escape and use their natural liberty; such as deer in a park, hares or conies in an enclosed warren, doves in a dovehouse, pheasants or partridges in a mew, hawks that are fed and commanded by the owner, and fish in a private pond or in trunks. These are no longer the property of a man than while they continue in his keeping or actual possession; but if at any time they regain their natural liberty, his property instantly ceases, unless they have animum revertendi, which is only to be known by their usual custom of returning.

A man may have a qualified property in animals feræ naturæ, by special privilege; that is, he may have the privilege of hunting, taking, and killing them, in exclusion of other persons: under which head may be considered all those animals which come under the denomination of game. Here a man may have a transient property in these animals, so long as they continue within his liberty, and may restrain any strangers from taking them therein; but the instant they depart into another liberty, this qualified property ceases. 2 Black. 391.

Larceny cannot be committed of things feræ naturæ, while at their natural liberty; but if they are made fit for food, and reduced to tameness, and known by the taker to be so, it may be larceny to take them. 1 Haw. 94. See GAME.

FER DE FOURCHETTE, in heraldry, a cross having at each end a forked iron, like that formerly used by soldiers to rest their musquets on. It differs from the cross fourché, the ends of which turn forked, whereas this has that sort of fork fixed upon the square end.

FERENTARII, in Roman antiquity, were auxiliary troops, lightly armed; their weapons being a sword, bow, arrows, and a sling.

FERIÆ, in Roman antiquity, holidays, or days upon which they abstained from work.

The Romans had two kinds of feriæ: 1. The public, common to all the people in general. 2. The private, which were only kept by some private families.

The public feriæ were fourfold: 1. Stativæ feriæ, holidays which always fell out upon the same day of the month, and were marked in the calendar: of these the chief were the agonalia, carmentalia, and lupercalia. 2. Conceptivæ feriæ, holidays appointed every year upon certain or uncertain days by the magistrates or the pontiff: such were the Latinæ, paganalia, compitalia, &c. 3. Imperativæ feriæ, holidays commanded or appointed by the authority of the consuls or prætors: of this kind we may reckon the lectisternuim. 4. Nundinæ, the days for fairs. The private feriæ were either confined to private families or particular persons, as birthdays; and those expiations upon the tenth day after a person died in a house, called feriæ denicales. From this term our word fair seems to be derived.

FERIA, in the Romish breviary, is applied to the several days of the week: thus Monday is the feria secunda, Tuesday the feria tertia, though these days are not working days, but holidays. The occasion of this was, that the first Christians used to keep the Easter-week holy, calling Sunday the prima feria, &c. whence the term feria was given to the days of every week. But besides these, they have extraordinary feriæ, viz. the last three days of passion-week, the two days following Easter-day, and the second feriæ of rogation.

FERMENTATION. During the spontaneous decomposition which vegetable substances undergo, it is obvious that the simple substances of which they are composed must unite together in a different manner from that in which they were formerly united, and form a new set of compounds which did not formerly exist. The specific gravity of these new compounds is almost always less than that of the old body. Some of them usually fly off in the state of gas or vapour. Hence the odour that vegetable bodies emit during the whole time that they are running through the series of their changes. When the odour is very offensive or noxious, the spontaneous decomposition is called putrefaction; but when the odour is not offensive, or when any of the new compounds formed is applied to useful purposes, the spontaneous decomposition is called fermentation. The term is supposed by some to have originated from the intestine motion which is always perceptible while vegetable substances are fermenting; while by others it is derived from the heat which in these cases is always generated. It is now very often applied to all the spontaneous changes which vegetable bodies undergo, without regard to the products. By fermentation, then, are now meant all the spontaneous changes which take place in vegetable substances after they are separated from the living plant. See CHEMISTRY.

Fermentation never takes place unless vegetable substances contain a certain portion

of water, and unless they are exposed to a temperature at least above the freezing-point. When dry or freezing, many of them continue long without alteration. Hence we have an obvious method of preventing fermentation.

Sugar, gum, sarcocol, starch, indigo, wax, resins, camphor, caoutchouc, sandaracha, gum-resins, wood, and suber, though mixed with water, and placed in the most favourable temperature, shew scarcely any tendency to change their nature. Oils absorb oxygen from the atmosphere, but too slowly to produce any intestine motion. Tan, some of the acids, and extract, are gradually decomposed; the surface of the liquid becomes mouldy, and an insipid sediment falls to the bottom; and when the process has once begun, it proceeds with greater rapidity. Albumen and fibrina putrefy very quickly, but the products have not been ascertained; gluten gradually changes into a kind of cheese.

But it is when several of the vegetable principles are mixed together that the fermentation is most perceptible, and the change most remarkable. Thus when gluten is added to a solution of sugar in water, the liquid soon runs into vinegar, or in certain cases to alcohol and vinegar. When gluten is mixed with starch and water, alcohol and vinegar usually make their appearance; but the greatest part of the starch remains unaltered. It has been observed that certain substances are peculiarly efficacious in exciting fermentation in others. These substances have received the name of ferments.

But the phenomena of fermentation do not appear in their greatest perfection in our artificial mixtures of vegetable principles. Those complicated parts of plants in which various principles are already mixed by nature, especially the liquid parts, exhibit the finest specimens of it; such as the sap of trees, the juices of fruits, the decoctions of leaves, seeds, &c. It is from such natural mixtures that we obtain all the products of fermentation which mankind have applied to useful purposes; such as indigo, beer, bread, vinegar, wine, &c. We shall first treat of the fermentation which takes place during the making of bread; secondly, of the fermentation which produces intoxicating liquors; and thirdly, of the fermentation which produces vinegar. These are usually called the panary, vinous, and acetous fermentations.

FERMENTATION, *panary*. Simple as the manufacture of bread may appear to us who have been always accustomed to consider it as a common process, its discovery was probably the work of ages, and the result of the united efforts of men whose sagacity, had they lived in a more fortunate period of society, would have rendered them the rivals of Aristotle or of Newton.

The method of making bread similar to ours was known in the East at a very early period; but neither the precise time of the discovery, nor the name of the person who published it to the world, has been preserved. We are certain that the Jews were acquainted with it in the time of Moses, for in Exodus (ch. xii. 15.) we find a prohibition to use leavened bread during the celebration of the passover. It does not appear, however, to have been known to Abraham; for we hear, in his history, of cakes frequently, but nothing of leaven. Egypt, both from the nature of the soil and the early period at which it was civilized, bids fairest for the discovery of making bread. It can scarcely be doubted that the Jews learned the art from the Egyptians. The Greeks assure us, that they were taught the art of making bread by the god Pan. We learn from Homer that it was known during the Trojan war. The Romans were ignorant of the method of making bread till the year 580 after the building of Rome, or 200 years before the commencement of the Christian æra. Since that period the art has never been unknown in the south of Europe: but it made its way to the north very slowly; and even at present in many northern countries, fermented bread is but very seldom used.

The only substance well adapted for making loaf-bread, is wheaten flour, which is composed of three ingredients: namely, gluten, starch, and a sweet mucous matter, which possesses nearly the properties of sugar, and which is probably a mixture of sugar and mucilage. It is to the gluten that wheat-flour owes its superiority to every other as the basis of bread. Indeed there are only two other substances at present known of which loaf-bread can be made: these are rye and potatoes. The rye loaf is by no means so well raised as the wheat loaf; and potatoes will not make bread at all without particular management. Potatoes, previously boiled and reduced to a very fine tough paste by a rolling-pin, must be mixed with an equal weight of potatoe-starch. This mixture, baked in the usual way, makes a very white, well-raised, pleasant bread. We are indebted for the process to Mr. Parmentier. Barley-meal perhaps might be substituted for starch.

The baking of bread consists in mixing wheat-flour with water, and forming it into a paste. The average proportion of these is, two parts of water to three of flour. But this proportion varies considerably, according to the age and the quality of the flour. In general, the older and the better the flour is, the greater is the quantity of water required. If the paste, after being thus formed, is allowed to remain for some time, its ingredients gradually act upon each other, and the paste acquires new properties. It gets a disagreeable sour taste, and a quantity of gas (probably carbonic acid gas) is evolved. In short, the paste ferments. These changes do not take place without water: that liquid, therefore, is a necessary agent. The gluten is altered, and probably acts on the starch; for if we examine the paste after it has undergone fermentation, the gluten is no longer to be found. If paste, after standing for a sufficient time to ferment, is baked in the usual way, it forms a loaf full of eyes like our bread, but of a taste so sour and unpleasant, that it cannot be eaten. If a small quantity of this old paste, or leaven as it is called, is mixed with new-made paste, the whole begins to ferment in a short time; a quantity of gas is evolved; but the glutinous part of the flour renders the paste so tough, that the gas cannot escape; it therefore causes the paste to swell in every direction: and if it is now baked into loaves, the immense number of air-bubbles imprisoned in every part renders the bread quite full of eyes, and very light. If the precise quantity of leaven necessary to produce the fermentation, and no more, has been used, the bread is sufficiently light, and has no unpleasant taste; but if too much leaven is employed, the bread has necessarily a bad taste; if too little, the fermentation does not come on, and the bread is too compact and heavy. To make good bread with leaven, therefore, is difficult.

The antient Gauls had another method of fermenting bread. They formed their paste in the usual way; and, instead of leaven, mixed with it a little of the barm or yeast which collects on the surface of fermenting beer. This mixture produced as complete and as speedy a fermentation as leaven; and it had the great advantage of not being apt to spoil the taste of the bread. About the end of the 17th century, the bakers in Paris began to introduce this practice into their processes. The practice was discovered, and exclaimed against; the faculty of medicine, in 1688, declared it prejudicial to health; and it was not till after a long time that the bakers succeeded in convincing the public that bread baked with barm is superior to bread baked with leaven. In this country the bread has for these many years been fermented with barm.

With respect to the nature of the barm which produces these effects, Mr. Henry of Manchester has proved, by a number of very interesting experiments, that carbonic acid is capable of being employed in many cases with success as a substitute for barm. But the analysis of Mr. Westrum has demonstrated, that the barm which collects on the surface of beer is of a much more complicated nature. That celebrated chemist obtained from 15060 parts of good barm the following substances:

15	carbonic acid
10	acetic acid
45	malic acid
240	alcohol
120	extractive
240	mucilage
315	sugar
480	gluten
13595	water
15060.	

Besides 69 parts of lime, 13 potass, some sac-lactic acid, and traces of phosphoric acid and silica.

But all these ingredients are not essential to barm. Westrum ascertained that the extractive, mucilage, sugar, and malic acid, are incapable of producing fermentation; that barm, deprived of its gluten by filtration, loses the property of exciting fermentation in beer; that the gluten of wheat is capable alone of exciting a fermentation; and that gluten, mixed with a vegetable acid, answers all the purposes of a ferment. Hence it follows, that these bodies alone are essential to barm. But leaven is precisely such a compound.

After the bread has fermented, and is properly raised, it is put into the oven, which is previously heated, and allowed to remain till it is baked. The mean heat of an oven, as ascertained by Mr. Tillet, is 448. The bakers do not use a thermometer; but they judge that the oven has arrived at the proper heat when flour thrown on the floor of it becomes black very soon without taking fire. We see, from Tillet's experiment, that this happens at 448°.

When the bread is taken out of the oven, it is found to be lighter than when put in, as might naturally have been expected, from the evaporation of moisture which must have taken place at that temperature. Mr. Tillet, and the other commissioners who were appointed to examine this subject, in consequence of a petition from the bakers of Paris, found that a loaf, which weighed, before it was put into the oven, 4.625 lbs., after being taken out baked, weighed, at an average, only 3.813 lbs. or 0.812 lb. less than the paste. Consequently, 100 parts of paste lose, at an average, 17.34 parts, or somewhat more than one-fifth, by baking. They found, however, that this loss of weight was by no means uniform, even with respect to those loaves which were in the oven at the same time, of the same form, and in the same place, and which were put in and taken out at the same instant. The greatest difference, in these circumstances, amounted to :2889, or 7.5 parts in the hundred, which is about one-thirteenth of the whole. This difference is very considerable; and it is not easy to say to what it is owing. It is evident, that if the paste has not all the same degree of moisture, and if the barm is not accurately mixed through the whole, if the fermentation of the whole is not precisely the same, that these differences must take place. Now it is needless to observe how difficult it is to perform all this completely. The French commissioners found, as might indeed have been expected, that, other things being equal, the loss of weight sustained is proportional to the extent of surface of the loaf, and to the length of time that it remains in the oven; that is, the smaller the extent of the external surface, or, which is the same thing, the nearer the loaf approaches to a globular figure, the smaller is the loss of weight which it sustains; and the longer it continues in the oven, the greater is the loss of weight which it sustains. Thus a loaf which weighed exactly 4 lbs. when newly taken out of the oven, being replaced as soon as weighed, lost, in ten minutes, .125 lb. of its weight; and in ten minutes more it again lost .0625 lb.

Loaves are heaviest when just taken out of the oven; they gradually lose part of their weight, at least if not kept in a damp place, or wrapped round with a wet cloth. Thus Mr. Tillet found that a loaf of 4 lbs. after being kept for a week, wanted .3125, or nearly one-thirteenth, of its original weight.

When bread is newly taken out of the oven, it has a peculiar and rather pleasant smell, which it loses by keeping, unless its moisture is preserved by wrapping it round with a moist cloth, as it does also the peculiar taste by which new bread is distinguished. This shews us that the bread undergoes chemical changes; but what these changes are, or what the peculiar substance is to which the odour of bread is owing, is not known.

Bread differs very completely from the flour of which it is made, for none of the ingredients of the flour can now be discovered in it. The only chemist who has attempted an analysis of bread, is Mr. Geoffroy. He found that 100 parts of bread contained the following ingredients:

24.735 water
32.030 gelatinous matter, extracted by boiling water
39.843 residuum insoluble in water

96.608
3.392 loss

100.

FERMENTATION, *vinous*. Under this name are comprehended every species of fermentation which terminates in the formation of an intoxicating liquid. Now these liquids, though numerous, may all be comprehended under two heads; those obtained from the juices of plants, and those obtained from the decoctions of seeds. These two heads may be distinguished by the names of the most remarkable products belonging to each, viz. wine and beer. Let us take a view of each of these.

1. *Wine*.—There is a considerable number of ripe fruits from which a sweet liquor may be expressed, having at the same time a certain degree of acidity. Of such fruits we have in this country the apple, the cherry, the gooseberry, the currant, &c. but by far the most valuable of these fruits is the grape, which grows luxuriantly in the southern parts of Europe. From grapes fully ripe may be expressed a liquid of a sweet taste, to which the name of must has been given. This liquid is composed almost entirely of five ingredients, viz. water, sugar, jelly, gluten, and a mixed acid, partly saturated with potass. The quantity of sugar which grapes fully ripe contain is very considerable; it may be obtained in crystals, by evaporating must to the consistence of syrup, separating the tartar which precipitates during the evaporation, and then setting the must aside for some months. The crystals of sugar are gradually formed. From a French pint of must, the marquis de Bullion extracted half an ounce (French) of sugar, and $\frac{1}{10}$ ounce of tartar. According to Proust, the Muscadine grape contains about 30 per cent. of a peculiar species of sugar.

When must is put into the temperature of about 70°, the different ingredients begin to act upon each other, and what is called vinous fermentation commences. The phenomena of this fermentation are, an intestine motion in the liquid, it becomes thick and muddy, its temperature increases, and carbonic acid gas is evolved. In a few days the fermentation ceases, the thick part subsides to the bottom or rises to the surface, the liquid becomes clear, it has lost its saccharine taste and assumed a new one, its specific gravity is diminished; and, in short, it has become the liquid well known under the name of wine.

These changes are produced altogether by the mutual action of the substances contained in must; for they take place equally, and wine is formed equally well, in close vessels as in the open air.

If the must is evaporated to the consistency of a thick syrup, or to a rob, as the elder chemists termed it, the fermentation will not commence, though the proper temperature, and every thing else necessary to produce fermentation, should be present. But if this syrup is again diluted with water, and placed in favourable circumstances, it will ferment. The presence of water therefore is absolutely necessary for the existence of vinous fermentation. But, on the other hand, if the must is too much diluted with water, it either refuses to ferment altogether, or its fermentation is very languid.

If the juice of those fruits which contain but little sugar, as currants, is put into a favourable situation, fermentation indeed takes place, but so slowly, that the product is not wine but vinegar; but if a sufficient quantity of sugar is added to these very juices, wine is readily produced. No substance whatever can be made to undergo vinous fermentation, and to produce wine, unless sugar is present. Sugar therefore is absolutely necessary for the existence of vinous fermentation; and we are certain that it is decomposed during the process, for no sugar can be obtained from properly fermented wine. It has been sufficiently demonstrated by the experiments of Macquer, and the observations of Chaptal, that the strength of the wine is always proportional to the quantity of sugar contained in the must. From the experiments of Bullion we learn, that when must contains little sugar, the fermentation is rapid, but the product yields little alcohol. When the proportion of sugar is great, the fermentation is slow, but the product yields much alcohol.

All those juices of fruits which undergo the vinous fermentation, either with or without the addition of sugar, contain an acid. The apple, for instance, contains malic acid; the lemon, citric acid; the grape, tartaric and malic acids. The marquis de Bullion has ascertained that must will not ferment if all the tartar which it contains is separated from it, but it ferments perfectly well on restoring that salt. The same chemist ascertained, that the strength of wine is considerably increased by adding tartar and sugar to the must. We may conclude from these facts, that the presence of a vegetable acid is necessary for the commencement of the vinous fermentation. It deserves attention that Bullion obtained more tartar from verjuice than from wine; and he observed that the more the proportion of sugar in grapes increased, the more that of tartar diminished.

All the juices of fruits which undergo the vinous fermentation contain an extractive matter, composed of what Deyeux has called the sweet principle. This substance has not been examined with much precision; but it seems to consist of mucilage, gluten, and extract. Now the presence of this substance is also necessary for the commencement of fermentation. For sugar, though diluted with water, and mixed with a vegetable acid, refuses to ferment, unless some mucilaginous matter is added. Bullion found that sugar, tartar, and water, did not ferment; but on adding vine-leaves the fermentation became rapid. And Bergman found that sugar dissolved in four times its weight of water, and mixed with yeast, undergoes the vinous fermentation; and the experiment has been often repeated since. In both these cases the ferment appears to be gluten.

Thus we see, that for the production of wine, a certain temperature, a certain portion of water, sugar, a vegetable acid, and gluten, are necessary. M. Lavoisier found that sugar would not ferment unless dissolved in at least four times its weight of water.

This seems to indicate that the particles of sugar must be removed to a certain distance from each other before the other ingredients can decompose them.

When all these substances exist in must in proper proportions, the fermentation commences very speedily, provided the liquid is placed in a proper temperature; and its rapidity (other things remaining the same) is always proportioned to the quantity of liquid exposed at once to fermentation. The heat evolved is always proportioned to the rapidity of the process, and indeed may be looked upon as the great cause of that rapidity. According to Chaptal, the temperature during fermentation is never lower than 60°, and sometimes it is as high as 95.

During the fermentation, the quantity of sugar is constantly diminishing; and when the process is completed, the whole of the sugar is decomposed. The liquid has become more fluid, specifically lighter, and has acquired a vinous taste, owing to the formation of alcohol. Whether the other substances which constitute a part of the must have undergone any change, or whether they have merely contributed to the decomposition of the sugar, is not precisely known. The experiments of Lavoisier, to whom we are indebted for the first precise explanation of fermentation, render the second supposition most probable. From these experiments it follows that the sugar is divided into two portions; one portion separates in the form of carbonic acid, and the other, containing a great excess of hydrogen, remains under the form of alcohol. This alcohol is combined with the colouring matter, and with the acids of the wine, so intimately, that it can only be separated by distillation. The carbonic acid carries along with it a certain portion of alcohol, as was pointed out some time ago by Chaptal. The extractive matter separates, either precipitating to the bottom or swimming on the surface.

It seems more than probable, from the experiments of Bullion and Chaptal, that the tartaric acid is partly decomposed during the fermentation, and that a portion of malic acid is formed. The process, therefore, is more complicated than was suspected by Lavoisier. It is obviously analogous to combustion, as is evident from the evolution of caloric and the formation of carbonic acid, which is a product of combustion. Proust has ascertained, that during the fermentation not only carbonic acid, but azotic gas also, is disengaged. This is a demonstration, that all the constituents of must are concerned; for sugar does not contain that principle.

After the fermentation has ceased, the liquor is put into casks, where the remainder of the sugar is decomposed by a slow fermentation; after which the wine, decanted off from the extractive matter, is put up in bottles.

The properties of wine differ very much from each other, according to the nature of the grapes from which the must was extracted, and according to the manner in which the process was conducted. These differences are too well known to require a particular description. But all wines contain less or more of the following ingredients, not to mention water, which constitutes a very great proportion of every wine.

1. *An acid.*—All wines give a red colour to paper stained with turnsole, and of course contain an acid. Chaptal has ascertained that the acid found in greatest abundance in wine is the malic, but he found traces also of citric acid, and it is probable that wine is never entirely destitute of tartar. All wines which have the property of frothing when poured into a glass, contain also carbonic acid, to which they owe their briskness. This is the case with champaign. These wines are usually weak; their fermentation proceeds slowly, and they are put up in close vessels before it is over. Hence they retain the last portions of carbonic acid that have been evolved.

2. *Alcohol.*—All wine contains less or more of this principle, to which it is indebted for its strength; but in what particular state of combination it exists in wine, cannot be easily ascertained. It is undoubtedly intimately combined with the other component parts of wine; as Fabroni has shewn that it cannot be separated by saturating the wine with dry carbonat of potass, though a very small portion of alcohol, added on purpose to wine, may be easily separated by means of that salt. But as alcohol separates along with the carbonic acid during the fermentation, we can scarcely doubt that it has been formed. When wine is distilled, the alcohol readily separates. The distillation is usually continued as long as the liquid which comes over is inflammable. The quantity obtained varies according to the wine, from a fourth part to a fourteenth part of the wine distilled. The spirit thus obtained is well known under the name of brandy. Bullion has observed, that when wine is distilled new, it yields more alcohol than if it is allowed to get old. What remains after this distillation is distinguished in France by the name of vinasse. It consists of tartar, &c. and when evaporated to dryness, and subjected to combustion, yields potass.

3. *Extractive matter.*—This matter exists in all wines; but its proportion diminishes according to the age of the wine, as it gradually precipitates to the bottom.

4. Every wine is distinguished by a peculiar flavour and odour, which probably depend upon the presence of a volatile oil, so small in quantity that it cannot be separated.

5. The colouring matter of wine is originally contained in the husk of the grape, and is not dissolved till the alcohol is developed. This matter is analogous to the other colouring matters of plants; a set of bodies possessed of remarkable properties, but too little examined hitherto to be capable of a clear explanation. This colouring matter precipitates when the wine is exposed to the heat of the sun. It sometimes also precipitates in old wine, and it may be easily separated by pouring lime-water into wine.

If wine be exposed to the heat of the sun during the summer, the colouring matter is detached in a pellicle, which falls to the bottom: when the vessel is opened, the discolouring is more speedy, and it is effected in two or three days during the summer. The wine thus deprived of its colour is not perceptibly weakened.

The following table, containing the different substances which Neumann extracted from various wines, is worth preserving.

A quart of	Highly rectified spirit.	Thick, oily, unctuous, resinous matter.	Gummy and tartarous matter.	Water.
	oz.d.gr.	oz.dr.g.	oz.dr.gr.	lb.oz.dr.gr.
Aland	1 6 0	3 2 0	1 5 0	2 5 3 0
Alicant	3 6 0	6 0 20	0 1 40	2 2 6 0
Burgundy	2 2 0	0 4 0	0 1 40	2 9 0 20
Carcassone	2 6 0	0 4 10	0 1 20	2 8 4 30
Champagne	2 5 20	0 6 40	0 1 0	2 8 3 0
French	3 0 0	0 6 40	0 1 0	2 8 0 20
Frontignac	3 0 0	3 4 0	0 5 20	2 4 6 30
Vin grave	2 0 0	0 6 0	0 2 0	2 9 0 0
Hermitage	2 7 0	1 2 0	0 1 40	2 7 5 20
Madeira	2 3 0	3 2 0	2 0 0	2 4 3 0
Malmsey	1 0 0	4 3 0	2 3 0	2 1 2 0
Vino de monte	2 6 0	0 3 0	0 2 40	2 8 0 20
Pulciano				
Moselle	2 2 0	0 4 20	0 1 30	2 9 0 10
Muscadine	3 0 0	2 4 0	1 0 0	2 5 4 0
Neufchatel	3 2 0	4 0 0	1 7 0	2 2 7 0
Palm sec	2 3 0	2 4 0	4 4 0	2 2 5 0
Pontac	2 0 0	0 5 20	0 2 0	2 9 0 40
OldRhenish	2 0 0	1 0 0	2 20	2 8 5 40
Rhenish	2 2 0	0 3 20	0 1 34	2 9 1 6
Salamanca	3 0 0	3 4 0	2 0 0	2 3 4 0
Sherry	3 0 0	6 0 0	2 2 0	2 0 6 0
Spanish	1 2 0	2 4 0	9 4 0	1 10 6 0
Vino Tinto	3 0 0	6 4 0	1 6 0	2 0 6 0
Tokay	2 2 0	4 3 0	5 0 0	2 0 3 0
Tyrol red wine	1 4 0	1 2 0	0 4 0	2 8 6 0
Red wine	1 6 0	0 4 40	0 2 0	2 9 3 20
White	2 0 0	0 7 0	0 3 0	2 7 0 0

To this head belong not only common wine, but all the intoxicating liquors made from vegetable juices; as cyder from apples, perry from pears, currant wine, &c. likewise the liquor made from the juice of the sugar-cane, the sugar-mapple, &c.

II. *Beer.*—The method of making beer, though undoubtedly not so obvious as that of making wine, was, notwithstanding, known in the most remote ages. Whatever grain is employed, the process is nearly the same. The barley is steeped in water for about 60 hours, in order to saturate it with that liquid. (See MALTING.) It ought then to be removed as speedily as possible, otherwise the water dissolves and carries off the most valuable part of the grain. The barley is then to be laid in a heap for 24 hours; heat is evolved, oxygen gas absorbed, carbonic acid gas emitted, and germination commences with the shooting forth of the radicle. It is then spread upon a cool floor, dried slowly, and is afterwards known by the name of malt.

Malt, previously ground to a coarse powder, is to be infused in a sufficient quantity of pure water, of the temperature of 160° for an hour. The infusion is then to be drawn off, and more water may be added, at a higher temperature, till all the soluble part of the malt is extracted. This infusion is known by the name of wort. It has a sweet taste, and contains a quantity of saccharine, and doubtless also of gelatinous matter. See BREWING.

The wort is immediately conveyed to a boiler, where it is boiled with hops, or some other equivalent bitter. It is then put into large fermenting vats.

When wort is placed in the temperature of about 60°, fermentation gradually takes

place in it, and the very same phenomena appear which distinguish the production of wine. The fermentation of wort then, is nothing but a particular case of the vinous fermentation. But wort does not ferment so well, nor so soon, nor does it produce nearly so great a quantity of good fermented liquor, as when yeast is added to it. The reason of which is, probably, that the fermentation does not commence till an acid is generated in the wort, and before that happens part of the saccharine contents are decomposed; whereas the yeast adds an acid, or at least something equivalent to it, at once.

Wort ferments in close vessels, as Mr. Collier ascertained by experiment, equally well as in the open air. The decomposition, therefore, is produced entirely by the substances contained in the wort, without the addition of any thing from the air. The quantity of beer produced in close vessels is much greater than when the process takes place in the open air. The reason of which is, that in the open air the beer gradually evaporates during the fermentation. Thus Mr. Collier found that 11 quarts, 3½ oz. fermented in open vessels, lost in 12 days 40 oz. whereas an equal weight, fermented in close vessels, lost only 8 oz. in the same time. Yet the quality of the beer was the same in each; for equal quantities of both, when distilled, yielded precisely the same portion of alcohol.

During the fermentation a quantity of carbonic acid gas is constantly disengaged, not in a state of purity, but containing, combined with it, a portion of the wort; and if this gas is made to pass through water, it will depose wort, which may be fermented in the usual manner.

When beer is distilled, alcohol is obtained, and the residuum is an acid liquor, the nature of which is still unknown. The theory of beer is so obviously the same with that of wine, that it requires no additional explanation.

FERMENTATION, *acetous*. If wine or beer is kept in a temperature between 70° and 90°, it gradually becomes thick, its temperature augments, filaments are seen moving through it in every direction, and a kind of hissing noise may be distinguished. These intestine motions gradually disappear, the filaments attach themselves to the sides and bottom of the vessel, and the liquor becomes transparent. But it has now lost its former properties, and is converted into acetous acid. This intestine decomposition has been long distinguished by the name of acetous fermentation, because its product is acetic acid. That this fermentation may take place, certain conditions must be attended to. The most important of these will appear from the following observations:

1. Neither pure alcohol, nor alcohol diluted with water, is susceptible of this change. The weaker the wine or the beer is on which the experiment is made, the more readily is it converted into vinegar; the stronger they are, they resist the change with the greater obstinacy. But it results from the experiments of Beccher, that strong wines, when they are made to undergo the acetous fermentation, yield a much better and stronger vinegar than weak wines. Hence it follows that alcohol, though of itself it refuses to undergo the change, yet when other bodies are present which readily ferment, it is decomposed during the process, and contributes to the formation of the acetic acid.

2. Wine, entirely deprived of extractive matter either by spontaneous deposition or by clarification, does not undergo the acetous fermentation, unless some mucilaginous matter is mixed with it. Chaptal exposed old wine destitute of this matter, in open bottles, to the greatest summer-heat of Montpelier for 40 days, and yet it did not become sour; but upon adding some vine-leaves to the same wine, it became acid in a few days.

3. Wine never becomes sour, provided it is completely deprived of all access to atmospheric air. The reason is, that during the acetous fermentation, oxygen is absorbed from the atmosphere in abundance; and unless that absorption can take place, no vinegar is ever formed. Hence the reason that wine or beer is more apt to become sour after the cork has been drawn, and still more apt when part has been poured out of the bottle.

4. A pretty high temperature is necessary for the commencement of the acetous fermentation. Wine or beer (unless very weak) scarcely becomes sour under the temperature of 65° or 70°. The fermentation is very apt to commence when the temperature suddenly rises. Hence wine and beer are more apt to become sour at certain seasons of the year than at others.

5. When the acetous fermentation is completed, the whole of the malic acid originally contained in the wine has disappeared as well as the alcohol. We must conclude, therefore, that they have been both converted into acetic acid. Part of the extractive matter has also undergone the same change, and seems indeed to have been the substance that first began the absorption of oxygen. Part of it is deposited in the state of flakes; part remains in solution, and disposes the vinegar to decomposition. Vinegar also contains a little tartar, and probably also citric acid. Malic acid is also found in new vinegar; a proof that this part of the wine is the last to undergo the acetous fermentation.

6. Acetic acid is formed in many other cases of the decomposition of vegetables besides the acetous fermentation These have been pointed out with much ingenuity by Vauquelin and Fourcroy. They may be reduced under three heads: 1st. When sugar, gum, tartar, wood, &c. are distilled in a retort, or even burnt in the open fire, acetic acid separates in combination with an empyreumatic oil which distinguishes its odour. Hence it was mistaken for other acids, and distinguished by the names of pyromucous, pyrolignous, pyrotartarous acids, till its real nature was ascertained by these distinguished chemists. 2dly. When concentrated sulphuric acid is poured upon the same vegetable bodies, they are decomposed in a very different manner, being converted into water, charcoal, and acetic acid. 3dly. Acetic acid is evolved in considerable quantity during the spontaneous decomposition of urine, and some other animal substances. Thus it appears, that the component parts of this important acid are extremely apt to combine together in those proportions which constitute it.

FERMENTATION, *putrid*, as it has been termed by the old chemists, is that process which converts vegetable and animal matters into soil. It is, however, not fermentation, but a different process, wanting almost all the characteristics of fermentation, and therefore will be treated separately under the article PUTREFACTION.

FERN. See FILIX.

FERRARIA, a genus of the triandria order, in the gynandria class of plants, and in the natural method ranking under the sixth order, ensatæ. The spathæ are uniflorous; the petals six in number, and wavingly curled; the stigmata cucullated or cowled; the capsule is trilocular, inferior. There are two species, natives of the Cape of Good Hope and Mexico. There is a great singularity in the root of one these species, that it vegetates only every other year, and sometimes every third year; in the intermediate time it remains inactive, though very sound and good.

FERRET, in zoology. See MUSTELA.

FERRUGINOUS, any thing partaking of iron, or that contains particles of that metal. It is particularly applied to certain mineral springs, whose waters are impregnated with the particles of iron generally termed chalybeats. See MINERAL WATERS.

FERRY, is a liberty by prescription, or the king's grant, to have a boat for passage upon a river, for carriage of horses and men, for reasonable toll. Savil, 11 & 14. The owner of a ferry cannot suppress that ferry, and put up a bridge in its place, without a licence. Show. 243. 257.

FERRUM. See IRON, CHEMISTRY, &c.

FERULA, *fennel giant*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The fruit is oval, compressed plane, with three striæ on each side. There are nine species, all of them herbaceous perennials, rising from three to ten or twelve feet high, with yellow flowers. They are propagated by seeds, which should be sown in autumn, and when planted out, ought to be four or five feet distant from each other, or from any other plants; for no other will thrive under their shade. The drug assafetida is obtained from a species of ferula, though not peculiarly; being also produced by some other plants. See Plate Nat. Hist. fig. 206.

FERULA, in the antient Eastern church, signified a place separated from the church, wherein the audientes were kept, as not being allowed to enter the church; whence the name of the place, the persons therein being under penance or discipline. This word was sometimes used to denote the prelate's crozier or staff.

FESSE, in heraldry, one of the nine honourable ordinaries, consisting of a line drawn directly across the shield, from side to side, and containing the third part of it, between the honour-point and the nombril.

FESTI DIES, in Roman antiquity, certain days in the year devoted to the honour of the gods. Numa, when he distributed the year into twelve months, divided the same into the dies festi, dies profesti, and dies intercisi. The festi were again divided into days of sacrifices, banquets, games, and feriæ.

The profesti were those days allowed to men for the administration of their affairs, whether of a public or private nature; these were divided into fasti, comitiales, comperendini, stati, and præliares.

The intercisi were days common both to gods and men, some parts of which were allotted to the service of the one, and some to that of the other.

FESTINO, in logic, the third mood of the second figure of syllogism, the first proposition whereof is an universal negative, the second a particular affirmative, and the third a particular negative; as in the following example:

FES No bad man can be happy:
TI Some rich men are bad men;
NO *Ergo*, some rich men are not happy.

FEUD-BOTE, a recompence for being concerned in a feud or quarrel.

FEVER, *febris*, in medicine, a disease, or rather class of diseases, whose characteristic is a preternatural heat felt through the whole body, or at least the principal parts of it. See MEDICINE.

FIBRARIÆ, a class of fossils. See ASBESTOS.

FIBRE, in anatomy, a perfectly simple body, or at least as simple as any thing in the human structure, being fine and slender like a thread, and serving to form other parts Hence some fibres are hard, as the bony ones; and others soft, as those destined for the formation of all the other parts.

FIBRINA, is that substance which constitutes the fibrous part of the muscles of animals. If a quantity of blood, newly drawn from an animal, be allowed to remain at rest for some time, a thick red clot gradually forms in it, and subsides. Separate this clot from the rest of the blood, put it into a linen cloth, and wash it repeatedly in water till it ceases to give out any colour or taste to the liquid; the substance which remains after this process is denominated fibrina. It has been long known to physicians under the name of the fibrous part of the blood, but has not till lately been accurately described.

It may be procured also from the muscles of animals. Mr. Hatchett, to whom we are indebted for a very interesting set of experiments on this substance, cut a quantity of lean beef into small pieces, and macerated it in water for 15 days, changing the water every day, and subjecting the beef to pressure at the same time, in order to squeeze out the water. As the weather was cold, it gave no signs of putrefaction during this process. The shreds of muscle, which amounted to about three pounds, were now boiled for five hours every day for three weeks in six quarts of fresh water, which was regularly changed every day. The fibrous part was now pressed, and dried by the heat of a water-bath. After this treatment it might be considered as fibrina nearly as pure as it can be obtained.

Fibrina is of a white colour, has no taste nor smell, and is not soluble in water nor in alcohol. When newly extracted from blood, it is soft and elastic, and resembles very much the gluten of vegetables. Its colour deepens very much in drying. That which is extracted from muscle by boiling and maceration has a certain degree of transparency, and is not ductile but brittle. Its colour does not deepen nearly so much as the fibrina from blood.

It undergoes no change, though kept exposed to the action of air; neither does it alter speedily, though kept covered with water. Mr. Hatchett kept a quantity of the fibrina which he had prepared from beef moistened with water during the whole month of April; it acquired a musty but not a putrid smell, neither were the fibres reduced to a pulpy mass. Even when kept two months under water, it neither became putrid, nor was converted into the fatty matter obtained by macerating recent muscle.

When fibrina is exposed to heat, it contracts very suddenly, and moves like a bit of horn, exhaling at the same time the smell of burning feathers. In a stronger heat it melts. When exposed to destructive distillation, it yields water, carbonat of ammonia, a thick heavy fetid oil, traces of acetic acid, carbonic acid, and carbureted hydrogen gas. The charcoal, as Mr. Hatchett ascertained, is more copious than that left by gelatine or albumen. It is very difficult to incinerate, owing to the presence of phosphat of soda and some phosphat of lime, which form a glassy coat on the surface. A considerable proportion of carbonat of lime also remains after the incineration of the charcoal.

Acids dissolve fibrina with considerable facility. Sulphuric acid gives it a deep-brown colour, charcoal is precipitated, and acetic acid formed. Muriatic acid dissolves it, and forms with it a green-coloured jelly. The acetic, citric, oxalic, and tartaric acids, also dissolve it by the assistance of heat; and the solutions, when concentrated, assume the appearance of jelly. Alkalies precipitate the fibrina from acids in flakes, soluble in hot water, and resembling gelatine in its properties.

Diluted nitric acid occasions the separation of a considerable portion of azotic gas, as was first observed by Berthollet. Mr. Hatchett steeped a quantity of fibrina in nitric acid, diluted with thrice its weight of water, for 15days. The acid acquired a yellow tinge, and possessed all the properties of the nitric solution of albumen. The fibrina thus treated dissolved in boiling water, and when concentrated by evaporation, became a gelatinous mass, soluble in hot water, and precipitated by tan and nitromuriat of tin, and therefore possessing the properties of gelatine. Ammonia dissolves the greater part of the fibrina after it has been altered by nitric acid. The solution is of a deep orange-colour, similar to the solution of albumen treated in the same way. Boiling nitric acid dissolves fibrina, exept some fatty matter which swims on the surface. The solution resembles that of albumen; except that ammonia throws down a white precipitate, consisting chiefly of oxalat of lime. During the solution, prussic acid comes over, and carbonic acid gas mixed with nitrous gas; a considerable portion of oxalic acid is formed, besides the fatty matter which swims. It is probable that this last substance does not differ much from the substance formed by causing nitric acid to act upon the muscles of animals, which the French chemists have distinguished by the name of adipocire.

The alkalies, while diluted, have but little effect upon fibrina; but when concentrated potass or soda is boiled upon it, a complete solution is obtained of a deep-brown colour, possessing the properties of soap. During the solution, ammonia is disengaged. When the solution is saturated with muriatic acid, a precipitate is obtained similar to that from animal soap, except that it sooner becomes hard and soapy when exposed to the air.

The earths, as far as is known, have little or no action on fibrina. Neither has the action of the metallic oxides and salts been examined.

Fibrina is insoluble in alcohol, ether, and oils. The effect of other reagents on it has not been examined.

From the properties above detailed, fibrina appears to be composed of the same constituents as albumen and gelatine; but it probably contains more carbon and azote, and possibly less oxygen. The close resemblance which it bears to albumen is very obvious from the experiments of Mr. Hatchett just detailed. Nitric acid converts both into gelatine, and alkalies convert both into a species of oil. Now as all the soft parts of animals consist of combinations of these three genera, it follows, as Mr. Hatchett has observed, that all the soft parts of animals may be either converted into gelatine or animal soap, both substances of the highest importance.

Fibrina exists only in the blood and the muscles of animals; but it is a genus which includes as many species as there are varieties in the muscles of animals, and the great variety of these substances is well known. The muscles of fish, of fowl, and of quadrupeds, bear scarcely any resemblance to each other.

A substance exactly resembling the fibrina, as it exists in the blood, has been detected by Vauquelin in the juice of the papaw-tree; the same juice which contained albumen in such plenty. Fibrina then must be ranked among vegetable substances.

When the juice of the papaw is treated with water, the greatest part dissolves; but there remains a substance insoluble, which has a greasy appearance. It softens in the air, and becomes viscid, brown, and semitransparent. When thrown on burning coals it melted, let drops of grease exude, emitted the noise of meat roasting, and produced a smoke which had the odour of fat volatilized. It left behind it no residue. This substance was the fibrina. The resemblance between the juice of the papaw and animal matter is so close, that we should almost be tempted to suspect some imposition, was not the evidence that it is really the juice of a tree quite unexceptionable.

The properties of fibrina are the following:

1. It is tasteless, fibrous, elastic, and resembles gluten.
2. It is insoluble in water and in alcohol.
3. It is not dissolved by alkalies.
4. But acids dissolve it without difficulty.
5. With nitric acid it gives out much azotic gas.
6. When distilled it yields much carbonat of ammonia and oil.
7. It soon putrifies when kept moist, becomes green, but does not acquire any resemblance to cheese. See GLUTEN.

FIBROLETE, a mineral, first observed by Bournon, in the matrix of the imperfect corundum. Colour white or dirty grey; specific gravity 3.214; texture fibrous; cross fracture compact; internal lustre glossy; infusible by the blowpipe. Usually in shapeless fragments. It is composed of

58.25	alumina
38.00	silica
3.75	a trace of iron, and loss.
100.00	

FIBULA, in anatomy, the outer and smaller bone of the leg.

FICTION OF LAW, is allowed of in several cases; but it must be framed according to the rules of law; and there ought to be equity and possibility in every legal fiction.

Fictions were invented to avoid inconvenience; and it is a maxim invariably observed, that no fiction shall extend to work an injury, its proper operation being to prevent a mischief, or remedy an inconvenience, that might result from the general rule of law. 3 Black. 434.

All fictions of law are to certain respects and purposes, and extend only to certain persons; as the law supposes the vouchee to be tenant of the land, where in rei veritate he is not; but this is as to the demandant himself, and to enable him to do things as to the demandant, and which the demandant may do to him; and therefore a fine levied by vouchee to the demandant, or fine or release from the defendant to the vouchee, is good; but fine levied by the vouchee to a stranger, or lease made to him by a stranger, is void. 3 Rep. 29. See FINE, and RECOVERY.

FICUS, a genus of the triœcia order, in the polygamia class of plants, and in the natural method ranking under the 53d order, scabridæ. The receptacle is common, turbinated, carnous, and connivent; inclosing the florets either in the same or in a distinct one. The male calyx is tripartite; no corolla; three stamina: the female calyx is quinquepartite; no corolla; one pistil; and one seed. There are 56 species, of which the following are the most remarkable.

1. Ficus indica, or banian-tree, is a native of several parts of the East Indies. It has a woody stem, branching to a great height and vast extent, with heart-shaped entire leaves ending in acute points. This tree is beautifully described by Milton in Paradise Lost, book ix. l. 1100.

Indeed the banian-tree, or Indian fig, is perhaps the most beautiful of nature's productions in that genial climate, where she sports with so much profusion and variety. Some of these trees are of amazing size and great extent, as they are continually increasing, and, contrary to most other things in animal and vegetable life, seem to be exempted from decay. Every branch from the main body throws out its own roots; at first, in small tender fibres, several yards from the ground: these continually grow thicker until they reach the surface; and there striking in, they increase to large trunks, and become parent trees, shooting out new branches from the top: these in time suspend their roots, which, swelling into trunks, produce other branches; thus continuing in a state of progression as long as the earth, the first parent of them all, contributes her sustenance. The Hindoos are peculiarly fond of the banian-tree; they look upon it as an emblem of the Deity, from its long duration, its out-stretching arms, and overshadowing beneficence; they almost pay it divine honours, and

"Find a fane in every sacred grove."

Near these trees the most esteemed pagodas are generally erected; under their shade the Brahmins spend their lives in religious solitude; and the natives of all casts and tribes are fond of recreating in the cool recesses, beautiful walks, and lovely vistas of this umbrageous canopy, impervious to the hottest beams of a tropical sun.

A remarkable large tree of this kind grows on an island in the river Nerbedda, ten miles from the city of Baroche, in the province of Guzerat, a flourishing settlement lately in possession of the East India company, but ceded by the government of Bengal, at the treaty of peace concluded with the Mahrattas in 1783, to Mahdajee Scindia, a Mahratta chief. It is distinguished by the name of Cubbeer Burr, which was given it in honour of a famous saint. It was once much larger than at present; but high floods have carried away the banks of the island where it grows, and with them such parts of the tree as had thus far extended their roots; yet what remains is about 2000 feet in circumference, measured round the principal stems; the overhanging branches, not yet struck down, cover a much larger space. The chief trunks of this single tree (which in size greatly exceed our English elms and oaks) amount to 350; the smaller stems, forming into stronger supporters, are more than 3000; and every one of these is casting out new branches, and hanging roots, in time to form trunks, and become the parents of a future progeny. Cubbeer Burr is famed throughout Hindostan for its great extent and surpassing beauty: the Indian armies generally encamp around it, and at stated seasons, solemn jatarras, or Hindoo festivals, are held there, to which thousands of votaries repair from various parts of the Mogul empire. It is said that 7000 persons find ample room to repose under its shade. The English gentlemen, on their hunting and shooting parties, used to form extensive encampments, and spend weeks together under this delightful pavilion; which is generally filled with green wood-pigeons, doves, peacocks, and a variety of feathered songsters; crowded with families of monkeys performing their antic tricks, and shaded by bats of a large size, many of them measuring upwards of six feet from the extremity of one wing to the other. This tree not only affords shelter, but sustenance, to all its inhabitants, being covered amidst its bright foliage with small figs of a rich scarlet, on which they all regale with as much delight as the lords of creation on their more various and costly fare.

2. The sycamorus, or sycamore of scripture. According to Mr. Hasselquist, this is a huge tree, the stem being often 50 feet round. The fruit is pierced in a remarkable manner by an insect. There is an opening made in the calyx near the time the fruit ripens, which is occasioned in two different ways: 1. When the squamæ, which cover the calyx, wither and are bent back, which, however, is more common to the carica than the sycamore. 2. A little below the scales, on the side of the flower-cup, there appears a spot before the fruit is ripe; the fruit in this place is affected with a gangrene which extends on every side, and frequently occupies a finger's breadth. It withers; the place affected becomes black; the fleshy substance in the middle of the calyx, for the breadth of a quill, is corroded; and the male blossoms, which are nearest to the bare side, appear naked, opening a way for the insect, which makes several furrows in the inside of the fruit, but never touches the stigmata, though it frequently eats the germen. The wounded or gangrenous part is at first covered or shut up by the blossoms; but the hole is by degrees opened and enlarged of various sizes in the different fruits; the margin and sides being always gangrenous, black, hard, and turned inwardly. The same gangrenous appearance is also found near the squamæ, after the insect has made a hole in that place. The tree is very common in the plains and fields of Lower Egypt. It buds in the end of March, and the fruit ripens in the beginning of June. It is wounded or cut by the inhabitants at the time it buds; for without this precaution they say it would not bear fruit.

3. The carica, or common fig, with an upright stem branching 15 or 20 feet high, with large palmated or hand-shaped leaves. Of this there are a number of varieties; as the common fig, a large, oblong, dark purplish-blue fruit, which ripens in August either on standards or walls, and the tree carries a great quantity of fruit. The brown or chesnut fig; a large, globular, chesnut-coloured fruit, having a purplish delicious pulp, ripening in July and August. The black Ischia fig; a middle-sized, shortish, flat-crowned, blackish fruit, having a bright pulp, ripening in the middle of August. The green Ischia fig; a large, oblong, globular-headed, greenish fruit, slightly stained by the pulp to a reddish-brown colour, ripens in the end of August. The brown Ischia fig; a small, pyramidal, brownish-yellow fruit, having a purplish very rich pulp, ripening in August and September. The Malta fig; a small flat-topped brown fruit, ripening in the middle of August or beginning of September. The round brown Naples fig; a globular, middle-sized, light-brown fruit, and brownish pulp, ripe by the end of August. The long brown Naples fig; a long dark-brown fruit, having a reddish pulp, ripe in September. The great blue fig; a large blue fruit, having a fine red pulp. The black Genoa fig; a large, pear-shaped, black-coloured fruit, with a bright red pulp, ripe in August.

Culture.—The last species is that most frequently cultivated in this country, and the only one which does not require to be kept in a stove. It may be propagated either by suckers arising from the roots, by layers, or by cuttings. The suckers are to be taken off as low down as possible; trim off any ragged part at bottom, leaving the tops entire, especially if for standards, and plant them in nursery lines at two or three feet distance from each other, or they may at once be planted where they are to remain, observing, that if they are designed for walls or espaliers, they may be headed to six or eight inches in March, the more effectually to force out lateral shoots near the bottom; but if intended for standards, they must not be topped, but trained with a stem, not less than 15 or 18 inches for dwarf-standards, a yard for half-standards, and four, five, or six, feet for full standards. They must then be suffered to branch out to form a head; observing that whether against walls, espaliers, or standards, the branches or shoots must never be shortened, unless to procure a necessary supply of wood: for the fruit is always produced on the upper parts of the young shoots; and if these are cut off, no fruit can be expected. The best season for propagating these trees by layers is in autumn; but it may be also

done any time from October to March or April. Choose the young pliable lower shoots from the fruitful branches; lay them in the usual way, covering the body of the layers three or four inches deep in the ground, keeping the top entire, and as upright as possible, and they will be rooted and fit to separate from the parent in autumn; when they may be planted either in the nursery, or where they are to remain, managing them as above directed. The time for propagating by cuttings is either in autumn at the fall of the leaf, or any time in March. Choose well-ripened shoots of the preceding summer, short, and of robust growth, from about 12 to 15 inches long, having an inch or two of the two-years wood at their base, the tops left entire, and plant them six or eight inches deep, in a bed or border of good earth, in rows two feet asunder; and when planted in autumn, it will be eligible to protect their tops in time of hard frost, the first winter, with any kind of long loose litter.

That part of the history of the fig-tree, which for many ages was so enigmatical, namely, the caprification, as it is called, is particularly worthy of attention, not only as a singular phænomenon in itself, but as it has furnished one of the most convincing proofs of the reality of the sexes in plants. In brief it is this: the flowers of the fig-tree are situated within a pulpy receptacle, which we call the fig or fruit; of these receptacles, in the wild fig-tree, some have male flowers only, and others have male and female, both distinct, though placed in the same receptacle. In the cultivated fig, these are found to contain only female flowers, which are fecundated by means of a kind of gnat bred in the fruit of the wild fig-trees, which pierces that of the cultivated, in order to deposit its eggs within; at the same time diffusing within the receptacle the farina of the male flowers. Without this operation the fruit may ripen, but no effective seeds are produced. Hence the garden fig can only be propagated by layers and cuttings in those countries where the wild fig is not known. The process of thus ripening the fruit, in the Oriental countries, is not left to nature, but is managed with great art, and different degrees of dexterity, so as to reward the skilful husbandman with a much larger increase of fruit than would otherwise be produced. A tree of the same size which in Provence, where caprification is not practised, may produce about 25 pounds of fruit, will by that art, in the Grecian islands, bring ten times that quantity.

Figs are a considerable article in the materia medica, chiefly employed in emollient cataplasms and pectoral decoctions. The best are those which come from Turkey. Many are also brought from the south of France, where they prepare them in the following manner. The fruit is first dipped in scalding-hot ley made of the ashes of the fig-tree, and then dried in the sun. Hence these figs stick to the hands, and scour them like lixivial salts; and for the same reason they purge gently, without griping. They are moderately nutrimental, grateful to the stomach, and easier to digest than any other of the sweet fruits. They have been said to produce lice when eaten as a common food; but this seems to be entirely without foundation. The reason of this supposition seems to be, that in the countries where they grow naturally, they make the principal food of the poor people, who are generally troubled with these vermin. The wood of the sycamore is not subject to rot, and has therefore been used for making coffins in which embalmed bodies were put. Mr. Hasselquist affirms, that he saw in Egypt coffins made of this kind of wood, which had been preserved sound for 2000 years.

FIDD, in the sea-language, an iron or wooden pin, to splice and fasten ropes together. It is made taperwise, and sharp at one end. The pin in the heel of the top-mast, which bears upon the chesse-trees, is likewise called a fidd.

FIELD, in heraldry, is the whole surface of the shield, or the continent, so called because it contains those achievements antiently acquired in the field of battle. It is the ground on which the colours, bearings, metal, furs, charges, &c. are represented. Among the modern heralds, field is less frequently used in blazoning than shield or escutcheon.

FIELD-BOOK, in surveying, that in which the angles, stations, distances, &c. are set down. See SURVEYING.

FIELD-COLOURS, in war, are small flags of about a foot and a half square, which are carried along with the quarter-masters general, for marking out the ground for the squadrons and battalions.

FIELD-FARE. See TURDUS.

FIELD-PIECES, small cannons, from three to twelve pounders, carried along with an army in the field.

FIELD-STAFF, a weapon carried by the gunners, about the length of a halbert, with a spear at the end, having on each side ears screwed on, like the cock of a matchlock, where the gunners screw in lighted matches, when they are upon command; and then the field-staffs are said to be armed.

FIELD-WORKS, in fortification, are those thrown up by an army in besieging a fortress, or by the besieged to defend the place. Such are the fortifications of camps, highways, &c.

FIERI FACIAS, a writ judicial, that lies at all times within the year and day for him who has recovered in an action of debt or damages, to the sheriff, to command him to levy the debt or damages of his goods against whom the recovery was had. Upon a fieri facias, the sheriff cannot deliver the defendant's goods to the plaintiff in satisfaction of his debt; nor ought he to deliver them to the defendant against whom execution is; but the goods are to be sold, and in strictness, the money is to be brought into court. Cro. Eliz. 504.

If the defendant dies after the execution awarded, and before it is served, yet it may be served upon his goods in the hands of his executor or administrator; for if the execution is awarded, the goods are bound, and the sheriff need not take notice of his death. 1 Mod. 188. And upon a fieri facias, the sheriff may take any thing but wearing clothes. Cumb. 356.

FIFE, or *Fiffario*. A shrill wind-instrument of the martial kind, consisting of a short narrow tube, with holes disposed along the side, for the regulation of its tones. It is not blown at the end, but at the side, like a German flute.

FIFTEENTH, an antient tribute or tax laid upon cities, boroughs, &c. throughout all England, and so termed because it amounted to a fifteenth part of what each city or town had been valued at; or it was a fifteenth of every man's personal estate according to a reasonable valuation. In Doomsday-book, there are certain rates mentioned for levying this tribute yearly. The present property-tax seems a revival of this antient system.

FIFTEENTH, in music, the appellation given to a certain stop in the organ. See STOP.

FIFTEENTH, an interval consisting of two octaves.

FIFTH, in music, a distance comprising four diatonic intervals, *i. e.* three tones and a half. The fifth is the second of the consonances in the order of their generation.

FIFTH, *sharp*. The sharp fifth is an interval consisting of eight semitones.

FIG. See FICUS.

FIGURATE *numbers*, such as do or may represent some geometrical figure, in relation to which they are always considered: as triangular, pentagonal, pyramidal, &c. numbers.

Figurate numbers are distinguished into orders, according to their place in the scale of their generation, being all produced one from another, viz. by adding continually the terms of any one, the successive sums are the terms of the next order, beginning from the first order, which is that of equal units 1, 1, 1, 1, &c.; then the 2d order consists of the successive sums of those of the first order, forming the arithmetical progression 1, 2, 3, 4, &c.; those of the 3d order the successive sums of those of the 2d, and are the triangular numbers 1, 3, 6, 10, 15, &c.; those of the 4th order are the successive sums of those of the 3d, and are the pyramidal numbers 1, 4, 10, 20, 35, &c.; and so on, as below.

Order.	Name.	Numbers.
1.	Equals,	1, 1, 1, 1, 1, &c.
2.	Arithmeticals,	1, 2, 3, 4, 5, &c.
3.	Triangulars,	1, 3, 6, 10, 15, &c.
4.	Pyramidals,	1, 4, 10, 20, 35, &c.
5.	2d Pyramidals,	1, 5, 15, 35, 70, &c.
6.	3d Pyramidals,	1, 6, 21, 56, 126, &c.
7.	4th Pyramidals,	1, 7, 28, 84, 210, &c.

The above are all considered as different sorts of triangular numbers, being formed from an arithmetical progression, whose common difference is 1. But if that common difference is 2, the successive sums will be the series of square numbers; if it be 3, the series will be pentagonal numbers, or pentagons; if it be 4, the series will be hexagonal numbers, or hexagons, and so on. Thus:

Arithmetical.	1st Sums or polygons.	2d Sums, or 2d Polygons
1, 2, 3, 4,	Tri. 1, 3, 6, 10	1, 4, 10, 20
1, 3, 5, 7,	Sqrs. 1, 4, 2, 16	1, 5, 14, 30
1, 4, 7, 10,	Pent. 1, 5, 12, 22	1, 6, 18, 40
1, 5, 9, 13, &c.	Hex. 1, 6, 15, 28	1, 7, 22, 50

And the reason of the names triangles, squares, pentagons, hexagons, &c. is, that those numbers may be placed in the form of these regular figures or polygons.

FIGURE, in conic sections, according to Apollonius, is the rectangle made under the latus rectum and transversum in the hyperbola and ellipsis.

FIGURE of the diameter; the rectangle under any diameter, and its proper parameter,

is, in the ellipsis and hyperbola, called the figure of that diameter.

FIGURE, in fortification, the plan of any fortified place, or the interior polygon, which, when the sides and angles are equal, is called a regular, and when unequal, an irregular figure.

FIGURE, in geometry: the superficies included between one or more lines, is denominated either rectilinear, curvilinear, or mixt, according as the extremities are bounded by right lines, curve lines, or both.

FIGURE, in grammar, a deviation from the natural rules of etymology, syntax, and prosody, either for brevity, elegance, or harmony.

FIGURE, in logic, denotes a certain order and disposition of the middle term in any syllogism.

Figures are fourfold: 1. When the middle term is the subject of the major proposition, and the predicate of the minor, we have what is called the first figure. 2. When the middle term is the predicate of both the premises, the syllogism is said to be in the second figure. 3. If the middle term is the subject of the two premises, the syllogism is in the third figure; and lastly, by making it the predicate of the major, and subject of the minor, we obtain syllogisms in the fourth figure. Each of these figures has a determinate number of moods, including all the possible ways in which propositions differing in quantity or quality can be combined, according to any disposition of the middle term, in order to arrive at a just conclusion.

FIGURE, in painting and designing, denotes the lines and colours which form the representation of any animal, but more particularly of a human personage. Thus a painting is said to be full of figures when there are abundance of representations of men; and a landscape is said to be without figures when there is nothing but trees, plants, mountains, &c. See PAINTING.

FIGURE, in rhetoric, is a manner of speaking different from the ordinary and plain mode, and more emphatical, expressing a passion, or containing a beauty. See RHETORIC.

FIGURED, in music, a term applied to that descendant, which, instead of moving note by note with the bass, consists of a free and florid melody. A bass, accompanied with numerical characters, denoting the harmony formed by the upper or superior parts of the composition, and directing the chords to be played by the organ, harpsichord, or pianoforte, is called a figured bass.

FIGURES: figures are not allowed to express numbers in indictments, but numbers must be expressed in words. Cro. Car. 109.

Roman figures are good in pleading, but otherwise of English figures. 2 Lev. 102.

FILACER, FILIZER, or FILAUR, an officer of the court of common-pleas, so called because he files those writs whereon he makes out process. There are fourteen of them in their several divisions and counties, and they make out all writs and processes upon original writs, issuing out of chancery, as well in real, as in psrsonal and mixed actions; and in actions merely personal, where the defendants are returned summoned, they make out pones and attachments, which being returned and executed, if the defendant appears not, they make forth a distringas, and so ad infinitum, or until he does appear; if he is returned nihil, then process of capias infinite, &c. They enter all appearances and special bails, upon any process made by them. They make the first scire facias upon special bail, writs of habeas corpus, distringas, nuper vicecomitem vel ballivum, and duces tecum, and all supersedeas upon special bail or otherwise; writs of habeas corpus cum causa, upon the sheriff's return, that the defendant is retained with other actions; writs of adjournment of a term, in case of pestilence, war, or public disturbance.

FILAGO, a genus of the polygamia necessaria order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; there is no pappus; the calyx is imbricated; the female florets placed among the scales of the calyx. There are seven species, commonly known by the name of cudweed, natives of most parts of Europe, herbaceous, most of them annual.

FILAMENT. See BOTANY.

FILAMENTS, *vegetable*, form a substance of great use in the arts and manufactures; furnishing thread, cloth, cordage, &c. For these purposes the filamentous parts of the cannabis and linum, or hemp and flax, are employed among us. But different vegetables have been employed in different countries for the same uses. Putrefaction destroys the pulpy or fleshy matter, and leaves the tough filaments entire; by curiously macerating the leaf of a plant in water, we obtain the fine flexible fibres which constituted the basis of the ribs and minute veins, and which now form a skeleton of the leaf.

The sieur de Flacourt, in his History of Madagascar, relates, that different kinds of cloth are prepared in that island from the filaments of the bark of certain trees boiled in strong lye; that some of these cloths are very fine, and approach to the softness of silk, but in durability come short of cotton; that others are coarser and stronger, and last thrice as long as cotton; and that of these the sails and cordage of his vessel were made.

The same author informs us, that the stalks of nettles are used for the like purposes in France. And sir Hans Sloane relates, in one of his letters to Mr. Ray, that he has been informed by several, that muslin and callico, and most of the Indian linens, are occasionally made from nettles.

In some of the Swedish provinces, a strong kind of cloth is said to be prepared from hop-stalks; and in the Transactions of the Swedish academy for the year 1750, there is an account of an experiment made in consequence of that report. Of the stalks, gathered in autumn, about as many were taken, as equalled in bulk a quantity of flax that would have produced a pound after preparation. The stalks were put into water, and kept covered with it during the winter. In March they were taken out, dried in a stove, and dressed as flax. The prepared filaments weighed nearly a pound, and proved fine, soft, and white: they were spun and woven into six ells of fine strong cloth. The author, Mr. Shisler, observes, that hop-stalks take much longer time to rot than flax; and that if not fully rotted, the woody part will not separate, and the cloth will neither prove white nor fine.

Hemp, flax, and all other vegetable filaments, and thread or cloth prepared from them, differ remarkably from wool, hair, silk, and other animal productions, not only in the principles into which they are resoluble by fire, but likewise in some of their more interesting properties, particularly in their disposition to imbibe colouring matters; many liquors, which give a beautiful and durable dye to those of the animal, giving no stain at all to those of the vegetable kingdom.

Fishing-nets are usually boiled with oak-bark, or other such astringents, which render them more lasting. Those made of flax receive from this decoction a brownish colour, which, by the repeated alternations of water and air, is in a little time discharged, whilst the fine glossy brown, communicated by the same means to silken nets, permanently resists both the air and water, and lasts as long as the animal filaments themselves. In like manner the stam of ink, or the black dye from solutions of iron, mixed with vegetable astringents, proves durable in silk and woollen; but from linen the astringent matter is extracted by washing, and only the yellow iron-mould remains.

Many other instances of this kind are known too well to the callico-printer, whose grand desideratum it is to find means of making the fibres of cotton receive the same colours that wool does. See CALLICO-PRINTING.

FILARIA, a genus of insects of the order intestina; body round, filiform, equal, and quite smooth; mouth dilated, with a roundish concave lip. There are several species, some infesting the mammalia, others infesting birds, others infesting insects in their perfect state, and some infesting the larvæ of insects. The medinensis is the most remarkable species; it inhabits the Indies, and is frequent in the morning dew, whence it enters the naked feet of the slaves, and creates the most troublesome itchings, accompanied with inflammation and fever. It must be cautiously drawn out by means of a piece of silk tied round its head, for if the animal should break, the remaining part grows with redoubled vigour, and is often fatal. It is frequently 12 feet long, and not larger than a horsehair.

FILBERT, or FILBERD. See CORYLUS.

FILE, among mechanics, a tool used in metal, &c. in order to smooth, polish, or cut.

This instrument is of iron, or forged steel, cut in little furrows, with chisels, and a mallet, in a certain direction, and of a certain depth, according to the grain or touch required. After cutting the file, it must be tempered with a composition of chimney soot, very hard and dry, diluted, and wrought up with urine, vinegar, and salt; the whole being reduced to the consistence of mustard. Tempering the files consists in rubbing them over with this composition, and covering them in loam; after which they are put into a charcoal fire, and taken out by the time they have acquired a cherry-colour, which is known by a small rod of the same steel put in along with them. Being taken out of the fire, they are thrown into cold spring-water, and when cold, they are cleaned with charcoal and a rag, and being clean and dry, are kept from rust by laying them up in wheat bran. Iron files require more heating than

steel ones. Files are of different forms, sizes, cuts, and degrees of fineness, according to the different uses and occasions for which they are made. Those in common use are the square, flat, triangular, half-round, round, thin file, &c. each of which may be of different sizes, as well as different cuts.

The rough or coarse-toothed files are to take off the unevenness of the work which the hammer made in the forging; and the fine-toothed files are to take out of the work the deep cuts or file strokes of the rough files; the files succeed one another in this order, first the rubber, then the bastard-toothed file, next the fine-toothed file, and lastly the smooth file. Thus the files of different cuts succeed one another, till the work is as smooth as it can be filed; after which it may be made still smoother, by emery, tripoli, &c. In using all sorts of files, the rule is to lean heavy on the file in thrusting it forward, because the teeth of the files are made to cut forward; but in drawing the file back again for a second stroke, it is to be lightly lifted just above the work, as it does not cut in coming back.

There are several machines invented for cutting files, by which a blind man may cut a file with more exactness than can be done in the usual method with the keenest sight. These machines may be worked by water as readily as by hand, and are adapted to cut coarse or fine, large or small, files, or any number at a time. Mr. Nicholson, a few years since, obtained a patent for machinery for the manufacture of files; which consists, 1. Of a carriage in which the file is fixed and moved along, for the purpose of receiving the successive strokes of a cutter or chisel. 2. The anvil by which the file is supported beneath the part which receives the stroke. 3. The regulating gear by which the distance between stroke and stroke is determined and governed: and 4. The apparatus for giving the stroke or cut. The four several parts aforesaid are supported by a frame of solid workmanship, either of wood or metal, or both, according to the nature of the work to be performed.

The action of this machinery is thus described: 1. The file, being prepared as usual for cutting, must be fixed in the clip of the carriage, and the sliding block brought up and fixed, to steady the other extremity. 2. The nut of the screw being then opened, the carriage is slided to its place, so that the chisel may be situated over that part of the file which is to receive the first stroke. 3. The nut is then closed, and the small roller of the pressing lever is made to bear upon the face of the file. 4. The first mover being then put into action, raises and lets fall the apparatus for giving the stroke by which the file receives a cut. 5. Immediately afterwards, or during the same action, as the case may be, the regulating gear moves the carriage, and consequently the file, through a certain space. 6. This cut is then again given, and in this manner the file becomes cut throughout. The file is then taken out and cut on the other side; the bur is taken off, or not, as the artist judges fit, and the cross strokes are given over the surfaces as before. This machinery, by means of certain slight alterations, is adapted to the manufacture of all descriptions of files, whether floats, rasps, or those of any figure and denomination.

FILE, in the art of war, a row of soldiers standing one behind another, which is the depth of the battalion, or squadron. The files of a battalion of foot are generally three deep, as are sometimes those of a squadron of horse. The files must be straight, and parallel one to another.

FILE, in law, is a record of the court; and the filing of a process of court, makes a record of it. Lill. 212.

FILIX, an order of the cryptogamia class of plants, comprehending the fern, horse-tail, adder's-tongue, maiden-hair, spleen-wort, polypody, &c.

FILUM, *in music* (Lat.), the name formerly given to the line drawn from the head of a note upwards or downwards, and which is now called the tail.

FILLET, in heraldry, a kind of bordure, containing only a third or fourth part of the breadth of the common bordure. It is supposed to be withdrawn inwards, and is of a different colour from the field. It runs quite round, near the edge, as a lace over a cloak. It is also used for an ordinary drawn like a bar, from the sinister point of the chief, across the shield, in manner of a scarf; though it sometimes is also seen in the situation of a bend, fesse, cross, &c.

FILTER, or FILTRE, in chemistry, a strainer commonly made of bibulous or filtring paper in the form of a funnel, through which any fluid is passed, in order to separate the gross particles from it, and render it limpid.

FILTERING paper, is paper without size. To use it as such, the paper is shaped into the form of a cone, and placed in a funnel, in order to support it; otherwise it would break.

FILTERING stones, basons, &c. are either natural or artificial, for the purpose of purifying water. Natural filtres are found in rocks, mountains, beds of sand, gravel, &c. Artificial filtering-basons consist of equal parts of pipe-clay, and coarse sand. They should be three-quarters of an inch thick.

FILTRATION, is a finer species of sifting. It is sifting through the pores of paper, or flannel, or fine linen, or sand, or pounded glass, or porous stones, and the like; but it is used only for separating fluids from solids or particles, that may happen to be suspended in them, and not chemically combined with the fluids. Thus salt water cannot be deprived of its salt by filtration, but muddy water may be cleansed by it. No solid, even in the form of powder, will pass through filtering substances. If water or any other fluid containing sand, insects, &c. is placed in a bag or hollow vessel, made of any of those substances, the sand, &c. will remain upon the filtre, and the liquor will pass clear through it, and may be received in a vessel placed under it.

Mr. Peacock obtained, about twelve years since, a patent for a new species of filtration, by means of gravel of different sizes suitable to the several strata. The various sizes of the particles of gravel, as placed in layers, should be nearly in the quadruple ratio of their surfaces; that is, upon the first layer, a second is to be placed, the diameters of whose particles are not to be less than one-half of the first, and so on in this proportion. This arrangement of filtring particles will gradually fine the water by the grosser particles being quite intercepted in their partly ascending with the water. An advantage in these filtres is, that they may be readily cleansed by drawing out the body of the fluid, by which it will descend in the filtre, and carry with it all the foul and extraneous substances.

FIMBRIÆ, denotes appendages disposed by way of fringe round the border of any thing.

FIN, in natural history, a well-known part of fishes, consisting of a membrane supported by rays, or little bony or cartilaginous ossicles. The number, situation, and figure of fins, are different in different fishes. As to number, they are found from one to ten, or more; with respect to situation, they stand either on the back only, the belly only, or on both; and as to figure, they are either of a triangular, roundish, or oblong-square form. Add to this, that in some they are very small; whereas, in others, they almost equal the whole body in length.

FINAL, *in music*, an old appellation given to the last sound of a verse in a chant; which, if complete, is on the key note; if incomplete, on some other note of the key.

FINAL LETTERS, among Hebrew grammarians, five letters so called, because they have a different figure at the end of words from what they have in any other situation.

FINALE (Ital.), a word signifying the last composition performed in any act of an opera, or part of a concert.

FINANCE, the œconomy of the public revenue and expenditure of nations. In former times, when the whole revenue drawn from the people by a few moderate and long-established taxes, was considered as the personal property of the sovereign, the purposes to which it was applied depended entirely on his discretion or that of his minister, as few princes were inclined in time of peace to reserve any part of their income as a provision for the additional expences of war; the extraordinary charges incurred in times of hostility were defrayed by extraordinary contributions from the people, which ceased with the occasion of them. Few sovereigns possessed sufficient credit either with their own subjects or foreigners to contract debts, so that at the conclusion of a war there was no occasion for a greater expenditure than before its commencement, and the revenue drawn from the people reverted to its former state. It is the system of defraying extraordinary expences by borrowing the money, for which an annual interest must be paid; and of suffering the debts thus incurred to accumulate, by which the sum to be annually paid is continually increasing, and the expences of every war are rendered far greater than those which preceded it; that has swelled the revenue and expenditure of most of the nations of Europe to an enormous magnitude, and caused their systems of finance to become complicated and oppressive. In Great Britain, where the system of running in debt, or, as it is commonly termed, the funding system, has been carried to a greater height than in any other country, its natural attendants, enormous taxation and expenditure, have made equal progress; and it is probably owing chiefly to the publicity which is given to all matters of finance, so that every person with little trouble may know how all the money raised for the public service is expended, that the people have been

induced to submit to taxes which both from their nature and amount would have appeared incredible to their forefathers.

The English system of finance rests on the produce of the various taxes which have been imposed at different periods, the aggregate amount of which, after deducting the expences of collection, together with a few small articles which cannot properly be called taxes, forms the whole of the public income. This income is annually appropriated to the several branches of the national expenditure, and when in consequence of any extraordinary expences it is known that the income of the current year will be insufficient to meet all the demands upon it, it is usual to borrow the sum necessary to make up the deficiency, either from individuals or public bodies, and to allow a fixed rate of interest on the money thus obtained, till the principal shall be repaid, or till the period originally agreed upon shall have expired. See REVENUE, LOANS, and NATIONAL DEBT.

The chancellor of the exchquer is, in Great Britain, the officer to whom the arrangement of the financial concerns of the country is chiefly entrusted. He causes accounts to be annually laid before parliament of the produce of the taxes, with estimates of the several branches of public expenditure for the ensuing year; and if the amount of the estimated expenditure exceeds the probable produce of the revenue, he adjusts the extent and conditions of the loan with such persons as are willing to advance the same, and proposes to parliament the new taxes which become necessary for paying the interest on the money thus borrowed. On the foundation of the accounts and estimates submitted to parliament, particular sums are voted for the several branches of the expenditure; and when the ways and means of raising the whole sum wanted have been determined, an act is passed appropriating the specific sums to the various articles forming the supplies which have been granted. In order to provide against any unforeseen expences, it is usual to grant also a certain sum appropriated to any particular purpose, to be applied to any branch of the expenditure in which there may be occasion for it; this is called a vote of credit, and has increased in amount with the progress of the supplies; in the American war it was 1,000,000*l.* per annum, of late it has generally been 2,500,000*l.* Soon after the commencement of each session, an account is laid before the house of commons, shewing how the moneys given for the service of the preceding year have been disposed of, and what part thereof remains unpaid. If the ways and means have fallen short of the sum they were expected to produce, the deficiency is made good as an article among the next year's supplies.

All the financial accounts of Great Britain are made up annually, and do not vary materially except in the amount of the several articles. A general view of the ordinary revenues and extraordinary resources constituting the public income for the year ending the 5th January, 1805, and of the different branches of the public expenditure for the same period, will furnish a distinct and comprehensive view of the subject, for the detail of which see CUSTOMS, EXCISE, STAMP-DUTIES, LAND-TAX, &c.

PUBLIC INCOME.

ORDINARY REVENUES.

Customs	£.	9,060,297	8 2¼
Excise (including Malt, &c. annual)		20,990,469	13 1
Stamps		3,564,894	10 6¼
Land and Assessed Taxes		6,042,485	3 3½
Post Office		1,107,358	9 1¼
Shilling in the £. on Pensions and Salaries		52,997	19 7¼
Sixpence in the £. on ditto		61,278	6 4
Hackney Coaches		26,656	11 3¼
Hawkers and Pedlars		7,014	8 7
Small branches of the Hereditary Revenue, viz. Alienation Fines, Post Fines, Seizures, Compositions, Proffers, and Crown Lands		131,980	12 7

EXTRAORDINARY RESOURCES.

Property Tax		3,484,351	10 5
Arrears of Income Duty		81,048	6 9¼
Lottery, Net Profit		413,645	7 2
Voluntary Contributions		590	17 9
Arrears of Taxes, collected under the Aid and Contribution Act		1,890	13 2¼
Moneys paid on account of the Interest of Loans raised for the service of Ireland		1,275,178	17 1
On Account of the Commissioners for issuing Exchequer Bills for the Island of Grenada, &c.		201,000	0 0
Interest on Stock, transferred by Instalments, for the Redemption of Land Tax		4,500	0 0
Fees of regulated Exchequer Offices		36,664	7 0
Imprest Money repaid by sundry Public Accountants		21,031	5 2¼
Other Moneys paid to the Public		13,230	0 2
Total, independent of Loans	£.	46,578,564	2 4¾
Loans, in part of £.14,500,000		13,209,351	13 9
Total	£.	59,787,915	16 1½

PUBLIC EXPENDITURE.

	£.	s.	d.	£.	s.	d.
Interest on the permanent Funded Debt	18,925,797	6	3¾			
Charges of Management	267,786	19	7¼	26,044,785	16	11
Sums applicable to the reduction of the Debt	6,851,201	11	0			
Interest on Exchequer Bills				624,859	18	10
The Civil List				928,000	0	0
Other charges on the Consolidated Fund, viz.						
Allowances to the Royal Family, Pensions, &c.	284,866	13	4			
Salaries and Allowances	23,441	19	0			
Courts of Justice	57,319	2	0	409,811	10	9
The Mint	20,727	2	9			
Bounties	23,456	13	8			
The Civil Government of Scotland				79,705	4	1¼
Other payments in anticipation of the Exchequer Receipt, viz.						
Bounties for Fisheries, Manufactures, Corn, &c.	336,524	0	11			
Pensions on the Hereditary Revenue	27,700	0	0			
Militia and Deserters' Warrants, &c.	286,668	10	6	727,582	3	11
Purchase of Legal Quays	76,689	12	6			
The Navy	7,345,821	4	9			
Victualling department	3,279,501	8	4			
Sick and Wounded ditto	277,000	0	0	11,759,351	5	5
Transport ditto	857,028	12	4			
The Ordnance				3,550,141	1	11
The Army. Regulars, Fencibles, Militia, &c.	9,500,000	0	0			
Barracks	1,786,048	0	0			
Staff Officers, and Officers of Garrisons	289,027	0	0			
Half-Pay	228,000	0	0			
Widows' Pensions	22,500	0	0	15,744,694	15	3
Chelsea Hospital	207,963	0	0			
Exchequer Fees	80,353	0	0			
Pay of Public Offices	70,000	0	0			
Extraordinary Services	3,560,803	15	3			
Remittances to Ireland, viz.						
Out of Loan, 1804	3,693,500	0	0	3,733,291	13	4
Out of Lotteries, 1804	39,791	13	4			
Miscellaneous Services,						
At Home	1,628,555	0	3¾	1,882,074	14	8¾
Abroad	253,519	14	5			
				65,484,298	5	2½
Deduct Loan for Ireland				3,733,291	13	4
Total			£.	61,751,006	11	10½

FINDING: any person finding any thing, has a special property therein, but he is answerable to the person in whom is the general property, but has a right against every person but the loser. The finder is not answerable for a mere nonfeasance or neglect: yet if he makes gain of, or abuses, or spoils the things he finds, he shall be answerable. If bank-bills, tickets, &c. stolen or lost, are paid to or delivered to another, without consideration, an action lies against any one in whose hands they are found; and the law seems to be the same, though a consideration was given, if the party had previous notice of their being lost or stolen. Str. 505.

But the property of goods found or stolen, may be changed by sale for a valuable consideration, and without notice, in a market overt; and the party purchasing them obtains a title to them, against the original owner.

FINES, a mode of transferring property. By the ancient common law, a charter of feoffment was the only written instrument by which lands were conveyed; but the inconvenience sometimes arising from the loss of the charter, or the difficulty of proving it from a lapse of years, induced men to look out for some more secure and lasting assurance. For this purpose fines were adopted, that is, a fictitious process; a suit is instituted concerning the lands intended to be conveyed; and after the writ is issued and the parties appear in court, the suit is compounded with the consent of the judges, whereby the lands in question are acknowledged to be the right of one of the contending parties. This agreement is inrolled among the records of the court, and being substituted in the place of the sentence which would have been given had the action continued, is of equal force with the judgment of a court, puts an end not only to that suit but to all others respecting the same matter; a writ is then issued to the sheriff of the county in which the lands lie, in the same form as if judgment had been obtained, commanding him to deliver possession to the person who thus acquires the land, which renders the ceremony of livery of seisin unnecessary. We are indebted to the civilians for the first idea of this method of conveyance, by whom it was called *transactio*, and was introduced by the French into their law. A fine consists of five parts: 1st. The original writ; 2nd. The licencia concordandi; 3rd. The concord; 4. The note; 5. The foot. A fine can be levied on any writ which in any sort concerns lands, but the writ chiefly in use, is the writ of covenant. When the sheriff of the county where the lands lie is a party to the fine, the writ must be directed to the coroner; the licentia concordandi is the perinission from the court to accommodate the suit. The concord comes in lieu of the sentence which would have been given had the action continued. The note is only the abstract of the writ of covenant, and the concord, naming the parties, the lands, and the agreement; and the foot chirograph or indenture includes the whole matter. Sir Edward Coke says, a fine is said to be levied when the writ of covenant is returned, and the concord duly entered. Fines are divided into executed and executory; and subdivided into, 1st. *Fines sur cognizance de droit comme ceo; 2. sur cognizance de droit tantum; 3. sur concessit;* and 4. *sur done grant & render.* A fine sur cognizance de droit comme ceo, &c. is the best and surest kind of fine. for thereby the deforciant in order to keep his covenant with the plaintiff, of conveying to him the lands in question, and at the same time to avoid the formality of an actual feoffment and livery, acknowledges in court a former feoffment to have been made by him to the plaintiff, so that this assurance is rather a confession of a former conveyance, than a conveyance now originally made. A fine sur cognizance de droit tantum, is merely the acknowledgement of the right without the circumstance of a preceding gift from the cognizor, and is commonly used to pass a reversionary interest which is in the cognizor. A fine sur concessit, is where the cognizor, though he acknowledges no precedent right, yet grants to the cognizee an estate de novo usually for life or years by way of supposed composition; and this may be done reserving a rent or the like, for it operates as a new grant. A fine sur done grant & render, is a double fine, comprehending the fine sur cognizance de droit comme ceo, and the fine sur concessit, and may be used to create particular limitations of estate; whereas the first conveys nothing but an absolute estate, and is the most used on that account: this is called a fine executed, and the others are but executory.

Fines were formerly levied in all the courts; but by Magna Charta they were usually thenceforth levied in the common pleas, and before two justices of that court; and the lord chief justice of the common pleas may alone take the acknowledgment of a fine out of court: but if he is a party to the writ, he cannot *quia judex in propria causa.* This rule extends to all our judges and commissioners. They are also taken by commissioners in the country, empowered by dedimus potestatem, who may be punished for abuses, and the fine taken before them set aside: and it may be levied of any things whereof a *precipe quod reddat* or *precipe quod faciat* lies, or a *precipe quod permittat* or *precipe quod teneat* may be brought. The force and effect of a fine depend principally on the common law, and the two statutes 4 Hen. VII. c. 24, and 32 Henry VIII. c. 36. The ancient common law as set forth in 18 Edward I. says, "the fine is so high a bar, and of so great force, and of a nature so powerful in itself, that it precludes not only those who are parties and privies to the fine, and their heirs, but all other persons in the world who are of full age, out of prison, of sound memory, and within the seas, the day of the fine levied, unless they put in their claim within a year and a day." But by a statute made in the reign of Edward I. persons were allowed to claim and falsify a fine at any indefinite time; but this giving rise to much contention and insecurity, a statute 6 Henry VII. wisely steered between the rigour of the common law and the latitude allowed by the former act, and limited the right of claim to five years, except femmecoverts, infants, prisoners, persons beyond the seas, or lunatics, who have five years after the death of their husbands, their attaining full age, recovering their liberty, or being restored to their right mind. The persons bound by a fine, are parties, privies, and strangers: the parties are the cognizors and cognizees, and all persons who may lawfully grant by deed may levy a fine, and this is almost the only act that a femme covert is allowed to do (when she is privately examined as to her voluntary consent), and is therefore the most usual and safe method whereby she can join in the sale, settlement, or incumbrance of any estate. Privies to a fine are such as are anywise related to the parties who levy the fine, and claim under them by any right of blood or other right of representation. Strangers to a fine are all other persons in the world except only parties and privies, who are also bound by a fine unless they prefer their claims within the space of five years. Persons who have not a present but future interest only have also five years allowed them to claim in from the time that right accrues; thus this conveyance not only binds the parties themselves and their heirs, but also all mankind whether concerned or no, if they fail to put in their claims within the time allowed by law.

FINES *for offences.* Originally all punishments were corporal; but after the use of money, when the profits of the courts arose from the money paid out of the civil causes, and the fines and confiscations in criminal ones, the commutation of punishments was allowed of; and the corporal punishment which was only in terrorem, changed into the pecuniary, whereby they found their own advantage. This begat the distinction between the greater and the less offences; for in the crimina majora there was at least a fine to the king, which was levied by a capiatur; but upon the less offences there was only an amercement, which was affeered, and for which a distringas, or action of debt only lay. 2 Bac. Abr. 502.

By the Bill of Rights 1 W. st. 2. c. 2. excessive fines ought not to be imposed; and all grants and promises of fines and forfeitures of particular persons, before conviction, are declared to be illegal and void. 4 Black. 379.

All courts of record may fine and imprison an offender, if the nature of the offence is such as deserves such punishment. 8 Co. 39. But no court, unless of record, can fine or imprison. 11 Co. 43. And all courts of law that have power given them to fine and imprison, are thereby made courts of record. 1 Salk. 200.

The sheriff in his torn, may impose a fine on all such as are guilty of any contempt in the face of the court; and may also impose what reasonable fine he shall think fitting, upon a suitor refusing to be sworn, or upon a bailiff refusing to make a panel, &c. or upon a tithingman neglecting to make his presentment, or upon one of the jury refusing to present the articles wherewith they are charged, or upon a person duly chosen constable refusing to be sworn. 2 Inst. 142.

Also the steward of a court-leet may by recognizance bind any person to the peace who shall make an affray in his presence, sitting the court; or may commit him to ward, either for want of sureties, or by way of punishment, without demanding any sureties of him; in which case he may afterwards impose a fine according to his discretion. F. N. B. 82.

Also the sheriff in his torn, and the steward of a court-leet, have a discretionary power

either to award a fine or amercement for contempt of the court, for a suitor's refusing to be sworn, &c.; and the steward of a court leet may either amerce or fine an offender, upon an indictment for an offence not capital, within his jurisdiction, without any farther proceeding or trial, especially if the crime was any way enormous, as an affray accompanied with wounding. Kitchin, 43, 51.

Some courts cannot fine or imprison, but amerce, as the county, hundred courts, &c. 11 Co. 43.

But some courts can neither fine, imprison, nor amerce; as ecclesiastical courts held before the ordinary, archdeacon, &c. or their commissaries, and such who proceed according to the canon or civil law. 11 Co. 44.

A fine may be mitigated the same term it was set, being under the power of the court during that time, but not afterwards. L. Raym. 376. And fines assessed in court by judgment upon an information, cannot be afterwards mitigated. Cro. Car. 251. If a fine certain is imposed by statute on any conviction, the court cannot mitigate it; but if the party come in before conviction, and submit to the court, they may assess a less fine; for he is not convicted, and perhaps never might. The court of exchequer may mitigate a fine certain, because it is a court of equity, and they have a privy seal for it. 3 Salk. 33.

FINERS of gold and silver, are those who separate these metals from coarser ores.

FINERY, in the iron-works, one of the forges at which the iron is hammered and fashioned into what they call a bloom, or square bar.

FINGER, *in music*, a word metaphorically applied to ability in execution in general, but especially on keyed instruments; as when we say, such a master possesses an expressive or an elegant finger; that lady displays a rapid or a delicate finger.

FINGER-BOARD. That thin, black covering of wood laid over the neck of a violin, violoncello, &c. and on which, in performance, the strings are pressed by the fingers of the left hand, while the right manages the bow.

FINGERING. Disposing of the fingers in a convenient, natural, and apt manner in the performance on any instrument, but more especially the organ and piano-forte. Good fingering is one of the first things to which a judicious master attends. It is, indeed, to this that the pupil must look as the means for acquiring a facile and graceful execution, and the power of giving passages with articulation, accent, and expression. Easy passages may be rendered difficult, and difficult ones impracticable, by bad fingering; and though there are many arrangements of notes which admit of various fingering, still, even in these, there is always one best way of disposing of the hand, either with regard to the notes themselves, or those which precede or follow them. But there are an infinite number of possible dispositions of notes, which can only be fingered in one particular way; and every attempt at any other, is but endangering the establishment of some awkwardness, which the practitioner will have to unlearn before he can hope to attain the true fingering. Hence it is obvious, that no qualification requisite to good performance is of more importance to the learner than that of just fingering; and that whatever talents and assiduity may be able to achieve independent of instruction, in this great particular the directions of a skilful master are indispensable.

FINTO, in music (Ital.), a feint, a term applied to the preparation for a cadence which is not executed; when the performer having done every thing that is requisite to a full close, instead of falling on the final, passes to some other note, or introduces a pause.

FIR-TREE. See ABIES.

FIRE. See CALORIC.

FIRE, *wild*, a kind of artificial or factitious fire, which burns even under water. It is composed of sulphur, pitch, nitre, and various other combustible materials; and is very hard to extinguish. Chemistry, however, has supplied a still more destructive kind of wild-fire, in the union of nitrous acid with oil of turpentine. These two liquids separately are perfectly cold; but when suddenly mixed, produce a flame not easily extinguished. This, with great appearance of reason, is supposed to be the wild-fire of the ancients, who, inclosing the two liquids in a glass ball which had a partition to keep them asunder, threw the ball into some ship of the enemy's; and the globe being thus broken, the liquids united, and set the vessel in flames. The French call it Greek fire, or feu Gregois, because first used by the Greeks, about the year 660; as is observed by the jesuit Petavius, on the authority of Nicetas, Theophanes, Cedrenus, &c.

The inventor, according to the same jesuit, was an engineer of Heliopolis in Syria, named Callinicus, who first applied it in the sea-fight commanded by Constantine Pogonates against the Saracens, near Cyzicus, in the Hellespont; and with such effect, that he burnt the whole fleet in which were 30,000 men. But others will have it of a much older date; and hold Marcus Gracchus the inventor: which opinion is supported by several passages both in the Greek and Roman writers, which show it to have been anciently used by both these nations in their wars.

F. Daniel gives us a good description of the Greek fire in his account of the siege of Damietta under St. Louis. Every body, says that author, was astonished with the Greek fire, which the Turks then prepared, and the secret whereof is now lost. They threw it out of a kind of mortar; and sometimes shot it with an odd sort of cross-bow, which was strongly bent by means of a handle or winch, of much greater force than the mere arm. That thrown with the mortar sometimes appeared in the air of the size of a tun, with a long tail, and a noise like that of thunder. The French by degrees got the secret of extinguishing it, in which they succeeded several times.

FIRE-PLACE. Our ancestors, equally careless of fuel and patient of heat and of cold, basked before a large pile of burning wood with a screen at their backs; and in attempting to substitute a coal-fire, it was at first forgotten that bacon, &c. &c. was not to be hung in the chimney. Economical fire-places should be constructed on the following principles: 1. To place the grate as near the floor as may be. 2. To bring it as forward as may be, consistently with the proper situation of the throat of the chimney, which ought to be directly over the fire, and not larger than is sufficient to give free passage at all times to the smoke. 3. The mantle-piece should be as low as it can be without suffering from the heat, or obstructing the proper radiation of it into the room, from the fuel and flame. By these means, the feet and legs are easily warmed, and the face not so much incommoded; while a much greater volume of heated air is retained in a room of equal size than by high grates and large openings. Since it has been found that chimneys may be cleansed with long flexible brushes, why should they not be built of smaller diameter, circular, and smoothly plaistered within?

FIRE, *machine for preserving from*. This machine consists of a pole, a rope, and a basket. The pole is of fir, or a common scaffold pole, of any convenient length from 36 to 46 feet; the diameter at bottom, or the greatest end, about five inches; and at the top or smallest end about three inches. At three feet from the top is a mortise through the pole, and a pulley fixed to it of nearly the same diameter with the pole in that part. The rope is about three quarters of an inch diameter, and twice the length of the pole; with a spring hook at one end, to pass through the ring in the handle of the basket when used: it is put through the mortise over the pulley, and then drawn tight on each side near the bottom of the pole, and made fast there till wanted. The basket should be of strong wicker-work, three feet and a half long, two feet and a half wide, rounded off at the corners, and four feet deep, rounding every way at the bottom. To the top of the basket is fixed a strong iron curve or handle, with an eye or ring in the middle; and to one side of the basket, near the top, is fixed a small cord, or guide-rope, of about the length of the pole. When the pole is raised, and set against a house over the window from which any persons are to escape, the manner of using it is so plain and obvious, that it need not be described. The most convenient distance from the house for the foot of the pole to stand, where practicable, is about twelve or fourteen feet. If two strong iron straps, about three feet long, rivetted to a cross bar, and spreading about fourteen inches at the foot, were fixed at the bottom of the pole, this would prevent its turning round or slipping on the pavement. And if a strong iron hoop, or ferule, rivetted (or welded) to a semicircular piece of iron spreading about twelve inches, and pointed at the ends, was fixed on at the top of the pole, it would prevent its sliding against the wall.

When these two last-mentioned irons are fixed on, they give the pole all the steadiness of a ladder; and because it is not easy, except to persons who have been used to it, to raise and set upright a pole of forty feet or more in length, it will be convenient to have two small poles or spars of about two inches diameter, fixed to the sides of the great pole at about two or three feet above the middle of it, by iron eyes rivetted to two plates, so as to turn every way; the lower end of these spars to reach within a foot of the bottom of the great pole, and to have ferules and short spikes to prevent sliding on the pavement, when used occasionally to support the great pole like a tripod. There should be two strong ash-trundles let through the pole,

one at four feet and one at five feet from the bottom, to stand out about eight inches on each side, and to serve as handles, or to twist the rope round in lowering a very heavy weight. If a block and pulley were fixed at about the middle of the rope, above the other pulley, and the other part of the rope made to run double, it would diminish any weight in the basket nearly one-half, and be very useful in drawing any person up, to the assistance of those in the chambers, or for removing any effects out of a chamber, which it might be dangerous to attempt by the stairs.

It has been proved, by repeated trials, that such a pole as we have been speaking of can be raised from the ground, and two or three persons taken out of the upper windows of a house, and set down safely in the street in the space of 35 seconds, or a little more than half a minute. Sick and infirm persons, women, children, and many others, who cannot make use of a ladder, may be safely and easily brought down from any of the windows of a house on fire by this machine, and by putting a short pole through the handles of the basket, may be removed to any distance without being taken out of the basket. The pole must always have the rope ready fixed to it, and may be conveniently laid up upon two or three iron hooks under any shade or gateway, and the basket should be kept at the watch-house. When the pole is laid up, the two spars should always be turned towards the head of it. The basket should be made of peeled rods, and the pole and spars painted of a light stone-colour, to render it more visible when used in the night.

FIRE, *machines for extinguishing*. In the year 1734, the states of Sweden offered a premium of 20,000 crowns for the best method of stopping the progress of accidental fires; when one Mr. Fuches, a German physician, made a preparation for that end, and the experiment was tried on a house built on purpose, of dry fir, at Legard-island. In the building were placed several tubs of tar and pitch, and a great quantity of chips, all which were set on fire; flames issuing through the top of the house, windows, &c. when he threw in one of the barrels containing the preparation, which immediately quenched the flames; a second barrel entirely cleared the smoke away; and the whole was executed to the astonishment of the spectators, and to the no small satisfaction of the inventor, who was about to return home, when unexpectedly the flames broke out again, supposed to be occasioned by a small quantity of combustible matter being introduced and set on fire secretly by some malicious person. Upon this the wrongheaded mob fell upon Mr. Fuches, and beat him most unmercifully, so that he narrowly escaped with his life. He soon after left the country, and never could be prevailed on to return. Another experiment of this kind was tried in 1761 in Holland, but failed through the perverseness of the populace.

Attempts of a similar nature have met with a better reception in England. Of these the most successful was that of Mr. Godfrey, whose contrivance is thus described by Mr. Ambrose Godfrey, grandson to the inventor. "The material to be employed consists of a small portion of gunpowder closely confined; which, when animated by fire, acts by its elastic force upon a proper medium, and not only divides it into the minutest atoms, but disperses it also in every direction, so as immediately to extinguish any fire within a certain distance. This medium is a liquor strongly impregnated with a preparation of anticombustible principles, which by their action upon burning materials extinguish the flames, and reduce them in general to the state of a black coal; and, by its opposite nature to fire, hinders the remaining sparks, notwithstanding the admission of the air, from kindling the flames afresh. By this means, the great point is obtained, in giving sufficient time for totally extinguishing any remains of fire." From this account, however, nothing can be made out; and the quackery of concealment, in a matter that so nearly concerns the welfare of the human race, can only be accounted for on the score of its insufficiency, or the impossibility of making it generally useful.

The mode of employing these machines, was that of throwing them into the different rooms of the house in which the flames began to appear. Used in this way, if the invention really possessed the merit ascribed to it, it evidently would have been of great use in extinguishing fires on shipboard; and would probably have been considered as a no less necessary part of a ship's lading than her stores or ammunition.

FIRE *in chimneys, method of extinguishing*. It is well known, that the inner parts of chimneys easily take fire; the soot that kindles therein emits a greater flame, according as the tunnel is more elevated, because the current of air feeds the fire. If this current could therefore be suppressed, the fire would soon be extinguished. In order to this, some discharge a pistol into the chimney, which produces no effect. Water thrown into the chimney at top is equally useless, becouse it comes down through the middle of the tunnel, and not along the sides. It would be more advisable to stop, with a wet blanket, the upper orifice of the tunnel; but the surest and readiest method is, to apply the blanket either to the throat of the chimney, or over the whole front of the fire-place. If there happens to be a chimney-board or a register, nothing can be so effectual as to apply them immediately; and having by that means stopped the draught of air from below, the burning soot will be put out as readily and as completely as a candle is put out by an extinguisher, which acts exactly upon the same principle.

FIRE, *securing buildings against*. Dr. Hales proposes to check the progress of fires by covering the floors of the adjoining rooms with earth. The proposal is founded on an experiment which he made with a fir-board half an inch thick, part of which he covered with an inch depth of damp garden-mold, and then lighted a fire on the surface of the mold; though the fire was kept up by blowing, it was two hours before the board was burnt through, and the earth prevented it from flaming. The thicker the earth is laid on the floors, the better: however, Dr. Hales apprehends that the depth of an inch will generally be sufficient: and he recommends to lay a deeper covering on the stairs, because the fire commonly ascends by them with the greatest velocity.

Mr. David Hartley made several trials in the years 1775 and 1776, in order to evince the efficacy of a method which he had invented for restraining the spread of fire in buildings. For this purpose, thin iron plates were well nailed to the tops of the joists, &c. the edges of the sides and ends being lapped over, folded together, and hammered close. Partitions, stairs, and floors, may be defended in the same manner; and plates applied to one side have been found sufficient. The plates are so thin as not to prevent the floor from being nailed on the joists, in the same manner as if this preventive was not used; they are kept from rust by being painted or varnished with oil and turpentine. The expence of this addition, when extending through a whole building, is reckoned at about five per cent. Mr. Hartley had a patent for this invention, and parliament voted a sum of money towards defraying the expence of his numerous experiments. The same preservative may also be applied to ships, furniture, &c. Mr. Hartley's patent has long since expired.

Earl Stanhope also discovered and published a very simple and effectual method of securing every kind of building against fire. This method he has divided into three parts, viz. under-flooring, extra-lathing, and inter-securing. The method of under-flooring is either single or double. In single under-flooring, a common strong lath of oak or fir, about one fourth of an inch thick, should be nailed against each side of every joist, and of every main timber, supporting the floor which is to be secured. Other similar laths are then to be nailed along the whole length of the joists, with their ends butting against each other. The top of each of these laths or fillets ought to be at $1\frac{1}{2}$ inch below the top of the joists or timbers against which they are nailed; and they will thus form a sort of small ledge on each side of all the joists. These fillets are to be well bedded in a rough plaister hereafter mentioned, when they are nailed on, so that there may be no interval between them and the joists; and the same plaister ought to be spread with a trowel upon the tops of all the fillets, and along the sides of that part of the joists which is between the top of the fillets and the upper edge of the joists. In order to fill up the intervals between the joists that support the floor, short pieces of common laths, whose length is equal to the width of these intervals, should be laid in the contrary direction to the joists, and close together in a row, so as to touch one another; their ends must rest upon the fillets, and they ought to be well bedded in the rough plaister, but are not to be fastened with nails. They must then be covered with one thick coat of the rough plaister, which is to be spread over them to the level of the tops of the joists; and in a day or two this plaister should be trowelled over close to the sides of the joists, without covering the tops of the joists with it.

In the method of double-flooring, the fillets and short pieces of laths are applied in the manner already described; but the coat of rough plaister ought to be little more than half as thick as that in the former method. Whilst this rough plaister is laid on, some more of the short pieces of laths above-mentioned must be laid in the intervals between the joists upon the first coat, and be dipped deep in it. They should be laid as close as possible to each other, and in the same direction with the first layer of short laths. Over this second layer of short laths there must be spread another coat of rough plais-

ter, which should be trowelled level with the tops of the joists without rising above them. The rough plaister may be made of coarse lime and hair; or, instead of hair, hay chopped to about three inches in length may be substituted with advantage. One measure of common rough sand, two measures of slaked lime, and three measures of chopped hay, will form in general a very good proportion, when sufficiently beaten up together in the manner of common mortar. The hay should be put in after the two other ingredients are well beaten up together with water. This plaister should be made stiff; and when the flooring-boards are required to be laid down very soon, a fourth or fifth part of quicklime in powder, formed by dropping a small quantity of water on the limestone a little while before it is used, and well mixed with this rough plaister, will cause it to dry very fast. If any cracks appear in the rough plaister-work near the joists when it is thoroughly dry, they ought to be closed by washing them over with a brush wet with mortar-wash; this wash may be prepared by putting two measures of quicklime and one of common sand in a pail, and stirring the mixture with water till the water becomes of the consistence of a thin jelly.

Before the flooring-boards are laid, a small quantity of very dry common sand should be strewed over the plaister-work, and struck smooth with a hollow rule, moved in the direction of the joists, so that it may lie rounding between each pair of joists. The plaister-work and sand should be perfectly dry before the boards are laid, for fear of the dry rot. The method of under-flooring may be successfully applied to a wooden staircase; but no sand is to be laid upon the rough plaister-work. The method of extra-lathing may be applied to ceiling joists, to sloping roofs, and to wooden partitions.

The third method, which is that of intersecuring, is very similar to that of under-flooring; but no sand is afterwards to be laid upon it. Intersecuring is applicable to the same parts of a building as the method of extra-lathing, but it is seldom necessary.

The author of this invention made several experiments, in order to demonstrate the efficacy of these methods. In most houses it is only necessary to secure the floors; and the extra expence of under-flooring, including all materials, is only about ninepence per square yard, and with the use of quicklime a little more. The extra expence of extra-lathing is no more than sixpence per square yard for the timber side-walls and partitions; but for the ceiling about ninepence per square yard. But in most houses no extra-lathing is necessary.

FIRE-FLIES, a species of flies common in Guiana, of which there are two species. The largest is more than an inch in length, having a very large head connected with the body by a joint of a particular structure, with which sometimes it makes a loud knock, particularly when laid on its back. The fly has two feelers or horns, two wings, and six legs. Under its belly is a circular patch, which, in the dark, shines like a candle; and on each side of the head near the eyes is a prominent, globular, luminous body, in size about one-third larger than a mustard-seed. Each of these bodies is like a living star, emitting a bright, and not small, light; since two or three of these animals, put into a glass vessel, afford a light sufficient to read without difficulty, if placed close to the book. When the fly is dead, these bodies will still afford considerable light, though it is less vivid than before; and if bruised, and rubbed over the hands or face, they become luminous in the dark, like a board smeared over with English phosphorus. They are of a reddish-brown or chesnut colour; and live in rotten trees in the day, but are always abroad in the night. The other kind is not more than half as large as the former: their light proceeds from under their wings, and is seen only when they are elevated, like sparks of fire appearing or disappearing at every second. Of these the air is full in the night, though they are never seen in the day. They are common not only in the southern, but in the northern parts of America during summer.

FIRE-BALL, in the art of war, a composition of meal-powder, sulphur, saltpetre, pitch, &c. about the bigness of a hand-grenade, coated over with flax, and primed with a slow composition of a fuse. This is to be thrown into the enemy's works in the night time, to discover where they are: or to fire houses, galleries, or blinds of the besiegers; but they are then armed with spikes or hooks of iron, that they may not roll off, but stick or hang where they are designed to have any effect.

FIRE-BOTE, is fuel or firing for necessary use, allowed to tenants, out of the lands granted to them.

FIRE-IRONS. These are too well known to need description: they are, however, mentioned, to notice a patent taken out by Mr. Bentham, for the improvement of them, by making all the parts that admit of it tubular instead of solid.

FIRE-POTS, in the military art, small earthen pots, into which is put a charged grenade, and over that powder enough till the grenade is covered; then the pot is covered with a piece of parchment, and two pieces of match across lighted: this pot being thrown by a handle of match, where it is designed, it breaks and fires the powder, and burns all that is near it, and likewise fires the powder in the grenade, which ought to have no fuse, that its operations may be the quicker.

FIRES and FIRECOCKS. By 14 G. III. c. 78, churchwardens in London, and within the bills of mortality, are to fix firecocks, &c. at proper distances in streets, and keep a large engine and hand-engine for extinguishing fire, under the penalty of ten pounds. And to prevent fires, workmen in the city of London, &c. must erect party-walls between buildings, of brick or stone of a certain thickness, &c. under penalties therein mentioned.

On the breaking out of any fire, all the constables and beadles shall repair to the place with their staves, and be assisting in putting it out, and causing people to work. No action lies against a person in whose house or chamber a fire accidentally begins.

FIRE-SHIPS, in the navy, are vessels charged with combustible materials or artificial fireworks; which having the wind of an enemy's ship, grapple her, and set her on fire.

Anderson, in his History of Commerce, vol. 1, p. 432, ascribes the invention to the English, in this instance, viz. some vessels being filled with combustible matter, and sent among the Spanish ships composing the Invincible Armada in 1588; and hence arose, it is said, the terrible invention of fire-ships.

But Livy informs us, that the Rhodians had invented a kind of fire-ships, which were used in junction with the Roman fleet in their engagement with the Syrians, in the year 190 before Christ: cauldrons of combustible and burning materials were hung out at their prows, so that none of the enemys' ships durst approach them; for these fell on the enemies' galleys, struck their beaks into them, and at the same time set them on fire.

FIRELOCKS, so called from their producing fire of themselves, by the action of the flint and steel; the arms carried by a foot-soldier. They were formerly three feet eight inches in the barrel, and weighed fourteen pounds; at present the length of the barrel is from three feet three inches to three feet six inches, and the weight of the piece only twelve pounds. They carry a leaden bullet of which 29 make 2lb. its diameter is .550 of an inch, and that of the barrel 1-50th part of the shot. Firelocks were first made use of in 1690, when matchlocks were universally disused; but when invented, we cannot ascertain. A firelock is called, by writers of about the middle of the last century, asnaphaan, which being a Low-Dutch word, seems to indicate its being a Dutch invention.

FIRE WORKS. It is not lawful for any person to make or cause to be made, or sell or expose to sale, any squibs; rockets, serpents, or other fireworks, or any cases, moulds, or other implements for making the same; or to permit the same to be cast or fired from his house or other place thereto belonging, into any public street or road; or to throw or fire, or be aiding in throwing and firing the same, in any public street, house, shop, river, or highway; and every such offence shall be adjudged a common nuisance. 9 and 10 W. c. 7.

FIRING *in line*, in the military art. According to regulations, the following principal heads constitute firing in line.

The object of fire against cavalry is to keep them at a distance, and to deter them from the attack; as their movements are rapid, a reserve is always kept up. But when the fire commences against infantry, it cannot be too heavy, or too quick while it lasts; and should be continued till the enemy is beaten or repulsed. This may not improperly be called offensive fire.

Defensive fire belongs principally to infantry, when posted on heights, which are to be defended by musquetry. As soldiers generally present too high, and as fire is of the greatest consequence to troops that are on the defensive, the habitual mode of firing should therefore be rather at a low level than a high one.

On these occasions the men are generally drawn up three deep; in which case the front rank kneeling, being the most efficacious as being the most raising, should not be dispensed with when it can be safely and usefully employed.

FIRING by half-battalions, the line advancing. The left wings halt, and the right ones continue to march 15 paces, at which instant the word march being given to the left wings, the right at the same time are ordered to halt, fire, and load, during which the left march on and pass them, till the right wings, being loaded and shouldered, receive the word march, on which the left ones halt, fire, &c. and thus they alternately proceed.

FIRING *by half-battalions, the line retir-*

ing. The right wings are ordered to halt, front, and when the left wings have gained fifteen paces, and have received the word halt, front, the right wings are instantly ordered to fire, load, face about, and march fifteen paces beyond the left ones, where they receive the word halt, front, on which the left wings fire, &c. and thus alternately proceed.

It is observed in the official rules and regulations, that in addition to the battalion directions, there must be a regulating battalion named, by the half-battalions of which each line will move, halt, and fire: the commander of each line will be with such half-battalion, and in giving his several commands must have an attention to the general readiness of the line, especially after loading, that the whole are prepared to step off together at the word march. The firing of the advanced wing succeeds the march, or the halt, front, of the retired wing instantly; and each half-battalion fires independant and quick, so that no unnecessary pauses being made betwixt the firing words, the fire of the line should be that of a volley as much as possible; and the whole being thereby loaded together, will be ready for the next command of movement. In these firings of the line advancing or retiring, the two first ranks will fire standing, and the rear rank support their arms.

In this manner also may the alternate battalions of a line advance or retire, and when the whole are to form, and that the last line moves up to the first, every previous help of advanced persons will be given to ensure its correctness.

FIRE *in line advancing*, is when the infantry marches in line to attack the enemy, and in advancing makes use of its fire. On these occasions it is better to fire the two first ranks only standing, reserving the third, than to make the front rank kneel and to fire the whole; but when it is necessary to fire at a considerable distance, or on a retiring enemy, volleys may be given by the three ranks, the front one kneeling.

FIRING *by platoons*, is practised when a line is posted, or arrives at a fixed situation. In this position, battalions fire independantly of one another, and the fire generally commences from the centre of each. The first fire of each battalion must be regular, and at established pauses and intervals; after which each platoon may continue to fire as soon as it is loaded, independant, and as quick as possible.

FIRING *by files*, is generally used behind a parapet, hedge, or abbatis. In this situation the two first ranks only can fire, and that must be by the two men of the same file always firing together, with coolness and deliberation. When, however, the parapet, hedge, or abbatis, is but a little raised, platoon firing may be resorted to.

Oblique FIRING *by battalions*, or otherwise, according to the ground, is extremely advantageous when it is found expedient to give an oblique direction to part of a line, or when it is discovered that their fire can in this manner be thrown against the opening of a defile, the flanks of a column, or against cavalry or infantry that direct their attack on some particular battalion or portion of the line.

Oblique-firing, is either to the right and left, or from the right and left to the centre, depending entirely on the situation of the object to be fired against. The Prussians have a particular contrivance for this purpose: if they are to level to the right, the rear ranks of every platoon are to make two quick but small paces to the left, and the body of each soldier to turn 1-8th of a circle; and are to take the same distance to the right, if they are to level to the left.

When a line halts at its points of firing, no time is to be lost in scrupulous dressing, and the firing is instantly to commence. But when a line halts, and is not to fire, the usual dressings must be attended to; and every thing will depend upon the coolness and attention of the officers and non-commissioned officers.

It should be observed with respect to firings in general, that after the march in front, and halt of the battalion, company or platoon firing ought invariably to begin from the centre, and not from the flank. In other cases, and in successive formations, it may begin from whatever division first arrives, and halts on its own ground.

Square-FIRING, is that method of firing where either a regiment or any body of men are drawn up in a square, each front of which is generally divided into four divisions or firings, and the flanks of the square, as being the weakest part, are sometimes covered by four platoons of grenadiers who flank the angles. The first fire is from the right division of each face, the second fire from the left division of each face, and so on; the grenadiers making the last fire.

Street-FIRING, is the method of firing adopted to defend or scour a street, lane, or narrow pass of any kind; in the execution of which the platoon must be formed according to the width of the place, leaving sufficient room on the flanks for the platoons which have fired, successively to file round to the rear of the others.

Street-FIRING *advancing*. When the column has arrived at the spot where the firing is to commence, the commanding officer from the rear gives the word halt; and the officer commanding the platoon, orders it to make ready, p'sent, fire; recover arms, outwards face (by half-platoons), quick march.

At the instant the men in the first platoon recover their arms after firing, the second platoon makes ready, and waits in that position till the front is cleared by the first platoon having filed round the flanks towards the rear, when the second advances, with recovered arms, until it receives the word halt, p'sent, fire.

As soon as the platoon which has fired, has got down the flanks, it must form in front of the colours, and prime and load.

Street FIRING *retiring*, is conducted on the same principles, except that the platoons fire without advancing, on the front being cleared by the former platoon filing round the flank.

Another method of street-firing, advancing, generally esteemed more eligible, is, after firing, to wheel out by subdivisions (the pivots having taken a side step to right and left outwards), prime and load, and as soon as the last platoon has passed, file inwards and form.

FIRKIN, an English measure of capacity, for things liquid, being the fourth part of the barrel: it contains 8 gallons of ale, soap, or herrings; and 9 gallons of beer.

FIRLOT, a dry measure used in Scotland. The oat-firlot contains 21¼ pints of that country; the wheat-firlot contains about 1211 cubic inches; and the barley-firlot 31 standard pints. Hence it appears that the Scotch wheat-firlot exceeds the English bushel by 33 cubic inches.

FIRST. A word applied to the upper part in a duet, trio, quartet, &c. either vocal or instrumental; also to the upper part of each kind in overtures, symphonies, concertos, and other full pieces. Such parts are called first, because they generally express the air; and from their superior acuteness possess a pre-eminence in the combined effect.

In the score the first part always occupies the stave immediately above that in which the second is written; the second, the stave immediately over that which contains the third, and so on.

FIRST-FRUITS and TENTHS. First fruits are the profits of every spiritual living, for one year, and tenths are the tenth part of the yearly value of such living, given anciently to the pope through all Christendom; but by stat. 26 H. VIII. c. 3, translated to the king here in England, for the ordering whereof there was a court erected, 32 H. VIII. c. 45, but again dissolved anno primo Mariæ, sess. 2. c. 10. And since that time, though these profits are reduced again to the crown, by the stat. 1 Eliz. c. 4, yet was the court never restored, but all matters therein wont to be handled, were transferred to the exchequer.

By stat. 26 H. VIII. the lord chancellor, bishops, &c. are empowered to examine into the value of every ecclesiastical benefice and preferment in their several dioceses; and every clergyman entered on his living before the first-fruits are paid or compounded for, is to forfeit double value. But stat. 1 Eliz. c. 4, ordains, that if an incumbent on a benefice does not live half a year, or is ousted before the year expires, his executors are to pay only a fourth part of the first-fruits; and if he lives the year and then dies, or is ousted in six months after, but half the first-fruits shall be paid; if a year and a half, three quarters of them; and if two years, then the whole; not otherwise. The archbishops and bishops have four years allowed for the payment, and shall pay one quarter every year, if they live so long upon the bishopric: other dignitaries in the church, pay theirs in the same manner, as rectors and vicars.

By 27 H. VIII. c. 8, no tenths are to be paid for the first year, as then the first fruits are due; and by several statutes of Anne, if a benefice is under fifty pounds per annum, clear yearly value, it shall be discharged of the payment of first-fruits and tenths.

The queen also restored to the church, what at first had been thus indirectly taken from it, by remitting the tenths and first-fruits entirely, but by applying these superfluities of the larger benefices, to make up the deficiencies of the smaller; for this purpose she granted a charter, whereby all the revenue of the first-fruits and tenths is vested in trustees for ever, to form a perpetual fund for the augmentation of poor livings under 50*l.* a year. This is usually called queen Anne's bounty, which has been still further regulated by subsequent statutes: though it

is to be lamented that the number of such poor livings is so great, that this bounty, extensive as it is, will be slow, and almost imperceptible in its operation; the number of livings under 50*l.* certified by the bishops, at the commencement of the undertaking, being 5597, the revenues of which, on a general average, did not exceed 23*l.* per annum. Black. 285, 286.

FISC, in the civil law, the treasury of a prince. It differs from the ærarium, which was the treasury of the public or people: thus, when the money arising from the sale of condemned persons' goods was appropriated for the use of the public, their goods were said publicari; but when it was destined for the support of the prince, they were called confiscari.

FISCAL, in the civil law, something relating to the pecuniary interest of the prince or people. The officers appointed for the management of the fisc, were called procuratores fisci, and advocati fisci; and among the cases enumerated in the constitutions of the empire, where it was their business to plead, one is against those who have been condemned to pay a fine to the fisc on account of their litigiousness, or frivolous appeals.

FISH, in natural history, constitutes a class of animals which have no feet, but always fins; add to this, that their body is either altogether naked, or only covered with scales; and that they are aquatic animals, which live mostly, if not always in water.

They form the 4th class of animals in the Linnæan system, and are divided into six orders, viz. the apodes, the jugulares, the thoracici, the abdominales, the branchiostegous, and chrondropterygious. See NATURAL HISTORY, PISCES, &c. The animals included in this class are always inhabitants of the waters; are swift in their motions, and voracious in their appetites. They breathe by means of gills, which are generally united by a bony arch, swim by means of radiate fins, and are mostly covered with cartilaginous scales. Besides the parts which they have in common with other animals, they are furnished with a nictitant membrane, and most of them with an air-bladder, by the contraction and dilatation of which, they can raise or sink themselves at pleasure. They are destitute of eyelids, external ears, neck, arms and legs. Their food is mucus, insects, dead bodies, lesser sea-fish, and sea-plants.

The generic character is taken from the shape of the body, covering, structure, figure, and parts of the head; but principally from the branchiostegous membrane. The specific character is taken from the cirri, jaws, fins, spines, lateral lines, digitated appendages, tail and colour. The age of fishes is known by numbering the concentric circles in a transverse section of the backbone, or the concentric circles on the scales. The characters of the six orders are, (1.) apodal, without ventral fins: (2.) jugular, ventral fins before the pectoral: (3.) thoracic, ventral fins under the pectoral: (4.) abdominal, ventral fins behind the pectoral: (5.) branchiostegous, gills destitute of bony rays: (6.) chondropterygious, gills cartilaginous. These two latter orders Linnæus refers to the class amphibia nantes; so that in fact he admits of only 4 orders: under these he enumerates 189 genera, and about 400 species.

FISH. Any person may erect a fish-pond without licence; because it is a matter of profit, and for the increase of victuals. 2 Inst. 199.

Concerning the right and property of fish, it has been held, that where the lord of the manor has the soil on both sides of the river, it is good evidence that he has the right of fishing; but where the river ebbs and flows, and is an arm of the sea, there it is common to all, and he who claims a privilege to himself must prove it. In the Severn, the soil belongs to the owners of the land, on each side; and the soil of the river Thames is in the king, &c. but the fishing is common to all. 1 Mod. 105.

Any person who shall unlawfully break, cut, or destroy, any head or dam of a fish-pond, or wrongfully fish therein, with intent to take or kill fish, shall on conviction at the suit of the king, or of the party, at the assizes or sessions, be imprisoned three months, and pay treble damages, and after the expiration of the three months, shall find sureties for his good behaviour for seven years, or remain in prison till he does. 5 Eliz. c. 21.

If any person shall enter into any park or paddock, fenced in and enclosed, or into any garden, orchard, or yard, adjoining or belonging to any dwelling-house, in or through which park or paddock, garden, orchard, or yard, any stream of water shall run, or wherein shall be any river, stream, pond, pool, moat, stew, or other water, and by any means or device whatsoever, shall steal, take, kill, or destroy, any fish bred or kept in it, without the consent of the owner, or shall be aiding therein, or shall receive or buy any such fish, knowing them to be so stolen or taken as aforesaid, and shall be convicted thereof at the assizes, within six calendar months after the offence shall be committed, he shall be transported for seven years. And any offender, surrendering himself to a justice, or being apprehended or in custody for such offence, or on any other account, who shall make confession thereof, and a true discovery on oath of his accomplice or accomplices, so that such accomplice may be apprehended, and shall on trial give evidence, so as to convict such accomplices, shall be discharged of the offence, so by him confessed.

And if any person shall take, kill, or destroy, or attempt to take, kill, or destroy, any fish in any river, or stream, pond, pool, or other water, (not in any park or paddock, or in any garden, orchard, or yard, adjoining or belonging to any dwelling-house, but in any other inclosed ground, being private property) he shall, on conviction before one justice, on the oath of one witness, forfeit 5*l.* to the owner of the fishery of such river, pond, or other water; and such justice, on complaint upon oath, may issue his warrant to bring the person complained of before him; and if he shall be convicted before such justice, or any other of the county or place, he shall immediately pay the said penalty of 5*l.* to such justice, for the use of the person, as the same is appointed to be paid unto; and in default thereof, shall be committed by such justice to the house of correction, for any time not exceeding six months, unless the forfeiture shall be sooner paid: or such owner of the fishery may, within six calendar months after the offence, bring an action for the penalty in any of the courts of record at Westminster. 5 G. III. c. 14.

FISH, in a ship, a plank or piece of timber, fastened to a ship's mast or yard to strengthen it, which is done by nailing it on with iron spikes, and woulding or winding ropes hard about them.

FISH, *royal*, these are whale and sturgeon, which the king is entitled to, when either are thrown on shore, or caught near the coasts. Plowd. 315.

FISHES, in heraldry, are the emblems of silence and watchfulness, and are borne either upright, embowed, extended, endorsed respecting each other, surmounting one another, fretted, &c. In blazoning fishes, those borne feeding, should be termed devouring; all fishes borne upright and having fins, should be blazoned hauriant; and those borne transverse the escutcheon, must be termed naiant.

FISH-PONDS, those made for the breeding or feeding of fish.

Fish-ponds are no small improvement of watery and boggy lands, many of which are fit for no other use. In making of a pond, its head should be at the lowest part of the ground, that the trench of the flood-gate or sluice, having a good fall, may not be too long in emptying. The best way of making the head secure, is to drive in two or three rows of stakes above six feet long, at about four feet distance from each other, the whole length of the pond-head, of which the first row should be rammed at least about four feet deep. If the bottom is false, the foundation may be laid with quicklime, which slacking, will make it as hard as a stone. Some lay a layer of lime, and another of earth dug out of the pond, among the piles and stakes; and when these are well covered, drive in others, as they see occasion, ramming in the earth as before, till the pond-head is of the height designed.

The dam should be made sloping on each side, leaving a waste to carry off the overabundance of water in times of floods or rains; and as to the depth of the pond, the deepest part need not exceed six feet, rising gradually in shoals towards the sides, for the fish to sun themselves, and lay their spawn. Gravelly and sandy bottoms, especially the latter, are best for breeding; and a fat soil, with a white fat water, as the washings of hills, commons, streets, sinks, &c. is best for fattening all sorts of fish. For storing a pond, carp is to be preferred for its quick growth, and great increase, as breeding five or six times a year; but tench for its goodness.

The quantity of fish to be supplied obviously depends upon the quantity of water, which should be divided, where it conveniently can, into five ponds.

Number 5 is intended for breeding, and should be double or treble the size of any of the other ponds. Or if this be inconvenient, there may be two for this purpose. This pond may likewise be the most distant from the house. If the breeding-pond should fail to answer this purpose, it will at least serve as a conservatory for fish of small size, to be obtained elsewhere: and indeed, fresh stores in any case will be found desirable. The contents of this pond in carp and tench, or

the greatest part, should be taken out annually in September or October, counted in braces, and such as are from five to seven inches long thrown into the pond called No. 4.

The contents of No. 4, when grown one year from the length of five or seven inches, must be put into No. 3. The contents of No. 3, having grown one year from No. 4, must be removed into No. 2. And in like manner, the contents of No. 2, after one year, must be removed into No. 1, which is to contain only such fish as are fit for the table. It is obvious that this pond for safety and convenience, should be the nearest to the house.

As No. 5 is to be the largest water, so No. 1 is to be the least; the rest of sizes between the two.

The shape of No. 1 should be oblong, for the convenience of the net, and the less disturbance of the fish in taking out what are wanted from time to time.

A book should be kept of the number and size of each kind in every pond.

Carp are fit for the table from three to seven pounds each. Tench from one pound and a half to three pounds each. Perch from three quarters of a pound to one or two pounds, &c.

It is supposed that none of the ponds have a strong current of very cold, acrid, innutritious water.

One acre of water upon a loam, clay, or marl, or any of these with a mixture of gravel, has been stated to be capable of supporting 2000 pounds weight of fish; the number of the fish making that weight being immaterial.

Carp and tench breed most freely in ponds, or pits newly made. Tench likewise in almost any ponds, where cattle are admitted.

It is evident that perch and pike should not be admitted in any degree in No. 5; but in all the other numbers, besides their own value, they are of important service, provided that they are strictly confined to a size greatly subordinate to that of the carp, or tench. For they destroy not only the accidental spawn of fish which breed, but also several animals, whose food is the same with that of carp and tench, as frogs, newts, &c. Pike above the weight of one or two pounds must not be admitted even amongst carp of the largest size and weight.

With regard to the absolute weight of fish, which any particular pond will support, this can only be determined by observation and experience; as it depends on the different degrees of nutrition in different waters. It is said, that carp and tench in waters which feed well, will before they are aged, double their weight in one year.

The third part of an acre in No. 1 would probably be sufficient for the demand of any family. For, upon the calculation above given, it would support near 700 pounds of fish, which might be divided thus.

50 brace of carp of three pounds each and upwards.

50 brace of tench, of two pounds each and upwards.

50 brace of perch, of one pound each and upwards.

That is, three brace of fish, weighing at least twelve pounds, for the use of every week.

Allowing one acre for No. 5, one-third of an acre for No. 1, and one acre and two-thirds for the intervening numbers, the whole water would be three acres. Upon this calculation the stock of No. 1 at 8*d*. per pound, would be worth 23*l*. 6*s*. 8*d*. per annum, and the expence annually of changing the fish from No. 5 to 4, &c. will not exceed 1*l*. 6*s*. 8*d*. So that the value of each acre would be at lowest 7*l*. 6*s*. 8*d*. annually.

No. 1 being supposed to be near the house, and at no great distance from the garden, if the fish should not thrive sufficiently, which will be seen by the disproportioned size of the head, and the whiteness or paleness of the scales, they may easily be supplied with more food by loose peas from the garden, the sweeping of the granary, worms saved by the gardener in digging, and the offal of the poultry killed for the kitchen; or by letting down the water about two feet, in the spring or summer, where there is a sufficient supply, and sowing the sides with oats, barley, rye, or wheat, very lightly raked in, and then stopping the sluice again.

In ponds already stocked, but not accurately regulated, it would be advisable to begin with that which has the most pike, otherwise with No. 4, or what is intended for No. 4, and throw all the fish under five inches length into No. 5, and the larger, according to their sizes, into the other numbers: and so on with No. 3, 2, 1.

Store-fish procured elsewhere, if taken in summer, should be moved in the night in clean straw, wetted occasionally after they are packed: except perch and pike, which can only be carried in clean pond or river water. In moving fish from one pond to another, they should be first put into tubs of water already prepared for them, and afterwards carried in buckets without water. In taking pike or perch, great care must be observed to avoid raising mud in the water.

In breeding-ponds, all water-fowls, as geese, ducks, &c. should be discouraged; and herons carefully destroyed. If any white fish, as roach, dace, &c. should be found, they are to be taken out; and if there is a spare piece of water for large pike they should be put into it as food for the pike.

Eels may be put with advantage into any except the breeding-ponds, in lieu of perch. The most easy way of taking them is by trimmers laid overnight, baited with small fish, not with worms; otherwise they may catch the carp; or a small thief-net may be baited with white fish.

Common sewers and drains from the laundry are prejudicial to fish: so are the leaves falling from trees in great quantities. The use of grains should likewise be avoided in large quantities, as having little nutriment whilst they are thus washed with water.

It seems better for the use of the table, as well as more humane, to kill fish designed for food by an incision with a sharp-pointed penknife, or punctures made with a pin longitudinally into the brain, about half an inch or an inch, according to the size of the fish, above the eyes. As this produces an instantaneous effect, it would probably save the cruel operation of crimping or flaying fish while alive, as in the case of pike and eels.

It is obvious, that this method of regulating fish will apply with its full effect in larger spaces of water: it will likewise apply in a considerable degree to smaller pieces, even where the change is but from a pond for the use of cattle to a single canal in a garden.

In situations near the great inland manufactures, and near the turnpike roads leading from an easy distance to the metropolis, water may be made by this kind of management, with little trouble or expence, to produce a large annual rent.

FISHERMEN. There shall be a master, wardens, and assistants of the fishmongers' company in London chosen yearly, at the next court of the lord mayor and aldermen after the 10th of June, who are constituted a court of assistants; and they shall meet once a month at their common hall to regulate abuses in fishery, register the names of fishermen, and mark their boats, &c.

FISHERY, a place where great numbers of fish are caught.

The principal fisheries for salmon, herring, mackrel, pilchards, &c. are along the coasts of England, Scotland, and Ireland; for cod, on the banks of Newfoundland; for whales, about Greenland; and for pearls, in the East and West Indies.

FISHERY, *free*, in law, or an exclusive right of fishing in a public river, is a royal franchise; and is considered as such in all countries where the feodal polity has prevailed: though the making such grants, and by that means appropriating, what it seems unnatural to restrain, the use of running water, was prohibited for the future by Magna Charta; and the rivers that were fenced in king John's time were directed to be laid open, as well as the forests to be disforested. This opening was extended by the second and third charters of Henry III. to those also that were fenced under Richard I.; so that a franchise of free fishery ought now to be as old at least as the reign of Henry II. This differs, as judge Blackstone observes, from a several of piscary, because he that has a several fishery must also be the owner of the soil, which in a free fishery is not requisite. It differs also from a common fishery, in that the free fishery is an exclusive right, the common is not so; and therefore, in a free fishery, a man has a property in the fish before they are caught; in a common piscary, not till afterwards. Some indeed have considered a free fishery not as a royal franchise, but merely as a private grant of a liberty to fish in the several fishery of the grantor. But the considering such right as originally a flower of the prerogative, till restrained by Magna Charta, and derived by royal grant (previous to the reign of Richard I.) to such as now claim it by prescription, may remove some difficulties in respect to this matter with which our law-books are embarrassed.

FISHERY, denotes also the commerce of fish, more particularly the catching them for sale. Were we to enter into a very minute consideration of the fisheries established in this kingdom, this article would swell beyond its proper bounds; since fisheries, however, if successful, are not only objects of great commercial importance, but also contribute materially to our naval strength, by becoming permanent nurseries for seamen, we shall take notice of some of the most considerable of the British fisheries, and the institutions set on foot for their support.

The situation of the British coasts is the

most advantageous in the world for catching fish: the Scottish islands, particularly those to the north and west, lie most commodious for carrying on the fishing trade to perfection. Of these advantages the Scots seem indeed to have been abundantly sensible; for their traffic in herrings is even noticed in history so early as the ninth century. The frequent laws which were enacted in the reigns of James III. IV. and V. discover a steady determined zeal for the benefit of the country, and the full restoration of these fisheries, which the Dutch had found means to engross.

The Scottish fisheries were, however, more particularly indebted to the zealous encouragement of James V. and VI.; the former having planned, and the latter carried into execution, various projects for their extension. The well-meant efforts of James VI. were impeded, and at last wholly suspended, by the disputes which prevailed in the kingdom at that period concerning the succession. Nevertheless the plan was resumed by Charles I. who "ordained an association of the three kingdoms, for a general fishing within the seas and coasts of his majesty's said kingdoms; and for the government of the said association, ordained, that there should be a standing committee chosen and nominated by his majesty and his successors from time to time," &c. Several persons of distinction embarked in the design, which the king honoured with his patronage, and encouraged by his bounty. He also ordered Lent to be more strictly observed; prohibited the importation of fish taken by foreigners; and agreed to purchase from the company his naval stores, and the fish for his fleets. Thus the scheme for establishing a fishery in the Hebrides began to assume a favourable aspect; but all the hopes of the adventurers were frustrated by the breaking out of the civil wars, and the very tragical death of their benefactor.

In 1661, Charles II., the duke of York, lord Clarendon, and other persons of rank and fortune, resumed the business of the fisheries with greater vigour than any of their predecessors. For this purpose, the most salutary laws were enacted by the parliaments of England and Scotland; in virtue of which, all materials used in, or depending upon, the fisheries, were exempted from all duties, excises, or imposts whatever. In England, the company were authorised to set up a lottery, and to have a voluntary collection in all parish churches. Houses of entertainment, as taverns, inns, ale-houses, were to take one or more barrels of herrings, at the stated price of 30*s.* per barrel: also 2*s.* 6*d.* per barrel Dutch was to be paid to the company on all imported fish taken by foreigners. Some families were also invited, or permitted, to settle at Stornaway: the herrings cured by the royal English company gave general satisfaction, and, as mentioned above, brought a high price for those days. Every circumstance attending this new establishment seemed the result of a judicious plan and thorough knowledge of the business, when the necessities of the king obliged him to withdraw his subscription or bounty; which gave such umbrage to the parties concerned, that they soon after dissolved.

In 1677, a new royal company was established in England, at the head of which were the duke of York, the earl of Derby, &c. Besides all the privileges which former companies had enjoyed, the king granted this new company a perpetuity, with power to purchase lands; and also 20*l.* to be paid them annually, out of the customs of the port of London, for every dogger or buss they should build and send out for seven years to come. A stock of 10,980*l.* was immediately advanced, and afterwards 1600*l.* more. This small capital was soon exhausted in purchasing and fitting out busses, with other incidental expences. The company made, however, a successful beginning; and one of their busses or doggers actually took and brought home 32,000 cod fish; other vessels had also a favourable fishery. Such flattering beginnings might have excited fresh subscriptions, when an unforeseen event ruined the whole beyond the possibility of recovery. Most of the busses had been built in Holland, and manned with Dutchmen; on which pretence the French, who were then at war with Holland, seized six out of seven vessels, with their cargoes and fishing-tackle: and the company being now in debt, sold in 1680 the remaining stores, &c. A number of gentlemen and merchants raised a new subscription of 60,000*l.* under the privileges and immunities of the former charter. This attempt also came to nothing, owing to the death of the king, and the troubles of the subsequent reign.

Soon after the Revolution this business was again resumed upon a more extensive scale; the proposed capital being 300,000*l.* of which 100,000*l.* was to have been raised by the surviving patentees or their successors, and 20,000*l.* by new subscribers. Copies of the letters patent, the constitution of the company, and terms of subscription, were lodged at sundry places in London and Westminster for the perusal of the public, while the subscription was filling. It is probable that king William's partiality to the Dutch fisheries, the succeeding war, or both of these circumstances, frustrated this new attempt; of which we have no further account in the annals of that reign or since.

The Scottish parliament had also, during the last three reigns, passed various acts for erecting companies and promoting the fisheries; but the intestine commotions of that country, and the great exertions which were made for the Darien establishment, enfeebled all other attempts, whether collectively or by individuals, within that kingdom.

In 1749, his late majesty, having, at the opening of the parliament, warmly recommended the improvement of the fisheries, the house of commons appointed a committee to inquire into the state of the herring and white fisheries, and to consider of the most probable means of extending the same. All ranks of men were elevated with an idea of the boundless riches that would flow into the kingdom from this source. A subscription of 500,000*l.* was immediately filled in the city, by a body of men who were incorporated for 21 years by the name of The Society of the Free British Fishery. Every encouragement was held out by government, both to the society and to individuals, who might embark in this national business. A bounty of 36*s.* per ton was to be paid annually out of the customs, for 14 years, to the owners of all decked vessels or busses, from 20 to 80 tons burden, which should be built after the commencement of the act, for the use of, and fitted out and employed in, the said fisheries, whether by the society or any other persons. At the same time numerous pamphlets and newspaper-essays came forth; all pretending to elucidate the subject, and to convince the public with what facility the herring-fisheries might be transferred from Dutch to British hands. This proved, however, a more arduous task than had been foreseen by superficial speculators. The Dutch were frugal in their expenditures and living; perfect masters of the arts of fishing and curing, which they had carried to the greatest height and perfection. They were in full possession of the European markets; and their fish, whether deserving or otherwise, had the reputation of superior qualities to all others taken in our seas. With such advantages, the Dutch not only maintained their ground against this formidable company, but had also the pleasure of seeing the capital gradually sinking, without having procured an adequate return to the adventurers; notwithstanding various aids and efforts of government from time to time in their favour, particularly in 1757, when an advance of 20*s.* per ton was added to the bounty.

In 1786 the public attention was again called to the state of the British fisheries, by the suggestions of Mr. Dempster in the house of commons, and by different publications that appeared upon the subject: in consequence of which, the minister suffered a committee to be named, to inquire into this great source of national wealth. To that committee it appeared, that the best way of improving the fisheries was, to encourage the inhabitants living nearest to the seat of them to become fishers. And it being found that the north-western coast of the kingdom, though abounding with fish and fine harbours, was utterly destitute of towns, an act was passed for incorporating certain persons therein named, by the style of "The British Society for extending of the fisheries, and improving the sea-coasts of this kingdom;" and to enable them to subscribe a joint stock, and therewith to purchase lands, and build thereon free towns, villages, and fishing-stations in the Highlands, and islands in that part of Great Britain called Scotland, and for other purposes. The isle of Mull, Loch-Broom, the Isles of Sky and of Canay, have already been marked as proper situations for some of these towns. The progress of such an undertaking from its nature must be slow, but still slower when carried on with a limited capital arising from the subscriptions of a few public-spirited individuals. But it is not to be doubted that it will ultimately tend to the increase of our fisheries, and to the improvement of the Highland part of this kingdom. Its tendency is also to lessen the emigration of a brave and industrious race of inhabitants, too many of whom have already removed with their families to America.

Anchovy-Fishery. The anchovy is caught in the months of May, June, and July, on the coasts of Catalonia, Provence, &c. at which season it constantly repairs up the straits of Gibraltar into the Mediterranean.

Collins says they are also found in plenty on the western coasts of England and Wales.

The fishing for them is chiefly in the night-time; when a light being put on the stern of their little fishing-vessels, the anchovies flock round, and are caught in the nets. But then it is asserted to have been found by experience, that anchovies taken thus by fire, are neither so good, so firm, nor so proper for keeping, as those which are taken without fire.

When the fishery is over, they cut off the heads, take out their gall and guts, and then lay them in barrels, and salt them. The common way of eating anchovies is with oil, vinegar, &c. in order to which they are first boned, and the tails, fins, &c. slipped off. Being put on the fire, they dissolve almost in any liquor. Or they are made into sauce by mincing them with pepper, &c. Some also pickle anchovies in small delft or earthen pots, made on purpose, of two or three pounds weight, more or less, which they cover with plaister to keep them the better. Anchovies should be chosen small, fresh pickled, white on the outside and red within. If genuine, they have round backs; for those which are flat or large are often nothing but sardines. Besides these qualities, the pickle, on opening the pots or barrels, should be of a good taste, and not have lost its flavour.

Cod-Fishery. There are two kinds of cod-fish; the one green or white cod; the other dried or cured cod; though it is all the same fish differently prepared; the former being sometimes salted and barrelled, then taken out for use; and the latter having lain for a competent time in salt, and then dried in the sun or smoke.

The chief fisheries for green cod are in the bay of Canada, on the great bank of Newfoundland, and on the isle of St. Peter, and the isle of Sable; to which places vessels resort from many parts both of Europe and America. They are from 100 to 150 tons burthen, and will catch between 30,000 and 40,000 cod each. The most essential part of the fishery is, to have a master who knows how to cut up the cod, one who is skilled to take off the head properly, and above all a good salter, on which the preserving of them, and consequently the success of the voyage, depend. The best season is from the beginning of February to the end of April; the fish, which in the winter retire to the deepest water, coming then on the banks, and fattening extremely. What are caught from March to June keep well; but those taken in July, August, and September, when it is warm on the banks, are apt to spoil soon. Each fisher takes but one at a time, yet the most expert will take from 350 to 400 in a day; but that is the most, the weight of the fish and the great coldness on the bank fatiguing very much. As soon as the cod are caught, the heads are taken off; they are opened, gutted, and salted; and the salter stows them in the bottom of the hold, head to tail, in beds a fathom or two square; putting layers of salt and fish alternately, but never mixing fish caught on different days. When they have lain thus three or four days to drain off the water, they are placed in another part of the ship, and salted again; where they remain till the vessel is loaded. Sometimes they are cut in thick pieces, and put in barrels for the greater convenience of carriage.

The principal fishery for dry cod is, from Cape Rose to the Bay des Exports, along the coast of Placentia, in which compass there are several commodious ports for the fish to be dried in. These, though of the same kind with the fresh cod, are much smaller, and therefore fitter to keep, as the salt penetrates more easily into them. The fishery of both is much alike; only this latter is most expensive, as it takes up more time, and employs more hands, and yet scarcely half so much salt is spent in this as in the other. The bait is herring, of which great quantities are taken on the coast of Placentia. When several vessels meet and intend to fish in the same port, he whose shallop first touches ground, becomes entitled to the quality and privileges of admiral: he has the choice of his station, and the refusal of all the wood on the coast at his arrival. As fast as the masters arrive, they unrig all their vessels, leaving nothing but the shrouds to sustain the masts; and in the mean time the mates provide a tent on shore covered with branches of trees, with sails over them, with a scaffold of great trunks of pines, 12, 15, 16, and often 20 feet high, commonly from 40 to 60 feet long, and about one-third as much in breadth. While the scaffold is preparing, the crew are fishing; and as fast as they catch, they bring their fish ashore, and open and salt them upon moveable benches; but the main salting is performed on the scaffold. When the fish have taken salt, they wash and hang them to drain on rails; when drained, they are laid on a sort of stages, which are small pieces of wood laid across, and covered with branches of trees, having the leaves stripped off for the passage of the air. On these stages they are disposed, a fish thick, head against tail, with the back uppermost, and are turned carefully every 24 hours. When they begin to dry, they are laid in heaps 10 or 12 thick, in order to retain their warmth; and every day the heaps are enlarged, till they become double their first bulk; then two heaps are joined together, which they turn every day as before; lastly, they are salted again, beginning with those first salted; and being laid in huge piles, they remain in that situation till they are carried on board the ships, where they are laid on the branches of trees disposed for that purpose, upon the ballast, and round the ship, with mats to prevent their contracting any moisture.

The cod supplies four kinds of commodities, viz. the sounds, the tongues, the roes, and the oil, which is extracted from its liver. The first are salted at the fishery, together with the fish, and put in barrels of from 600 to 700 pounds. The tongues are cured in like manner, and brought in barrels of from 400 to 500 pounds. The roes are also salted in barrels, and serve to cast into the sea to draw fish together, and particularly pilchards. The oil comes in barrels of from 400 to 520 pounds and is used in dressing leather. In Scotland, they catch a small kind of cod on the coasts of Buchan, and all along the Murray Frith on both sides; as also in the Frith of Forth, Clyde, &c. which is much esteemed. They salt and dry them in the sun upon rocks, and sometimes in the chimney.

Herring-Fishery. Our great stations for this fishery are off the Shetland and Western isles, and off the coast of Norfolk, in which the Dutch also share. See the article CLUPEA. There are two seasons for herring-fishing: the first from June to the end of August; and the second in autumn, when the fogs become very favourable for this kind of fishing. The Dutch begin their herring-fishing on the 24th of June, and employ a vast number of vessels called busses, between 54 and 60 tons burden each, and carrying three or four small guns. They never stir out of port without a convoy, unless there are enough together to make about 18 or 20 cannon among them, in which case they are allowed to go in company. Before they go out, they make a verbal agreement, which has the same force as if it was in writing. The regulations of the admiralty of Holland have been partly followed by the French and other nations, and partly improved and augmented with new ones; as, that no fisher shall cast his net within 100 fathoms of another boat: that while the nets are cast, a light shall be kept on the hind part of the vessel: that when a boat is by any accident obliged to leave off fishing, the light shall be cast into the sea: that when the greater part of a fleet leaves off fishing, and casts anchor, the rest shall do the same, &c.

In the late king's reign, very vigorous efforts were made, and bounties allowed, for the encouragement of the British herring-fisheries: the first was, of 30*s.* per ton to every buss of 70 tons and upwards. This bounty was afterwards raised to 50*s.* per ton, to be paid to such adventurers as were entitled to it by claiming it at the place of rendezvous. The busses are from 20 to 90 tons burden, but the best size is 80. A vessel of 80 tons ought to take ten lasts, or 120 barrels of herrings, to clear expences, the price of the fish to be admitted to be a guinea a barrel. A ship of this size ought to have 18 men, and three boats; one of 20 tons should have six men, and every five tons above require an additional hand. To every ton are 250 yards of net; so a vessel of 80 tons carries 20,000 square yards; each net is 12 yards long, and 10 deep; and every boat takes out from 20 to 30 nets, and puts them together, so as to form a long train; they are sunk at each end of the train by a stone, which weighs it down to the full extent: the top is supported by buoys made of sheep-skin, with a hollow stick at the mouth, fastened tight; through this the skin is blown up, and then stopped with a peg, to prevent the escape of the air. Sometimes these buoys are placed at the top of the nets; at other times the nets are suffered to sink deeper, by lengthening the cords fastened to them, every cord being for that purpose 10 or 12 fathoms long. But the best fisheries are generally in more shallow water.

Of the Scots fishery in the Western Isles, the following account is given by Mr. Pennant: "The fishing is always performed in the night, unless by accident. The busses remain at anchor, and send out their boats a little before sunset; which continue out, in winter and summer, till daylight; often taking up and emptying their nets, which they do 10 or 12 times in a night, in case of good success. During winter it is a most

dangerous and fatiguing employ, by reason of the greatness and frequency of the gales in these seas, and in such gales are the most successful captures; but by the providence of Heaven, the fishers are seldom lost, and what is wonderful, few are visited with illness. They go out well prepared, with a warm great coat, boots, and skin aprons, and a good provision of beef and spirits. The same good fortune attends the busses, which in the tempestuous season, and in the darkest nights, are continually shifting in these narrow seas from harbour to harbour. Sometimes 80 barrels of herrings are taken in a night by the boats of a single vessel. It once happened, in Loch-Slappan in Skie, that a buss of 80 tons might have taken 200 barrels in one night, with 10,000 square yards of net; but the master was obliged to desist, for want of a sufficient number of hands to preserve the capture. The herrings are preserved by salting after the entrails are taken out. The last is an operation performed by the country people, who get three-halfpence per barrel for their trouble, and sometimes, even in the winter, can gain fifteeen-pence a day. This employs both women and children; but the salting is only entrusted to the crew of the busses. The fish are laid on their backs in the barrels, and layers of salt between them. The entrails are not lost, for they are boiled into an oil; 8000 fish will yield ten gallons, valued at one shilling the gallon. A vessel of 80 tons takes out 244 barrels of salt; a drawback is allowed for each barrel used by the foreign or Irish exportation of the fish; but there is a duty per barrel for the home-consumption, and the same for those sent to Ireland. The barrels are made of oak staves, chiefly from Virginia; the hoops from several parts of our own island, and are either of oak, birch, hazel, or willow; the last from Holland, liable to a duty. The barrels cost about 3*s.* each; they hold from 500 to 800 fish, according to the size of the fish; and are made to contain 32 gallons. The barrels are inspected by proper officers: a cooper examines if they are statutable and good; if faulty he destroys them, and obliges the maker to stand to the loss."

Herrings are cured either white, (*i. e.* pickled) or red. Of the first, those done by the Dutch are the most esteemed, being distinguished into four sorts, according to their sizes; and the best are those that are fat, fleshy, firm, and white, salted the same day they are taken with good salt and well barrelled. The British-cured herrings are little inferior if not equal to the Dutch; for, in spite of all their endeavours to conceal the secret, their method of curing, lasting, or casking the herrings, has been discovered, and is as follows. After they have hauled in their nets, which they drag in the stern of their vessel backwards and forwards in traversing the coast, they throw them upon the ship's deck, which is cleared of every thing for that purpose: the crew is separated into divisions, and each division has a peculiar task; one part opens and guts the herrings, leaving the melts and roes; another cures and salts them, by lining or rubbing their inside with salt; the next packs them, and between each row and division they sprinkle handfuls of salt; lastly, the cooper puts the finishing hand to all, by heading the casks very tight and stowing them in the hold. Red-herrings must lie 24 hours in the brine, inasmuch as they are to take all their salt there; and when they are taken out, they are spitted, that is, strung by the head on little wooden spits, and then hung in a chimney made for that purpose. After which, a fire of brush wood, which yields much smoke but no flame, being made under them, they remain there till sufficiently smoked and dried, and are afterwards barrelled up for keeping.

Lobster-Fishery. Lobsters are taken along the British channel, and on the coast of Norway, whence they are brought to London for sale; and also in the frith of Edinburgh, and on the coast of Northumberland. See the article CANCER. By 10 and 11 W. III. c. 24. no lobster is to be taken under eight inches in length, from the peak of the nose to the end of the middle fin of the tail; and by 9 G. II. cap. 33. no lobsters are to be taken on the coast of Scotland from the first of June to the first of September.

Mackrel-Fishery. The mackrel is a summer fish of passage, found in large shoals, in different parts of the ocean, not far north; but especially on the French and English coasts. The fishing is usually in the months of April, May, and June, and even July, according to the place. See SCOMBER. They enter the English Channel in April, and proceed up to the straits of Dover as the summer advances; so that by June they are on the coasts of Cornwall, Sussex, Normandy, Picardy, &c. where the fish is most considerable. They are an excellent food fresh; and not to be despised when well prepared, pickled, and put up in barrels; a method of preserving them chiefly used in Cornwall. The fish is taken in two ways; either with a line or nets: the latter is the more considerable, and is usually performed in the night-time. The rules observed in the fishing for mackrel are much the same as those already mentioned in the fishery of herrings.

There are two ways of pickling them: the first is, by opening and gutting them, and filling the belly with salt, crammed in as hard as possible with a stick; which done they range them in strata or rows, at the bottom of the vessel, strewing salt between the layers. In the second way, they put them immediately into tubs full of brine, made of fresh water and salt, and leave them to steep, till they have imbibed salt enough to make them keep; after which they are taken out, and barrelled up, taking care to press them close down. Mackrel are not cured or exported as merchandize, except a few by the Yarmouth and Leostoff merchants, but are generally consumed at home; especially in the city of London, and the sea-ports between the Thames and Yarmouth east, and the Land's-end of Cornwall west.

Oyster-Fishery. This fishery is principally carried on at Colchester in Essex; Feversham and Milton in Kent; the Isle of Wight; the Swales of the Medway; and Tenby on the coast of Wales. From Feversham, and the adjacent parts, the Dutch have sometimes loaded a hundred large hoys with oysters in a year. They are also taken in large quantities near Portsmouth, and in all the creeks and rivers between Southampton and Chichester: many of which are carried about by sea to London and to Colchester, to be fed in the pits about Wavenhoe and other places. See OSTREA.

Pilchard-Fishery. The chief pilchard-fisheries are along the coasts of Dalmatia, on the coast of Bretagne, and along the coasts of Cornwall and Devonshire. That of Dalmatia is very plentiful: that on the coasts of Bretagne employs annually about 300 ships. Of the pilchard-fishery on the coast of Cornwall, the following account is given by Dr. Borlase: "It employs a great number of men on the sea, training them to naval affairs; employs men, women, and children at land, in salting, pressing, washing, and cleaning; in making boats, nets, ropes, casks, and all the trades depending on their construction and sale. The poor are fed with the offals of the captures, the land with the refuse of the fish and salt; the merchant finds the gains of commission and honest commerce, the fisherman the gains of the fish. Ships are often freighted hither with salt, and into foreign countries with the fish, carrying off at the same time part of our tin. Of the usual produce of the great number of hogsheads exported each year for ten years from 1747 to 1756 inclusive, from the four ports of Fowey, Falmouth, Penzance, and St. Ives, it appears that Fowey has exported yearly 1732 hogsheads; Falmouth 14,631 hogsheads and two-thirds; Penzance and Mount's-bay 12,149 hogsheads and one-third; St. Ives 1282 hogsheads; in all amounting to 29,795 hogsheads. Every hogshead for ten years last past, together with the bounty allowed for each hogshead exported, and the oil made out of each hogshead, has amounted one year with another at an average, to the price of 1*l.* 13*s.* 3*d.*: so that the cash paid for pilchards exported has, at a medium, annually amounted to the sum of 49,532*l.* 10*s.*" The numbers that are taken at one shooting out of the nets are amazingly great. Mr. Pennant says, that Dr. Borlase assured him, that on the 5th of October 1767, there were at one time inclosed in St. Ives's bay 7000 hogsheads, each hogshead containing 35,000 fish, in all 245 millions.

The pilchards naturally follow the light, which contributes much to the facility of the fishery: the season is from June to September. On the coasts of France they make use of the roes of the cod-fish as a bait; which, thrown into the sea, makes them rise from the bottom, and run into the nets. On our coasts there are persons posted ashore, who, spying by the colour of the water where the shoals are, make signs to the boats to go among them to cast their nets. When taken, they are brought on shore to a warehouse, where they are laid up in broad piles, supported with backs and sides; and as they are piled, they salt them with bay-salt; in which lying to soak for 30 or 40 days, they run out much blood, with dirty pickle and bittern: then they wash them clean in sea-water; and when dry, barrel and press them hard down to squeeze out the oil, which issues out at a hole in the bottom of the cask.

Salmon-Fishery. The chief salmon-fisheries in Europe are in England, Scotland, and Ireland, in the rivers and sea-coasts adjoining to the river-mouths. The most distinguished for salmon in Scotland are, the

river Tweed, the Clyde, the Tay, the Dee, the Don, the Spey, the Ness, the Bewly, &c. in most of which it is very common, about the height of summer, especially if the weather happens to be very hot, to catch four or five score of salmon at a draught. The chief rivers in England for salmon are, the Tyne, the Trent, the Severn, and the Thames. The fishing is performed with nets, and sometimes with a kind of locks or weirs made on purpose, which in certain places have iron or wooden grates so disposed, in an angle, that being impelled by any force in a contrary direction to the course of the river, they may give way and open a little at the point of contact, and immediately shut again, closing the angle. The salmon, therefore, coming up into the rivers, are admitted into these grates, which open, and suffer them to pass through, but shut again and prevent their return. The salmon is also caught with a spear, which they dart into him when they see him swimming near the surface of the water. It is customary likewise to catch them with a candle and lanthorn, or wisp of straw set on fire; for the fish naturally following the light, are struck with the spear, or taken in a net spread for that purpose, and lifted with a sudden jerk from the bottom.

"The capture of salmon in the Tweed, about the month of July, (says Mr. Pennant) is prodigious. In a good fishery, often a boat-load, and sometimes near two, are taken in a tide: some few years ago there were above 700 fish taken at one haul, but from 50 to 100 is very frequent. The coopers in Berwick then begin to salt the salmon thoroughly in pipes and other large vessels, and afterwards barrel them to send abroad, having then far more than the London markets can take off their hands.

"Most of the salmon taken before April, or to the setting in of the warm weather, is sent fresh to London in baskets; unless now and then the vessel is disappointed by contrary winds of sailing immediately; in which case the fish is brought ashore again to the coopers' offices, and boiled, pickled, and kitted, and sent to the London markets by the same ship, and fresh salmon put in the baskets in lieu of the stale ones. At the beginning of the season, when a ship is on the point of sailing, a fresh clean salmon will sell from a shilling to eighteen pence a pound; and most of the time that this part of the trade is carried on, the prices are from five to nine shillings per stone; the value rising and falling according to the plenty of fish, or the prospect of a fair or foul wind. Some fish are sent in this manner to London the latter end of September, when the weather grows cool; but then the fish are full of large roes, grow very thin-bellied, and are not esteemed so palatable.

"The season for fishing in the Tweed begins November 30th, but the fishermen work very little till after Christmas: it ends on Michaelmas-day; yet the corporation of Berwick (who are conservators of the river) indulge the fishermen with a fortnight past that time, on account of the change of the style.

"There are on the river 41 considerable fisheries, extending upwards, about 14 miles from the mouth (the others above being of no great value), which are rented for near 3400*l.* per annum: the expence attending the servants' wages, nets, boats, &c. amounts to 5000*l.* more; which together makes up the sum 10,400*l.* Now, in consequence, the produce must defray all, and no less than 20 times that sum of fish will effect it; so that 208,000 salmon must be caught there one year with another.

"Scotland possesses great numbers of fine fisheries on both sides of that kingdom. The Scotch in early times had most severe laws against the killing of this fish: for the third offence was made capital, by a law of James IV. Before that, the offender had power to redeem his life. They were thought in the time of Henry VI. a present worthy of a crowned head; for in that reign the queen of Scotland sent to the duchess of Clarence 10 casks of salted salmon, which Henry directed to pass duty-free. The salmon are cured in the same manner as at Berwick, and a great quantity is sent to London in the spring; but after that time, the adventurers begin to barrel and export them to foreign countries; but we believe that commerce is far less lucrative than it was in former times, partly owing to the great increase of the Newfoundland fishery, and partly to the general relaxation of the discipline of abstinence in the Romish church.

"Ireland (particularly the north) abounds with this fish; the most considerable fishery is at Cranna, on the river Ban, about a mile and a half from Coleraine. When I made the tour of that hospitable kingdom in 1754, it was rented by a neighbouring gentleman for 620*l.* a year; who assured me, that the tenant, his predecessor, gave 1600*l.* per annum, and was a much greater gainer by the bargain, for the reasons before-mentioned, and on account of the number of poachers who destroy the fish in the fence-months.

"The mouth of this river faces the north; and is finely situated to receive the fish that roam along the coast in search of an inlet into some fresh water, as they do all along that end of the kingdom which opposes itself to the northern ocean. We have seen near Ballicastle, nets placed in the sea at the foot of the promontories that jut into it, which the salmon strike into as they are wandering close to shore; and numbers are taken by that method.

"In the Ban they fish with nets 18 score yards long, and are continually drawing night and day the whole season, which we think lasts about four months, two sets of 16 men each alternately relieving one another. The best drawing is when the tide is coming in; we were told, that in a single draught there were once 840 fish taken.

"A few miles higher up the river is a weir, where a considerable number of fish that escape the nets are taken. We were lately informed, that in the year 1760, about 320 tons were taken in the Cranna fishery."

With regard to the manner of curing salmon when the fish are taken, they are opened along the back, the guts and gills, and the greatest part of the bones removed, so as to make the inside as smooth as possible. They then salt the fish in large tubs for the purpose, where they lie a considerable time soaking in brine; and about October, they pack them close up in barrels, and send them to London or up the Mediterranean. They have also in Scotland a great deal of salmon salted in the common way, which after soaking in brine a competent time is well pressed, and then dried in smoke: this is called kipper, and is chiefly made for home consumption; and if properly cured and prepared, is reckoned very delicious.

Sturgeon-Fishery. See ACCIPENSER. The greatest sturgeon-fishery is in the mouth of the Volga, on the Caspian sea; where the Muscovites employ a great number of hands, and catch them in a kind of inclosure formed by huge stakes representing the letter Z repeated several times. These fisheries are open on the side next the sea, and close on the other, by which means the fish ascending in its season up the river, is embarrassed in these narrow angular retreats, and is easily killed with a harping-iron. Sturgeons, when fresh, eat deliciously; and in order to make them keep, they are salted or pickled in large pieces, and put in cags of from 30 to 50 pounds. But the great object of this fishery is the roe, of which the Muscovites are extremely fond, and of which is made the cavear, or kavia, so much esteemed by the Italians. See CAVEAR.

Tunny-Fishery. The tunny (a species of SCOMBER, which see) was a fish well-known to the antients, and made a great article of commerce: and there are still very considerable tunny-fisheries on the coasts of Sicily, as well as several other parts of the Mediterranean. The nets are spread over a large space of sea by means of cables fastened to anchors, and are divided into several compartments. The entrance is always directed, according to the season, towards that part of the sea from which the fish are known to come. A man placed upon the summit of a rock high above the water, gives the signal of the fish being arrived; for he can discern from that elevation what passes under the waters infinitely better than any person nearer the surface. As soon as notice is given that the shoal of fish has penetrated as far as the inner compartment, or the chamber of death, the passage is drawn close, and the slaughter begins. The undertakers of these fisheries pay an acknowledgment to the king, or the lord upon whose land they fix the main stay or foot of the tonnara; they make the best bargain they can; and till success has crowned their endeavours, obtain this leave for a small consideration; but the rent is afterwards raised in proportion to their capture.

The tunny enters the Mediterranean about the vernal equinox, travelling in a triangular phalanx, so as to cut the waters with its point, and to present an extensive base for the tides and currents to act against and impel forwards. These fish repair to the warm seas of Greece to spawn, steering their course thither along the European shores, but as they return, approach the African coast; the young fry is placed in the van of the squadron as they travel. They come back from the east in May, and abound on the coast of Sicily and Calabria about that time. In autumn they steer northward, and frequent the neighbourhood of Amalfi and Naples; but during the whole season stragglers are occasionally caught. When taken in May, the usual time of their appearance in the Calabrian bays, they are full of spawn, and their flesh is then esteemed unwholesome, apt to occasion head-achs and flatulen-

cy; the milts and roes are particularly so at that season. To prevent these bad effects, the natives fry them in oil, and afterwards salt them. The quantity of this fish consumed annually in the two Sicilies almost exceeds the bounds of calculation. From the beginning of May to the end of October it is eaten fresh, and all the rest of the year it is in use salted. The most delicate part is the muzzle. The belly salted was called tarantallum, and accounted a great delicacy by the Romans; its present name is surra. The rest of the body is cut into slices, and put into tubs.

Turbot-Fishery. Turbots grow to a large size, viz. from 23 to 30 pounds. They are taken chiefly off the north coast of England, and others off the Dutch coast. The large turbot (as well as several other kinds of flat fish) are taken by the hook and line, for they lie in deep water; the method of taking them in weirs or staked nets being very precarious. When the fishermen go out to sea, each person is provided with three lines, which are coiled on a flat oblong piece of wicker-work; the hooks being baited, and placed regularly in the centre of the coil. Each line is furnished with 14 score of hooks, at the distance of six feet two inches from each other. The hooks are fastened to the lines upon sneads of twisted horsehair 27 inches in length. When fishing, there are always three men in each coble, and consequently nine of these lines are fastened together, and used as one line, extending in length near three miles, and furnished with 2520 hooks. An anchor and a buoy are fixed at the first end of the line, and one more of each at the end of each man's lines; in all four anchors, which are commonly perforated stones, and four buoys made of leather or cork. The line is always laid across the current. The tides of flood and ebb continue an equal time upon our coast, and, when undisturbed by winds, run each way about six hours; they are so rapid that the fishermen can only shoot and haul their lines at the turn of the tide, and therefore the lines always remain upon the ground about six hours; during which the myxine glutinosa of Linnæus will frequently penetrate the fish that are on the hooks, and entirely devour them, leaving only the skin and bones. The same rapidity of tides prevents their using hand-lines; and therefore two of the people commonly wrap themselves in the sail, and sleep, while the other keeps a strict look-out, for fear of being run down by ships, and to observe the weather. For storms often rise so suddenly, that it is with extreme difficulty they can sometimes escape to the shore, leaving their lines behind.

Besides the coble, the fishermen have also a five-men boat, which is forty feet long and 15 broad, and 25 tons burden; it is so called, though navigated by six men and a boy, because one of the men is commonly hired to cook, &c. and does not share in the profits with the other five. This boat is decked at each end, but open in the middle, and has two large lug-sails. All our able fishermen go in these boats to the herring-fishery at Yarmouth in the end of September, and return about the middle of November. The boats are then laid up till the beginning of Lent, at which time they go off in them to the edge of the Dogger, and other places, to fishfor turbot, cod, ling, skates, &c. They always take two cobles on board; and when they come upon their ground, anchor the boat, throw out the cobles, and fish in the same manner as those do who go from the shore in a coble; with this difference only, that here each man is provided with double the quantity of lines, and instead of waiting the return of the tide in the coble, they return to their boat and bait their other lines; thus hawling one set and shooting another every turn of tide. They commonly run into harbour twice a week to deliver their fish.

The best bait is fresh herring cut in pieces of a proper size: the five-men boats are always furnished with nets for taking them. Next to herrings are the lesser lampreys. The next baits in esteem are small haddocks cut in pieces, sand worms, and limpets, here called flidders; and when none of these can be had, they use bullock's liver. The hooks are two inches and a half long in the shank, and near an inch wide between the shank and the point. The line is made of small cording, and is always tanned before it is used. Turbots are extremely delicate in their choice of baits; for if a piece of herring or haddock has been twelve hours out of the sea, and then used as bait, they will not touch it.

FISHERY, *Whale.* For the natural history of the whale, the importance of the whale-fishery to Britain, and other particulars, see the article BALÆNA.

We shall here only remark, that the legislature, justly considering that trade as of great national importance, bestowed on it at different periods very considerable encouragement. In particular, every British vessel of 200 tons or upwards, bound to the Greenland seas on the whale-fishery, if found to be duly qualified according to the act, obtained a licence from the commissioners of the customs to proceed on such voyage; and on the ship's return, the master and mate making oath that they proceeded on such voyage and no other, and used all their endeavours to take whales, &c. and that all the whale-fins, blubber, oil, &c. imported in their ship, were taken by their crew in those seas, there was allowed 40*s*. for every ton, according to the admeasurement of the ship.

It was afterwards found, however, that so great a bounty was neither necessary to the success of the trade, nor expedient with regard to the public. In 1786, therefore, the acts conferring the said emoluments being upon the point of expiring, the subject was brought under the consideration of parliament; and it was proposed to continue the former measures, but with a reduction of the bounty from 40*s*. to 30*s*. In proposing this alteration, it was stated, "that the sums which this country had paid in bounties for the Greenland fishery amounted to 1,265,461*l*.; that in the last year we had paid 94,858*l*.; and that, from the consequent reduction of the price of the fish, the public at present paid 60 per cent. upon every cargo. In the Greenland fishery there were employed 6000 seamen, and these seamen cost government 13*l*. 10*s*. per man per annum, though we were never able to obtain more than 500 of that number to serve on board our ships of war. Besides, the vast encouragement given to the trade had occasioned such a glut in the market, that it was found necessary to export considerable quantities; and thus we paid a large share of the purchase-money for foreign nations, as well as for our own people, besides supplying them with the materials of several important manufactures." This proposition was opposed by several members, but was finally carried; and the propriety of the measure became very soon apparent. At that time (1786) the number of ships employed from England in the whale-fishery to Davis's Straights and the Greenland seas amounted to 139, besides 15 from Scotland. The proposed alteration took place the next year (1787); and notwithstanding the diminution of the bounty, the trade increased; the number of ships employed the same year from England amounting to 217, and the next year (1788) to 222.

The whale-fishery has of late years been considerably indebted to the introduction of a new kind of harpoon, called the gun-harpoon, which the Society for the Encouragement of Arts have exerted themselves to bring into general use.

FISHING, in general, the art of catching fish, whether by means of nets or spears, or of the line and hook. That which is performed by the net, spear, or harpoon, for fish that go in shoals, has been explained in the preceding articles. That performed by the rod, line, and hook, is usually termed angling; see that article: and for the particular manner of angling for the different kinds of fish, see their respective names. The following, however, require to be mentioned here.

1. The barbel, so called on account of the barb or beard that is under his chaps (see CYPRINUS), though a coarse fish, gives considerable exercise to the angler's ingenuity. They swim together in great shoals, and are at their worst in April, at which time they spawn, but soon come in season: the places whither they chiefly resort, are such as are weedy and gravelly rising grounds, in which this fish is said to dig and root with his nose like a swine. In the summer he frequents the strongest and swiftest currents of waters; as deep bridges, weirs, &c. and is apt to settle himself amongst the piles, hollow places, and moss weeds, and will remain there immoveable: but in winter he retires into deep waters, and helps the female to make a hole in the sands to hide her spawn in, to hinder its being devoured by other fish. He is a very curious and cunning fish; for if his baits are not sweet, clean, well scoured, and kept in sweet moss, he will not bite; but if those are well-ordered and carefully kept, he will bite with great eagerness. The best bait for him is the spawn of a salmon, trout, or any other fish; or a piece of chandler's greaves which has been boiled and washed; he will also take a large lob-worm; and if you would have good sport with him, bait the places where you intend to fish with it a night or two before with tallow-chandler's greaves; and the earlier in the morning, or the later in the evening, that you fish, the better it will be. Your rod and line must be both strong and long, with a running plummet on the line; and let a little bit of lead be placed a foot or more above the hook, to keep the bullet from falling on it: so the bait will be at the bottom, where they always bite; and when the fish takes the bait, your plummet will lie and not choke him. By the bending of your rod you may know when he bites, as also with

your hand you will feel him make a strong snatch; then strike, and you will rarely fail, if you play him well; but if you manage him not dexterously he will break your line. The best time for fishing is about nine in the morning, and the most proper season is the latter part of May, June, July, and the beginning of August.

2. The bleak is an eager fish, caught with all sorts of worms bred on trees or plants; as also with flies, paste, sheep's blood, &c. Bleak may be angled for with half a score of hooks at once, if they can be all fastened on: he will also in the evening take a natural or artificial fly. If the day is warm and clear, there is no fly so good for him as the small fly at the top of the water, which he will take at any time of the day, especially in the evening. But if the day is cold and cloudy, gentles and caddis are the best; about two feet under water. But the best method is with a drabble, thus: tie 8 or 10 small hooks across a line, two inches above one another; the biggest hook the lowermost, (whereby you may sometimes take a better fish) and bait them with gentles, flies, or some small red worms, by which means you may take half a dozen or more at a time; but when you have them they are not worth the catching, except as a bait for a pike, trout, &c.

3. For the bream observe the following directions, which will also apply to carp, tench, or perch fishing. Procure about a quart of large red worms: put them into fresh moss well washed and dried every three or four days, feeding them with fat mould and chopped fennel, and they will be thoroughly scoured in about three weeks.

Let your lines be silk, and silkworm-gut at bottom; let the floats be either swan quills or goose-quills. Let your plumb be a piece of lead in the shape of a spear, with a small ring at the point of it; fasten the lead to the line, and the line-hook to the lead; about ten or twelve inches space between lead and hook will be enough; and take care the lead be heavy enough to sink the float. Having baited your hook well with a strong worm, the worm will draw the hook up and down in the bottom, which will provoke the bream to bite the more eagerly. It will be best to fit up three or four rods and lines in this manner, and set them as will be directed, and this will afford you much the better sport. Find the exact depth of the water if possible, that your float may swim on its surface directly over the lead; then provide the following ground-bait. Take about a peck of sweet gross-ground-malt, and having boiled it a very little, strain it hard through a bag, and carry it to the water-side where you have sounded; and into the place where you suppose the fish resort, there throw in the malt by handfuls squeezed hard together, or rather mixed with a little clay, that the stream may not separate it before it comes to the bottom; and be sure to throw it in at least a yard above the place where you intend the hook shall lie, otherwise the stream will carry it down too far. Do this about nine o'clock at night, keeping some of the malt in the bag, and go to the place about three the next morning, but approach very warily, lest you should be seen by any of the fish; for it is said that they have their sentinels watching on the top of the water, while the rest are feeding below. Having baited your hook so that the worm may crawl to and fro, the better to allure the fish to bite, cast it in at the place where you find the fish to stay most, which is generally in the broadest and deepest part of the river, so that it may rest about the midst of your ground-bait. Cast in your second line so that it may rest a yard above that, and a third about a yard below it. Let your rods lie on the bank with some stones to keep them down at the great ends; and then withdraw yourself, yet not so far but that you can have your eye upon all the floats: and when you see one bitten and carried away, do not be too hasty to run in, but give time to the fish to tire himself, and then touch him gently. When you perceive the float sink, creep to the water-side, and give it as much line as you can. If it is a bream or carp, he will run to the other side. Strike him gently, and hold your rod at a bend a little while, but do not pull, for then you will spoil all; but you must tire them before they can be landed, for they are very shy. If there are any carp in the river, it is an even chance that you take one or more of them; but if there are any pike or perch, they will be sure to visit the ground-bait, though they will not touch it, being drawn together by the great resort of the small fish, and until you remove them, it is in vain to think of taking the bream or carp. In this case, bait one of your hooks with a small bleak, roach, or gudgeon, about two feet deep from your float, with a little red worm at the point of your hook, and if a pike is there he will be sure to snap at it. This sport is good till nine o'clock in the morning, and in a gloomy day till night; but do not frequent the place too much, lest the fish grow shy.

4. The carp. A person who angles for carp, must arm himself with abundance of patience, because of their extraordinary subtilty and shyness: they always choose to lie in the deepest places either of ponds or rivers, where there is but a small running stream. Further, observe, that they will seldom bite in cold weather; and you cannot be too early or too late at the sport in hot weather; yet if he bites you need not fear his hold, for he is one of those leather-mouthed fish that have their teeth in the throat. Neither must you forget, in angling for him, to have a strong rod and line; and since he is so very wary, it will be proper to entice him, by baiting the ground with a coarse paste.

He seldom refuses the red worm in March, the caddis in June, or the grasshopper in July, April, and September. This fish, however, does not only delight in worms, but also in sweet paste, of which there is great variety; the best is made of honey and sugar mixed up with flour, some veal minced fine, and a little cotton or white wool to make it adhere to the hook. Some of it ought to be thrown into the water a few hours before you begin to angle; neither will small pellets thrown into the water two or three days before be worse for this purpose, especially if chickens' guts, garbage, or blood mixed with bran and cow-dung, are also thrown in. If you fish with gentles, anoint them with honey. Honey and crumbs of wheat-bread, mixed together, make also a very good paste; or pellets of wheat-bread alone will answer very well.

In taking a carp either in a pond or river, if the angler intends to add profit to his pleasure, he must take a peck of ale-grains, and a good quantity of any blood to mix with the grains; baiting the ground with it where he intends to angle. This food will wonderfully attract the scale-fish, as carp, tench, roach, dace, and bream. Let him angle in a morning, plumbing his ground, and angling for carp with a strong line: the bait must be either paste or a knotted red worm; and by this means he will have sport enough.

5. The pike is caught either by a live bait, which is cruel, or by a trowl, which is a dead or artificial fish, frog, or mouse, fastened to a double hook with some lead to sink it, and gently played by the hand of the angler so as to imitate life. There are two ways of trowling, at snap or at gorge; at snap, the angler strikes the moment the fish springs at the bait; at gorge he suffers him to carry it to his hole, giving it out line as may be required, and swallow it, and strikes him in about ten minutes.

6. Salmon and trout fishing are nearly alike. The trout is caught with a worm, a minnow, or a fly; but the only elegant sport of this kind is that with the artificial fly, which will be afterwards described.

7. The gudgeon is a small fish, of very delicious taste. It spawns three or four times in the summer season, and feeds in streams, slighting all kinds of flies, but is easily taken with a small red worm, fishing near the ground; and being a leather-mouthed fish, will not easily get off the hook when struck. The gudgeon may be either fished with a float, the hook being on the ground, or by hand, with a running line on the ground without cork or float. He will bite well at wasps, gentles, and cadworms; and a person may fish with two or three hooks at the same time. Before you angle for gudgeons, stir up the sand or gravel with a long pole, which will make them gather to the place, and bite the faster.

8. The tench is a fine fresh-water fish, having very small scales, but large smooth fins, with a red circle about the eyes, and a little barb hanging at each corner of the mouth. It takes more delight among weeds in ponds than in clear rivers, and loves to feed in foul water. His slime is said to have a healing quality for wounded fish, upon which he is called the fishes' physician. When carp, pike, &c. are hurt, it is said they find relief by rubbing themselves against the tench. The season for catching this fish is June, July, and August, very early and late, or even all night, in the still part of the rivers. The bait is a large red worm, at which he bites eagerly, especially if dipped in tar. He delights in all sorts of paste made of strong-scented oils, or tar, or a paste of brown-bread and honey; nor does he refuse the cadworm, lobworm, flagworm, green gentles, cod bait, or soft boiled bread-grain.

9. Smelts are caught at high-tide during the summer and autumn months, with a hook and line, about Limehouse and Poplar. They fish with about ten hooks on the same line, at different depths, each baited with a sm l piece of smelt, and sometimes two or three are caught at once.

An Epitome of the whole ART of FISHING, wherein are shown at one view, the Harbours, Seasons, and Depths, for catching all sorts of Fish usually angled for; also the various Baits for each, so digested at to contain the Essence of all the Treatises ever written on the subject, exempt from the superfluities, which tend more to perplex than instruct.

Names.	Where found.	Season.	Time to angle.	Depth from ground.	Proper Baits.			
					Flies. No.	Pastes. No.	Worms. No.	Fish and Insects. No. 8.
Bream	rough str. river or mid. pond	April to Mich.	sun-rise to 9 3 to sun-set	touch ground	——	1 3	1 to 7	
Barbel	gravel-banks in currents under bridges	April to Aug.	very early or late	ditto	——	2	2 6 7	——
Bleak	sandy bottom, deep rivers, ships' sterns	May to Oct.	all day	6 inches from bottom	1 2	2	2 3 8	——
Carp	still deep mud-bottom, pond or river	May to Aug.	sun-rise to 9 3 to sun-set	3 inches from bottom hot weather, mid-water	——	1 3 4	1 2 3 4 7	——
Chub or Chevin	ditto	May to Dec.	ditto	ditto	1 to 5	2	1 2 4 5	7 8
Dace	sandy bottom, deep rivers, ships' sterns	May to Oct.	all day	6 to 12 inches from bottom	ditto	3 4	1 to 5 & 8	——
Gudgeon	gravel shoals	May to Oct.	ditto	near, or on ground	——	ditto	2 8	——
Pike	near clay-banks	all the year	ditto	mid-water	wh. stro. and snap	line float hook fixt	—— on shore	1 2 3 4 5 6 7
Perch — river in stream	gravel or weedy bottom	May to Aug.	S.-rise to 10 2 to sun-set	ditto	2	1	3 5 7 8	1 6
Perch — pond deepest part		Aug. to May	mid-day	6 inches from bottom				
Pope	deep holes in rivers	May to Oct.	all day	ditto	5	——	all	——
Roach	sandy bottom, deep rivers, ships' sterns	May to Oct.	ditto	6 to 12 inches	1 2 4 5	3 4	ditto	8
Salmon	deep rivers	Mar. to Sept.	8 to 9, 3 to 6	mid-way to the bottom	all large	——	1 5 6 7	1
Smelts	ships' sterns and docks	Apr. to Oct.	all day	mid-way to the bottom variable	all small	——	1 2 5	bits of smelts
Trout	purling stream, and eddies of stony-bottom river	Mar. to Mich.	ditto	cold weather, 6 inches to 9 hot weath. top to mid-wat.	1 to 5	——	1 2 5 to 8	1 8
Tench	mud-bottom, river or pond	all the year	sun-rise to 9 3 to sun-set	cold wea. 3 inch. from bot. hot weather, mid-water	——	1 3 4	1 3 4 to 7	——
Umber or Grayling	clay-bottom, swift stream	all the year	all day	cold weather, 6 to 9 inch. hot weath. top to mid-wat.	1 to 5	——	all	1 8

Description of proper baits for the several sorts of fish referred to in the foregoing table.—Flies. 1. Stone-fly, found under hollow stones at the side of rivers, is of a brown colour, with yellow streaks on the back and belly, has large wings, and is in season from April to July. 2. Green drake, found among stones by river-sides, has a yellow body ribbed with green, is long and slender, with wings like a butterfly, his tail turns on his back, and from May to midsummer is very useful. 3. Oak-fly found in the body of an old oak, or ash, with its head downwards, is of a brown colour, and excellent from May to September. 4. Palmer-fly or worm, rather a hairy caterpillar, found on leaves of plants, and when it comes to a fly is excellent for trout. 5. Ant-fly, found in ant-hills from June to September. 6. The May-fly is to be found playing by the river-side, especially against rain. See EPHEMERA. 7. The black-fly is to be found upon every hawthorn after the buds are fallen off.

Almost the only sport in fishing that may be called so, is fly-fishing. The fly is either natural or artificial.

1. Natural flies are innumerable. The most usual for this purpose are mentioned in the above lines. There are two ways to fish with natural flies; either on the surface of the water, or a little underneath it. In angling for chevin, roach, or dace, move not your natural fly swiftly, when you see the fish make at it; but rather let it glide freely towards him with the stream: but if it be in a still or slow water, draw the fly slowly sideways by him, which will make him eagerly pursue it.

2. The artificial fly is best used when the waters are so troubled by the winds, that the natural fly cannot be seen nor rest upon them. Of artificial flies there are reckoned no less than 12 sorts, of which the following are the principal. 1. For March, the dun-fly, made of dun-wool, and the feathers of the partridge's wing, or the body made of black wool, and the feathers of a black drake. 2. For April, the stone-fly, the body made of black wool, with a little yellow under the wings and tail. 3. For the beginning of May, the ruddy fly, made of red wool, and bound about with black silk, with the feathers of a black capon hanging dangling on his sides next his tail. 4. For June, the greenish fly, the body made of black wool, with a yellow list on either side, the wings taken off the wings of the buzzard, bound with black broken hemp. 5. The moorish fly, the body made of duskish wool, and the wings made of the blackish mail of a drake. 6. The tawny fly, good till the middle of June, the body made of tawny wool, the wings made contrary one against the other, of the whitish mail of a white drake. 7. For July, the wasp-fly, the body made of black wool, cast about with yellow silk, and the wings of drakes' feathers. 8. The steel-fly, good in the middle of July, the body made with greenish wool, cast about with the feathers of a peacock's tail, and the wings made of those of the buzzard. 9. For August, the drake-fly, the body made with black wool cast about with black silk, his wings of the mail of a black drake with a black head. The May-fly is also excellently imitated by the tackle-makers.

The best rules for artificial fly-fishing are, 1. To fish in a river somewhat disturbed with rain: or in a cloudy day, when the waters are moved by a gentle breeze; the south wind is best; and if the wind blows high, yet not so but that you may conveniently guard your tackle, the fish will rise in plain deeps: but if the wind is small, the best angling is in swift streams. 2. Keep as far from the water-side as may be; fish down the stream with the sun at your back, and do not disturb the water with your line. 3. Ever angle in clear rivers with a small fly and slender wings; but in muddy places use a larger. 4. When after rain the water becomes brownish, use an orange fly; in a clear day, a light-coloured fly; a dark fly for dark waters, &c. 5. Let the line be at least twice as long as the rod, unless the river is encumbered with trees. 6. For every sort of fly, have several of the same, differing in colour, to suit with the different complexions of several waters and weathers. 7. Have a nimble eye and active hand, to strike presently with the rising of the fish, or else he will be apt to throw out the hook. 8. Let the fly fall first into the water, and not the line, which will scare the fish. 9. In slow rivers, or still places, cast the fly across the river, and let it sink a little in the water, and draw it gently back with the current. Salmon-flies should be made with their wings standing one behind the other, whether two or four. This fish delights in the gaudiest colours that can be; chiefly in the wings, which must be long, as well as the tail. The best wing is the hackle of the golden pheasant.

Pastes.—1. Take the blood of a sheep, and mix it with honey and flour to a proper consistence. 2. Take old cheese grated, a little butter sufficient to work it, and colour it with saffron; in winter use rusty bacon instead of butter. 3. Crumbs of bread chewed or worked with honey or sugar, moistened with gum-water. 4. Bread chewed, and worked in the hand till it becomes stiff, which with a little cotton wool to make it stick on the hook is the best of all.

Worms.—1. The earth-bob, found in sandy ground after ploughing; it is white, with a red head, and bigger than a gentle; another is found in heathy ground with a blue head. Keep them in an earthen vessel well covered, and a sufficient quantity of the mould they harbour in. They are excellent from April to November. 2. Gentles, to be had from putrid flesh; let them lie in wheat-bran a few days before used. 3. Flag-worms, found in the roots of flags: they are of a pale yellow colour, are longer and thinner than a gentle, and must be scoured like them. 4. Cow-dung, bog, or clap-bait, found under cow-dung from May to Michaelmas; it is like a gentle, but larger. Keep it in its native earth like the earth-bob. 5. Cadis-worm, or cod-bait, found under loose stones in shallow rivers: they are always covered with a case of sticks or small gravel, and when drawn out of their case are yellow, bigger than a gentle, with a black or blue head, and are in season from April to July. Keep them in flannel bags. 6. Lob-worm, found in gardens: it is very large, and has a red head, a streak down the back, and a flat broad tail. 7. Marsh-worms, found in marshy ground; keep them in moss ten days before you use them: their colour is a blueish red; are a good bait from March to Michaelmas. 8. Brandling or red-worms, found in rotten dunghills and tanners' bark; they are red or rather striped worms, very good for all small fish, have sometimes a yellow tail, or a smaller sort are called tag-tails or gilt-tails, they have not the annular stripe of the brandling.

Fish and Insects.—1. Minnow. 2. Gudgeon. 3. Roach. 4. Dace. 5. Smelt. 6. Yellow frog. 7. Snail slit. 8. Grasshopper.

Floats, are little appendages to the line, used for fishing at bottom, and serving to keep the hook and bait suspended at the proper depth, to discover when the fish have hold of them, &c. Of these there are many kinds: some made of quills, which are the best for slow waters; but for strong streams sound cork, without flaws or holes, bored through with a hot iron, into which is put a quill of a fit proportion, is preferable; the cork should be shaped to a pyramidal form, and made smooth.

The fishing-hook, in general, ought to be long in the shank, somewhat thick in the circumference, the point even and straight; the bend should be in the shank. For setting the hook on, use strong but small silk, laying the hair on the inside of the hook; for if it is on the outside, the silk will fret and cut it asunder.

FISSURE *of the bones*, in surgery, is when they are divided either transversely or longitudinally, not quite through, but cracked after the manner of glass, by any external force. See SURGERY.

FISTULA, in the antient music, an instrument of the wind-kind, resembling our flute, or flageolet. See FLUTE.

FISTULA, in surgery, a deep, narrow, and callous ulcer, generally arising from abscesses. See SURGERY.

FISTULARIA, pipe-fish, a genus of the order abdominales. The generic character is, snout cylindric; mouth terminal; body lengthened; gill-membrane seven-rayed.

1. Fistularia tabacaria, or slender fistularia. This highly singular fish seems to have been first described by Marcgrave in his Natural History of Brasil, under the name of petimbuaba. He informs us that it grows to the length of three or four feet, and is of a shape resembling that of an eel, with the mouth toothless and pointed, and the upper lip longer than the lower; the head about nine inches long, from the eyes to the tip of the mouth; the eyes are large and ovate, with a bright-blue pupil and silvery iris, marked on the fore and hind part by a red spot; the skin smooth, like that of an eel, and of a liver-colour marked both above and on each side by a row of blue spots, with greenish ones intermixed. The appearance of the tail is highly singular, being pretty deeply forked, as in the generality of fishes, while from the middle of the furcature springs a very long and thickish bristle or process, of a substance resembling that of whalebone, and gradually tapering to a fine point. A variety has been observed by Dr. Bloch, in which this part was double, and the snout serrated on each side. This variety, or perhaps sexual difference, appears from the observations of Commerson, detailed by Cepede, to be of a brown colour above, and silvery beneath, but without the blue spots so remarkable on the smooth-snouted kind. The count de Cepede informs us that the spine of this fish is of a very peculiar structure; the first vertebra being of immoderate length, the three next much shorter, and the rest gradually decreasing as they approach the tail: he adds that there are no visible ribs.

This species is said to live chiefly on the smaller fishes, sea-insects, and worms, which the structure of its snout enables it readily to obtain by introducing that part into the cavities of the rocks, under stones, &c. where those animals are usually found.

2. Fistularia Chinensis, or Chinese fistularia. Length from three feet to four feet; general shape like that of an eel, but the body thicker in proportion than in the preceding species: head lengthened into a strong cartilaginous, or rather bony and laterally compressed tubular snout, much broader than in the former species: mouth small; eyes rather large; scales of moderate size, strong, and much resembling in their structure those of the genera perca and chætodon; from the middle of the back to the dorsal fin run several strong, short, and rather distant spines: dorsal and anal fin of similar shape, and placed opposite each other, pretty near the tail, which is short, rounded, and marked by a pair of black stripes; pectoral fins rounded: ventral small, and placed considerably beyond the middle of the body: general colour pale reddish-brown, with several deep or blackish spots on various parts of the body, and three or four pale or whitish longitudinal stripes on each side, from the gills to the tail: fins pale yellow. Native of the Indian seas, preying on worms, sea-insects, &c. Though observed only in the tropical seas, yet its fossil impressions have been found under the volcanic strata of mount Bolca in the neighbourhood of Verona.

3. Fistularia paradoxa, paradoxical fistularia. A small species, described by Seba, and more accurately by Dr. Pallas. Length from two to four inches: body angular, and beset at the interstices of the lines with small spines: head small: eyes large, and situated at the base of the snout, which much resembles that of a syngnathus, and is long, slightly descending, straight, horny, compressed, sharp above, and bicarinated beneath: it is armed on each side, near the base, by a small conic spine. It is a native of the Indian seas.

FIT, in medicine, denotes much the same with paroxysm. See PAROXYSM.

FITS *of easy reflection and transmission.* See OPTICS.

FITCHEE', in heraldry, a term applied to a cross, when the lower end of it is sharpened into a point.

FIXED BODIES are those which bear a considerable degree of heat without evaporating, or losing any of their weight. See CHEMISTRY.

FIXED AIR. See AIR, CARBONIC ACID GAS, and CHEMISTRY.

FIXED STARS. See ASTRONOMY.

FLACOURTIA, a genus of the class and order dioecia polyandria. The male calyx is five-parted; corolla none; stamina very numerous. Female calyx many-leaved; corolla none; germen superior. Styles 5 to 9. Berry many-celled. There is one species, a small tree of Madagascar, bearing an eatable fruit in some degree resembling a plumb.

FLAG, a general name for colours, standards, antients, banners, ensigns, &c. which are frequently confounded with each other.

The fashion of pointed, or triangular flags, as now used, came from the Mahometan Arabs, or Saracens, upon their seizing of Spain, before which time all the ensigns of war were stretched, or extended on cross pieces of wood, like the banners of a church. The pirates of Algiers, and throughout the coasts of Barbary, bear an hexagonal flag.

FLAG, is more particularly used at sea, for the colours, antients, standards, &c. borne on the top of the masts of vessels, to notify the person who commands the ship, of what nation it is, and whether it is equipped for war or trade.

The admiral in chief carries his flag on the main top; and the vice-admiral on the fore-top; and the rear-admiral on the mizen top.

When a council of war is to be held at sea, if it is on board the admiral, they hang a flag in the main shrouds; if in the vice-admiral, in the fore shrouds; and if in the rear-admiral, in the mizen shrouds.

Beside the national flag, merchant-ships frequently bear lesser flags on the mizen mast, with the arms of the city where the master ordinarily resides: and on the fore-mast, with the arms of the place where the person who freights them lives.

To lower, or strike the FLAG, is to pull it down upon the cap, or to take it in, out of

respect, or submission, due from all ships or fleets inferior, to those any way justly their superiors. To lower or strike the flag in an engagement is a sign of yielding.

The way of leading a ship in triumph is to tie the flags to the shrouds or the gallery, in the hind part of the ship, and let them hang down towards the water, and to tow the vessels by the stern.

To heave out the FLAG, is put out, or put abroad, the flag.

To hang out the white FLAG, is to ask quarter; or it shews when a vessel is arrived on a coast, that it has no hostile intention, but comes to trade, or the like. The red flag is a sign of defiance and battle.

FLAG-OFFICERS, those who command the several squadrons of a fleet, such as the admirals, vice-admirals, and rear-admirals.

The flag-officers in our pay are the admiral, vice-admiral, and rear-admiral, of the white, red, and blue. See the article ADMIRAL.

FLAG-SHIP, a ship commanded by a general or flag-officer, who has a right to carry a flag, in contradistinction to the secondary vessels under its command.

FLAG-STAVES, are staves set on the heads of the top-gallant-masts, serving to let fly, or unfurl, the flag.

FLAGS, in falconry, are the feathers in a hawk's wing, near the principal ones.

FLAG is used for sedge, a kind of rush; and for the upper part of turf, pared off to burn.

FLAG-FLOWER, in botany, a plant called by botanists iris. See IRIS.

Corn-FLAG. See GLADIOLUS.

FLAGELLANTES, *whippers*, in church-history, certain enthusiasts in the 13th century, who maintained, that there could be no remission of sins without flagellation, or whipping. Accordingly, they walked in procession, preceded by priests carrying the cross, and publicly lashed themselves, till the blood dropped from their naked backs.

FLAGELLARIA, a genus of the hexandria monygynia class and order of plants: flower petals none; the perianthium is divided into six segments; and the fruit is a roundish berry, containing a single seed. There are two species, shrubs of the East Indies.

FLAGEOLET, or *flajeolet*, a little flute, used chiefly by shepherds, and country people. It is made of box, or any other hard wood, and sometimes of ivory; and has six holes besides that at the bottom, the mouth-piece, and that behind the neck.

FLAIL, an instrument for thrashing corn. See HUSBANDRY.

A flail consists of the following parts: 1. The hand-staff, or piece held in the thrasher's hand. 2. The swiple, or that part which strikes out the corn. 3. The caplins, or strong double leathers, made fast to the tops of the hand-staff and swiple. 4. The middle-hand, being the leather-thong, or fish-skin, that ties the caplins together.

FLAIR, in the sea-language. When a ship is housed in near the water, so that the work above hangs over too much, it is said to flair over. This makes the ship more roomy aloft, for the men to use their arms.

FLAME, in physiology: when oxygen gas is decomposed slowly, the heat is imperceptible, because the caloric is dissipated as soon as generated. When the decomposition goes on faster, the bodies concerned become sensibly warm. A quicker decomposition of the gas heats the bodies so as to render them red hot, which state is called ignition: and when the process is attended with the production of certain fluids, as hydrogen, &c. and the decomposition of oxygen air affords a sufficient developement of caloric, then the fluids themselves are ignited, and decomposed, which constitutes flame, and is thence termed inflammation. When a candle is first lighted, which must be done by the application of actual flame, a degree of heat is given to the wick sufficient to destroy the affinity of its constituent parts: some of the tallow is instantly melted, volatilized, and decomposed, its hydrogen takes fire, and the candle melts. As this is destroyed by combustion another portion melts, rises and supplies its place, and undergoes a like decomposition. In this way combustion is maintained in a candle. The most brilliant flame is exhibited in oxygen gas, and in this flames of different colours may be produced: thus a mixture of nitrate of strontia and charcoal powder, previously ignited, burns with a rose-coloured flame: one part of boracic acid, and three of charcoal mixed, will burn green: one part of nitrate of barytes and four of charcoal powder burn with a yellow flame: equal parts of nitrate of lime and charcoal powder burn orange-red.

FLAMINGO, in ornithology. See PHŒNICOPTERUS.

FLANEL, or *flannel*, a kind of slight, loose, woollen stuff, composed of a woof and warp, and woven on a loom with two treadles, after the manner of bays. Dr. Black assigns as a reason why flannel and other substances of the kind keep our bodies warm, that they compose a rare and spongy mass, the fibres of which touch each other so slightly, that the heat moves slowly through the interstices, which being filled only with air, and that in a stagnant state, gives little assistance in conducting the heat. Count Rumford, however, has inquired farther into the matter, and finds that there is a relation betwixt the power which the substances usually worn as clothing have of absorbing moisture, and that of keeping our bodies warm. Having provided a quantity of each of those substances mentioned below, he exposed them, spread out upon China plates, for the space of 24 hours to the warm and dry air of a room, which had been heated by a German stove for several months, and during the last six hours had raised the thermometer to 85° of Fahrenheit: after which he weighed equal quantities of the different substances with a very accurate balance. They were then spread out upon a China plate, and removed into a very large uninhabited room upon the second floor, where they were exposed 48 hours upon a table placed in the middle of the room, the air of which was at 45° of Fahrenheit. At the end of this space they were weighed, and then removed into a damp cellar, and placed on a table in the middle of the vault, where the air was at the temperature of 45°, and which by the hygrometer seemed to be fully saturated with moisture. In this situation they were suffered to remain three days and three nights; the vault being all the time hung round with wet linen cloths, to render the air as completely damp as possible. At the end of three days they were weighed, and the weights at the different times were found as in the following table.

		Weight after being dried in the hot room.	Weight after coming out of the cold room.	Weight after remaining 72 hours in the vault.
Sheeps' wool		1000 parts	1084	1163
Beaver's fur			1072	1125
The fur of a Russian hare			1065	1115
Eider down			1067	1112
Silk	Raw single thread		1057	1107
	Ravellings of white taffety		1054	1103
Linen	Fine lint		1046	1102
	Ravellings of fine linen		1044	1082
Cotton wool			1043	1089
Ravellings of silver lace			1000	1000

On these experiments our author observes, that though linen, from the apparent ease with which it receives dampness from the atmosphere, seems to have a much greater attraction for water than any other; yet it would appear, from what is related above, that those bodies which receive water in its inelastic form with the greatest ease, or are most easily wet, are not those which in all cases attract the moisture of the atmosphere with the greatest avidity. "Perhaps (says he), the apparent dampness of linen to the touch arises more from the ease with which that substance parts with the water it contains, than from the quantity of water it actually holds: in the same manner as a body appears hot to the touch, in consequence of its parting freely with its heat; while another body, which is really at the same temperature, but which withholds its heat with greater obstinacy, affects the sense of feeling much less violently."

FLANKS *of an army*, are the troops encamped on the right and left, as the flanks of a battalion are the files on the right and left.

FLANKS *of a bastion*, in fortification, that part which joins the face to the curtin. See FORTIFICATION.

FLANKED, in heraldry, is used by the French to express our parti per saltier. Coats, however, makes it to be the same with flanch.

FLAT, in the sea-language. To flat in the fore-sail, to hale it in by the sheet, as near the ship's side as possible; which is done when a ship will not fall off from the wind.

FLAT, in music, a character which being placed before a note signifies that the note is to be sung or played half a tone lower than its natural pitch.

FLAT double, or double flat, a character compounded of two flats, and signifying that the note before which it is placed is to be sung or played two semitones lower than its natural pitch.

FLATULENCY. See MEDICINE.

FLAX. See LINUM.

FLEA. See PULEX.

FLEAM, in surgery and farriery, an instrument for letting a horse or other animal blood. See FARRIERY.

FLEECE, the covering of wool, shorn off the bodies of sheep. See WOOL.

FLEECE, *order of the golden*, an order of knighthood instituted by Philip II. duke of Burgundy. These knights at first were twenty-four, besides the duke himself, who reserved the nomination of six more: but Charles V. increased them to fifty. He gave the guardianship of this order to his son Philip king of Spain, since which the Spanish monarchs are chiefs of the order. The knights had three different mantles ordained them at the grand solemnity, the collar, and fleece.

FLEECY-HOSIERY, a very useful kind of manufacture, in which fine fleeces of wool are interwoven into a cotton piece of the common stocking texture. The following is the specification of the patent granted to Mr. Holland, of Broad-street, Bloomsbury, in the county of Middlesex, for a method of making stockings, socks, waistcoats, and other clothing, for persons afflicted with complaints requiring warmth, and for common use in cold climates, and for making false or downy calves in stockings.

"Having in the common stocking-frame, twisted silk, cotton-yarn, flaxen or hempen thread, worsted or woollen yarn, or any such-like twisted or spun materials, begin the work in the common manner of manufacturing hosiery, and having worked one or more course or courses in the common way, begin to add a coating, thus: draw the frame over the arch, and then hang wool or jersey, raw or unspun, upon the beards of the needles, and slide the same off their beards upon their stems, till it comes exactly under the nibs of the sinkers; then sink the jacks and sinkers, and bring forward the frame, till the wool or jersey is drawn under the beards of the needles, and having done this, draw the frame over the arch, and place a thread of spun materials upon the needles (under the nibs of the sinkers), and proceed in finishing the course in the usual way of manufacturing hosiery with spun materials. Any thing manufactured in this way has, on the one side, the appearance of common hosiery, and on the other side the appearance of raw wool. The raw or unspun materials may be worked in with every course, or with every second, third, or other course or courses, in quantity proportioned to the warmth and thickness required. The above-mentioned raw or unspun materials may be fixed also thus: having drawn the frame over the arch, hang them upon the beards of the needles, slide them off the beards upon their stems, and without sinking the jacks and sinkers, draw the frame off the arch, and bring the raw or unspun materials forward under the beards of the needles; then draw the same over the arch, and proceed in finishing the course, as before-directed. The said raw or unspun materials may be fixed likewise thus: hang them upon the beards of the needles, without having the frame over the arch, and slide them off their beards upon their stems; then bring forward the frame till the raw or unspun materials are drawn under the beards of the needles, and, having done this, draw the frame over the arch, and proceed in finishing the course as before directed. Hosiery may be coated by any of these methods, not only with wool or jersey, but also with silk, cotton, flax, hemp, hair, or other things of the like nature, raw or unspun, but the method first described fixes them most firmly. The common stocking-frame is mentioned above, but any other frame, upon a similar principle, may answer the purpose. The method of making the false or downy calves in stockings, is by working raw or unspun wool, or jersey, or any other raw or unspun materials, into the calves of stockings, in the different methods before described, and to any required form or thickness." The latter use to which this invention is applied, we may be allowed to say, is somewhat ludicrous.

FLEET, commonly implies a company of ships of war, belonging to any prince or state; but sometimes it denotes any number of trading-ships, employed in a particular branch of commerce.

In sailing, a fleet of men of war is usually divided into three squadrons; the admiral's, the vice-admiral's, and the rear-admiral's squadron, all which, being distinguished by their flags and pendants, are to put themselves, and, as near as may be, to keep themselves in their customary places, viz. the admiral, with his squadron, to sail in the van, that so he may lead the way to all the rest in the day-time, by the sight of his flag on the maintopmast-head; and in the night-time by his lights or lanterns. The vice-admiral and his squadron are to sail in the centre, or middle of the fleet. The rear-admiral, and the ships of his squadron, to bring up the rear. But sometimes other divisions are made; and those composed of the lighter ships and the best sailers, are placed as wings to the van, centre, and rear.

Merchant-fleets generally take their denomination from the place they are bound to, as the Turkey fleet, East India fleet, &c. These, in time of peace, go in fleets for their mutual aid and assistance: in time of war, besides this security, they likewise procure convoys of men of war, either to escort them to the places whither they are bound, or only a part of the way, to a certain place or latitude, beyond which they are judged out of danger of privateers, &c.

FLEET, a prison in London, to which persons are committed for contempt of the king and his laws, particularly of his courts of justice: or for debt, where any person will not, or is unable to pay his creditors. There are large rules, and a warden belonging to the Fleet prison, which had its name from the float or fleet of the river or ditch on the side whereof it stands.

FLESH, in anatomy, a fibrous part of an animal body, soft and bloody, being that of which most of the other parts are composed, and by which they are connected together: or, more properly, it is that part of the body where the blood-vessels are so small, as only to retain blood enough to preserve their colour red.

By chemical analysis it is found that muscular flesh is composed of a great number of fibres or threads, commonly of a reddish or whitish colour; but its appearance is too well known to require any description. Hitherto it has not been subjected to a perfectly accurate chemical analysis. Mr. Thouvenel, indeed, has published a very valuable dissertation on the subject; and it is to him that we are indebted for almost all the facts known concerning the composition of muscle. Some additions have also been made by M. Fourcroy. And Mr. Hatchett has not neglected this part of the subject in his interesting dissertations on animal substances.

It is scarcely possible to separate the muscle from all the other substances with which it is mixed. A quantity of fat often adheres to it closely; blood pervades the whole of it: and every fibre is enveloped in a particular thin membranous matter, which anatomists distinguish by the name of cellular substance. The analysis of the muscle, then, cannot be supposed to exhibit an accurate view of the composition of pure muscular fibre, but only of muscular fibre not perfectly separated from other substances.

When a muscle is cut in small pieces, and well washed with water, the blood and other liquids contained in it are separated, and part of the muscular substance is also dissolved. The muscle, by this process, is converted into a white fibrous substance, still retaining the form of the original body. The water assumes the colour which results from mixing water with some blood. When heated it coagulates; brown flakes swim on the surface, consisting of albumen combined with the colouring matter of the blood; some fibrina likewise precipitates. If the evaporation is continued, more albumen precipitates, and at last the whole assumes the form of a jelly. When evaporated to dryness, and treated with alcohol, the gelatine thus formed, together with a little phosphat of soda and of ammonia, remain undissolved; but the alcohol dissolves a peculiar extractive matter, first observed by Thouvenel. This matter may be obtained by evaporating the alcohol to dryness. It has a reddish-brown colour, a strong acrid taste, and an aromatic odour. It is soluble both in water and alcohol; and when its watery solution is very much concentrated, it assumes an acid and bitter taste. It swells upon hot coals, and melts, emitting an acid and penetrating smell. It attracts moisture from the air, and forms a saline efflorescence. In a hot atmosphere it becomes sour and putrefies. When distilled it yields an acid partly combined with ammonia.

If the muscle, after being thus treated with cold water, is boiled for a sufficient time in water, an additional portion of the same substances is separated from it. Some albumen collects on the surface in the form of scum, accompanied with melted fat. The water, when sufficiently concentrated by evaporation, assumes the form of a jelly. When evaporated to dryness, and treated with alcohol, the gelatine and phosphoric salts remain, while the extractive matter of Thouvenel is dissolved, and may be obtained by evaporating to dryness. It is by this process that it is procured in a sufficient quantity for examination, cold water abstracting only a very small portion from the muscle.

The muscle, thus treated with water, is left in the state of grey fibres, insoluble in water, and becoming brittle when dry. This substance possesses all the properties of fibrina.

From these facts, ascertained by Thouvenel and Fourcroy, it appears that the muscles are composed chiefly of fibrina, to which they owe their fibrous structure and their

form (see FIBRINA); and that they contain also

2. Albumen
3. Gelatine
4. Extractive
5. Phosphat of soda
6. Phosphat of ammonia
7. Phosph. of lime and carb. of ditto.

For the discovery of the last ingredients we are indebted to Mr. Hatchett, who found that 500 parts of beef-muscle left, after combustion, a residuum of 25.6 parts, consisting chiefly of these salts. When muscles are long boiled in water, Mr. Hatchett found that the greater part of the phosphat of lime, as well as of the alkaline phosphats, was dissolved; for the muscle, after this treatment, when dissolved in nitric acid, yielded scarcely any phosphat of lime; whereas if it was dissolved directly in nitric acid, a precipitate of phosphat of lime was thrown down by ammonia. Hence it would appear, either that the phosphat of lime is united to gelatine, or that it is rendered soluble by means of it. The carbonat of lime still remains after the action of water, and is converted into oxalat when the muscle is treated with nitric acid.

The muscles of different animals differ exceedingly from each other in their appearance and properties, at least as articles of food; but we know little of their chemical differences. The observations of Thouvenel alone were directed to that object, and they are imperfect. The flesh of the ox contains, according to him, the greatest quantity of insoluble matter, and leaves the greatest residuum when dried: the flesh of the calf is more aqueous and mucous: the land and water turtle yields more matter to water than the muscle of the ox; but Thouvenel ascribes the difference to foreign bodies, as ligaments, &c. mixed with the muscle of the turtle: snails yield to water a quantity of matter intermediate between that given by beef and veal: with them the muscles of frogs, cray fish, and vipers, agree nearly in this respect; but the muscles of fresh-water fish, notwithstanding their softness, yield a considerably smaller proportion.

When meat is boiled, it is obvious that the gelatine, the extractive, and a portion of the salts, will be separated, while the coagulated albumen and fibrina will remain in a solid state. Hence the flavour and the nourishing nature of soups is derived from the extractive and gelatine. When meat is roasted, on the other hand, all these substances continue in it, and the taste and odour of the extractive are greatly heightened by the action of the fire. Hence the superior flavour of roasted meat.

FLEVILLEA, a genus of the hexandria order, in the dioecia class of plants. The male calyx and corolla are quinquefid; the stamina five; the nectarium five converging filaments. The female calyx is quinquefid; there are three styli; the fruit a hard trilocular barky apple.

FLEXIBLE, in physics, a term applied to bodies capable of being bent or diverted from their natural figure or direction.

FLEXION, in anatomy, is applied to the motion by which the arm or any other member of the body is bent. It is also applied to the muscles, nerves, &c.

FLEXION, or *flexure of curves*. See the article FLEXURE.

FLEXOR. See ANATOMY.

FLEXURE OF CURVES, in the higher geometry, is used to signify that a curve is both concave and convex, with respect to a given right line.

FLIGHT, is evading the course of justice, by a man's voluntarily withdrawing himself. On an accusation of treason or felony, or even of petty larceny, if the jury find that the party fled for the same, he shall forfeit his goods and chattels, although he be acquitted of the offence; for the very flight itself is an offence, carrying with it a strong presumption of guilt, and is at least an endeavour to elude and stifle the course of justice prescribed by the law. But now the jury very seldom find the flight; such forfeiture being looked upon, since the vast increase of personal property, as too large a penalty for an offence, to which a man is prompted by the natural love of liberty. 4 Black. 387.

FLINT. See SILICA.

FLINT, a stone very useful in modern war, is found in pieces of different sizes, and usually of a figure more or less globular, commonly among chalk, and often arranged in some kind of order.

Its texture is compact. Its fracture smooth, conchoidal. The stones are always covered by a white crust. Specific gravity from 2.58 to 2.63. Colour varies from honey-yellow to brownish-black. Very brittle, and splits into splinters in every direction. Two pieces of flint rubbed smartly together phosphoresce, and emit a peculiar odour. When heated it decrepitates, and becomes white and opaque. When exposed long to the air it often becomes covered with a white crust. A specimen of flint analysed by Klaproth contained,

98.00 silica,
.50 lime,
.25 alumina,
0.25 oxide of iron,
1.00 water.

100.00

Vauquelin obtained from another,

97 silica,
1 alumina and iron.

98.

Another specimen analysed by Dolomieu was composed of,

97 silica,
1 alumina, and oxide of iron
2 water.

100.

The whole crust with which flint is enveloped consists of the same ingredients, and a little carbonat of lime. Water is essential to flint; for when it is separated by heat the stone loses its properties.

The manufacture of gun-flints is chiefly confined to England, and two or three departments of France. The operation is exceedingly simple, and a good workman will make 1000 flints a day. The whole art consists in striking the stone repeatedly with a kind of mallet, and bringing off at each stroke a splinter, sharp at one end, and thicker at the other. The splinters are afterwards shaped at pleasure, by laying the line at which it is wished they should break, upon a sharp instrument, and then giving it small blows with a mallet.

FLOAT *of a fishing-line*, the cork or quill that floats or swims above the water.

FLOAT also signifies a certain quantity of timber bound together with rafters athwart, and put into a river to be conveyed down the stream; and even sometimes to carry burdens down a river with the stream.

FLOAT-BOARDS, those boards fixed to water-wheels of undershot mills, serving to receive the impulse of the stream, whereby the wheel is carried round. See MILLWORK.

FLOOD, among seamen, is when the tide begins to come up, or the water begins to rise: then they call it young flood; after which it is quarter-flood, half-flood, and high-flood.

FLOOD-MARK, the mark which the sea makes on the shore, at flowing-water, and the highest tide: it is also called high-water mark.

FLOOKING, among miners, a term used to express a peculiarity in the load of a mine. The load or quantity of ore is frequently intercepted in its course, by the erossing of a vein of earth or stone, or some different metallic substance; in which case the load is moved to one side, and this transient part of the land is called a flooking.

FLORIN, is sometimes used for a coin, and sometimes for a money of account.

Florin, as a coin, is of different values, according to the different metals and different countries where it is struck. The gold florins are most of them of a very coarse alloy, some of them not exceeding thirteen or fourteen carats, and none of them seventeen and a half. As to silver florins, those of Holland are worth about 1*s.* 8*d.*: those of Genoa were worth 8¼*d.* sterling. See COIN.

FLORINIANS, *florinians*, in church history, a sect of heretics of the second century, so denominated from their leader Florinus, who made God the author of evil. They are a species of the gnostics, but deny the judgment and resurrection, and hold that our Saviour was not born of a virgin. They were also called Borborites.

FLORIST, *florista*, according to Linnæus, is an author or botanist who writes a treatise called Flora, comprehending only the plants and trees to be found growing naturally in any place. However, in the more common acceptation of the word, florist signifies a person well skilled in flowers, their kinds and cultivation.

FLOS, in chemistry, the most subtile part of bodies, separated from the more gross parts by sublimation, in a dry form. See CHEMISTRY.

FLOTSAM, JETSAM, AND LAGAN. Flotsam is when a ship is sunk or cast away, and the goods float on the sea; jetsam is when a ship is in danger of being sunk, and to lighten the ship the goods are cast into the sea, and the ship notwithstanding perishes; and lagan is when the goods so cast into the sea are so heavy that they sink to the bottom, and therefore the mariners fasten to them a buoy or cork, or such other thing that will not sink, to enable them to find them again. 5 Rep. 106. b. The king shall have flotsam, jetsam, and lagan, when the ship is lost, and the owners of the goods are not known, but not otherwise. F. N. B. 122. Where the

proprietors of the goods may be known, they have a year and a day to claim flotsam.

FLOUR, the meal of wheat-corn, finely ground and sifted.

FLOUR-MILLS are put in motion by the application of various forces: sometimes the first mover is wind, at others water, at others the force of steam, at others the muscular energy of animals. The mechanism of the grinding part of most of these is nearly the same, and pretty well understood: we shall here give an account of the construction of the several figures in the plate.

Fig. 1. (see Plate Flour-mills) represents a common pair of flour-stones; A, is a trundle fixed to a spindle B, so as to turn with it; the lower end of this spindle turns in a brass socket fixed in the beam, CD, called the bridge-tree; and the upper end of this spindle turns in a wooden bush, fixed into the middle of the nether mill-stone, which lies on the floor, EF. The top part of the spindle, above the bush, is square, and goes into a strong iron cross, *abcd*, fig. 2, called the crow: the four ends of this crow are let into the under-surface of the running-millstone, shewn upside downwards in fig. 2; so that when the spindle is turned by the trundle A, the stone will turn with it. The end, *c*, of the bridge tree, fig. 1, is jointed into the post, G: the other goes through a long mortise in the post, H, and has an iron rod, I, fixed to it; on the top of this are a screw and hand-nut, K, by turning of which the two mill-stones can be brought nearer together, and vice versa, so as to grind finer or coarser. The two stones are inclosed in an octagonal box, LM, which is about two inches more across than the diameter of the running-stone. Upon the top of this box is a frame to support the hopper, N, to which is hung the shoe or spout, O, by a strap fastened to the back of it; to the other end of the shoe a line, *e*, is fastened, the drawing of which regulates the aperture between the shoe and the hopper, and the quantity of corn that comes from the hopper: this is otherwise done by a small shuttle, *f*, in the front of the hopper: to the end of the shoe, O, a small line, *g*, is fastened, the other end of which is tied to a wooden spring, *h*. The top of the spindle, B, has a small square hole in it, into which is put the feeder, P; this feeder, as the spindle turns round, pushes the shoe from it, and it is brought back by the spring, *h*, three times in each revolution of the stone and spindle, and so causes the corn constantly to run down from the hopper, through the upper millstone, and by the motion thereof it gets between the stones, and is ground. The great velocity of the upper or running stone creates a centrifugal force in the corn, and throws it farther from the centre, till it is thrown quite out at the circumference of the stone in the form of flour, and passes through a spout, Q, to a meal-chest below. The grinding surfaces of both stones, in order to bruise and cut the corn, are hollowed into straight grooves, as shewn in fig. 2.

Fig. 3, is a wire bolting-machine; A is the riger and band by which it is turned, from a drum in some part of the mill; on its spindle rows of brushes are fixed, as shewn in fig. 4. These brushes turn round within a cylindrical frame, CD, fig. 3; withinside of this frame is nailed wire-cloth, which is very fine at the end D, and gets coarser as it goes towards C; this frame is fixed from turning round, by its ends going into the framing of the box in which the whole is contained, and is farther steadied by four chains, EEE, fastened to the top of the box: at one end of the box is a square hole for the feeding-trough, G, to pass through; this trough is loosely connected to the trough H, (which brings the flour from the floor above) by leather nailed round their ends: the trough G is supported on the end of a crooked piece of wood, *a*, moving round a pin as a centre, at *d*; when the brushes are turned round with a great velocity, the stubs, *e*, in the end of the spindle, shewn in fig. 4, move the trough, G, to one side, and its line, *f*, the spring, *c*, immediately pulls it back again. This shakes the flour down through it into the cylinder, CD, and the brushes rubbing it round against the wire, that sort which is fine enough passes through into the hopper, K: the rest passes on in the cylinder, and goes through into the hoppers, L and M, according to the different degrees of fineness, till at last the bran falls out at a hole in the end, into the hopper, N: these hoppers have troughs, connecting with their bottoms, going through the floor, and the mouths of the flour-sacks are hooked to them in the room below, to receive the different sorts of flour and the bran.

Fig. 5 is the common bolting-cloth; A, is the riger turned by a strap; on its axis, within the box, is a reel, fig. 6, over which is put a bag, open at the ends, called the bolting-cloth, C D, in fig. 5, and tied to the reel by its ends; it is woven very fine at the end, D, and gradually gets coarser towards the end, *c*; the feeding-troughs, G and H, are the same as already described in fig. 4; by the side of the reel are three wooden bars, *ab*, and another behind, fixed in the box by their ends. When the reel is turned with a great velocity, the four arms, *cdef*, fig. 6, shake the trough, G, and cause the flour to run regularly down into the bolting-cloth, and the centrifugal force causes the cloth to swing against the three sticks, *ab*, beats the fine flour through the cloth into the hopper, K, and the other sorts into the hoppers LMN; the bran falls out at the end of the cloth into the hopper, O, and goes through the end of the box and the floor, in a wooden trough, to the end of which a sack is hooked to receive it in the floor beneath. There are troughs from the bottom of the hopper, KLMN, to convey the flour to the sacks, as described in fig. 4.

We shall hereafter, under the article MILLS, give a more detailed account of the theory of mills, and of the means by which they may be worked with the greatest advantage, and with the least expence of power.

FLOWER, *flos*, among botanists and gardeners, the most beautiful part of trees and plants, containing the organs or parts of fructification. See BOTANY.

FLOWERS, *preserving of*. The method of preserving flowers in their natural beauty through the whole year has been much sought after by many people. Some have attempted it by gathering them when dry, and not too much opened, and burying them in dry sand; but this, though it preserves their figure well, takes off from the liveliness of their colour. Muntingius prefers the following method to all others. Gather roses, or other flowers, when they are not yet thoroughly open, in the middle of a dry day: put them into a good earthen vessel glazed within; fill the vessel up to the top with them; and when full, sprinkle them over with some good French wine, with a little salt in it; then set them by in a cellar, tying down the mouth of the pot. After this they may be taken out at pleasure; and on setting them in the sun, or within reach of the fire, they will open as if growing naturally; and not only the colour, but the odour also, will be preserved.

The flowers of plants are by much the most difficult parts to preserve in any tolerable degree of perfection; of which we have instances in all the collections of dried plants, or horti sicci. In these the leaves, stalks, roots, and seeds of the plants, appear very well preserved; the strong texture of these parts making them always retain their natural form, and the colours in many species naturally remaining. But where these fade, the plant is little the worse for use as to knowing the species. But it is very much otherwise in regard to the petals: these are naturally by much the most beautiful parts of the plant to which they belong; but they are so much injured in the common way of drying, that they not only lose, but change their colours one into another, by which means they give occasion to many errors; and they usually also wither up, so as to lose their very form and natural shape. The primrose and cowslip kinds are very eminent instances of the change of colours in the flowers of dried specimens: for those of this class of plants easily dry in their natural shape; but they lose their yellow, and, instead of it, acquire a fine green colour, much superior to that of the leaves in their most perfect state. The flowers of all the violet kind lose their beautiful blue, and become of a dead-white: so that in dried specimens there is no difference between the blue-flowered violet and the white-flowered kinds.

Sir Robert Southwell has communicated to the world a method of drying plants, by which this defect is proposed to be in a great measure remedied, and all flowers preserved in their natural shape, and many in their natural colours. For this purpose, two plates of iron are to be prepared of the size of a large half-sheet of paper, or larger for particular occasions: these plates must be made so thick as not to be apt to bend; and there must be a hole made near every corner for the receiving a screw to fasten them close together. When these plates are prepared, lay in readiness several sheets of paper, and then gather the plants with their flowers when they are quite perfect. Let this be always done in the middle of a dry day; and then lay the plant and its flower on one of the sheets of paper doubled in half, spreading out all the leaves and petals as nicely as possible. If the stalk is thick, it must be pared or cut in half, so that it may lie flat; and if it is woody, it may be peeled, and only the bark left. When the plant is thus expanded, lay round about it some loose leaves and petals of the flower, which may serve to complete any part that is deficient. When all is thus prepared, lay several sheets of paper over the plant, and as many under it; then put the whole between the iron plates, laying the papers smoothly on one, and laying the

other evenly over them: screw them close, and put them into an oven after the bread is drawn, and let them lie there two hours. After that, make a mixture of equal parts of aquafortis and common brandy; shake these well together, and when the flowers are taken out of the pressure of the plates, rub them lightly over with a camel's-hair pencil dipped in this liquor; then lay them upon fresh brown paper, and covering them with some other sheets, press them between this and other papers with a handkerchief till the wet of these liquors is dried wholly away. When the plant is thus far prepared, take the bulk of a nutmeg of gum-dragon; put this into a pint of fair water cold, and let it stand 24 hours; it will in this time be wholly dissolved: then dip a fine hair-pencil in this liquor, and with it daub over the back sides of the leaves, and lay them carefully down on a half-sheet of white paper fairly expanded, and press them down with some more papers over these. When the gum-water is fixed, let the pressure and papers be removed, and the whole work is finished. The leaves retain their verdure in this case, and the flowers usually keep their natural colours. Some care, however, must be taken that the heat of the oven be not too great. When the flowers are thick and bulky, some art may be used to pare off their backs, and dispose the petals in a due order; and after this, if any of them are wanting, their places may be supplied with some of the supernumerary ones dried on purpose; and if any of them are only faded, it will be prudent to take them away, and lay down others in their stead: the leaves may be also disposed and mended in the same manner.

Another method of preserving both flowers and fruit sound throughout the whole year is also given by the same author. Take saltpetre, one pound; armenian bole, two pounds; clean common sand, three pounds. Mix all well together; then gather fruit of any kind that is not fully ripe, with the stalk to each; put these, one by one, into a wide-mouthed glass, laying them in good order. Tie over the top with an oil-cloth, and carry them into a dry cellar, and set the whole upon a bed of the prepared matter of four inches thick in a box. Fill up the remainder of the box with the same preparation; and let it be four inches thick all over the top of the glass, and all round its sides. Flowers are to be preserved in the same sort of glasses, and in the same manner; and they may be taken up after a whole year as plump and fair as when they were buried.

FLOWER DE LIS, or *Flower de luce*, in heraldry, a bearing representing the lily, called the queen of flowers, and the true hieroglyphic of royal majesty; but of late it is become more common, being borne in some coats one, in others three, in others five, and in some semee, or spread all over the escutcheon in great numbers. The arms of France are, three flower-de-lis, or, in a field azure. It is observed by antiquarians, that flower de Louis is the proper name, having been borne by St. Louis on his shield, and that it is not a lily but an iris.

FLOWN SHEETS, in the sea language: a ship is said to sail with flown sheets when her sails are not haled home, or close to the blocks. The sheets are flown; that is, they are let loose, or run as far as they will.

FLUATS, in chemistry, salts first discovered by Scheele; they are distinguished by the following properties: (1) When sulphuric acid is poured upon them, they emit acrid vapours of fluoric acid, which corrode glass. (2) When heated, several of them phosphoresce. (3) They are not decomposed by heat, nor altered by combustibles. (4) They combine with silica by means of heat. Most of them are sparingly soluble in water.

Fluat of lime—fluor spar. This mineral is found abundantly in different countries, particularly in Derbyshire. It is both amorphous and crystallized.

The primitive form of its crystals is the regular octahedron; that of its integrant molecules the regular tetrahedron. The varieties of its crystals hitherto observed amount to 9. These are the primitive octahedron; the cube; the rhomboidal dodecahedron; the cubo-octahedron, which has both the faces of the cube and of the octahedron; the octahedron wanting the edges; the cube wanting the edges, and either one face or two faces in place of each.

Werner divides this species into three subspecies.

1. *Earthy.* Colour greenish white or bluish green. Composed of earthy powder, somewhat agglutinated. Moderately heavy. Phosphoresces on hot coals. Found in Hungary in a vein. Acccording to Pelletier, it is composed of

21	lime
15	alumina
31	silica
28	fluoric acid
1	phosphoric acid
1	muriatic acid
1	oxide of iron
1	water
99.	

2. *Compact fluor.* Colour greenish grey, often spotted. Found in mass. Greasy. Fracture even, passing to the conchoidal. Scratches calcareous spar. Moderately heavy.

3. *Fluor spar.* The texture of fluat of lime is foliated. Causes single refraction. Very brittle. Specific gravity from 3.0943 to 3.1911. Colours numerous, red, violet, green, reddish yellow, blackish purple. Its powder thrown upon hot coals emits a bluish or greenish light. Two pieces of it rubbed in the dark phosphoresce. It decrepitates when heated. Before the blowpipe it melts into a transparent glass.

It admits of a polish, and is often formed into vases and other ornaments.

FLUENT, in fluxions, the flowing quantity, or that which is continually either increasing, or decreasing, whether line, surface, solid, &c. See FLUXION.

FLUID, in physiology, an appellation given to all bodies whose particles easily yield to the least partial pressure, or force impressed. See HYDROSTATICS.

FLUIDITY, is that state or affection of bodies which exhibits them in a liquid form.

All substances in nature, as far as we are acquainted with them, occur in one or other of the three following states; namely, the state of solids, of liquids, or of elastic fluids or vapours. It has been ascertained, that in a vast number of cases, the same substance is capable of existing successively in each of these states. Thus sulphur is usually a solid body; but when heated to 212° it is converted into a liquid; and at a still higher temperature (about 570°), it assumes the form of an elastic vapour of a deep-brown colour. Water also in our climate is usually a liquid; but when cooled down to 32°, it is converted into a solid body, and at 212° it assumes the form of an elastic fluid.

All solid bodies, a very small number excepted, may be converted into liquids by heating them sufficiently, and on the other hand, every liquid, except spirit of wine, is convertible into a solid body, by exposing it to a sufficient degree of cold. All liquid bodies may, by heating them, be converted into elastic fluids, and a great many solids are capable of undergoing the same change; and, lastly, the number of elastic fluids which by cold are condensible into liquids or solids, is by no means inconsiderable. These facts have led philosophers to form this general conclusion, "that all bodies, if placed in a temperature sufficiently low, would assume a solid form; that all solids become liquids when sufficiently heated; and that all liquids, when exposed to a certain temperature, assume the form of elastic fluids." The state of bodies then depends upon the temperature in which they are placed; in the lowest temperatures they are all solid, in higher temperatures they are converted into liquids, and in the highest of all they become elastic fluids. The particular temperatures at which bodies undergo those changes, are exceedingly various, but they are always constant for the same bodies. Thus we see that heat produces changes on the state of bodies, converting them all, first into liquids, and then elastic fluids.

I. When solid bodies are converted by heat into liquids, the change in some cases takes place at once. There is no interval between solidity and liquidity; but in other cases a very gradual change may be perceived; the solid becomes first soft, and it passes slowly through all the degrees of softness, till at last it becomes perfectly fluid. The conversion of ice into water is an instance of the first change, for in that substance there is no intervening state between solidity and fluidity. The melting of glass, of wax, and of tallow, exhibits instances of the second kind of change; for these bodies pass through every possible degree of softness before they terminate in perfect fluidity. In general, those solid bodies which crystallize or assume regular prismatic figures, have no interval between solidity and fluidity, while those that do not usually assume such shapes have the property of appearing successively in all the intermediate states.

Solid bodies never begin to assume a liquid form till they are heated to a certain temperature; this temperature is constant in all. In the first class of bodies it is very well defined; but in the second, though it is equally constant, the exact temperature of fluidity cannot be pointed out with such precision on account of the infinite number of shades of softness through which the bodies pass before they acquire their greatest possible fluidity. But even in these bodies we can easily ascertain that the same temperature always produces the same degree of fluidity. The temperatures at which this change from soli-

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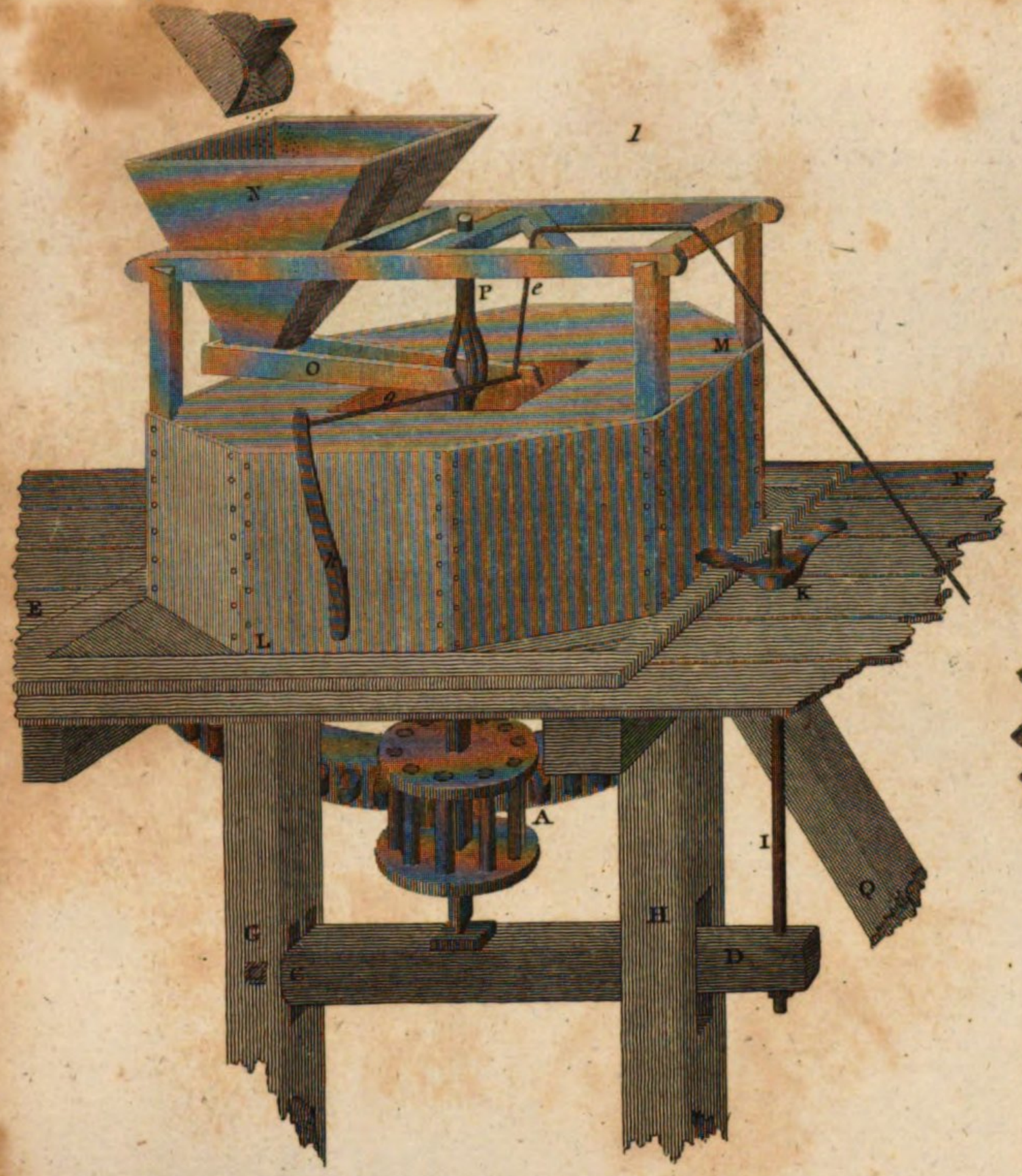

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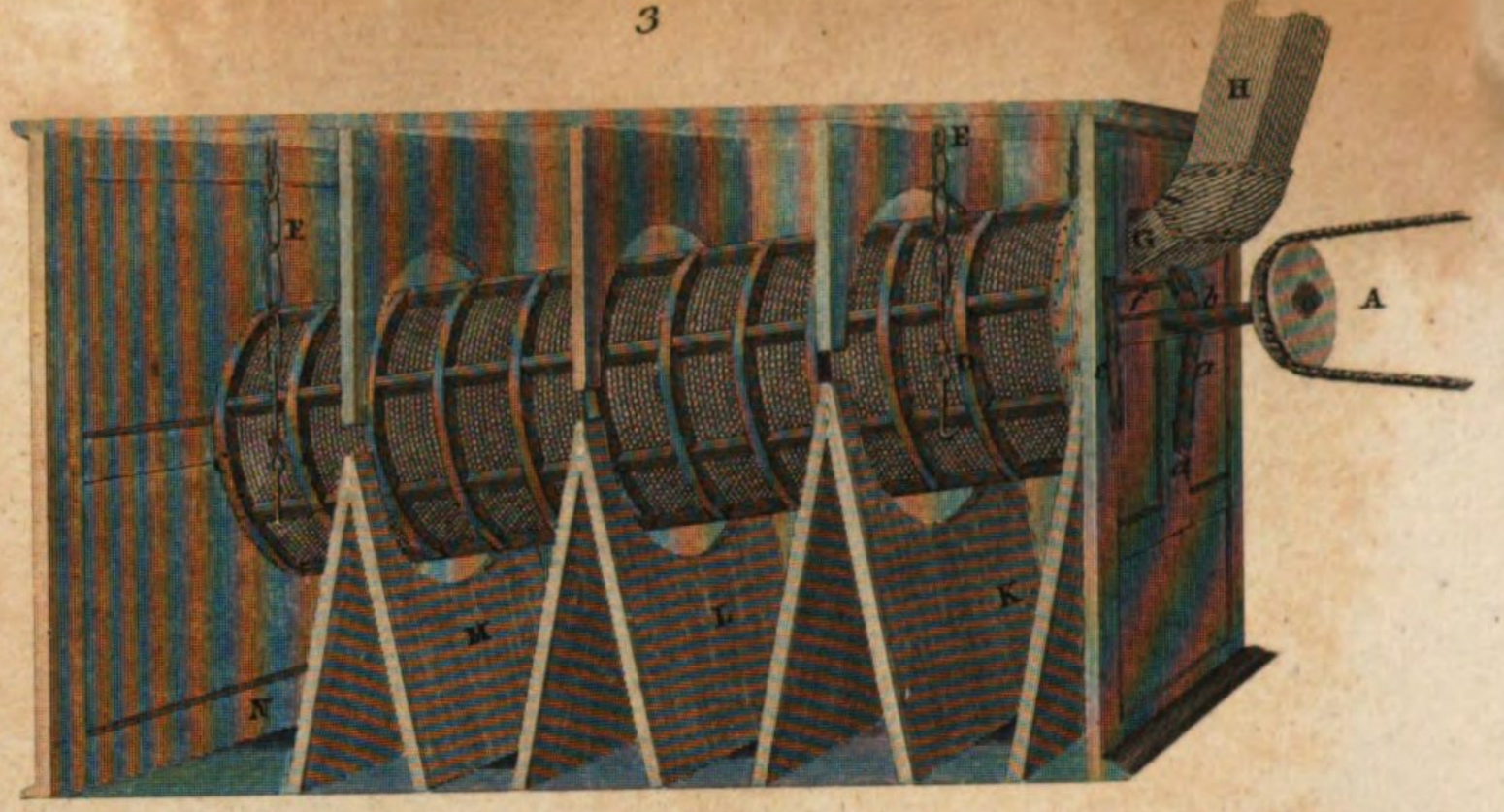

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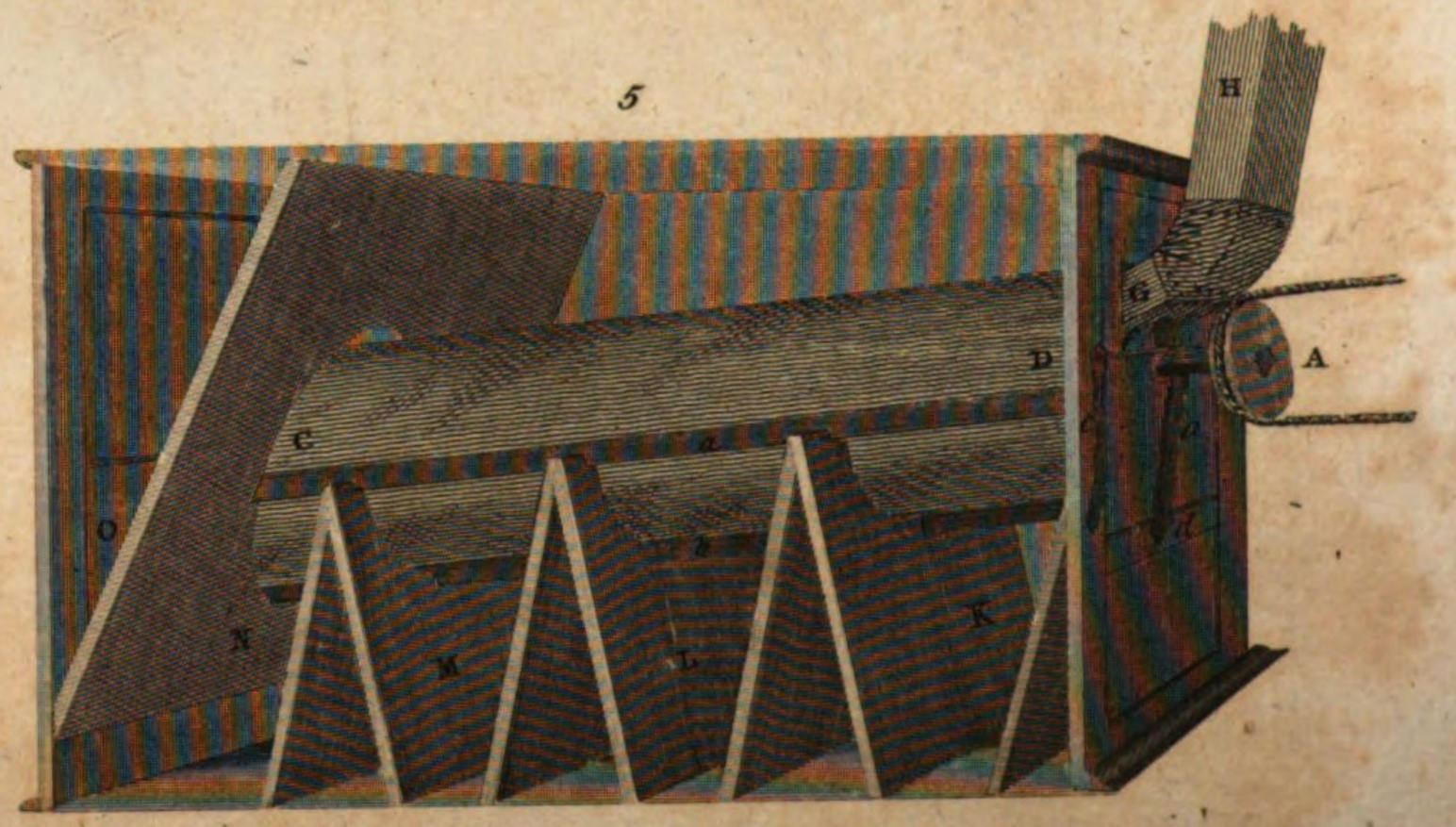

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dity to liquidity takes place, receive different names according to the usual state of the body thus changed. When the body is usually observed in a liquid state, we call the temperature at which it assumes the form of a solid, its freezing point, or congealing point. Thus the temperature in which water becomes ice, is called the freezing point of water; on the other hand, when the body is usually in the state of a solid, we call the temperature at which it liquifies its melting point: thus 212° is the melting point of sulphur, 442° the melting point of tin.

The following table contains a list of the melting points of a considerable number of solid bodies.

Substance.	Melting point.
Lead	594°
Bismuth	576
Tin	442
Sulphur	212
Wax	142
Spermaceti	133
Phosphorus	100
Tallow	92
Oil of anise	50
Olive-oil	36
Ice	32
Milk	30
Vinegar	28
Blood	25
Oil of bergamot	23
Wines	20
Oil of turpentine	14
Sulphuric acid	36
Mercury	39
Liquid ammonia	46
Ether	46
Nitric acid	66.

Before Dr. Black began to deliver his chemical lectures in Glasgow in 1757, it was universally supposed that solids were converted into liquids by a small addition of heat, after they had been once raised to the melting point, and that they returned again to the solid state on a very small diminution of the quantity of heat necessary to keep them at that temperature. An attentive view of the phenomena of liquefaction and solidification gradually led this sagacious philosopher to observe their inconsistence with the then received opinions, and to form another, which he verified by direct experiments, and drew up an account of his theory, and the proofs of it, which was read to a literary society in Glasgow on April 23d, 1762; and every year after he gave a detailed account of the whole doctrine in his lectures.

The opinion which he formed was, that when a solid body is converted into a liquid, a much greater quantity of heat enters into it than is perceptible immediately after by the thermometer. This great quantity of heat does not make the body apparently warmer, but it must be thrown into it in order to convert it into a liquid; and this great addition of heat is the principal and most immediate cause of the fluidity induced. On the other hand, when a liquid body assumes the form of a solid, a very great quantity of heat leaves it without sensibly diminishing its temperature; and the state of solidity cannot be induced without the abstraction of this great quantity of heat. Or, in other words, whenever a solid is converted into a fluid, it combines with a certain dose of caloric, without any augmentation of its temperature; and it is this dose of caloric which occasions the change of the solid into a fluid. When the fluid is converted again into a solid, the dose of caloric leaves it, without any diminution of its temperature; and it is this abstraction which occasions the change. Thus the combination of a certain dose of caloric with ice causes it to become water, and the abstraction of a certain dose of caloric from water causes it to become ice. Water then is a compound of ice and caloric; and in general all fluids are combinations of the solid, to which they may be converted by the application of cold, and a certain dose of caloric.

Such is the opinion concerning the cause of fluidity taught by Dr. Black as early as 1762. Its truth was established by the following experiments:

First. If a lump of ice, at the temperature of 22°, is brought into a warm room, in a very short time it is heated to 32°, the freezing point. It then begins to melt; but the process goes on very slowly, and several hours elapse before the whole ice is melted. During the whole of that time its temperature continues at 32°; yet as it is constantly surrounded by warm air, we have reason to believe that caloric is constantly entering into it. Now as none of this caloric is indicated by the thermometer, what becomes of it, unless it has combined with that portion of the ice which is converted into water, and unless it is the cause of the melting of the ice?

Dr. Black took two thin globular glasses, four inches in diameter, and very nearly of the same weight. Both were filled with water; the contents of the one were frozen into a solid mass of ice, the contents of the other were cooled down to 33°; the two glasses were then suspended in a large room at a distance from all other bodies, the temperature of the air being 47°. In half an hour the thermometer placed in the water-glass rose from 33° to 40°, or 7 degrees; the ice was at first 4 or 5 degrees colder than melting snow, but in a few minutes the thermometer applied to it stood at 32°. The instant of time when it reached that temperature was noted, and the whole left undisturbed for ten hours and a half. At the end of that time the whole ice was melted, except a very small spongy mass, which floated at the top, and disappeared in a few minutes. The temperature of the ice water was 40°.

Thus 10½ hours were necessary to melt the ice, and raise the product to the temperature of 40°. During all this time it must have been receiving heat with the same celerity as the water-glass received it during the first half-hour. The whole quantity received then was 21 times 7, or 147°; but its temperature was only 40°: therefore 139 or 140 degrees had been absorbed by the melting ice, and remained concealed in the water into which it had been converted, its presence not being indicated by the thermometer.

That caloric, or heat, is actually entering into the ice, is easily ascertained by placing the hand on a thermometer under the vessel containing it. A current of cold air may be perceived descending from it during the whole time of the process.

But it will be said, perhaps, that the heat which enters into the ice does not remain there, but is altogether destroyed. This opinion is refuted by the following experiment.

Second. If, when the thermometer is at 22°, we expose a vessel full of water at 52° to the open air, and beside it another vessel full of brine at the same temperature, with thermometers in each, we shall find that both of them gradually lose caloric, and are cooled down to 32°. After this the brine (which does not freeze till cooled down to 0°) continues to cool without interruption, and gradually reaches 22°, the temperature of the air, but the pure water remains stationary at 32°. It freezes, indeed, but very slowly; and during the whole process its temperature is 32°. Now, why should the one liquid refuse all on a sudden to give out caloric and not the other? Is it not much more probable that the water, as it freezes, gradually gives out the heat which it had absorbed during its liquefaction; and that this evolution maintains the temperature of the water at 32°, notwithstanding what it parts with to the air during the whole process? We may easily satisfy ourselves that the water while congealing is constantly imparting heat to the surrounding air; for a delicate thermometer suspended above it is constantly affected by an ascending stream of air less cold than the air around. The following experiment, first made by Fahrenheit, and afterwards often repeated by Dr. Black and others, affords a palpable evidence, that such an evolution of caloric actually takes place during congelation.

Third. If, when the air is at 22°, we expose to it a quantity of water in a tall beer-glass, with a thermometer in it and covered, the water gradually cools down to 22° without freezing. It is therefore 10° below the freezing point. Things being in this situation, if the water is shaken, part of it instantly freezes into a spongy mass, and the temperature of the whole instantly rises to the freezing point, so that the water has acquired ten degrees of caloric in an instant. Now whence came these ten degrees? Is it not evident that it must have come from that part of the water which was frozen, and consequently that water in the act of freezing gives out caloric?

From many experiments made on water in these circumstances, it is found that the quantity of ice which forms suddenly on the agitation of water, cooled down below the freezing point, bears always a constant ratio to the coldness of the liquid before agitation. Thus when water is cooled down to 22° very nearly $\frac{1}{14}$ of the whole freezes; when the previous temperature is 27°, about $\frac{1}{28}$ of the whole freezes. In all cases when water is cooled down below 32°, it loses a portion of the caloric which is necessary to constitute its liquidity. The instant that such water is agitated, one portion of the liquid seizes upon the quantity of caloric in which it is deficient, at the expence of another portion, which of course becomes ice. Thus when water is cooled down to 22°, every particle of it wants 10° of the caloric necessary to keep it in a state of liquidity. Thirteen parts of it seize 10 degrees each from the fourteenth part. These thirteen of course acquire the temperature of 32°; and the other part, being deprived of $10 \times 13 = 130$, which with the ten de-

grees that it had lost before constitute 140°, or the whole of the caloric necessary to keep it fluid, assumes of consequence the form of ice.

Fourth. If these experiments should not be considered as sufficient to warrant Dr Black's conclusion, the following, for which we are indebted to the same philosopher, puts the truth of his opinion beyond the reach of dispute. He mixed together given weights of ice at 32°, and water at 190° of temperature. The ice was melted in a few seconds, and the temperature produced was 53°.

The weight of the ice was 119 half-drachms;
That of the hot water 135
of the mixture 254
of the glass vessel 16

Sixteen parts of glass have the same effect in heating cold bodies, as eight parts of equally hot water. Therefore, instead of the 16 half-drachms of glass, eight of water may be substituted, which makes the hot water amount to 143 half-drachms.

In this experiment there were 158 degrees of heat contained in the hot water, to be divided between the ice and the water. Had they been divided equally, and had the whole been afterwards sensible to the thermometer, the water would have retained $\frac{143}{262}$ parts of this heat, and the ice would have received $\frac{119}{262}$ parts: that is to say, the water would have retained 86°, and the ice would have received 72°; and the temperature after mixture would have been 104°. But the temperature by experiment is found to be only 53°; the hot water lost 137°, and the ice only received an addition of temperature equal to 21°. But the loss of 18° of temperature in the water is equivalent to the gain of 21° in the ice. Therefore $158° - 18° = 140°$ of heat have disappeared altogether from the hot water. These 140° must have entered into the ice, and converted it into water without raising its temperature.

In the same manner, if we take any quantity of ice, or, which is the same thing, snow at 32°, and mix it with an equal weight of water at 172°, the snow instantly melts, and the temperature of the mixture is only 32°. Here the water is cooled 140°, while the temperature of the snow is not increased at all; so that 140° of caloric have disappeared. They must have combined with the snow; but they have only melted it, without increasing its temperature. Hence it follows irresistibly, that ice, when it is converted into water, absorbs and combines with 140° of caloric.

Water, then, after being cooled down to 32°, cannot freeze till it has parted with 140° of caloric; and ice, after being heated to 32°, cannot melt till it has absorbed 140° of caloric. This is the cause of the extreme slowness of these operations. With regard to water, then, there can be no doubt that it owes its fluidity to the caloric which it contains, and that the caloric necessary to give fluidity to ice is equal to 140°.

To the quantity of caloric which thus occasions the fluidity of solid bodies by combining with them, Dr. Black gave the name of latent heat, because its presence is not indicated by the thermometer; a term sufficiently expressive, but other philosophers have rather chosen to call it caloric of fluidity.

Dr. Black and his friends ascertained also, by experiment, that the fluidity of melted wax, tallow, spermaceti, and metals, is owing to the same cause. Landriani proved, that this is the case with sulphur, alum, nitre, and several of the metals; and it has been found to be the case with every substance hitherto examined. We may consider it therefore as a general law, that whenever a solid is converted into a fluid, it combines with caloric, and that this is the cause of its fluidity.

From the experiments of Dr. Irvine, it appears that the caloric of fluidity of spermaceti is 145°
Bees-wax 175
Tin 500.

These are the only substances in which the quantity of caloric, absorbed during fusion, has been ascertained. In all of them we see this rule to hold, that the caloric of fluidity increases with the temperature at which liquidity takes place.

Dr. Black has rendered it exceedingly probable also, or rather he has proved by his experiments and observations, that the softness of such bodies as are rendered plastic by heat, depends upon a quantity of latent heat which combines with them. Metals also owe their malleability and ductility to the same cause. Hence the reason why they become hot and brittle when hammered.

II. Thus it appears, that the conversion of solids into liquids, is occasioned by the combination of a dose of caloric with the solid. But there is another change of state still more remarkable, to which bodies are liable when exposed to the action of heat. Almost all liquids, when raised to a certain temperature, gradually assume the form of an elastic fluid, invisible like air, and possessed of the same mechanical properties. Thus water, by boiling, is converted into steam, an invisible fluid, 1800 times more bulky than water, and as elastic as air. These fluids retain their elastic form as long as their temperature remains sufficiently high; but when cooled down again, they lose that form, and are converted into liquids. All liquids, and even a considerable number of solids, are capable of undergoing this change when sufficiently heated.

With respect to the temperatures at which liquids undergo this change, they may be all arranged under two divisions. There are some liquids which are gradually converted into elastic fluids at every temperature, while others again never begin to assume that change till their temperature reaches a certain point. Water is a well-known example of the first class of bodies. If an open vessel, filled with water, is carefully examined, we find that the water diminishes in bulk day after day, and at last disappears altogether. If the experiment is made in a vessel sufficiently large, and previously exhausted of air, we shall find that the water will fill the vessel in the state of invisible vapour, in whatever temperature it is placed. Alcohol likewise, and ether, and volatile oils, gradually assume the form of an elastic fluid in all temperatures. But sulphuric acid and the fixed oils never begin to assume the form of vapour till they are raised to a certain temperature. Though left in open vessels they lose no perceptible weight; neither does sulphuric acid lose any weight, though kept ever so long in the temperature of boiling water. When liquids gradually assume the form of elastic fluids in all temperatures, they are said to evaporate spontaneously. The second class of liquids want that property altogether.

When all other circumstances are the same, the evaporation of liquids increases with their temperature; and after they are heated to a certain temperature, they assume the form of elastic fluids with great rapidity. If the heat is applied to the bottom of the vessel containing the liquids, as is usually the case, after the whole liquid has acquired this temperature, those particles of it which are next the bottom become an elastic fluid first: they rise up, as they are formed, through the liquid, like air-bubbles, and throw the whole into violent agitation. The liquid is then said to boil. Every particular liquid has a fixed point at which this boiling commences (other things being the same), and this is called the boiling point of the liquid. Thus water begins to boil when raised to 212°. It is remarkable, that after a liquid has begun to boil, it never becomes any hotter, however strong the fire to which it is exposed. A strong heat indeed makes it boil more rapidly, but does not increase its temperature. This was first observed by Dr. Hooke. See BOILING.

It was observed, when treating of the melting point of solids, that it is capable of being varied considerably by altering the situation of the body. Thus water may be cooled down considerably lower than 32°, without freezing. The boiling point is still less fixed, depending entirely on the degree of pressure to which the liquid to be boiled is exposed. If we diminish the pressure, the liquid boils at a lower temperature; if we increase it, a higher temperature is necessary to produce ebullition. From the experiments of professor Robison, it appears that, in a vacuum, all liquids boil about 145° lower than in the open air under a pressure of 30 inches of mercury; therefore water would boil in vacuo at 67°, and alcohol at 34°. In a Papin's digester, the temperature of water may be raised to 300°, or even 400°, without ebullition: but the instant that this great pressure is removed, the boiling commences with prodigious violence.

The elasticity of all the elastic fluids into which liquids are converted by heat, increases with the temperature; and the vapour formed, when the liquid boils in the open air, possesses an elasticity just equal to that of air, or capable at a medium of balancing a column of mercury 30 inches high. The following very important table, drawn up by Mr. Dalton from his own experiments, exhibits the elasticity of steam, or the vapour of water of every temperature, from —40° to 325°. The elasticities of all the temperatures from 32° to 212° were ascertained by experiment; the rest were calculated by observing the rate at which the elasticity increased or diminished according to the temperature.

TABLE
OF THE ELASTICITY OF STEAM.

Temperature.	Force of Vap. in inches of Mercury.	Temperature.	Force of Vap. in inches of Mercury.	Temperature.	Force of Vap. in inches of Mercury.	Temperature.	Force of Vap. in inches of Mercury.	Temperature.	Force of Vap. in inches of Mercury.	Temperature.	Force of Vap. in inches of Mercury.
—40°	.013	50°	.375	106°	2.25	162°	9.91	217°	33.09	273°	80.98
—30	.020	51	.388	107	2.32	163	10.15	218	33.72	274	82.01
—20	.030	52	.401	108	2.39	164	10.41	219	34.35	275	83.13
—10	.043	53	.415	109	2.46	165	10.68	220	34.99	276	84.35
		54	.429	110	2.53	166	10.96	221	35.63	277	85.47
0	.064	55	.443	111	2.60	167	11.25	222	36.25	278	86.50
1	.066	56	.458	112	2.68	168	11.54	223	36.88	279	87.63
2	.068	57	.474	113	2.76	169	11.83	224	37.53	280	88.75
3	.071	58	.490	114	2.84	170	12.13	225	38.20	281	89.87
4	.074	59	.507	115	2.92	171	12.43	226	38.89	282	90.99
5	.076	60	.524	116	3.00	172	12.73	227	39.59	283	92.11
6	.079	61	.542	117	3.08	173	13.02	228	40.30	284	93.23
7	.082	62	.560	118	3.16	174	13.32	229	41.02	285	94.35
8	.085	63	.578	119	3.25	175	13.62	230	41.75	286	95.48
9	.087	64	.597	120	3.33	176	13.92	231	42.49	287	96.64
10	.090	65	.616	121	3.42	177	14.22	232	43.24	288	97.80
11	.093	66	.635	122	3.50	178	14.52	233	44.00	289	98.96
12	.096	67	.655	123	3.59	179	14.83	234	44.78	290	100.12
13	.100	68	.676	124	3.69	180	15.15	235	45.58	291	101.28
14	.104	69	.698	125	3.79	181	15.50	236	46.39	292	102.45
15	.108	70	.721	126	3.89	182	15.86	237	47.20	293	103.63
16	.112	71	.745	127	4.00	183	16.23	238	48.02	294	104.80
17	.116	72	.770	128	4.11	184	16.61	239	48.84	295	105.97
18	.120	73	.796	129	4.22	185	17.00	240	49.67	296	107.14
19	.124	74	.823	130	4.34	186	17.40	241	50.50	297	108.31
20	.129	75	.851	131	4.47	187	17.80	242	51.34	298	109.48
21	.134	76	.880	132	4.60	188	18.20	243	52.18	299	110.64
22	.139	77	.910	133	4.73	189	18.60	244	53.03	300	111.81
23	.144	78	.940	134	4.86	190	19.00	245	53.88	301	112.98
24	.150	79	.971	135	5.00	191	19.42	246	54.68	302	114.15
25	.156	80	1.00	136	5.14	192	19.86	247	55.54	303	115.32
26	.162	81	1.04	137	5.29	193	20.32	248	56.42	304	116.50
27	.168	82	1.07	138	5.44	194	20.77	249	57.31	305	117.68
28	.174	83	1.10	139	5.59	195	21.22	250	58.21	306	118.86
29	.180	84	1.14	140	5.74	196	21.68	251	59.12	307	120.03
30	.186	85	1.17	141	5.90	197	22.13	252	60.05	308	121.20
31	.193	86	1.21	142	6.05	198	22.69	253	61.00	309	122.37
		87	1.24	143	6.21	199	23.16	254	61.92	310	123.53
32	.200	88	1.28	144	6.37	200	23.64	255	62.85	311	124.69
33	.207	89	1.32	145	6.53	201	24.12	256	63.76	312	125.85
34	.214	90	1.36	146	6.70	202	24.61	257	64.82	313	127.00
35	.221	91	1.40	147	6.87	203	25.10	258	65.78	314	128.15
36	.229	92	1.44	148	7.05	204	25.61	259	66.75	315	129.29
37	.237	93	1.48	149	7.23	205	26.13	260	67.73	316	130.43
38	.245	94	1.53	150	7.42	206	26.66	261	68.72	317	131.57
39	.254	95	1.58	151	7.61	207	27.20	262	69.72	318	132.72
40	.263	96	1.63	152	7.81	208	27.74	263	70.73	319	133.86
41	.273	97	1.68	153	8.01	209	28.29	264	71.74	320	135.00
42	.283	98	1.74	154	8.20	210	28.84	265	72.76	321	136.14
43	.294	99	1.80	155	8.40	211	29.41	266	73.77	322	137.28
44	.305	100	1.86	156	8.60	212	30.00	267	74.79	323	138.42
45	.316	101	1.92	157	8.81			268	75.80	324	139.56
46	.328	102	1.98	158	9.02	213	30.60	269	76.82	325	140.70
47	.339	103	2.04	159	9.24	214	31.21	270	77.85		
48	.351	104	2.11	160	9.46	215	31.83	271	78.89		
49	.363	105	2.18	161	9.68	216	32.46	272	79.94		

Mr. Dalton has discovered that the elasticity of every other vapour or steam is precisely the same, with that of the steam of water at the same distance from its boiling point. Thus water boils at 212°; its elasticity at the temperature of 182°, or 30 under its boiling point, we see from the table is 15.86. Alcohol boils at 176°; the elasticity of the steam of alcohol at 146°, or 30° under its boiling point, is likewise 15.86. This very important discovery enables us to ascertain the elasticity of the vapours of all liquids whatever at any temperature, provided their boiling points are known. We have only to find how many degrees the temperature at which the elasticity required is distant from the boiling point of this liquid. The same number of degrees, added to or subtracted from 212°, gives us a temperature, opposite to which in the above table we shall find the elasticity required.

Such are the phenomena of the conversion of liquid into elastic fluids. Dr. Black applied his theory of latent heat to this conversion with great sagacity; and demonstrated, that it is owing to the very same cause as the conversion of solids into liquids; namely, to the combination of a certain dose of caloric with the liquid, without any increase of temperature. The truth of this very important point was established by the following experiments.

First. When a vessel of water is put upon the fire, the water gradually becomes hotter till it reaches 212°; but afterwards its temperature is not increased. Now caloric must be constantly entering from the fire and combining with the water. But as the water does not become hotter, the caloric must combine with that part of it which flies off in the form of steam; but the temperature of the steam is only 212°; therefore the caloric combined with it does not increase its temperature. We must conclude, then, that the change of water to steam is owing to the combination of this caloric; for it produces no other change.

Dr. Black put some water in a tin-plate vessel upon a red-hot iron. The water was of the temperature 50°; in four minutes it began to boil, and in 20 minutes it was all boiled off. During the first four minutes it had received 162°, or 40½ per minute. If we suppose that it received as much per minute during the whole process of boiling, the caloric which entered into the water and converted it into steam would amount to $40\frac{1}{2} \times 20 = 810°$. This caloric is not indicated by the thermometer, for the temperature of steam is only 212°; therefore Dr. Black called it latent heat.

Second. Water may be heated in a Papin's digester to 400° without boiling; because the steam is forcibly compressed, and prevented from making its escape. If the mouth of the vessel is suddenly opened while things are in this state, part of the water rushes out in the form of steam, but the greater part still remains in the form of water, and its temperature instantly sinks to 212°; consequently 188° of caloric have suddenly disappeared. This caloric must have been carried off by the steam. Now as only about 1-5th of the water is converted into steam, that steam must contain not only its own 188°, but also the 188° lost by each of the other four parts; that is, it must contain $188° \times 5$, or about 940°. Steam therefore is water combined with at least 940° of caloric, the presence of which is not indicated by the thermometer. This experiment was first made by Dr. Black, and afterwards with more precision by Mr. Watt.

Third. When hot liquids are put under the receiver of an air-pump, and the air is suddenly drawn off, the liquids boil, and their temperature sinks with great rapidity a considerable number of degrees. Thus water, however hot at first, is very soon reduced to the temperature of 70°, and ether becomes suddenly so cold, that it freezes water placed round the vessel which contains it. In these cases the vapour undoubtedly carries off the heat of the liquid: but the temperature of the vapour is never greater than that of the liquid itself; the heat therefore must combine with the vapour, and become latent.

Fourth. If one part of steam at 212° is mixed with nine parts by weight of water at 62°, the steam instantly assumes the form of water, and the temperature after mixture is 178.6°, consequently each of the nine parts of water has received 116.6° of caloric; of course the steam has lost $9 \times 116.6° = 1049.4°$ of caloric. But as the temperature of the steam is diminished by 33.3°, we must subtract this

sum. There will remain rather more than 1000°, which is the quantity of caloric which existed in the steam without increasing its temperature. This experiment cannot be made directly; but it may be made by passing a given weight of steam through a metallic worm, surrounded by a given weight of water. The heat acquired by the water indicates the caloric which the steam gives out during its condensation. From the experiments of Mr. Watt made in this manner, it appears that the latent heat of steam amounts to 940°. The experiments of M. Lavoisier make it rather more than 1000°.

By the experiments of Dr. Black and his friends, it was ascertained, that not only water, but all other liquids during their conversion into vapour, combine with a dose of caloric, without any change of temperature; and that every kind of elastic fluid, during its conversion into a liquid, gives out a portion of caloric without any change of temperature. Dr. Black's law then is very general, and comprehends every change in the state of a body. The cause of the conversion of a solid into a liquid is the combination of the solid with caloric; that of the conversion of a liquid into an elastic fluid is the combination of the liquid with caloric. Liquids are solids combined with caloric; elastic fluids are liquids combined with caloric. This law, in its most general form, may be stated as follows: whenever a body changes its state, it either combines with caloric, or separates from caloric.

No person will dispute that this is one of the most important discoveries hitherto made in philosophy. Science is indebted for it entirely to the sagacity of Dr. Black. Other philosophers indeed have laid claim to it; but these claims are either without any foundation, or their notions may be traced to Dr. Black's lectures, as their opinions originated many years posterior to the public explanation of Dr. Black's theory in the chemical chairs of Glasgow and Edinburgh.

III. A very considerable number of bodies, both solids and liquids, may be converted into elastic fluids by heat; and as long as the temperature continues sufficiently high, they retain all the mechanical properties of gaseous bodies. It is exceedingly probable, that if we could command a heat sufficiently intense, the same change might be produced on all bodies in nature. This accordingly is the opinion at present admitted by philosophers. But if all bodies are convertible into elastic fluids by heat, it is exceedingly probable that all elastic fluids in their turn might be converted into solids or liquids, if we could expose them to a sufficiently low temperature. In that case, all the gases must be supposed to owe their elasticity to a certain dose of caloric: they must be considered as compounds of caloric with a solid or liquid body. This opinion was first stated by Amontons, and it was supported with much ingenuity both by Dr. Black and Lavoisier, and his associates. It is at present the prevailing opinion; and it is certainly supported not only by analogy, but by several very striking facts.

If its truth is admitted, we must consider all the gases as capable of losing their elasticity by depriving them of their heat: they differ merely from the vapours in the great cold which is necessary to produce this change. Now the fact is, that several of the gases may be condensed into liquids by lowering their temperatures. Oxymuriatic acid gas becomes liquid at a temperature not much under 40°; and at 32° it even forms solid crystals. Ammoniacal gas condenses into a liquid at —45°. None of the other gases have been hitherto condensed.

It is well known, that the condensation of vapours is greatly assisted by pressure; bu the effect of pressure diminishes as the temperature of vapours increases. It is very likely that pressure would also contribute to assist the condensation of gases. It has been tried without effect indeed in several of them. Thus air has been condensed till it was heavier than water; yet it showed no disposition to lose its elasticity. But this may be ascribed to the high temperature at which the experiment was made relative to the point at which air would lose its elasticity.

At the same time it cannot be denied, that there are several phenomena scarcely reconcilable to this constitution of the gases, ingenious and plausible as it is. One of the most striking is the sudden solidification which ensues when certain gases are mixed together. Thus when ammoniacal gas and muriatic acid gas are mixed, the product is a solid salt; yet the heat evolved is very inconsiderable, if we compare it with the difficulty of condensing these gases separately, and the great cold which they endure before losing their elasticity. In other cases too, gaseous bodies unite, and form a new gas, which retains its elasticity as powerfully as ever. Thus oxygen gas and nitrous gas combined form a new gas, namely, nitric acid, which is permanent till it comes into contact with some body on which it can act.

FLUOR-ALBUS. See MEDICINE.

FLUOR-SPAR. See FLUAT of LIME.

The principal use of fluats is for smelting ores, where they act as very powerful fluxes, and on this account are much valued. They are found in various countries, particularly Sweden, and some other northern countries of Europe. From this quality of melting easily in combination with other earthy matters, they have got the name of fluors. "The resemblance between the coloured fluors and the compositions made of coloured glass (says Cronstedt), has perhaps contributed not only to the fluors being reckoned of the same value with the coloured quartz crystals, by such collectors as only mind colour and figure, but to their also obtaining a rank among the precious stones in the apothecaries' and druggists' shops." Mr. Fabroni observes, that the combination of calcareous earth with the sparry acid is almost always transparent: it often crystallizes in regular cubes, sometimes single from one line to two inches in diameter, and sometimes of an indeterminate figure. They are sometimes of a blue colour; others are purple like amethysts; some are of a brown colour, others opaque. M. Magellan says, that fluors in general have this singular property, that on being melted by the flame of the blowpipe, together with gypsum, the product resulting from both is all formed with facets on the outside; but if melted with terra ponderosa, its surface is quite round or spherical.

FLUORIC ACID. The mineral called fluor, or fusible spar, and in this country Derbyshire spar, was not properly distinguished from other spars till Margraff published a dissertation on it in the Berlin Transactions for 1768. He first proved, that it contained no sulphuric acid, as had been formerly supposed: he then attempted to decompose it, by mixing together equal quantities of this mineral and sulphuric acid, and distilling them. By this method he obtained a white sublimate, which he supposed to be the fluor itself volatilized by the acid. He observed with astonishment, that the glass retort was corroded, and even pierced with holes. Nothing more was known concerning fluor till Scheele published his experiments three years after, by which he proved that it is composed chiefly of lime and a particular acid, which has been called fluoric acid.

The composition of fluoric acid is equally unknown with that of muriatic acid. Mr. Henry tried in vain to decompose it by means of electricity. It is always obtained from fluor spar, in which mineral it is found in abundance. For the investigation of the properties of this acid, we are indebted chiefly to Scheele and Priestley.

1. It may be obtained by putting a quantity of the spar in powder into a retort, pouring over it an equal quantity of sulphuric acid, and then applying a very gentle heat. A gas issues from the beak of the retort, which may be received in the usual manner in glass jars standing over mercury. This gas is fluoric acid.

The acid may be obtained dissolved in water by luting to the retort a receiver containing water. The distillation is to be conducted with a very moderate heat, not only to allow the gas to condense, but also to prevent the fluor itself from subliming. After the process, provided a glass retort has been employed, a crust of white earth is found in the receiver, which has all the properties of silica.

Scheele supposed that the silica produced was formed of fluoric acid and water; and Bergman adopted the same opinion. But Wiegleb and Buccholz showed that the quantity of silica was exactly equal to what the retort lost in weight; and Meyer completed the proof that it was derived from the glass, by the following experiment. He put into each of three equal cylindrical tin vessels a mixture of three ounces of sulphuric acid and one ounce of fluor, which had been pulverized in a mortar of metal. Into the first he put one ounce of pounded glass; into the second the same quantity of quartz in powder; and into the third nothing. Above each of the vessels he hung a sponge moistened with water, and having covered them, he exposed them to a moderate heat. The sponge in the first cylinder was covered with the crust in half an hour; the sponge in the second in two hours; but no crust was formed in the third, though it was exposed several days. In consequence of this decisive experiment, Bergman gave up his opinion; and wrote an account of Meyer's experiment to Morveau, who was employed in translating his works, to enable him to correct the mistake in his notes.

Soon after the discovery of this acid, difficulties and doubts concerning its existence as a peculiar acid were started by some French chemists. To remove these objec-

tions, Mr. Scheele instituted and published a new set of experiments; which not only completely established the peculiar nature of the fluoric acid, but once more displayed the unrivalled abilities of the illustrious discoverer. It would be needless to enumerate these objections, as they originated entirely from want of precision, and did not produce a single convert.

2. Fluoric acid gas is invisible and elastic like air; it does not maintain combustion, nor can animals breathe it without death. It has a pungent smell, not unlike that of muriatic acid. It is heavier than common air. It corrodes the skin almost instantly.

3. Neither caloric nor light produces any alteration on it.

4. When water is admitted in contact with this gas, it absorbs it rapidly; and if the gas has been obtained by means of glass vessels, it deposits at the same time a quantity of silica.

Water absorbs a considerable proportion of this gas, but the precise quantity has not been determined. The compound is usually termed fluoric acid by chemists. It is specifically heavier than water, has an acid taste, reddens vegetable blues, and does not freeze till cooled down to 23°. When heated, the acid gas is easily expelled, except the last portions of it, which adhere with great obstinacy.

5. Neither oxygen gas nor any of the simple combustibles or incombustibles produce any change on fluoric acid, either in the gaseous or liquid state.

6. Fluoric acid gas does not act upon any of the metals, but liquid fluoric acid is capable of oxiding iron, zinc, copper, and arsenic. It does not act upon gold, platinum, silver, mercury, lead, tin, antimony, cobalt.

7. It combines with alkalies, earths, and metallic oxides, and forms with them salts which are denominated fluats. See FLUAT.

The most singular property of fluoric acid is the facility with which it corrodes glass and siliceous bodies, especially when hot, and the ease with which it holds silica in solution even when in the state of gas. This affinity for silica is so great, that the thickest glass vessels can only withstand its action for a short time; and the greatest precautions are scarcely sufficient to obtain it entirely free from siliceous earth.

8. It produces no change, as far as is known, upon any of the acids already described.

9. Its affinities are as follows:

Lime,
Barytes,
Strontian,
Magnesia,
Potass,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia,
Silica.

10. As fluoric acid produces an insoluble compound with lime, it may be employed with great advantage, as Pelletier has observed, to detect the presence of that earth when held in solution. A drop or two of the acid causes a milky cloud or precipitate to appear, if any lime is present. The property which this acid has of corroding glass, has induced several ingenious men to attempt, by means of it, to engrave, or rather etch, upon glass. The glass is covered completely with wax; and then that part where the letters or figures are to appear is laid bare, by removing the wax. The whole is then exposed for some time to the hot vapours of fluoric acid. This simple process is employed with advantage in writing labels on glass vessels, and in graduating thermometers, and other similar instruments. The discovery is by no means new; it has been shewn by Beckman and Accum, that this acid was employed for that purpose by Henry Swanhard, an artist of Nuremberg, as early as 1670. He seems to have kept his art for some time secret, but the receipt was made public by Pauli in 1725. See ETCHING ON GLASS.

FLUSTRA, a genus of insects of the order zoophyta; an animal of the polypus kind, proceeding from porous shells; stem fixed, foliaceous, membranaceous, consisting of numerous rows of cells united together, and woven like a mat. There are many species. The verticillata is found in the Mediterranean, adhering to fuci: the cells, when magnified, appear surrounded by sharp denticles, with a long bristle in the front of each, bending inwards like a horn; the mouths incline forwards, and their whole substance appears full of small points.

FLUTE, *fistula*, an instrument of music, the simplest of all those of the wind kind. It is played on by blowing it with the mouth, and the tones or notes are changed by stopping and opening the holes disposed for that purpose along its side. The antient fistulæ, or flutes, were made of reeds, afterwards of wood, and last of metal; but how they were blown, whether as our flutes, or as hautboys, does not appear.

FLUTE, *German*, is an instrument entirely different from the common flute. It is not, like that, put into the mouth to be played, but the end is stopt with a tampion, or plug, and the lower lip is applied to a hole about two inches and a half, or three inches, distant from the end. This instrument is usually about a foot and and a half long, rather larger at the upper end than the lower, and perforated with holes, besides that for the mouth, the lowest of which is stopt and opened by the little finger's pressing on a brass, or sometimes a silver key, like those in hautboys, bassoons, &c. It is found exceedingly sweet and agreeable, and serves as a treble in a concert.

FLUTE, or FLUYT, (originally perhaps float) is a kind of long vessel, with flat ribs, or floor timbers; round behind, and swelled in the middle; serving chiefly for the carrying of provisions in fleets, or squadrons of ships, though it is also used for merchandize.

FLUTES, or FLUTINGS, in architecture, perpendicular channels, or cavities, cut along the shaft of a column, or pilaster. See ARCHITECTURE.

FLUX, in medicine, an extraordinary issue, or evacuation, of some humours of the body. See MEDICINE.

FLUX, in metallurgy, is sometimes used synonymously with fusion: for instance, an ore, or rather matter, is said to be in liquid flux, when it is completely fused. But the word flux is generally used to signify certain saline matters, which facilitate the fusion of ores, and other substances which are difficultly fusible in assays, and in the reductions of ores. We shall here describe the fluxes recommended by Bergman, in vol. ii.

1. The phosphoric acid, or rather the microcosmic salt, as it is called, which contains that acid partly saturated with mineral, partly with ammonia, and loaded besides with much water. This salt, when exposed to the flame, boils and foams violently, with a continual crackling noise, until the water and ammonia have flown off; afterwards it is less agitated, sending forth something like black scoriæ arising from the burned gelatinous part: these, however, are soon dispelled, and exhibit a pellucid sphericle encompassed by a beautiful green cloud, which is occasioned by the deflagration of the phosphorus, arising from the extrication of the acid by means of the inflammable matter. The clear globule which remains, upon the removal of the flame, continues longer soft than that formed by borax, and therefore is more fit for the addition of the matter to be dissolved. The ammonia is expelled by the fire; therefore an excess of acid remains in what is left behind, which readily attracts moisture in a cool place. 2. Soda, when put upon charcoal, melts superficially, penetrates the charcoal with a crackling noise, and then disappears. In the spoon it yields a permanent and pellucid sphericle, as long as it is kept fluid by the blue apex of the flame; but when the heat is diminished, it becomes opaque, and assumes a milky colour. It attacks several earthy matters, particularly those of the siliceous kind, but cannot be employed on charcoal. 3. Crystallized borax, exposed to the flame urged by the blow-pipe or charcoal, first becomes opaque, white, and excessively swelled, with various protuberances, or branches proceeding out from it. When the water is expelled, it easily collects itself into a mass, which, when well fused, yields a transparent sphericle, retaining its transparency even after cooling. If calcined borax is employed, the clear sphericle is obtained the sooner.

Having provided every thing necessary, the following directions are next to be attended to. 1. A common tallow candle, not too thick, is generally preferable to a wax candle, or to a lamp. The snuff must not be cut too short, as the wick should bend towards the object. 2. The weaker exterior flame must first be directed upon the object, until its effects are discovered; after which the interior flame must be applied. 3. We must observe with attention whether the matter decrepitates, splits, swells, vegetates, boils, &c. 4. The piece exposed to the flame should scarcely ever exceed the size of a pepper-corn, but ought always to be large enough to be taken up by the forceps. 5. A small piece should be added separately to each of the fluxes; concerning which it must be observed whether it dissolves wholly or only in part; whether this is effected with or without effervescence, quickly or slowly; whether the mass is divided into a powder, or gradually and externally corroded; with what colour the glass is tinged, and whether it becomes opaque, or remains pellucid.

Having given these directions, Mr. Bergman proceeds next to consider the subjects proper to be examined by the blowpipe. These he divides into four classes: 1 Saline;

2. Earthy; 3. Inflammable; and 4. Metallic. As the subject, however, is treated at considerable length, we shall refer the reader to Mr. Bergman's writings, and confine ourselves in this place to what he has advanced concerning the last of these subjects, namely, metallic substances.

The perfect metals, when calcined (oxygenated) in the moist way, recover their former nature by simple fusion. The imperfect metals are calcined by fire, especially by the exterior flame; and then, in order to their being reduced, indispensably require the contact of an inflammable substance. With respect to fusibility, the two extremes are mercury and platina; the former being scarcely ever seen in a solid form, and the latter almost as difficult of fusion. The metals, therefore, may be ranked in this order, according to their degrees of fusibility. 1. Mercury; 2. Tin; 3. Bismuth; 4. Lead; 5. Zinc; 6. Antimony; 7. Silver; 8. Gold; 9. Arsenic; 10. Cobalt; 11. Nickel; 12. Iron; 13. Manganese; 14. Platinum. The last two do not yield to the blowpipe, and indeed forged iron does not melt without difficulty; but cast iron perfectly.

Metals in fusion affect a globular form, and easily roll off the charcoal, especially when of the size of a grain of pepper. Smaller pieces, therefore, ought either to be used, or they should rest in hollows made in the charcoal. On their first melting they assume a polished surface, an appearance always retained by the perfect metals; but the imperfect are soon obscured by a pellicle formed of the calx (oxide) of the metal. The colours communicated by the calces vary, according to the nature of the metal from which the calx is produced. Some of the calces easily recover their metallic form by simple exposure to flame upon the charcoal; others are reduced in this way with more difficulty; and some not at all. The reduced calces of the volatile metals immediately fly off from the charcoal. In the spoon they exhibit globules; but it is very difficult to prevent them from being first dissipated by the blast.

The metals are taken up by the fluxes; but as soda yields an opaque spherule, it is not to be made use of. Globules of borax dissolve and melt any metallic calx; and, unless too much loaded with it, appear pellucid and coloured. A piece of metal calcined in flux produces the same effect, but more slowly. A portion of the calx generally recovers its metallic form, and floats on the melted matter like one or more excrescences.

The calces of the perfect metals are reduced by borax in the spoon, and adhere to it at the point of contact, and there only. The microcosmic salt acts like borax, but does not reduce the metals. It attacks them more powerfully on account of its acid nature; at the same time it preserves the spherical form, and therefore is adapted in a peculiar manner to the investigation of metals.

The tinge communicated to the flux frequently varies, being different in the fused and in the cooled globule; for some of the dissolved calces, while fused, show no colour, but acquire one while cooling; but others, on the contrary, have a much more intense colour while in the state of fluidity. Should the transparency be injured by too great a concentration of colour, the globule, on compressing it with the forceps, or drawing it out into a thread, will exhibit a thin and transparent mass; but if the opacity arises from supersaturation, more flux must be added; and as the fluxes attract the metals with unequal forces, the latter precipitate one another.

Metals when mineralized by acids have the properties of metallic salts; when mineralized by carbonic acid, they possess the properties of calces, that volatile substance being easily expelled without any effervescence; but when combined with sulphur they possess properties of a peculiar kind. They may then be melted, or even calcined upon the charcoal, as also in a golden or silver spoon. The volatile parts are distinguished by the smell or smoke; the fixed residua, by the particles reduced or precipitated upon iron, or from the tinge of the fluxes.

Gold in its metallic state fuses on the charcoal, and is the only metal which remains unchanged. It may be oxygenated in the moist way by solution in aqua regia; but to calcine it also by fire, we must pursue the following method: To a globule of microcosmic salt, let there be added a small piece of solid gold, of gold leaf, purple mineral, or, which is best of all, of the crystalline salt formed by a solution of gold in aqua regia containing sea-salt. Let this again be melted, and added while yet soft to turbith mineral, which will immediately grow red on the contact. The fusion being afterwards repeated, a vehement effervescence arises; and when this is considerably diminished, let the blast be stopped for a few moments, again begun, and so continued until almost all the bubbles disappear. After this the spherule, on cooling, assumes a ruby colour; but if this does not happen, let it be just made soft by the exterior flame, and upon hardening, this tinge generally appears. Should the process fail at first, owing to some minute circumstances which cannot be described, it will succeed on the second or third trial. The ruby-coloured globule, when compressed by the forceps while hot, frequently becomes blue; by sudden fusion it generally assumes an opal colour, which by refraction appears blue, and by reflection of a brown red. If further urged by the fire it loses all colour, and appears like water; but the redness may be reproduced several times by the addition of turbith mineral. The flux is reddened in the same manner by the addition of tin instead of turbith; but it has a yellowish hue, and more easily becomes opaque; while the redness communicated by turbith mineral has a purple tinge, and quite resembles a ruby. Borax produces the same phenomena, but more rarely; and in all cases the slightest variation in the management of the fire will make the experiment fail entirely.

The ruby colour may also be produced by copper; whence a doubt may arise, whether it is the gold or the remains of the copper that produce this effect. Mr. Bergman thinks it probable that both may contribute towards it, especially as copper is often found to contain gold.

This precious metal cannot directly be mineralized by sulphur; but by the medium of iron is sometimes formed into a golden pyrites. Here, however, the quantity of gold is so small, that a globule can scarcely be extracted from it by the blowpipe.

Grains of native platinum are not affected by the blowpipe, either alone or mixed with fluxes; which, however, are frequently tinged green by it: but platinum, precipitated from aqua regia by vegetable or volatile alkali, is reduced by microcosmic salt to a small malleable globule. Our author has been able to unite seven or eight of these into a malleable mass; but more of them produced only a brittle one. Platinum scarcely loses all its iron, unless reduced to very thin fusion.

Silver in its metallic state easily melts, and resists calcination. Silver leaf fastened by means of the breath, or a solution of borax, may easily be fixed on it by the flame, and through the glass it appears of a gold colour; but care must be taken not to crack the glass. Calcined silver precipitated from nitrous acid by fixed alkali is easily reduced. The microcosmic acid dissolves it speedily and copiously; but on cooling it becomes opaque, and of a whitish yellow, which is also sometimes the case with leaf-silver. Copper is discovered by a green colour, and sometimes by that of a ruby, unless we choose rather to impute that to gold. The globules can scarcely be obtained pellucid, unless the quantity of calx is very small; but a longer fusion is necessary to produce an opacity with borax. The globule, loaded with dissolved silver during the time of its fusion in the spoon, covers a piece of copper with silver, and becomes itself of a pellucid green: antimony quickly takes away the milky opacity of dissolved luna cornea, and separates the silver in distinct grains. Cobalt, and most of the other metals likewise, precipitate silver on the same principles as in the moist way, viz. by a double elective attraction. This metal, when mineralized by marine and vitriolic acids, yields a natural luna cornea, which produces a number of small metallic globules on the charcoal: it dissolves in microcosmic salt, and renders it opaque, and is reduced, partially at least, by borax. Sulphurated silver, called also the glassy ore of that metal, fused upon charcoal, easily parts with the sulphur it contains; so that a polished globule is often produced, which, if necessary, may be depurated by borax. The silver may also be precipitated by the addition of copper, iron, or manganese. When arsenic makes part of the compound, as in the red ore of arsenic, it must first be freed from the sulphur by gentle roasting, and finally entirely depurated by borax. It decrepitates in the fire at first.

Copper, together with sulphur and arsenic mixed with silver, called the white ore of silver, yields a regulus having the same alloy.

Galena, which is an ore of lead containing sulphur and silver, is to be freed in the same manner from the sulphur; after which the lead is gradually dissipated by alternately melting and cooling, or is separated in a cupel from the galena by means of the flame. Bergman has not been able to precipitate the silver distinct from the lead, but the whole mass becomes malleable; and the same is true of tin, but the mass becomes more brittle.

Pure mercury flies off from the charcoal with a moderate heat, the fixed heterogeneous matters remaining behind. When calcined, it is easily reduced and dissipated, and the fluxes take it up with effervescence; but

it is soon totally driven off. When mineralized by sulphur, it liquefies upon the charcoal, burns with a blue flame, smokes, and gradually disappears; but, on exposing cinnabar to the fire on a polished piece of copper, the mercurial globules are fixed upon it all round.

Lead in its metallic state readily melts, and continues to retain a metallic splendour for some time. By a more intense heat it boils and smokes, forming a yellow circle upon the charcoal. It communicates a yellow colour, scarcely visible, to the fluxes; and when the quantity is large, the globule, on cooling, contracts more or less of a white opacity. It is not precipitated by copper when dissolved; nor do the metals precipitate it from sulphur in the same order as from the acids. When united to carbonic acid, it grows red on the first touch of the flame; when the heat is increased it melts, and is reduced to a multitude of small globules. When united with phosphoric acid it melts, and yields an opaque globule, but is not reduced. With fluxes it shows the same appearances as oxide of lead. When mineralized by sulphur, lead easily liquefies, and being gradually deprived of the volatile part, yields a distinct regulus, unless too much loaded with iron. It may be precipitated by iron and copper.

A small piece of copper, either solid or foliated, sometimes communicates a ruby colour to fluxes, especially when assisted by tin or turbith mineral. If the copper is a little more or further calcined, it produces a green pellucid globule, the tinge of which grows weaker by cooling, and even verges towards a blue. By long fusion with borax, the colour is totally destroyed upon charcoal, but scarcely in the spoon. When once destroyed, this colour can scarcely be reproduced by nitre; but it remains fixed with microcosmic salt. If the calx or metal to be calcined is added in considerable quantity during fusion, it acquires an opaque red on cooling, though it appears green while pellucid and fused; but by a still larger quantity it contracts an opacity even while in fusion, and upon cooling a metallic splendour. Even when the quantity of copper is so small as scarcely to tinge the flux, a visible pellicle is precipitated upon a piece of polished iron added to it during strong fusion, and the globule in its turn takes the colour of polished iron; and in this way the smallest portions of copper may be discovered. The globule made green by copper, when fused in the spoon with a small portion of tin, yields a spherule of the latter mixed with copper, very hard and brittle: in this case the precipitated metal pervades the whole of the mass, and does not adhere to the surface. Cobalt precipitates the calx of copper dissolved in the spoon by a flux, in a metallic form, and imparts its own colour to glass, which nickel cannot do. Zinc also precipitates it separately, and rarely upon its own surface, as we can scarcely avoid melting it. When mineralized by the carbonic acid, copper grows black on the first contact of the flame, and melts in the spoon; on the charcoal the lower part, which touches the support, is reduced. With a superabundance of marine acid, it tinges the flame of a beautiful colour; but with a small quantity shows no appearance of the metal in that way. Thus the beautiful crystals of Saxony, which are cubic, and of a deep green, do not tinge the flame, though they impart a pellucid greenness to microcosmic salt. An opaque redness is easily obtained with borax: but Mr. Bergman could not produce this colour with microcosmic salt. Copper simply sulphurated, when cautiously and gently roasted by the exterior flame, yields at last by fusion a regulus surrounded with a sulphurated crust. The mass roasted with borax separates the regulus more quickly.

If a small quantity of iron happens to be present, the piece to be examined must first be roasted, after which it must be dissolved in borax, and tin added to precipitate the copper. The regulus may also be obtained by sufficient calcination and fusion, even without any precipitant, unless the ore is very poor. When the pyrites contain copper, even in the quantity of the one-hundredth part of their weight, its presence may be detected by these experiments. Let a grain of pyrites, of the size of a flax-seed, be roasted, but not so much as to expel all the sulphur; let it then be dissolved by borax, a polished rod of iron added, and the fusion continued until the surface when cooled loses all splendour. As much borax is required as will make the whole of the size of a grain of hemp-seed. Slow fusion is injurious, and the precipitation is also retarded by too great tenuity; but this may be corrected by the addition of a little lime. Too much calcination is also inconvenient; for by this the globule forms slowly, is somewhat spread, becomes knotty when warm, corrodes the charcoal, destroys the iron, and the copper does not precipitate distinctly. This defect is corrected by a small portion of crude ore. When the globule is properly melted, according to the directions already given, it ought to be thrown into cold water immediately on stopping the blast, in order to break it suddenly. If the copper contained in it is less than one-hundredth part, one end of the wire only has a cupreous appearance, but otherwise the whole.

Dr. Gahn has another method of examining the ores of copper, namely, by exposing a grain of the ore, well freed from sulphur by calcination, to the action of the flame driven suddenly upon it by intervals. At those instants a cupreous splendour appears on the surface, which otherwise is black; and this splendour is more quickly produced in proportion as the ore is poorer. The flame is tinged green by cupreous pyrites on roasting.

Forged iron is calcined, but can scarcely be melted. It cannot be melted by borax, though it may by microcosmic salt, and then it becomes brittle. Calcined iron becomes magnetic by being heated on the charcoal, but melts in the spoon. The fluxes become green by this metal; but in proportion as the oxygen is more abundant, they grow more of a brownish yellow. On cooling, the tinge is much weakened, and when originally weak, vanishes entirely. By too much saturation the globule becomes black and opaque. The sulphureous pyrites may be collected into a globule by fusion, and is first surrounded by a blue flame; but as the metal is easily calcined, and changes into black scoriæ, neither by itself nor with fluxes does it exhibit a regulus. It grows red on roasting.

Tin easily melts before the blowpipe, and is calcined. The fluxes dissolve the calx sparingly; and when saturated, contract a milky opacity. Some small particles of this metal dissolved in any flux may be distinctly precipitated upon iron. Crystallized ore of tin, urged by fire upon the charcoal, yields its metal in a reguline state.

Bismuth presents nearly the same appearances as lead; the calx is reduced on the coal, and fused in the spoon. The calx, dissolved in microcosmic salt, yields a brownish yellow globule, which grows more pale upon cooling, at the same time losing some of its transparency. Too much calx renders the matter perfectly opaque. Borax produces a similar mass in the spoon, but on the coal a grey one, which can scarcely be freed from bubbles. On fusion the glass smokes, and forms a cloud about it. Bismuth is easily precipitated by copper and iron. Sulphurated bismuth is easily fused, exhibiting a blue flame and sulphureous smell. Cobalt, when added, by means of sulphur, enters the globule; but the scoria soon swells into distinct partitions; which, when further urged by fire, throw out globules of bismuth. Sulphurated bismuth, by the addition of borax, may be distinctly precipitated by iron or manganese.

Regulus of nickel when melted is calcined, but more slowly than other metals. The calx imparts an hyacinthine colour to fluxes, which grows yellow on cooling, and by long-continued fire may be destroyed. If the calx of nickel is contaminated by ochre of iron, the latter is first dissolved. Nickel dissolved is precipitated on iron, or even on copper; an evident proof that it does not originate from either of these metals. Sulphurated nickel is no where found without iron and arsenic: the regulus is obtained by roasting, and fusing with borax, though it still remains mixed with some other metals.

Regulus of arsenic takes fire by a sudden heat, and not only deposits a white smoke on charcoal, but diffuses the same all around. The calx smokes with a smell of garlic, but does not burn. The fluxes grow yellow, without growing opaque, on adding a proper quantity of calx, which is dispelled by a long continuance of the heat. This semimetal is precipitated in a metallic form by iron and copper, but not by gold. Yellow arsenic liquefies, smokes, and totally evaporates: when heated by the external flame, so as neither to liquefy nor smoke, it grows red, and yellow again upon cooling. When it only begins to melt, it acquires a red colour, which remains after cooling. Realgar liquefies more easily, and is besides totally dissipated.

Regulus of cobalt melts, and may partly be depurated by borax, as the iron is first calcined and taken up. The smallest portion of the calx tinges the flux of a deep-blue colour, which appears of a violet by refraction, and this colour is very fixed in the fire. Cobalt is precipitated upon iron from the blue globule, but not upon copper. When calx of iron is mixed with that of cobalt in a flux, the former is dissolved. This semimetal takes up about one-third of its weight of sulphur in fusion, after which it can hardly be melted again. It is precipitated by iron, copper, and several other metals. The common ore yields an impure regulus by roasting. The green cobalt, examined by our author, tinges the microcosmic salt blue; but

at the same time shows red spots, indicating copper.

Zinc exposed to the blowpipe melts, takes fire, sending forth a beautiful blueish-green flame, which however is soon extinguished by a lanuginous calx; but if the reguline nucleus included in this lanuginous matter (commonly called flowers of zinc) is urged by the flame, it will be now and then inflamed, and, as it were, explode and fly about. With borax it froths, and at first tinges the flame. It continually diminishes, and the flux spreads upon the charcoal; but in fused microcosmic salt, it not only froths, but sends forth flashes with a crackling noise. Too great heat makes it explode with the emission of ignited particles. The white calx, or flowers, exposed to the flame on charcoal, becomes yellowish, and has a kind of splendour which vanishes when the flame ceases. It remains fixed, and cannot be melted. The fluxes are scarcely tinged, but when saturated by fusion, they grow opaque and white on cooling. Clouds are formed round the globules, of a nature similar to those of the metallic calx. Dissolved zinc is not precipitated by any other metal. When mineralized by carbonic acid gas, it has the same properties as calcined zinc. In the pseudo-galena sulphur and iron are present. These generally, on the charcoal, smell of sulphur, melt, and tinge the flame more or less, depositing a cloud all around. Those which have no matrix are tinged by those which contain iron, and acquire by saturation a white opaque colour, verging to brown or black, according to the variety of composition.

Regulus of antimony, fused and ignited on the charcoal, affords a beautiful object; for if the blast of air be suddenly stopped, a thick white smoke rises perpendicularly, while the lower part round the globule is condensed into crystalline spiculæ, similar to those called argentine flowers. The calx tinges fluxes of an hyacinthine colour; but on fusion smokes, and is easily dissipated, especially on the charcoal, though it also deposits a cloud on it. The dissolved metal may be precipitated by iron and copper, but not by gold. Crude antimony liquefies on the charcoal, spreads, smokes, penetrates it, and at last disappears entirely, except a ring which it leaves behind.

Regulus of manganese scarcely yields to the flame. The black calx tinges the fluxes of a blueish colour; borax, unless saturated, communicates more of a yellow colour. The colour may be gradually dissolved altogether by the interior flame, and again reproduced by a small particle of nitre, or the exterior flame alone. Combined with carbonic acid, it is of a white colour, which changes by ignition to black. In other respects it shows the same experiments as the black calx.

Fixed alkalis, nitre, borax, tartar, and common salt, are the saline matters of which fluxes are generally composed. But the word flux is more particularly applied to mixtures of different proportions of only nitre and tartar; and these fluxes are called by particular names, according to the proportions of these ingredients, as in the following instances.

FLUX, *white*, is made with equal parts of nitre and of tartar detonated together, by which they are alkalised. The residuum of this detonation is an alkali composed of the alkalis of the nitre and of the tartar, both which are absolutely of the same nature. As the proportion of nitre in this mixture is more than is sufficient to consume entirely all the inflammable matter of the tartar, the alkali remaining after the detonation is perfectly white, and is therefore called white flux; and as this alkali is made very quickly, it is also called extemporaneous alkali. When a small quantity only of white flux is made, as a few ounces for instance, some nitre always remains undecomposed, and a little of the acid of the tartar, which gives a red, or even a black colour, to some part of the flux; but this does not happen when a large quantity of white flux is made, because then the heat is much greater. This small quantity of undecomposed nitre and tartar which remains in white flux is not hurtful in most of the metallic fusions in which this flux is employed; but if the flux is required perfectly pure, it might easily be disengaged from those extraneous matters by a long and strong calcination, without fusion.

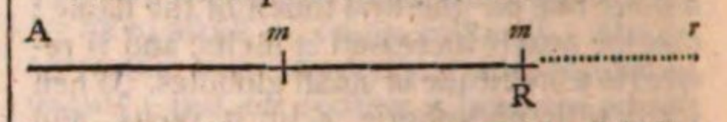
FLUX, *crude*. By crude flux is meant the mixture of nitre and tartar in any proportions, without detonation. Thus the mixture of equal parts of the two salts used in the preparation of the white flux, or the mixture of one part of nitre and two parts of tartar for the preparation of the black flux, are each of them a crude flux before detonation. It has also been called white flux, from its colour; but this might occasion it to be confounded with the white flux above described. The name, therefore, of crude flux is more convenient. Crude flux is detonated and alkalised during the reductions and fusions in which it is employed; and is then changed into white or black flux, according to the proportions of which it is composed. This detonation produces good effects in these fusions and reductions, if the swelling and extravasation of the detonating matters are guarded against. Accordingly, crude flux may be employed successfully in many operations; as, for instance, in the ordinary operation for procuring the regulus of antimony.

FLUX, *black*. Black flux is produced from the mixture of two parts of tartar and one part of nitre detonated together. As the quantity of nitre which enters into the composition of this flux is not sufficient to consume all the inflammable matter of the tartar, the alkali which remains after the detonation contains much black matter, of the nature of coal, and is therefore called black flux. This flux is designedly so prepared, that it shall contain a certain quantity of inflammable matter; for it is thereby capable, not only of facilitating the fusion of metallic earths like the white flux, but also of reviving these metals. From this property it is also called reducing flux; the black flux, therefore, or crude flux made with such proportions of the ingredients as to be convertible into black flux, ought always to be used when considered as metallic matters are at once to be fused and reduced. See FUSION.

FLUXION, in mathematics, denotes the velocity by which the fluents or flowing quantities, increase or decrease; and may be positive or negative, according as it relates to an increment or decrement.

The doctrine of fluxions, first invented by sir Isaac Newton, is of great use in the investigation of curves, and in the discovery of the quadratures of curvilinear spaces, and their rectifications. In this method, magnitudes are conceived to be generated by motion, and the velocity of the generating motion is the fluxion of the magnitude. Thus, the velocity of the point that describes a line, is its fluxion, and measures its increase or decrease. When the motion of this point is uniform, its fluxion or velocity is constant, and may be measured by the space described in a given time. But when the motion varies, the fluxion or velocity at any given point is measured by the space that would be described in a given time, if the motion was to be continued uniformly from that term.

Thus let the point *m* be conceived to move



from A, and generate the variable right line A*m*, by a motion any how regulated; and let its velocity, when it arrives at any proposed position or point R, be such as would, was it to continue uniform from that point, be sufficient to describe the line R*r*, in the given time allotted for the fluxion, then will R*r* be the fluxion of the variable line A*m*, in the term or point R. The fluxion of a plane surface is conceived in like manner, by supposing a given right line *m n* (plate Miscel. fig. 89) to move parallel to itself, in the plane of the parallel and immoveable lines A F and B G; for if, as above, R*r* be taken to express the fluxion of the line A *m*, and the rectangle R*r*s S be completed; then that rectangle, being the space which would be uniformly described by the generating line *m n*, in the time that A*m* would be uniformly increased by *m r*, is therefore the fluxion of the generated rectangle B*m*, in that position. If the length of the generating line *m n* continually varies, the fluxion of the area will still be expounded by a rectangle under that line, and the fluxion of he abciss or base; for let the curvilinear space A*n m* (fig. 90) be generated by the continual and parallel motion of the variable line *m n*; and let R*r* be the fluxion of the base or abciss A*m*, as before; then the rectangle R*r*sS, will be the fluxion of the generated space A*mn*. Because, if the length and velocity of the generating line *m n* were to continue invariable from the position RS, the rectangle R*r*sS would then be uniformly generated with the very velocity wherewith it begins to be generated, or with which the space A*mn* is increased in that position.

FLUXIONS, *Notation of*. Invariable quantities, or those which neither increase nor decrease, are represented by the first letters of the alphabet, as *a*, *b*, *c*, *d*, &c. and the variable or flowing quantities by the last letters, as *v*, *w*, *x*, *y*, *z*; thus, the diameter of a given circle may be denoted by *a*; and the sine of any arch thereof, considered as variable, by *x*. The fluxion of a quantity represented by a single letter, is expressed by the same letter with a dot or full point over it: thus, the fluxion of *x* is represented by $\dot{x}$, and that of *y* by $\dot{y}$. And, because these fluxions are themselves often variable quantities, the velocities with which they either increase or decrease, are the fluxions of the former fluxions, which may be called second fluxions, and are denoted by the same letters with two dots over them, as $\ddot{x}$, $\ddot{y}$. In the same

manner the fluxions of second fluxions are called third fluxions, and denoted by the same letters with three dots over them, as $\dddot{x}, \dddot{y}$; and so on for fourth, fifth, &c. fluxions.

The whole doctrine of fluxions consists in solving the two following problems, viz. 1. From the fluent, or variable flowing quantity given, to find the fluxion; which constitutes what is called the direct method of fluxions. 2. From the fluxion given, to find the fluent, or flowing quantity; which makes the inverse method of fluxions.

Direct Method of Fluxions.—The doctrine of this part of fluxions is comprized in these rules:

1. To find the fluxion of any simple variable quantity, the rule is to place a dot over it: thus, the fluxion of x is $\dot{x}$, and of y, $\dot{y}$. Again, the fluxion of the compound quantity $x+y$, is $\dot{x}+\dot{y}$; also the fluxion of $x-y$, is $\dot{x}-\dot{y}$.

2. To find the fluxion of any given power of a variable quantity, multiply the fluxion of the root by the exponent of the power, and the product by that power of the same root, whose exponent is less by unity than the given exponent. This rule is expressed more briefly, in algebraical characters, by $nx^{n-1}\dot{x}$ = the fluxion of x^n. Thus, the fluxion of x^3 is $\dot{x} \times 3 \times x^2 = 3x^2\dot{x}$; and the fluxion of x^5 is $\dot{x} \times 5 \times x^4 = 5x^4\dot{x}$. In the same manner the fluxion of $\overline{a+y}^7$ is $7\dot{y} \times \overline{a+y}^6$; for the quantity a being constant, $\dot{y}$ is the true fluxion of the root $a+y$. Again, the fluxion of $\overline{a^2+z^2}^{\frac{3}{2}}$ will be $\frac{3}{2} \times 2z\dot{z} \times \overline{a^2+z^2}^{\frac{1}{2}}$: for here, x being put $= a^2+z^2$, we have $\dot{x} = 2z\dot{z}$; and therefore $\frac{3}{2}x^{\frac{1}{2}}\dot{x}$, for the fluxion of $x^{\frac{3}{2}}$ (or $\overline{a^2+z^2}^{\frac{3}{2}}$) is $= 3z\dot{z}\sqrt{a^2+z^2}$.

3. To find the fluxion of the product of several variable quantities, multiply the fluxion of each, by the product of the rest of the quantities; and the sum of the products, thus arising, will be the fluxion sought. Thus, the fluxion of xy is $\dot{x}y+\dot{y}x$; that of xyz, is $\dot{x}yz+\dot{y}xz+\dot{z}xy$; and that of $vxyz$, is $\dot{v}xyz+\dot{x}vyz+\dot{y}vxz+\dot{z}vxy$. Again, the fluxion of $\overline{a+x} \times \overline{b-y} = ab+bx-ay-xy$, is $b\dot{x}-a\dot{y}-\dot{x}y-\dot{y}x$.

4. To find the fluxion of a fraction, the rule is, from the fluxion of the numerator multiplied by the denominator, subtract the fluxion of the denominator multiplied by the numerator, and divide the remainder by the square of the denominator. Thus the fluxion of $\frac{x}{y}$, is $\frac{y\dot{x}-x\dot{y}}{y^2}$; that of $\frac{x}{x+y}$, is $\frac{\dot{x} \times \overline{x+y} - \overline{\dot{x}+\dot{y}} \times x}{\overline{x+y}^2} = \frac{y\dot{x}-x\dot{y}}{\overline{x+y}^2}$; and that of $\frac{x+y+z}{x+y}$, or $1+\frac{z}{x+y}$, is $\frac{\dot{z} \times \overline{x+y} - \overline{\dot{x}+\dot{y}} \times z}{\overline{x+y}^2}$; and so of others.

In the examples hitherto given, each is resolved by its own particular rule: but in those that follow, the use of two or more of the above rules is requisite: thus (by rules 2. and 3.) the fluxion of x^2y^2 is found to be $2x^2y\dot{y}+2y^2x\dot{x}$; that of $\frac{x^2}{y^2}$, is found (by rules 2. and 4.) to be $\frac{2y^2x\dot{x}-2x^2y\dot{y}}{y^4}$; and that of $\frac{x^2y^2}{z}$, is (by rules 2. 3. and 4.) found to be $\frac{\overline{2x^2y\dot{y}+2y^2x\dot{x}} \times z - x^2y^2\dot{z}}{z^2}$.

5. When the proposed quantity is affected by a co-efficient, or constant multiplicator, the fluxion found as above must be multiplied by that co-efficient or multiplicator: thus, the fluxion of $5x^3$, is $15x^2\dot{x}$; for the fluxion of x^3 is $3x^2\dot{x}$, which, multiplied by 5, gives $15x^2\dot{x}$. And, in the very same manner, the fluxion of ax^n will be $nax^{n-1}\dot{x}$.

Having thus explained the manner of determining the first fluxions of variable quantities, it remains to say something of second, third, &c. fluxions. We have already observed, that the second fluxion of a quantity is the fluxion of the first fluxion; and by the third fluxion is meant the fluxion of the second; the fourth, of the third; and so on. The fluxions, therefore, of every order, are only the measures of the velocities by which their respective flowing quantities, viz. the fluxions of the immediately preceding order, are generated. Hence it appears, that a second fluxion always shews the rate of the increase or decrease of the first fluxion; and that the third, fourth, &c. fluxions differ in nothing, except their order and notation, from first fluxions; and therefore, are also determinable in the very same manner, by the rules already laid down: thus (by rule 4.) the (first) fluxion of x^3 is $3x^2\dot{x}$; and if $\dot{x}$ is supposed constant, that is, if the root x be generated with an equable or uniform velocity, the fluxion of $3x^2\dot{x}$ (or $3\dot{x} \times x^2$) again taken (by the same rule) will be $3\dot{x} \times 2x\dot{x}$, or $6x\dot{x}^2$; which, therefore, is the second fluxion of x^3. Again, the third fluxion of x^3, or the fluxion of $6x\dot{x}^2$, is found to be $6\dot{x}^3$; further than which we cannot go in this case, because the last fluxion, $6\dot{x}^3$, is here a constant quantity.

In the preceding example, the root x is supposed to be generated with an equable velocity: but if the velocity be an increasing or decreasing one, then $\dot{x}$, expressing the measure thereof, being variable, will also have its fluxion, which is denoted, as said above, by $\ddot{x}$; and the fluxion of $\ddot{x}$ by $\dddot{x}$, and so on with respect to the higher orders.

Here follow some examples, in which the root x (or y) is supposed to be generated with a variable velocity. Thus, the fluxion of x^3 being $3x^2\dot{x}$ (or $3x^2 \times \dot{x}$), the fluxion of $3x^2 \times \dot{x}$, considered as a rectangle, will (by rule 3.) be found to be $6x\dot{x} \times \dot{x} + 3x^2 \times \ddot{x} = 6x\dot{x}^2 + 3x^2\ddot{x}$; which is the second fluxion of x^3. Moreover, from the fluxion last found, we shall in like manner get $6\dot{x} \times \dot{x}^2 + 6x \times 2\dot{x}\ddot{x} + 6x\dot{x} \times \ddot{x} + 3x^2 \times \dddot{x}$ (or $6\dot{x}^3 + 18x\dot{x}\ddot{x} + 3x^2\dddot{x}$) for the third fluxion of x^3. Thus also, if $\dot{y} = nx^{n-1}\dot{x}$, then will $\ddot{y} = n \times \overline{n-1} \times x^{n-2}\dot{x}^2 + nx\ddot{x}^{n-1}$; and if $\dot{z}^2 = \dot{x}\dot{y}$, then will $2\dot{z}\ddot{z} = \dot{x}\ddot{y} + \dot{y}\ddot{x}$: and so of others.

The reader is here desired, once for all, to take particular notice, that the fluxions of all kinds and orders whatever, are contemporaneous, or such as may be generated together, with their respective velocities, in one and the same time.

Inverse Method of Fluxions, or the manner of determining the fluents of given fluxions.

If what is already delivered, concerning the direct method, be duly considered, there will be no great difficulty in conceiving the reasons of the inverse method: though the difficulties that occur in this last part, upon another account, are indeed vastly greater. It is an easy matter, or not impossible at most, to find the fluxion of any flowing quantity whatever; but, in the inverse method, the case is quite otherwise; for, as there is no method for deducing the fluent from the fluxion *a priori*, by a direct investigation; so it is impossible to lay down rules for any other forms of fluxions, than those particular ones that we know, from the direct method, belong to such kinds of flowing quantities; thus, for example, the fluent of $2x\dot{x}$ is known to be x^2; because, by the direct method, the fluxion of x^2 is found to be $2x\dot{x}$: but the fluent of $y\dot{x}$ is unknown, since no expression has been discovered that produces $y\dot{x}$ for its fluxion. Be this as it will, the following rules are those used by the best mathematicians, for finding the fluents of given fluxions.

1. To find the fluent of any simple fluxion, you need only write the letters without the dots over them: thus, the fluent of $\dot{x}$ is x, and that of $a\dot{x}+b\dot{y}$, is $ax+by$.

2. To assign the fluent of any power of a variable quantity, multiplied by the fluxion of the root; first divide by the fluxion of the root, add unity to the exponent of the power, and divide by the exponent so increased; for, dividing the fluxion $nx^{n-1}\dot{x}$ by $\dot{x}$, it becomes nx^{n-1}; and adding 1 to the exponent $(n-1)$ we have nx^n; which, divided by n, gives x^n, the true fluent of $nx^{n-1}\dot{x}$. Hence, by the same rule, the fluent of $3x^2\dot{x}$ will be $= x^3$; that of $2x^5\dot{x} = \frac{x^6}{3}$; that of $y^{\frac{1}{2}}\dot{y} = \frac{2}{3}y^{\frac{3}{2}}$; that of $ay^{\frac{5}{3}}\dot{y} = \frac{3ay^{\frac{8}{3}}}{8}$; and that of $y^{\frac{m}{n}}\dot{y} = \frac{y^{\frac{m}{n}+1}}{\frac{m}{n}+1} = \frac{y^{\frac{m+n}{n}}}{\frac{m+n}{n}} = \frac{ny^{\frac{m+n}{n}}}{m+n}$; that of $\frac{a\dot{x}}{x^n}$, or $a\dot{x}x^{-n} = \frac{ax^{1-n}}{1-n}$; that of $\overline{a+z}^3 \times \dot{z} = \frac{\overline{a+z}^4}{4}$; and that of $\overline{a^m+z^m}^n \times z^{m-1}\dot{z} = \frac{\overline{a^m+z^m}^{n+1}}{m \times \overline{n+1}}$.

In assigning the fluents of given fluxions, it ought to be considered, whether the flowing quantity, found as above, requires the addition or subtraction of some constant quantity, to render it complete: thus, for instance, the fluent of $nx^{n-1}\dot{x}$ may be either represented by x^n or by $x^n \pm a$; for a being a constant quantity, the fluxion of $x^n \pm a$, as well as of x^n, is $nx^{n-1}\dot{x}$.

Hence it appears, that the variable part of a fluent only can be assigned by the common method, the constant part being only assignable from the particular nature of the problem. Now to do this, the best way is to consider how much the variable part of the fluent first found, differs from the truth, when the quantity which the whole fluent ought to express is equal to nothing; then that difference, added to, or subtracted from, the said variable part, as occasion requires, will give the fluent truly corrected. To make this plainer by an example or two, let $\dot{y} = \overline{a+x}^3 \times \dot{x}$. Here we first find $y = \frac{\overline{a+x}^4}{4}$; but when $y = 0$, then $\frac{\overline{a+x}^4}{4}$ becomes $= \frac{a^4}{4}$; since x, by hypothesis, is then $= 0$: therefore $\frac{\overline{a+x}^4}{4}$ always exceeds y by $\frac{a^4}{4}$; and so the fluent, properly corrected, will

be $y = \frac{\overline{a+x}^4 - a^4}{4} = a^3x + \frac{3a^2x^2}{2} + ax^3 + \frac{x^4}{4}$. Again, let $\dot{y} = \overline{a^m + x^m}^n \times x^{m-1}\dot{x}$: here we first have $y = \frac{\overline{a^m + x^m}^{n+1}}{m \times \overline{n+1}}$; and making $y = 0$, the latter part of the equation becomes $\frac{a^{mn+1}}{m \times \overline{n+1}} = \frac{a^{mn+m}}{m \times \overline{n+1}}$; whence the equation or fluent, properly corrected, is $y = \frac{\overline{a^m + x^m}^{n+1} - a^{mn+m}}{m \times \overline{n+1}}$. Hitherto x and y are both supposed equal to nothing, at the same time; which will not always be the case: thus, for instance, though the sine and tangent of an arch are both equal to nothing, when the arch itself is so; yet the secant is then equal to the radius. It will therefore be proper to add some examples, in which the value of y is equal to nothing, when that of x is equal to any given quantity a. Thus, let the equation $\dot{y} = x^2\dot{x}$ be proposed; whereof the fluent first found is $y = \frac{x^3}{3}$; but when $y = 0$, then $\frac{x^3}{3} = \frac{a^3}{3}$, by the hypothesis; therefore the fluent, corrected, is $y = \frac{x^3 - a^3}{3}$. Again, suppose $\dot{y} = x^n\dot{x}$; then will $y = \frac{x^{n+1}}{n+1}$; which, corrected, becomes $y = \frac{a^{n+1} - x^{n+1}}{n+1}$. And, lastly, if $\dot{y} = \overline{c^2 + bx^2}^{\frac{1}{2}} \times x\dot{x}$; then, first, $y = \frac{\overline{c^2 + bx^2}^{\frac{3}{2}}}{3b}$; therefore, the fluent corrected, is $y = \frac{\overline{c^2 + bx^2}^{\frac{3}{2}} - \overline{c^2 + ba^2}^{\frac{3}{2}}}{3b}$.

3. To find the fluents of such fluxionary expressions as involve two or more variable quantities, substitute, instead of such fluxion, its respective flowing quantity; and, adding all the terms together, divide the sum by the number of terms, and the quotient will be the fluent. Thus, the fluent of $\dot{x}y + \dot{y}x = \frac{xy + xy}{2} = \frac{2xy}{2} = xy$; and the fluent of $\dot{x}yz + \dot{y}xz + \dot{z}yx = \frac{xyz + xyz + xyz}{3} = \frac{3xyz}{3} = xyz$. But it seldom happens that these kinds of fluxions, which involve two variable quantities in one term, and yet admit of known and perfect fluents, are to be met with in practice.

Having thus shewn the manner of finding such fluents as can be truly exhibited in algebraic terms, it remains now to say something with regard to those other forms of expressions involving one variable quantity only; which yet are so affected by compound divisors and radical quantities, that their fluents cannot be accurately determined by any method whatsoever. The only method with regard to these, of which there are innumerable kinds, is to find their fluents by approximation, which, by the method of infinite series, may be done to any degree of exactness. See the article SERIES.

Thus, if it were proposed to find the fluent of $\frac{a\dot{x}}{a - x}$, it becomes necessary to throw the fluxion into an infinite series, by dividing $a\dot{x}$ by $a - x$: thus, $a\dot{x} \div \overline{a - x} = \dot{x} + \frac{x\dot{x}}{a} + \frac{x^2\dot{x}}{a^2} + \frac{x^3\dot{x}}{a^3} + \frac{x^4\dot{x}}{a^4} +$, &c. Now the fluent of each term of this series, may be found by the foregoing rules to be $x + \frac{x^2}{2a} + \frac{x^3}{3a^2} + \frac{x^4}{4a^3} + \frac{x^5}{5a^4} +$, &c.

Again, to approximate the fluent of $\frac{\overline{a^2 - x^2}^{\frac{1}{2}} \times x^n\dot{x}}{\overline{c^2 - x^2}^{\frac{1}{2}}}$, we first find the value of $\frac{\overline{a^2 - x^2}^{\frac{1}{2}}}{\overline{c^2 - x^2}^{\frac{1}{2}}}$, expressed in a series, to be $\frac{a}{c} + \frac{\frac{3a}{8c^5} - \frac{1}{4ac^3} - \frac{1}{8a^3c}}{\frac{a}{2c^3} - \frac{1}{2ac}} \times x^2 + \frac{\frac{5a}{16c^7} - \frac{3}{16ac^5} - \frac{1}{16a^3c^3} - \frac{1}{16a^5c}}{\frac{a}{2c^3} - \frac{1}{2ac}} \times x^4 +$, &c. which value being multiplied by $x^n\dot{x}$, and the fluent taken by the rules above laid down, we get $\frac{ax^{n+1}}{\overline{n+1} \times c} + \frac{\frac{3a}{8c^5} - \frac{1}{4ac^3} - \frac{1}{8a^3c}}{\frac{a}{2c^3} - \frac{1}{2ac}} \times \frac{x^{n+3}}{n+3} + \frac{\frac{5a}{16c^7} - \frac{3}{16ac^5} - \frac{1}{16a^3c^3} - \frac{1}{16a^5c}}{\frac{a}{2c^3} - \frac{1}{2ac}} \times \frac{x^{n+5}}{n+5} + \frac{\frac{7a}{32c^9} - \frac{5}{32ac^7} - \frac{3}{32a^3c^5} - \frac{1}{32a^5c^3} - \frac{1}{32a^7c}}{\frac{a}{2c^3} - \frac{1}{2ac}} \times \frac{x^{n+7}}{n+7} +$, &c.

In order to shew the usefulness of fluxions, we shall give an example or two. Thus, suppose it were required, (1) To divide a given right line AB into two such parts, AC, CB, that their products or rectangles may be the greatest possible. Let AB $= a$, and let the part AC, considered as variable (by the motion of C towards B) be denoted by x. Then BC being $= a - x$, we have AC $\times$ BC $= ax - xx$, whose fluxion $a\dot{x} - 2x\dot{x}$ being put $= 0$, we get $a\dot{x} = 2x\dot{x}$; and, consequently, $x = \frac{1}{2}a$. Hence it appears that AC (or x) must be exactly one-half of AB.

(2) To find the fraction which shall exceed its cube by the greatest quantity possible: Let x denote a variable quantity; then the excess of x above x^3, being represented by $x - x^3$, if the fluxion of it be taken, we shall have $\dot{x} - 3x^2\dot{x} = 0$; therefore $1 = 3x^2$, $x^2 = \frac{1}{3}$, and $x = \sqrt{\frac{1}{3}}$.

(3) To determine the greatest rectangle that can be inscribed in a given triangle. See Plate Miscel. fig. 91. Put the AC $= b$, and its altitude BD $= a$: let the altitude BS of the inscribed rectangle an, considered as variable, be denoted by x. Then, since AC and ac are parallel, it will be BD (a) : AC (b) :: DS $(a - x)$: $\frac{ab - bx}{a}$ = the line ac. And the area of the rectangle, or $ac \times BS = \frac{abx - bx^2}{a}$, the fluxion of which is $\frac{ab\dot{x} - 2bx\dot{x}}{a}$, and being put equal to 0, we have $a = 2x$, and $x = \frac{a}{2}$. Hence the greatest inscribed triangle is that, the altitude of which is half the altitude of the triangle.

(4) Of all right-angled plain triangles, containing the same given area, to find that of which the sum of the legs AB + BC is the least possible. Let one leg AB be denoted by x, and the area of the triangle by a, then the other leg will be $\frac{2a}{x}$, the fluxion of which is $\dot{x} - \frac{2a\dot{x}}{x^2} = 0$: therefore $x^2 = 2a$, and $x = \sqrt{2a}$. Whence BC $= \left(\frac{2a}{x}\right) = \frac{2a}{\sqrt{2a}} = \sqrt{2a}$.

(5) To determine the dimensions of the least isosceles triangle, ACD, fig. 92, that can circumscribe a given circle. Let the distance OD of the vertex of the triangle from the centre of the circle be called x, and the remaining part OB, or radius, be represented by a; then, if OS perpendicular to DC be drawn, we have DS $= \sqrt{x^2 - a^2}$: and since DC : OS :: DB : BC, we have BC $= \frac{a \times \overline{x+a}}{\sqrt{x^2 - a^2}}$, which multiplied by BD or $x + a$, gives $\frac{a \times \overline{x+a}^2}{\sqrt{x^2 - a^2}}$ for the area of the triangle. Which being a minimum, its square is also a minimum, consequently $\frac{\overline{x+a}^4}{x^2 - a^2}$, or its equal $\frac{\overline{x+a}^3}{x - a}$, a minimum also; the fluxion of which is $\frac{3\dot{x} \times \overline{x+a}^2 \times \overline{x-a} - \dot{x} \times \overline{x+a}^3}{\overline{x-a}^2} = 0$; this being divided by $\frac{\dot{x} \times \overline{x+a}^2}{\overline{x-a}^2}$, we get $3 \times \overline{x-a} - \overline{x+a} = 0$, whence $2x = 4a$, and $x = 2a$. Therefore OD is equal to 2OS, and DC $=$ 2BC $=$ AC; and so the triangle ACD, when the least possible, is equilateral.

(6) Again, suppose it were required to find the solid contents of a spheroid, AFBH (plate Miscel. fig. 93). Let the axis AB, about which the solid is generated, be $= a$, the radius $= p = 1$, and the other axis FH of the generating ellipsis $= b$; then, from the property of the ellipsis, we have $a^2 : b^2 :: AD \times BD\ (x \times \overline{a-x}) : DE^2\ (y^2)$. Hence $y^2 = \frac{b^2}{a^2} \times \overline{ax - xx}$; and the fluxion of the solid $\dot{s}\ (= py^2\dot{x}) = \frac{pb^2}{a^2} \times \overline{ax\dot{x} - x^2\dot{x}}$; and the solidity $s = \frac{pb^2}{a^2} \times \overline{\frac{1}{2}axx - \frac{1}{3}x^3}$ = the segment AIE; which, when AD (x) = AB (a), becomes $\left(\frac{pb^2}{a^2} \times \overline{\frac{1}{2}a^3 - \frac{1}{3}a^3}\right)$ $\frac{1}{6}pab^2$ = the content of the whole spheroid. Where, if b (FH) be taken $= a$ (AB), we shall also get $\frac{1}{6}pa^3$ for the true content of the sphere, whose diameter is a. Hence a sphere or spheroid is $\frac{2}{3}$ of its circumscribing cylinder: for the area of the circle FH being expressed by $\frac{pb^2}{4}$, the content of the cylinder, whose diameter is FA, and altitude AB, will be $\frac{pb^2a}{4}$; of which $\frac{1}{6}pab^2$ is evidently two-third parts.

FLY, in zoology, a large order of insects, the distinguishing characteristic of which is, that their wings are transparent; by this they are distinguished from beetles, butterflies, and grasshoppers. See MUSCA.

FLY, in mechanics, a cross with leaden weights at its ends, or rather a heavy wheel at right angles to the axis of a windlass, jack, &c.; by means of which the force of the power, whatever it may be, is not only preserved, but equally distributed in all parts of the revolution of the machine. See MECHANICS.

The fly may be applied to several sorts of engines, whether moved by men, horses,

wind, or water, or any other animate or inanimate power; and is of great use in those parts of an engine which have a quick circular motion, and where the power or the resistance acts unequally in the different parts of a revolution. This has made some people imagine, that the fly adds a new power; but though it may be truly said to facilitate the motion, by making it more uniform, yet upon the whole it causes a loss of power, and not an increase; for as the fly has no motion of its own, it certainly requires a constant force to keep it in motion; not to mention the friction of the pivots of the axis, and the resistance of the air. The reason, therefore, why the fly becomes useful in many engines, is not that it adds a new force to them; but because, in cases where the power acts unequally, it serves as a moderator to make the motion of revolution almost every where equal: for as the fly has accumulated in itself a great degree of power, which it equally and gradually exerts, and as equally and gradually receives, it makes the motion in all parts of the revolution pretty nearly equal and uniform. The consequence of this is, that the engine becomes more easy and convenient to be acted on and moved by the impelling force; and this is the only benefit obtained by the fly.

The best form for a fly, is that of a heavy wheel or circle, of a fit size, as this will not only meet with less resistance from the air, but being continuous, and the weight every where equally distributed through the perimeter of the wheel, the motion will be more easy, uniform, and regular. In this form, the fly is most aptly applied to the perpendicular drill, which it likewise serves to keep upright by its centrifugal force: also to a windlass or common winch, where the motion is quick; for in pulling upwards from the lower part, a person can exercise more power than in thrusting forward in the upper quarter; where, of course, part of his force would be lost, was it not accumulated and conserved in the equable motion of the fly. Hence, by this means, a man may work all day in drawing up a weight of 40lb. whereas 30lb. would create him more labour in a day without the fly.

In order to calculate the force of the fly joined to the screw for stamping the image upon coins, let us suppose the two arms of the fly to be each fifteen inches long, measuring from the centre of the weight to the axis of motion, the weights to be fifty pounds each, and the diameter of the axis pressing upon the dye, to be one inch. If every stroke is made in half a second, and the weights describe an half-circumference, which in this case will be four feet, the velocity will at the instant of the stroke be at the rate of eight feet in a second, so that the momentum of it will be 800; but the arms of the fly being as levers, each fifteen inches long, whilst the semi-axis is only half an inch we must increase this force thirty times, which will give 24000; an immense force equal to 100lb. falling 120 feet, or near two seconds in time; or to a body of 750lb. falling $16\frac{1}{12}$ feet, or one second in time. Some of the engines for coining crown-pieces have the arms of the fly five times as long, and the weights twice as heavy; so that the effect is ten times greater.

FLY, in the sea-language, that part of the mariner's compass, on which the several winds or points are drawn.

Let fly the sheet, is a word of command to let loose the sheet, in case of a gust of wind, lest the ship should overset, or spend her topsails and masts; which is prevented by letting the sheet go amain, that it may hold no wind.

FLY-BOAT, a large vessel with a double prow, carrying from seven to eight hundredweight of goods.

FLY, *vegetable*, a very curious natural production, chiefly found in the West Indies. Excepting that it has no wings, it resembles the drone both in size and colour more than any other British insect. In the month of May it buries itself in the earth, and begins to vegetate. By the end of July, the tree is arrived at its full growth, and resembles a coral branch; and is about three inches high, and bears several little pods, which dropping off become worms, and thence flies, like the British caterpillar. Such was the account originally given of this extraordinary production. But several boxes of these flies having been sent to Dr. Hill for examination, his report was this: "There is in Martinique a fungus of the clavaria kind, different in species from those hitherto known. It produces soboles from its sides; I call it therefore clavaria sobolifera. It grows on putrid animal bodies, as our fungus ex pede equino, from the dead horse's hoof. The cicada is common in Martinique, and in its nympha state, in which the old authors call it tettigometra: it buries itself under dead leaves to wait its change; and when the season is unfavourable, many perish. The seeds of the clavaria find a proper bed in this dead insect, and grow. The tettigometra is among the cicadæ in the British museum; the clavaria is just now known. This is the fact, and all the fact; though the untaught inhabitants suppose a fly to vegetate, and though there is a Spanish drawing of the plants growing into a trifoliate tree, and it has been figured with the creature flying with this tree upon its back." Edwards has taken notice of this extraordinary production in his Gleanings of Natural History.

FLYERS, in architecture, such stairs as go straight, and do not wind round.

FLYING, the progressive motion of a bird, or other winged animal, in the liquid air. The parts of birds chiefly concerned in flying, are the wings, by which they are sustained or wafted along. The tail, Messrs. Willughby, Ray, and many others, imagine to be principally employed in steering and turning the body in the air, as a rudder; but Borelli has put it beyond all doubt, that this is the least use of it, which is chiefly to assist the bird in its ascent and descent in the air; and to obviate the vacillations of the body and wings: for, as to turning to this or that side, it is performed by the wings and and inclinations of the body, and but very little by the help of the tail. The flying of a bird, in effect, is quite a different thing from the rowing of a vessel. Birds do not vibrate their wings towards the tail, as oars are struck towards the stern, but waft them downwards; nor does the tail of the bird cut the air at right angles, as the rudder does the water, but is disposed horizontally, and preserves the same situation what way soever the bird turns.

In effect, as a vessel is turned about on its centre of gravity to the right, by a brisk application of the oars to the left, so a bird in beating the air with its right wing alone, towards the tail, will turn its fore part to the left. Thus pigeons, changing their course to the left, would labour with their right wing, keeping the other almost at rest. Birds of a long neck alter their course by the inclinations of their head and neck, which altering the course of gravity, the bird will proceed in a new direction.

The manner of flying is thus: The bird first bends his legs, and springs with a violent leap from the ground; then opens and expands the joints of his wings, so as to make a right line perpendicular to the sides of his body: thus the wings, with all the feathers in them, constitute one continued lamina. Being now raised a little above the horizon, and vibrating the wings with great force and velocity perpendicularly against the subject air, that fluid resists those succussions, both from its natural inactivity and elasticity, by means of which the whole body of the bird is protruded. The resistance the air makes to the withdrawing of the wings, and consequently the progress of the bird, will be so much the greater, as the waft or stroke of the fan of the wing is longer; but as the force of the wing is continually diminished by this resistance, when the two forces come to be in equilibrio, the bird will remain suspended in the same place: for the bird only ascends so long as the arch of air the wing describes, makes a resistance equal to the excess of the specific gravity of the bird above the air. If the air, therefore, is so rare as to give way with the same velocity as it is struck with, there will be no resistance, and consequently the bird can never mount. Birds never fly upwards in a perpendicular line, but always in a parabola. In a direct ascent, the natural and artificial tendency would oppose and destroy each other, so that the progress would be very slow. In a direct descent they would aid one another, so that the fall would be too precipitate.

Artificial FLYING, that attempted by men, by the assistance of mechanics.

The art of flying has been attempted by several persons in all ages. The Leucadians, out of superstition, are reported to have had a custom of precipitating a man from a high cliff into the sea, first fixing feathers, variously expanded, round his body, in order to break his fall. Friar Bacon, who lived five hundred years ago, not only affirms the art of flying possible, but assures us, that he himself knew how to make an engine in which a man sitting might be able to convey himself through the air, like a bird; and further adds, that there was then one who had tried it with success; but this method, which consisted of a couple of large, thin, hollow copper globes, exhausted of the air, and sustaining a person who sat thereon, Dr. Hook shews to be impracticable. The philosophers of king Charles the Second's reign, were exceedingly busied about this art. The famous bishop Wilkins was so confident of success in it, that he says, he does not question that, in future ages, it will be as usual to hear a man call for his wings, when he is going a journey, as it is now to call for his boots.

FLYING ARMY, a small body under a lieutenant or major-general, sent to harass the country, intercept convoys, prevent the ene-

my's incursions, cover its own garrisons, and keep the enemy in continual alarm.

FLYING PINION, is part of a clock, having a fly, or fan, whereby to gather air, and so bridle the rapidity of the clock's motion, when the weight descends in the striking part. See CLOCKWORK.

FOCUS, in geometry and conic sections, is applied to certain points in the parabola, ellipsis, and hyperbola, where the rays reflected from all parts of these curves concur and meet.

FOCI of an ellipsis, are two points in the longest axis, on which as centres the figure is described. If from the foci two right lines are drawn, meeting one another in the periphery of the ellipsis, their sum will be always equal to the longest axis; and therefore when an ellipsis and its two axes are given, and the foci are required, you need only take half the longest axis in yonr compasses, and setting one foot in the end of the shorter, the other foot will cut the longer in the focus required.

FOCUS of an hyperbola, is that point in the axis, through which the latus rectum passes; from whence if any two right lines are drawn meeting in either of the opposite hyperbolas, their difference will be equal to the principal axis.

FOCUS *of a parabola*, a point in the axis within the figure, distant from the vertex one fourth part of the latus rectum.

FOCUS, in optics, is the point in which the rays are collected, after they have undergone reflection or refraction. See OPTICS.

FODDER, in the civil law, is used for a prerogative that the prince has, to be provided of corn and other meats for his horses, by the subjects, in his warlike expeditions.

FODDER, or FOTHER, in mining, a measure containing twenty-two hundred and a half weight, though in London but twenty hundredweight.

FOETUS. See PHYSIOLOGY.

FOG, or MIST, a meteor, consisting of condensed vapours, floating near the surface of the earth. Mists, according to lord Bacon, are imperfect condensations of the air, consisting of a large proportion of the air, and a small one of the aqueous vapour: and these happen in the winter, about the change of the weather from frost to thaw, or from thaw to frost; but in the summer and in the spring, from the expansion of the dew. If the vapours, which are raised plentifully from the earth and waters, either by the solar or subterraneous heat, do at their first entrance into the atmosphere meet with cold enough to condense them to a considerable degree, their specific gravity is by that means increased, and thus they will be stopped from ascending; and either return back in form of dew or of drizzling rain, or remain suspended some time in the form of a fog. Vapours may be seen on the high grounds as well as the low, but more especially about marshy places. They are easily dissipated by the wind, as also by the heat of the sun. They continue longest in the lowest grounds, because those places contain most moisture, and are least exposed to the action of the wind. Hence we may easily conceive, that fogs are only low clouds, or clouds in the lowest region of the air; as clouds are no other than fogs raised on high. When fogs stink, then the vapours are mixed with putrid and offensive exhalations. Objects viewed through fogs appear larger and more remote than through the common air. Mr. Boyle observes that, upon the coast of Coromandel, and most maritime parts of the East Indies, there are, notwithstanding the heat of the climate, annual fogs, so thick, as to occasion people of other nations who reside there, and even the more tender sort of the natives, to keep their houses close shut up. Fogs are commonly pretty strongly electrified, as appears from Mr. Cavallo's experiments upon them. See METEOROLOGY.

FOIL, among glass-grinders, a sheet of tin, with quicksilver, &c. laid on the backside of a looking-glass, to make it reflect. See FOLIATING OF LOOKING-GLASSES.

FOIL, among jewellers, a thin leaf of metal placed under a precious stone, in order to increase its brilliancy, or give it an agreeable and different colour. These foils are made either of copper, gold, or gold and silver together; the copper foils are commonly known by the name of Nuremberg, or German foils; they are prepared as follows: Procure the thinnest copper-plates you can get; beat these plates gently upon a well-polished anvil, with a polished hammer, as thin as possible; and placing them between two iron plates as thin as writing-paper, heat them in the fire; then boil the foils, in a pipkin, with equal quantities of tartar and salt, constantly stirring them till by boiling they become white; after which, taking them out, and drying them, give them another hammering till they are made fit for your purpose; however, care must be taken not to give the foils too much heat, for fear of melting, nor must they be too long boiled, for fear of attracting too much salt.

The manner of polishing these foils is as follows: take a plate of the best copper, one foot long and about five or six inches wide, polished to the greatest perfection; bend this to a long convex, fasten it upon a half roll, and fix it to a bench or table; then take some chalk, washed as clean as possible, and filtred through a fine linen-cloth, till it is as fine as you can make it; and having laid some on the roll, and wetted the copper all over, lay your foils upon it, and with a polishing stone and the chalk, polish your foils till they are bright as a looking-glass; after which they must be dried, and laid up secure from dust.

FOLD-NET, among sportsmen, a sort of net with which small birds are taken in the night, of which there are two sorts; the least may be managed by one man only, but the greatest must be carried by two, and used thus: let the net be fixed on both sides to two strong, straight, and light poles about twelve feet long, each man holding one of them; let there be one behind them, at the distance of two yards, to carry lights: the nets must be carried between the wind and the birds, which all naturally roost on their perches with their breasts against the wind; in consequence of this, he that beats the bushes on the other side of the hedge, will drive them out that way towards the light.

FOLDING *of sheep*. See HUSBANDRY.

FOLIAGE, in architecture, is used for the representations of such flowers, leaves, branches, rinds, &c. whether natural or artificial, as are used for enrichments on capitals, friezes, pediments, &c.

FOLIATE, in the higher geometry, a name given by Mr. de Moivre to a curve of the second order, expressed by the equation $x^3+y^3=axy$; being a species of defective hyperbolas with one asymptote, and consisting of two infinite legs crossing one another, and forming a sort of leaf.

FOLIATING *of looking-glasses*, the spreading the plates over, after they are polished, with amalgam, in order to reflect the image. It is performed thus: a thin blotting paper is spread on the table, and sprinkled with fine chalk; and then a fine lamina or leaf of tin, called foil, is laid over the paper; upon this mercury is poured, which is to be distributed equally over the leaf with a hare's foot, or cotton: over this is laid a clean paper, and over that the glass plate, which is pressed down with the right-hand, and the paper drawn gently out with the left: this being done, the plate is covered with a thicker paper, and loaden with a greater weight, that the superfluous mercury may be driven out, and the tin adhere more closely to the glass. When it is dried, the weight is removed, and the looking-glass is complete. Some add an ounce of marcasite, melted by the fire; and, lest the mercury should evaporate in smoke, pour it into cold water; and when cooled, squeeze it through a cloth or through leather.

Some add a quarter of an ounce of tin and lead to the marcasite, that the glass may dry the sooner.

FOLIATING *of globe looking-glasses*, is done as follows: Take five ounces of quicksilver, and one ounce of bismuth; of lead and tin half an ounce each: first put the lead and tin into fusion, then put in the bismuth, and when you perceive that in fusion too, let it stand till it is almost cold, and pour the quicksilver into it; after this, take the glass globe, which must be very clean, and the inside free from dust; make a paper funnel, which put into the hole of the globe, as near to the glass as you can, so that the amalgam when you pour it in, may not splash, and cause the glass to be full of spots; pour it in gently, and move it about, so that the amalgam may touch every where. If you find the amalgam begin to get curdly and fixed, then hold it over a gentle fire, and it will easily flow again. And if you find the amalgam too thin, add a little more lead, tin, and bismuth to it. The finer and clearer your globe is, the better will the looking-glass be.

FOLKMOTE, or FOLCMOTE, according to Kennet, was the common-council of all the inhabitants of a city, town, or borough; though Spelman will have the folkmote to have been a sort of annual parliament or convention of the bishops, thanes, aldermen, and freemen, on every May-day. Dr. Brady, on the contrary, tells us, that it was an inferior court, held before the king's reeve, or his steward, every month, to do folk right.

FOMAHAUT, in astronomy, a star of the first magnitude, in the constellation Aquarius. See ASTRONOMY.

FOMENTATION, in medicine, the bathing any part of the body with a warm liquor.

FONTEVRAUD, or order of Fontevraud, a religious order instituted about the latter part of the 11th century. By the rules of this order the nuns were to keep silence for ever, and their faces to be always covered

with their veils; and the monks wore a leathern girdle, at which hung a knife and sheath.

FONTANESIA, a genus of the diandria monogynia class and order. The calyx is four-parted, inferior: petals two, two-parted: capsule membranaceous, not opening, two-celled, one-seeded. There is one species, an herb of Syria.

FONTINALIS, water-moss, a genus of the natural order of musci, in the cryptogamia class of plants. The anthera is hooded; the calyptra, or covering of the anthera, sessile, inclosed in a perichætium or empalement of leaflets different from those of the rest of the plant. There are six species, all of them natives of Britain. They grow on the brinks of rivulets, and on the trunks of trees. The most remarkable is the antipyretica, with purple stalks. The Scandinavians line the insides of their chimneys with this moss, to defend them against the fire; for, contrary to the nature of all other moss, this is scarcely capable of burning.

FOOD. See MATERIA MEDICA.

FOOD of plants. See PLANTS.

FOOT, a part of the body of most animals whereon they stand, walk, &c.

Animals are distinguished with respect to the number of their feet, into bipedes, two-footed; such are men and birds: quadrupedes, four-footed; such are most land-animals: and multipedes, or many-footed, as insects. The reptile kind, as serpents, &c. have no feet; the crab kind of fish have ten feet, but most other fishes have no feet at all: the spider, mites, and polypuses, have eight; flies, grasshoppers, and butterflies, have six feet. Animals destined to swim, and water-fowl, have their toes webbed together, as the phocæ, goose, duck, &c. The fore feet of the mole, rabbit, &c. are wonderfully formed for digging and scratching up the earth, in order to make way for their head.

FOOT, in the Latin and Greek poetry, a metre or measure composed of a certain number of long and short syllables. These feet are commonly reckoned twenty-eight, of which some are simple, as consisting of two or three syllables, and therefore called disyllabic or trisyllabic feet; others are compound, consisting of four syllables, and are therefore called tetrasyllabic feet.

FOOT is also a long measure, consisting of twelve inches. Geometricians divide the foot into ten digits, and the digit into ten lines.

FOOT, *square*, is the same measure both in breadth and length, containing 144 square or superficial inches.

FOOT, *cubic*, or *solid*, is the same measure in all the three dimensions, length, breadth, and depth or thickness, containing 1728 cubic inches. The foot is of different lengths in different countries. The Paris royal foot exceeds the English by nine lines; the antient Roman foot of the capitol, consisted of 4 palms, equal to $11\frac{7}{16}$ inches English; Rhineland or Leyden foot, by which the northern nations go, is to the Roman foot as 950 to 1000. The proportions of the principal feet of several nations, compared with the English, are as follow.

The English foot being divided into 1000 parts, or into 12 inches, the other feet will be as follow:

	1000 parts.	feet.	inch.	lines.
London foot	1000	0	12	0
Amsterdam	942	0	11	3
Antwerp	946	0	11	2
Bologna	1204	1	2	4
Bremen	964	0	11	6
Cologne	954	0	11	4
Copenhagen	965	0	11	6
Dantzick	944	0	11	3
Dort	1184	1	2	2
Frankfort on the Maine	948	0	11	4
The Greek	1007	1	0	1
Lorrain	958	0	11	4
Mantua	1569	1	6	8
Mechlin	919	0	11	0
Middleburg	951	0	11	9
Paris royal	1068	1	0	9
Prague	1026	1	0	3
Rhineland or Leyden	1033	1	0	4
Riga	1831	1	9	9
Roman	967	0	11	6
Old Roman	970	0	11	8
Scotch	1005	1	0	$\frac{5}{7}$
Strasburg	920	0	11	0
Toledo	899	0	10	7
Turin	1062	1	0	7
Venice	1162	1	1	9

FOOT of the forest, pes forestæ, in our antient customs, contained eighteen inches, or $1\frac{1}{2}$ of the common foot.

FOOT-LEVEL, among artificers, an instrument that serves as a foot-rule, a square, and a level. See the articles LEVEL, RULE, and SQUARE.

FOOT-PACE, or HALF-PACE, among carpenters, a pair of stairs, whereon, after four or six steps, you arrive at a broad place, where you may make two or three paces before you ascend another step. The design of this is, to ease the legs in ascending the rest of the steps.

FORAMEN, in anatomy, a name given to several apertures or perforations in divers parts of the body.

FORCE, in mechanics, denotes the cause of the change in the state of a body when being at rest it begins to move, or has a motion which is either not uniform, or not direct. See MECHANICS.

FORCE, in our common law, is most usually applied in its worst sense, signifying unlawful violence. Force is either simple or compound: simple force is that which is so committed, that it is accompanied by no other crime; as if one by force shall enter into another man's possession, without doing any other unlawful act; mixed or compound force, is that violence which is committed with such a fact, as of itself only is criminal; as if one by force enters into another man's possession, and kills a man, or ravishes a woman there, &c.

All force is against law; and it is lawful to repel force by force. 1 Inst. 267.

Where a crime, in itself capital, is endeavoured to be committed by force, it is lawful to repel that force, by the death of the party attempting. 4 Black. 181.

FORCEPS, in surgery, &c. a pair of scissars for cutting off, or dividing, the fleshy membranous parts of the body, as occasion requires. See SURGERY.

FORCER, or FORCING-PUMP, in mechanics, is a kind of pump in which there is a forcer or piston without a valve. See HYDRAULICS, and FIRE-ENGINE.

FORCIBLE ENTRY and DETAINER. Forcible entry is a violent actual entry into a house or land, &c. or taking a distress of any person weaponed, whether he offers violence or fear of hurt to any there, or furiously drives any out of the possession thereof. West. Symbol. p. 2.

Where one or more persons armed with unusual weapons, violently enter into the house or land of another; or where they do not enter violently, if they forcibly put another out of his possession; or if one enters another's house without his consent, although the doors be open, &c. these are all forcible entries punishable by the law. Co. Lit. 257. So when a tenant keeps possession of the land at the end of his term against the landlord, it is a forcible detainer. 1 Haw. 145.

If any person is put out or disseised of any lands and tenements in a forcible manner; or put out peaceably, and after holden out with strong hand; the party grieved shall have assize of novel disseisin, or writ of trespass against the disseisor; and if he recovers (or if any alienation is made to defraud the possessor of his right, which is also declared by the statute to be void), he shall have treble damages, and the defendant shall also make fine and ransom to the king. 8 H. VI. c. 9. But as this action is at the suit of the party, and only for the right, it lies only where the entry for the defendant was not lawful; for though a man enters with force, where his entry is lawful, he shall not be punished by way of action, but he may be indicted by the statute, for the indictment is for the force and for the king, and he shall make fine to the king, be his right ever so good. Dalt. c. 129. He shall recover treble damages, as well for the mesne occupation, as for the first entry; and though he shall recover treble damages, he shall recover costs which shall be trebled also; for the word damages includes costs of suit. 1 Inst. 257.

An indictment will lie at common law for a forcible entry, though generally brought on the statutes; but it must shew on the face of it sufficient actual force. 3 Bur. 1702.

If the party grieved will lose the benefit of his treble damages and costs, he may have the assistance of the justices at the general sessions, by way of indictment on the statute 8 H. VI. which being found there, he shall be restored to his possession by a writ of restitution granted out of the same court to the sheriff. Dalt. c. 129.

Forcible entry and detainer is also punishable under the statute, by one justice of peace, and by certiorari. Dalt. c. 44.

FORCIBLE MARRIAGE. If any person shall take away any woman having lands or goods, or that is heir apparent to her ancestor, by force and against her will, and afterwards she be married to him, or to another by his procurement, or defiled; he and also the procurers and receivers of such a woman, shall be adjudged principal felons.

And by 39 Eliz. c. 9, the benefit of clergy is taken away from the principals, procurers, and accessaries before. And by 4 and 5 P. et M. c. 8, if any person shall take or convey away any unmarried woman under the age of sixteen (though not attended with force), he shall be imprisoned two years, or fined at the discretion of the court; and if he deflower her, or contract matrimony without consent of parents or guardians, he shall be imprisoned five years or fined, and the marrying of any person under 21 without such consent is void.

FORCING, among gardeners, signifies the making trees produce ripe fruit before their usual time.

FORCING OF WINE. See WINE.

FORE-CASTLE, *of a ship*, that part where the foremast stands. It is divided from the rest by a bulk-head. See SHIP.

FORE-CLOSED, in law, signifies the being shut out, and excluded or barred, the equity of redemption on mortgages, &c. See MORTGAGE.

FORE-FOOT, in the sea-language, signifies one ship's lying, or sailing, across another's way; as if two ships being under sail, and in ken one of another, one of them lying in her course with her stem so much a weather the other, that holding on their several ways, neither of them altering their courses, the windward ship will run ahead of the other; then it is said, such a ship lies with the other's forefoot.

FOREIGN *attachment*, is an attachment of the goods of foreigners, found within a city or liberty, for the satisfaction of some citizen to whom the foreigner is indebted; or it signifies an attachment of a foreigner's money in the hands of another person.

FOREIGN *courts*. Upon a principle of the law of nations, every state being free, independant, and uncontroulable, the sentence of any foreign court of competent jurisdiction, is not to be called in question, but is admitted as evidence of the fact upon which it is founded. If however in such sentence any foreign jurisdiction should state the evidence, upon which its sentence or device is founded, subsequent evidence may be admitted to disprove such evidence, and consequently the sentence or decree which is a deduction from it. But where it is peremptorily given as a sentence, it is conclusive evidence which the English courts will not allow to be questioned.

FOREIGNERS, are persons subject to a foreign state to which they owe an allegiance, and although made free denizens or naturalized in Great Britain, they are nevertheless expressly disabled by the act of settlement from bearing offices in the government, from being members of the privy council, or members of parliament. See ALIEN.

FOREIGN *opposer*, or *apposer*, an officer in the exchequer to whom all sheriffs, after they are apposed of their sums out of the pipe-office, repair to be apposed by him of their green wax. He examines the sheriff's estreats with the record, and apposes the sheriff, what he says to every particular sum therein.

FOREIGN *plantations:* a writ of error lies here upon any of the judgments in foreign plantations, or in any dominions belonging to England. Vaugh. 402.

FOREIGN *plea:* a foreign plea is where the action is carried out of the county where it is laid, and is to be sworn, which a plea to the jurisdiction is not. Carth. 402.

FOREIGN *service*, is that whereby a mesne lord holds over of another, without the compass of his own fee; or that which a tenant performs either to his own lord, or to the lord paramount out of the fee. Bracton, lib. 2. c. 16.

FOREIGN *state*, is the dominion of a foreign power. Thus, if any foreign subject purchase goods in London, and then depart privately to his own country, the owner of the goods may have a certificate from the lord-mayor of London, on an affidavit being made of the sale and delivery of the goods, upon which the proper court in that state, will execute a legal process upon the party. At the instance of an ambassador also or consul, any criminal flying from justice to any foreign state, may be delivered up to the laws of the country where the crime was committed. Where any contract is made abroad if the party is resident in England, it may be recovered by the English courts.

FOREIGN *seamen*, serving two years on board British ships, whether of war, trade, or privateers, during the time of war, shall be deemed natural-born subjects.

FOREJUDGER, a judgment whereby a man is deprived, or put out, of the thing in question.

FOREJUDGED *the court*, is when an officer or attorney of the court of common-pleas is expelled the same for some offence, or for not appearing to an action by bill filed against him; and in the latter he is not to be readmitted till he shall appear. By 2 H. IV. c. 8. he shall lose his office and be forejudged the court.

FORLORN-HOPE, in the military art, signifies men detached from several regiments, or otherwise appointed, to make the first attack in day of battle, or at a siege, to storm the counterscarp, mount the breach, &c.

FOREMAST of a ship, that which carries the fore-sail and fore-top-sail yards. Its length is usually $\frac{8}{9}$ of the main mast; and the fore-top-gallant-mast is $\frac{1}{2}$ the length of the fore-top-mast.

FOREMAST-MEN, are those on board a ship that take in the top-sails, sling the yards, furl the sails, bowse, trice, and take their turn at the helm, &c.

FORE-REACH, in the sea-language: a ship is said to fore-reach upon another, when both sailing together, one sails better, or outgoes the other.

FORESTS, are waste grounds belonging to the king, replenished with all manner of beasts of chace or venery, which are under the king's protection, for the sake of his royal recreation and delight; and to that end, and for preservation of the king's game, there are particular laws, privileges, courts and officers, belonging to the king's forests. 1 Black. 279.

The forest courts are, the courts of attachments, of regard, of swainmote, and of justice seat.

The court of attachments is to be held before the verderers of the forest, once in every forty days, to enquire of all offenders against the king's deer, or covert for the game, who may be attached by their bodies, if found in the very act of transgression, otherwise by their goods; and in this court the foresters are to bring in their attachment, or presentments of vert and venison: and the verderers are to receive the same, and to inroll them, and to certify them under their seals, to the court of justice seat, or swainmote, for this court can only inquire of but not convict offenders.

The court of regard or survey of dogs is be holden every third year, for the lawing or expeditating of mastiffs, which is done by cutting off the claws of the fore-feet, to prevent them from running after deer. No other dogs than mastiffs were permitted to be kept within the king's forests, it being supposed that the keeping of these, and these only, was necessary for the defence of a man's house.

The court of swainmote is to be holden before the verderers as judges, by the steward of the swainmote, thrice in every year, the swains or freeholders within the forest composing the jury. The jurisdiction of this court, is, to enquire into the oppressions and grievances committed by the officers of the forest, and to receive and try presentments certified from the court of attachments, against the offenders in vert and venison; and this court may not only enquire, but convict also, which conviction shall be certified to the court of justice seat, under the seals of the jury, for this court cannot proceed to judgment.

The court of justice seat, is the principal court; which is held before the chief justice in eyre, or chief itinerant judge, or his deputy, to hear and determine all trespasses within the forest, and all claims of franchises, liberties, and privileges, and all pleas and causes whatsoever therein arising. It may also proceed to try presentments made in the inferior courts of the forest, and to give judgment upon the convictions that have been made in the swainmote courts. It may be held every third year. This court may fine and imprison, it being a court of record; and a writ of error lies to the court of king's bench. 1 Black. 289. 2 Black. 38. 3 Black. 71. But the forest laws have long ago ceased to be put in execution. 1 Black. 289.

FOREST-TREES. The planting of forest-trees is profitable as well as pleasing and respectable; and a young planter may live to reap much reward from his labour, or he may leave a valuable inheritance to his children. "The plantation and care of timber is like buying the reversion of an estate; for a little money expended, we become heirs to great sums. In countries scarce of firing, and where poles and rails are wanted, underwood will pay the proprietor triple more in value than the best fields of corn, and the oaks among it remain a great estate to succeeding generations." Poor land, that does not for corn, would be profitably cultivated in wood; but such ground should be sown, rather than planted. Wet places may be advantageously planted with the amphibious tribe, as willow, sallow, withy, osier, &c.

For those who may be disposed to plant forest-trees, the following directions are offered: The manual work proper to this business, is nearly the same as for fruit-trees and shrubs; and though plantations of forest-trees need not be so nicely attended to as fruit-trees, yet the better the work is performed, the fairer is the prospect in growing good

timber: a check by an error at first planting is a loss of time, and a damage done to trees which is sometimes never recovered. To give an instance: the mould is often thrown on the roots of a forest-tree in lumps, when if a little sifted earth was used, so as just to cover them with fine mould, the trouble would be amply repaid by the quick striking, and future strength of the tree.

Ground designed for planting should be prepared as long as it can beforehand, by the use of the plough or spade; and if some sort of previous cultivation, either in corn or vegetables, was adopted, the soil would be better fitted to receive the trees. At any rate, the places where the trees are to be set, should be previously dug somewhat deep, and cleared of rubbish, perennial weeds, tcouch, &c. If wet, let it be properly drained, for none but aquatics can do well in a cold and very moist soil.

In open planting for timber, to make only the holes good where the trees are set, is sufficient, if the soil is not strong (which generally speaking however it should be); and in such plantations the plough being used for corn, or some sort of crop to be carried off, the whole soil will be prep red for the trees' roots to spread. A plantation of this sort may be constantly under the plough, till the trees shade too much; and then it may be sown down for grass, which lying warm, and coming early, would be found useful. The opportunity given to improve a soil by this cultivation, would insure very fine timber.

But a plantation of trees being made (as suppose of oaks) at due distances, and the ground ploughed for two or three years, while they got a little ahead, then it might be sown profitably, with nuts, keys, and seeds for underwood, observing to thin the plants the second year, and again the third, till two or three feet asunder in poor ground, and to three or four feet distance if rich. In fourteen or fifteen years (or much sooner for some purposes), the ash-poles, &c. will be fine, and meet with a ready sale as useful stuff: afterwards the underwood will be fit to cut, in a strong state, every eleven or twelve years. In the management of underwood, some have thinned the plants while young, to three feet asunder, and cut them down at three years, to about six inches, in order to form stools, which in about ten years are cut, having produced several stems from each. Some persons have cut seedling trees down at this age to three inches for timber, leaving only one strong shoot to grow from each stool; and thus finer trees are frequently (or rather certainly) produced, than from seedlings not cut down.

The distances of the timber-plants, may be from twenty-five to thirty-five feet, according to the soil, or opinion of the planter. If no view to underwood, the above open planting may be made close, by setting first the principals (which should be fine plants), and then filling up with others that are worse, to within about eight or nine feet of one another. They will at this distance come to fair timber, or may be thinned at pleasure; and even among these, a small crop of underwood might be had which would shelter the timber-plants, and help to draw them up straight.

As to little plantations, of thickets, coppices, clumps, and rows of trees, they are to be set close according to their nature, and the particular view the planter has, who will take care to consider the usual size they attain, and their mode of growth. An advantage at home for shade or shelter, and a more distant object of sight, will make a difference. For some immediate advantage, very close planting may take place, but good trees cannot be thus expected; yet if thinned in time, a straight tall stem is thus procured, which afterwards is of great advantage.

For little clumps or groups of forest-trees (as elms), these may be planted three or four in a spot, within five or six feet of one another, and thus be easily fenced; having the air freely all round, and a good soil, such clumps produce fine timber.

Single trees of every sort grow off apace, and are more beautiful than when in the neighbourhood of others, and particularly firs, pines, larches, limes, walnuts, and chesnuts: the edible fruited chesnut is exceedingly good for timber; but the horse is only ornamental, flourishing most on high dry ground. As to rows of trees, whether single or double, when planted for a screen, they may be set about seven or eight feet asunder, upon an average, according to their nature, taking care to prune them occasionally, from too galling an interference.

Avenues are now seldom planted; but when they are, two good rows of elms, limes, chesnuts, &c. should be set at the width of the house, at full thirty feet distance in the rows: to thicken which, intermediate plants may be set; and also an inner row, to be removed when the principal trees are full grown. Avenues to prospects should be fifty or sixty feet wide.

The best season for planting the deciduous kinds of forest-trees, is toward the end of October, and for evergreen sorts, the end of March; though the soil, whether light and dry, or heavy and wet, should somewhat direct; evergreen trees being to be planted generally with safety, early in autumn, if the soil is warm; but in all cases trees should be planted in dry weather, that the mould may be loose to drop in, and lie close between the roots, which is a material thing: trees planted in rain or mists, are injured by the moisture moulding the roots.

Forest-trees for planting are generally preferred rather large, and being so, should not be taken up carelessly, but with as much of an uninjured spread of roots as possible; yet free-growing plants of about three or four feet high, promise in the end to make finer trees than those that are planted larger. Some say they are best at this size from the seed-bed; and others, to have been once planted out, having had their tap roots then cut: and generally speaking this is the case, as they have a more bushy and horizontal root.

In the act of planting, let every thing be done as for fruit-trees; *i.e.* the hole dug wide and deep, the ground well broken, or rather sifted, to lie immediately about the roots, &c. Let the trees be made fast by stakes, and litter laid about their roots to keep out frost and drought. It is of much consequence to take care that the roots (especially of evergreen trees) do not get withered before planted. Evergreens do best in a dry, but deciduous forest-trees (generally) in a moist soil, if it is not wet. Oaks, in particular, though at first they may appear to do poorly, grow well in strong moist ground, and make the best timber.

Fencing is the last thing to be considered, If trees are planted where cattle go, their stems must be protected from barking and rubbing. The common way of small posts and little rails is well known; but if large cattle are not fed where the trees are, good thorns stuck round them, and tied to them, are sufficient, and indeed this might do in almost all cases. There are various ways, ordinarily known; but whatever mode is used, let it be at first well executed, and afterwards repaired in time, as often as there is need.

Whoever plants forest-trees, should take care to dress them by proper pruning, and suffering no suckers to remain about their roots. Their tops should be kept equal, and not permitted to spread too much in heavy branches, but trained in a light and spiral way, always preserving the leading shoot, to encourage mounting, which is the perfection of a forest-tree. The stems of all trees designed for timber, should be constantly and timely attended to, as it is necessary to rub off buds, or to cut off the side shoots, except here and there a small one, which may serve to detain the sap to the swelling of the trunk; but branches being left on of any strength, keep the tree from mounting, and draw it crooked; and such branches, if cut off when large, occasion knots, and sometimes a decay at the part.

Plantations growing thick should be thinned in time, but not too much at once, especially in hilly situations; for those trees which remain, come suddenly to be exposed (after having been brought up under the shelter of others), and suffer much; getting crooked, stunted, and bushy, instead of having their desirable erect form, without which they are not adapted for superior uses, or agreeable to the eye.

Ornamental trees, as the crab, black cherry, mountain ash, &c. may prove profitable, as well as agreeable, here and there one amongst forest-trees, and should therefore not be omitted: the wood is good.

FORE-STAFF, or CROSS-STAFF, an instrument used at sea for taking the altitude of the sun, moon, or stars. It is called fore-staff, because the observer, in using it, turns his face towards the object; whereas in using Davis's quadrant, the back of the observer is towards the object; and hence its denomination of back-staff. See INSTRUMENTS ASTRONOMICAL.

FORESTALLING, is the buying or bargaining for any corn, cattle, or other merchandize, by the way, before it comes to any market or fair, to be sold; or by the way, as it comes from beyond the seas, or otherwise, towards any city, port, haven, or creek of this realm, to the intent to sell the same again at a higher price.

At the common law, all endeavours to enhance the price of any merchandize, and all practices which have an apparent tendency thereto, whether by spreading false rumours, or by purchasing things in a market before the accustomed hour, or by buying and selling again the same thing in the same market, or by any other such-like devices, are highly criminal, and punishable by fine and imprisonment. 1 Haw. 234.

Several statutes have from time to time been made against these offences in general, which were repealed by 12 Geo. III. c. 71.

But though these offences are no longer combated by the statutes, they are still punishable upon indictment at the common law, by fine and imprisonment.

FORESTER, a sworn officer of the forest, appointed by the king's letters patent, to walk the forest at all hours, watch over the vert and venison; also to make attachments and true presentments of all trespasses committed within the forest.

FORFEITURE, is a punishment annexed by law, to some illegal act or negligence in the owner of lands, tenements, or hereditaments, whereby he loses all his interest therein, and they go to the party injured, as a recompence for the wrong which either he alone or the public together with him have sustained. 2 Black. 267.

The offences which induce a forfeiture of lands and tenements, are principally the following: treason, felony, misprision of treason, præmunire, drawing a weapon on a judge, striking any one in the presence of the king's court of justice, and popish recusancy, or non-observance of any certain laws enacted in restraint of papists.

By the common law, all lands of inheritance of which the offender is seised in his own right, and also all rights of entry to lands in the hands of a wrong-doer, are forfeited to the king on an attainder of high treason, although the lands are holden of another; for there is an exception in the oath of fealty, which saves the tenant's allegiance to the king; so that if he forfeits his allegiance, even the lands he held of another lord are forfeited to the king, for the lord himself cannot give of lands but upon that condition. Co. Lit. 8.

Also upon an attainder of petit treason or felony, all lands of inheritance of which the offender is seised in his own right, as also all rights of entry to lands in the hands of a wrong-doer, are forfeited to the lord of whom they are immediately holden: for this by the feudal law was deemed a breach of the tenant's oath of fealty in the highest manner; his body with which he had engaged to serve the lord being forfeited to the king, and thereby his blood corrupted, so that no person could represent him; and all personal estates, whether they are in action or possession, which the party has or is entitled to, in his own right, and not as executor or administrator to another, are liable to such forfeiture in the following cases:

1st. Upon a conviction of treason or felony. But the lord cannot enter into the lands, holden of him upon an escheat for petit treason or felony, without a special grant, till it appears by due process that the king has had his prerogative of the year, day, and waste. Stamf. P.C. 191.

As to forfeiture of goods and chattels, it seems agreed that all things whatever, which are comprehended under the notion of a personal estate, are liable to such forfeiture.

2nd. Upon a flight found before the coroner, on view of a dead body.

3d. Upon an acquittal of a capital felony, if the party is found to have fled. 2 Haw. 450.

4th. If a person indicted of petit larceny and acquitted is found to have fled for it, he forfeits his goods as in cases of grand larceny. 2 Haw. 451. But the party may in all cases, except that of the coroner's inquest, traverse the finding of the flight; and it seems agreed that the particulars of the goods found to be forfeited may also be traversed.

5th. Upon a presentment by the oaths of twelve men, that a person arrested for treason or felony fled from, or resisted, those who had him in custody, and was killed by them in the pursuit or scuffle. Id.

6th. If a felon waive, that is, leave any goods in his flight from those who either pursue him, or are apprehended by him so to do, he forfeits them, whether they are his own goods, or goods stolen by him; and at common law, if the owner did not pursue and appeal the felon he lost the goods for ever: but by 21 H. VIII. c. 11, for encouraging the prosecution of felons, it is provided, that if the party comes in as evidence on the indictment, and attaints the felon, he shall have a writ of restitution. 4 Inst. 134.

7th. If a man is felo de se, he forfeits his goods and chattels. 5 Co. 109.

8th. A convict within clergy forfeits all his goods, though he may be burnt in the hand; yet thereby he becomes capable of purchasing other goods. But, on burning in the hand, he ought to be immediately restored to the possession of his lands. 2 H. 388, 389.

The forfeiture upon an attainder of treason or felony shall have relation to the time of the offence for the avoiding all subsequent alienation of the lands; but to the time of conviction, or fugam fecit found, &c. only as to chattels, unless the party was killed in flying from, or resisting those who had arrested him: in which case it is said that the forfeiture shall relate to the time of the offence. Plowd. 488.

FORFEITURE *in civil cases.* A forfeiture of copyhold by felling timber was relieved in equity; but the lord-keeper declared, that in case of a wilful forfeiture he would not relieve. Chan. Cas. 96. In case of a forfeiture equity can relieve, where they can give satisfaction. 1 Salk. 156.

FORFEITURE *of marriage,* a writ which antiently lay against him, who by holding knight's service, and being under age, and unmarried, refused her whom the lord offered him without his disparagement, and married another. F. N. B. 141.

FORFICULA, *earwig,* an insect of the coleoptera order. The generic character is, antennæ setaceous; wing-sheaths halved; wings covered; tail forcipated. This is not a numerous genus. The forficula auricularia, or common earwig, is an insect so familiarly known, that a formal description might seem unnecessary: its structure, however, is highly curious, and its natural history well worthy of particular observation. The wings of this insect are remarkably elegant, and are convoluted beneath their small sheaths in so curious a manner that they cannot be viewed without admiration: they are very large in proportion to the animal, transparent, and slightly iridescent. The earwig flies only by night, and it is not without great difficulty that it can be made to expand its wings by day: it is even probable that they would receive injury by any long exposure to the diurnal air; the animal therefore keeps them completely covered; and indeed so unusual a circumstance is it to see them expanded, that sir Thomas Brown, in his Pseudodoxia Epidemica, has thought it necessary to confute the commonly received opinion, that the earwig is an "impennous insect."

The female earwig deposits her eggs, which are rather large for the size of the animal, of a white colour, and of an oval shape, under stones, or in any damp situation, where they may be secure from too much heat or drought. From these eggs are hatched the young larvæ, which are at first very small, but have very much the general aspect of the parent animal, except that they are of a white or whitish colour, and that the limbs of the forceps at the tip of the abdomen are not yet curved inwards. The parent insect, according to the observations of Degeer, guards and broods over her young nearly in the same manner as a hen does over her chickens; and they generally remain close to the sides, or under the abdomen of the parent, for several hours in the day. They change their skin at certain intervals during the earlier stages of their growth; and after each change acquire a darker colour and a greater degree of resemblance to the full-grown insect; till at length the wing-sheaths and wings are formed, and the animals may be considered as perfect.

The usual food of the earwig consists of decayed fruit, and other vegetable substances; and it does not seem to be naturally carnivorous, though, if kept without proper nourishment, it will, like many other animals, occasionally attack and devour even its own species.

The popular dread in which this insect is held, on a supposition of its sometimes entering the cavity of the ear, and piercing the tympanum, is considered by some as problematical, though we believe there are instances of earwigs, which naturally creep into holes and apertures of every kind, having accidentally taken shelter in the ears of persons asleep, and occasioning great pain. The best means of expelling them, we have heard, is to drop a small quantity of brandy or other spirit into the ear.

FORGE, properly signifies a small furnace, in which smiths and other artificers of iron or steel, &c. heat their metals red-hot, in order to soften and render them more malleable and manageable on the anvil.

The forge used by the several operators in iron is very simple: we shall instance that of the blacksmiths, to which all the rest are reducible, the construction of which is as follows. The hearth or fireplace of the forge is to be built up from your floor with brick, about two feet and a half, or sometimes more, according to the purpose you design to forge for: if your forge is intended for heavy work, your hearth must lie lower than it need be for light work: the forge may be of what breadth is thought convenient. It may be built with hollow arches underneath, to set several things out of the way: the back of it is built upright to the top of the ceiling, and inclosed over the fireplace with a hovel, which ends in a chimney to carry away the smoke. In the back of the forge, against the fireplace, is fixed a thick iron plate, with a taper pipe in it, about five inches long, which pipe comes through the back of the forge,

Into this taper pipe is placed the nose or pipe of the bellows: the office of this is to preserve the pipe of the bellows and the back of the forge about the fireplace, from burning. Right before the back is placed, at about two feet distance, the trough, which reaches commonly the whole breadth of the forge, and is as broad as is thought necessary. The bellows is placed behind the back of the forge, having one of its boards so fixed, that it can neither move upwards nor downwards. At the ear of the upper board is fastened a rope or chain, which reaches up to the rocker, and is fastened there to the further end of the handle. This handle is fastened across a rock-staff, which moves between two cheeks upon the centre pins, in two sockets; so that by drawing down this handle the moving board of the bellows rises; and by a considerable weight set on the top of its upper board, sinks down again, and by this agitation performs the office of a pair of bellows.

FORGE is also used for a large furnace, in which iron ore, taken out of the mine, is melted down; or it is more properly applied to another kind of furnace, where the iron ore, melted down and separated in a former furnace, and then cast into sows and pigs, is heated and fused over again, and beaten afterwards with large hammers, and thus rendered more soft, pure, ductile, and fit for use.

Of these there are two kinds: the first is called the finery, where the pigs are worked into gross iron, and prepared for the second, which is called the chafery, where it is further wrought into bars fit for use.

FORGERY, is where a person counterfeits the signature of another with intent to defraud, which by the law of England is made a capital felony.

A receipt to a cash memorandum is not a receipt on acquittance for the payment of money within 2 Geo. II. c. 25, against forgery.

Forgery may be committed by making a mark in the name of another person. It may also be committed in the name of a person who never had existence. And it may be committed of an instrument, though such an instrument as the one forged does not exist either in law or fact.

Indorsing a real bill of exchange with a fictitious name is forgery; although the use of a fictitious name was not essential to the negociation.

A forged bank-note (although the word pounds is omitted in the body of it), and there is no water-mark in the paper, is a counterfeit note for the payment of money.

Altering an entry of money received, made by a cashier of the bank, in the bank-book of a person keeping cash there, by prefixing a figure to increase the amount of the sum received, is forging a receipt for money.

A receipt indorsed on a bill of exchange in a fictitious name is forgery, although such name does not purport to be the name of any particular person.

If a person who has for many years been known by a name which was not his own, and afterwards assumes his real name, in that name draws a bill of exchange, he will not be guilty of forgery, although such bill was drawn for fraudulent purposes.

If any person shall falsely make, forge, or counterfeit, or cause or procure to be falsely made, forged, or counterfeited, or willingly aid or assist in the false making or counterfeiting, any deed, will, bond, writing obligatory, bill of exchange, promissory note for payment of money, acquittance, or receipt, either for money or goods, with intent to defraud any person; or shall utter or publish the same as true, knowing the same to be false, forged, or counterfeited, he shall be guilty of felony without benefit of clergy; but not to work corruption of blood, or disherison of heirs. 2 Geo. II. c. 25.

Forging or imitating stamps to defraud the revenue is forgery by the several stamp acts; and the receiving of them is made single felony, punishable with seven years transportation. 12 Geo. III. c. 48.

FORGING, in smithery, the beating or hammering iron on the anvil, after having first made it red-hot in the forge, in order to extend it into various forms, and fashion it into works.

There are two ways of forging and hammering iron; one is by the force of the hand, in which there are usually several persons employed, one of them turning the iron and hammering likewise, and the rest only hammering. The other way is by the force of a water-mill, which raises and works several huge hammers beyond the force of man; under the strokes of which the workmen present large lumps or pieces of iron, which are sustained at one end by the anvils, and at the other by iron chains fastened to the ceiling of the forge.

This last way of forging is only used in the largest works, as anchors for ships, &c. which usually weigh several thousand pounds. For the lighter works, a single man serves to hold, heat, and turn with one hand, while he hammers with the other.

Each purpose the work is designed for requires its proper heat; for if it is too cold, it will not feel the weight of the hammer, as the smiths call it, when it will not batter under the hammer; and if it is too hot, it will red-sear, that is, break or crack under the hammer.

The several degrees of heats the smiths give their irons, are, first, a blood-red heat; secondly, a white flame heat; and, thirdly, a sparkling or welding heat.

FORISFAMILIARI. A son is properly said to be forisfamiliari when he accepts of his father's part of his lands, and is contented with it in the life-time of his father, so that he cannot claim any more.

FORM, *printer's*, an assemblage of letters, words and lines, ranged in order, and so disposed into pages by the compositor; from which, by means of ink and a press, the printed sheets are drawn. Every form is inclosed in an iron chase, wherein it is firmly locked by a number of pieces of wood; some long and narrow, and others of the form of wedges. There are two forms required for every sheet, one for each side; and each form consists of more or fewer pages, according to the size of the book. See PRINTING.

FORM *of a series*, in algebra, that affection of an undeterminate series, which arises from the different values of the indices of the unknown quantity.

FORM, is required in law proceedings, otherwise the law would be no art; but it ought not to be used to ensnare or entrap. Hob. 232. The formal part of the law, or method of proceeding, cannot be altered but by parliament: for if once those outworks were demolished, there would be an inlet to all manner of innovation in the body of the law itself. 1 Black. 142.

FORMA PAUPERIS, is when any person has cause of suit, and is so poor that he cannot support the usual charges of suing at law or in equity. In this case, upon his making oath that he is not worth five pounds his debts being paid, and bringing a certificate from some lawyer that he has just cause of suit, the judge admits him to sue in forma pauperis, that is, without paying fees to counsellor, attorneys, or clerk; and he shall have original writs and subpœnas gratis. 11 H. VII. c. 12.

And he shall when plaintiff be excused from costs, but shall suffer other punishment at the discretion of the judge. And it was formerly usual to give such paupers, if nonsuited, their election either to be whipped or pay the costs, though the practice is now disused. 3 Black. 400.

It seems agreed that a pauper may recover costs, though he pay none; for although the counsel and clerks are bound to give their labour to him, yet they are not bound to give it to his antagonist. Id.

FORMEDON, in law, a writ that lies for a person who has a right to lands or tenements, by virtue of any entail, arising from the statute of Westm. 2 Ch. II.

This writ is of three kinds, viz. a descender, remainder, and reverter. Formedon in descender lies where a tenant entail infeoffs a stranger, or is disseised and dies, the heir may bring this writ to recover the land. Formedon in remainder lies where a man gives lands, &c. to a person in tail, and for default of issue of his body, the remainder to another in tail: here if the tenant in tail dies without issue, and a stranger abates and enters into the land, he in remainder shall have this writ. Formedon in reverter lies where lands are entailed on certain persons and their issue, with remainder over for want of issue, and on that remainder failing, then to revert to the donor and his heirs: in this case, if the tenant in tail dies without issue, and also he in remainder, the donor and his heirs, to whom the reversion returns, may have this writ for the recovery of the estate, though the same be aliened, &c. Writs of formedon are now scarcely ever brought, the title to lands being commonly tried upon an ejectment.

FORMIC ACID, in chemistry, an acid that exists abundantly in the formica rufa, or red ant. The existence of this acid was first made known by Mr. Ray, in a correspondence with Dr. Hulse. The doctor informed him that these insects, when irritated, give out a clear liquid, which tinges blue flowers red: a fact which had been observed by others. Hence it was found to be an acid, which was obtained by bruising the insects, by distilling them, and by infusing them in water. The French chemists obtained the acid by bruising ants, and macerating them in alcohol. When the alcohol was distilled over, an acid liquor remained, which saturated with lime, mixed with sulphuric acid, and distilled, yielded a liquid that possessed all the properties of acetic acid. This acid was formerly considered as possessing pecu-

liar properties, and then denominated formic acid; but it has lately been ascertained to consist of a mixture of acetic and malic acids.

FORMICA, *ant*, an insect of the hymenoptera class. The generic character is, head large, with diffracted filiform antennæ; mouth with large jaws, and four unequal feelers; thorax narrowed behind, and furnished with an upright scale; abdomen subglobose; males and females winged; neutrals apterous; females and neutrals furnished with a concealed sting. According to Linnæus there are 18 species. The insects of this genus live in large societies, somewhat in the manner of bees and wasps, and are like them divided into males, females, and neutrals, which latter constitute the great or general assortment, and appear to conduct the business of the nest, which is usually placed at a small distance from the surface in some slight elevation either prepared by the insects themselves, or previously formed by some other animals, as moles, &c. They feed both on animal and vegetable substances, devouring the smaller kind of insects, caterpillars, &c. as well as fruits of different kinds. They are particularly attracted by sweets; and for this reason they ascend such trees as are infested with aphides, in order to obtain the saccharine substance discharged by those animals; and hence seems to have arisen the idea of their enmity against the genus aphis. Some species of ants are furnished with a sting, while others are destitute of that part.

The largest of the European ants is the formica herculanea, or great wood-ant, of a chesnut colour, with the abdomen measuring two lines or more in length. This species is chiefly found in dry woods of pine or fir, where it inhabits a large conical nest or hillock, composed of dry vegetable fragments, chiefly of fir-leaves: the nest is internally distributed into several paths or tubes, converging towards the central part, and opening externally: in the middle or centre reside the young, or larvæ, which are nursed by the neutral ants, and are occasionally brought to the surface, in order to be more within the influence of the air and sunshine for a certain time, after which they are again conveyed to the bottom or centre. When full-grown, they envelop themselves in oval, white, silken cases, in which they undergo their change into chrysalis, and at length emerge in their complete form. The males and females are winged, and the females are much larger than the males.

The common or black ant, formica nigra Lin. is a well-known inhabitant of our fields and gardens, residing in great numbers beneath mole-hills and other elevated spots. It is of a brownish-black colour, and of a glossy or polished surface. The eggs of this species are deposited early in the spring, and are extremely small, and of a white colour. From these are hatched the larvæ, which are of a thickish form, destitute of legs, and somewhat resemble in miniature the maggots of wasps and bees. They are carefully nourished by the neutral or labouring ants till they are arrived at their full growth, when they enclose themselves in smooth, oval, pale-yellow, silken webs or cases, in which state they are popularly known by the mistaken title of ant-eggs; the real eggs, as before observed, being white, and extremely small. It is generally in the months of June and July that the larvæ thus enclose themselves. The chrysalis, if taken out of its silken case, is of a white colour, and exhibits all the limbs of the future animal in an imperfect or contracted state. During the time of their remaining as chrysalis, the neutral ants attend them with the same care as when in their larva state, frequently shifting their situation, and placing them at greater or smaller elevations, according to the different state of the atmosphere. This care of the ants in conveying their pupæ from place to place, seems to have been often mistaken for a sedulous industry in collecting grains of wheat, which the pupæ, on a cursory review, much resemble.

About the beginning of August the males and females may be observed in the nests: these differ from the neutrals in being furnished with wings, and the female is far larger than the male, the body equalling in size that of the common window-fly, and the upper wings being very long and large. At this time of the year the males and females emigrate in vast numbers; sometimes flying at a considerable height, and sometimes creeping along the surface. It is not uncommon to see them enter houses at this period, attracted by sweets in particular, either moist or dry. After the breeding season the males live but a very short time, and the females return to their nests in order to deposit their eggs. During the winter this species, like the rest of the European ants, remains in a state of torpor, without laying up provisions for that season, as erroneously supposed; and during the spring emerges from its concealment, and recommences its labours.

Ants feed both on animal and vegetable substances of various kinds. Their addiction to animal substances is often turned to good account by anatomists, who, when they wish to obtain the skeleton of any animal too small or delicate to admit of being prepared the usual way, dispose the animal in a proper position in a small box, with perforations in the lid, and deposit it in a large ant-hill; in consequence of which, after a certain space, the whole of the softer parts are eaten away by these insects, and the skeleton remains in its proper position. It is thus that very elegant skeletons of frogs, snakes, &c. may be obtained.

This addiction to animal food in the insects of the genus formica can hardly be said to be productive of any mischief in the European regions; but in various parts of America and the West Indian islands the ravages committed by ants are incredible. One of the chief of these destroyers is the formica omnivora of Linnæus, a very small species, of a brown or chesnut colour: it is extremely voracious, attacking every animal substance to which it can gain access. It occurs in various parts of Africa as well as in America and in the West Indies; and it is said to be so numerous in some districts, that a deer, hog, &c. being killed, and left on the ground by night, will by the next morning have the flesh entirely cleared from the bones, and be reduced to a complete skeleton.

The formica rufa is black; thorax compressed; and with legs ferruginous. See Plate Nat. Hist. fig. 208.

FORRAGE, in the military art, denotes hay, oats, barley, wheat, grass, clover, &c. brought into the camp by the troopers for the sustenance of their horses.

FORSKOHLEA, a genus of the pentagynia order, in the decandria class of plants. The calyx is pentaphyllous, and longer than the corolla. There are ten petals spatulated, *i. e.* roundish before, with a linear base. There are three species, two of them annuals, natives of Egypt, the Cape, and Teneriffe.

FORSTERA, a genus of the triandria order, in the gynandria class of plants. The perianthium is double; the exterior one beneath, three-leaved; the interior one above, and six-cleft; the corolla tubular. There is one species, an herbaceous plant of New Zealand.

FORT, in the military art, a small fortified place, environed on all sides with a moat, rampart, and parapet. Its use is to secure some high ground, or the passage of a river, to make good an advantageous post, to defend the lines and quarters of a siege, &c.

Forts are made of different figures and extents, according as the ground requires. Some are fortified with bastions, others with demi-bastions. Some again are in form of a square, others of a pentagon. A fort differs from a citadel, as this last is built to command some town. See FORTIFICATION.

FORTIFICATION, may be defined the science of military architecture; and when applied to a city, town, or other place, it consists in the art of putting any of these in such a posture of preparation, by means of ramparts, parapets, ditches, and outworks, that each individual part defends, and is defended by, some other parts, so that a small number of men can hold out for a considerable time against a multitude.

When scattered families abandoning a wandering and pastoral life, settled in communities for mutual support, and built towns for common advantage, it became necessary to think of the means of defence: the trunks and branches of trees, and then walls and ditches, rudely constructed, were accordingly the first elements of fortification; and as the art of war was also in its infancy, these were sufficient to defeat hasty attacks, and prevent sudden incursions. At length offensive weapons were invented; and as the assailants had thus acquired a decided advantage, it became necessary to employ new means to frustrate them. Loop-holes, through which the arrows of the besieged might be directed with almost unerring certainty, were accordingly recurred to; and at length square towers were made to project from the walls, so as to enable the men placed within them to scour the ditches and defend the walls. In the progress of improvement the outer line of these quadrangular masses was made to assume a curvilinear direction; and at the present day there still remain numerous traces of this mode in all the antient castles in the kingdom.

But as the science advanced towards perfection new advantages were obtained; and instead of presenting a large semicircular portion of masonry to the enemy, an angle only was projected, and such a fortunate disposition of the works thereby produced, that no part could be attacked with impunity. In process of time ramparts were added; and the antient towers, which had been changed into

bastions, were provided with ravelins, horn-works, and outworks of all kinds, so as to resist the violence of cannon and mortar batteries; and defy, at least for a time, the efforts of the besiegers, provided with all the various implements of modern warfare.

Fortification is either regular or irregular. The regular is that built in a polygon, the sides and angles of which are all equal, being commonly about a musket-shot from each other. Irregular fortification, on the contrary, is where the sides and angles are not uniform, equidistant, or equal.

I. Of regular Fortification.

Authors in general agree as to the form, but they differ in respect to the construction of the parts. The chief of those who have written on this art, are Pagan, Blondel, Vauban, Coehorn, Scheiter, and Muller: in addition to these the names of Robins, Belidor, Folard, le Blond, marshal Saxe, Tielke, and Belair, ought also to be enumerated, as they have greatly contributed to the general knowledge of the science.

It must be constantly recollected by every engineer, that his views are not to be confined to the mere art of fortification. He must be able to take advantage of natural strength and position. Chains of mountains and streams of water, together with the influence of climate, should constitute a part of the natural system to which he should direct his application.

According to count Pagan, fortification consists of three different sorts, viz. the great, the mean, and the little, the principal dimensions of which are contained in the following

TABLE.

		The Little.		The Mean.		The great Fortification.	
		For Squares.	For all other Polygons	For Squares.	For all other Polygons	For Squares.	For all other Polygons
		160	160	180	180	200	200
		21	30	24	30	27	30
		45	50	55	55	60	60
		18-3	23-2	19-1	24	22	24-2
		63-5	50-4	63-4	60-4	73-2	70-5
		115-5	112-3	126-1	126-5	141-4	141-2
The great Fortification.	Exterior side	-	-	-	-	200	200
	The perpendicular	-	-	-	-	27	30
	The face	-	-	-	-	60	60
	The flank	-	-	-	-	22	24-2
	The curtin	-	-	-	-	73-2	70-5
	The line of defence	-	-	-	-	141-4	141-2

Blondel fortifies within the given polygon: he establishes two sorts of fortification; the great one, whose exterior side is 200 toises, and the lesser one, 170; because he will not have the line of defence exceed 140 toises, which is the greatest musket-shot, nor less than 120 toises, not to increase the number of bastions. He begins by the diminishing angle, which may be found by taking 90 degrees from the angle of the polygon, and by adding 15 degrees to the third of the remainder.

Vauban's method is divided into little, mean, and great; the little is chiefly used in the construction of citadels; the mean, in that of all sorts of towns; and the great, in particular cases only.

TABLE.

Great.	260	22	60	50	
	200	25	55	60	
Mean.	190	31	53	55	
	180	30	50	55	
Little.	170	25	47	52	
	160	23	45	50	
	150	21	42	50	
	140	20	40	45	
Forts.	130	16	35	40	
	120	15	33	38	
	110	14	30	35	
	100	12½	28	30	
	90	11	5	28	
	80	10	22	25	
		Side of polygon	Perpendicular	Faces bastion	Cap. of ravel.

In the first vertical column are the numbers expressing the lengths of the exterior sides from 80 to 260.

In the second, the perpendiculars answering to these sides.

In the third, the lengths of the faces of the bastions; and in the fourth, the lengths of the capitals of the ravelins.

Belidor's method is divided also into little, mean, and great; and in all three the exterior side is 200 toises; the perpendicular of the little is 50, that of the mean 55, and the great 40; the faces of the first 70, the second 70, and the third 55 toises.

Scheiter's method is divided into the great, mean, and small sort. The exterior side of the polygon for the great sort is 200 toises, the mean sort 180, and the small 160. The line of defence in the first is 140 toises, the second 130, and the third 120. This line is always razant. All the other lines are fixed at the same length for all polygons, whose structure chiefly depends upon the knowledge of the exterior side, of the capital, or of the flanked angle, the rest being easily finished.

TABLE of CAPITALS and FLANKED ANGLES.

Polygons.	IV	V	VI	VII	VIII	IX	X	XI	XII
The flanked angles in the 3 sorts of fortification	deg. 64	76	84	90	95	97	99	101	103
Capital for the great sort	toise 46	49	51	52	53	54½	56½	58	59
Capital for the mean sort	42	44½	46½	48½	50	51	52½	54	54
Capital for the small sort	39	41½	42½	45	46	47½	48½	50	50½

Errard, of Bois-le-Duc, who was employed by Henry IV. and was the first that laid down rules in France respecting the best method of fortifying a place so as to cover its flank, constructs that flank perpendicular to the face of the bastion; but by endeavouring to cover it effectually, he makes the gorges too exiguous, the embrazures too oblique, and leaves the ditch almost defenceless.

The chevalier de Ville, who succeeded Errard, draws the flank line perpendicular to the curtin; but here again the embrasures are too oblique, especially in the polygons, and the ditch is necessarily ill guarded. This engineer's method of fortifying is styled by most authors, the French method. His favourite maxim is, to make the flank angle straight, and the flank equal to the demi-gorge.

Count Pagan makes the flank perpendicular to the line of defence, which method seems to agree perfectly with this maxim, because by that means the flank so raised covers as much as possible the face of the opposite bastion; but notwithstanding this apparent advantage, the flank becomes too small, and is too much exposed to the enemy's batteries. This engineer aequired great reputation during the several sieges which he assisted in conducting under Louis XIII. His system has been improved upon by Alain Marrison Mallet, and his construction in fortification is to this day esteemed the most perfect. It differs very little from marshal Vauban's first system. Count Pagan has pointed out the method of building casemates in a manner peculiar to himself.

Marshal Vauban has judiciously steered between these different methods. He has drawn his flank in such a manner, that it does not stand too much exposed, nor does its collateral line of defence extend too far from the direct line of defence. He has effected this by lengthening out his flank, and giving it a circular form.

It cannot be disputed that large and

extensive flanks and demigorges are superior to narrow and confined ones. The more capacious the flank is, the better calculated will it prove for the disposition of a formidable train of artillery. From this conviction many writers, in their proposed systems of fortification, have added a second flank, in order to augment the line of defence; but they did not foresee that this second flank is not only incapable of covering the face of the opposed bastion, except in a very oblique and insecure direction, but that the right flank, or the flank of the bastion, is thereby more exposed to the enemy's batteries, which, it must be acknowledged on all sides, is a great fault.

The prevailing system of the present day is, to make the flanks of the bastion as wide as possible, without having recourse to a second flank, unless it be absolutely necessary. Those gorges are likewise best which are most capacious, because they afford space and ground in the bastion for the construction of entrenchments within, should the enemy have effected a practicable breach.

All parts of a fortification which stand exposed to the immediate attacks of a besieging enemy, must be strong enough to bear the boldest attempts, and the most vigorous impressions. This is a self-evident maxim, because it must be manifest to the most common understanding, that works are erected round a place for the specific purpose of preventing an enemy from getting possession of it. It consequently follows, that flanked angles are extremely defective when they are too acute, since their points may be easily flanked and destroyed by the besiegers' cannon.

The Dutch construct at sixty degrees; but according to Vauban's method, no work should be under seventy-five degrees, unless circumstances and situation should particularly require it.

The diagram annexed, together with the explanation that follows, will convey an idea of M. Vauban's method, in respect to the fortification of towns. See Plate Farriery, &c.

Inscribe in a circle a polygon of as many sides as the fortification is designed to have fronts; let AB, fig. 9, be one of the sides of half an hexagon, which bisect by the perpendicular CD; divide half of it AC into nine equal parts, and one of these into ten others; then these divisions will serve as a scale to construct all the parts of the fortification, and each of them is supposed to be a toise or fathom, that is, six French feet; and therefore the whole side AB is supposed to be 180 toises. As the dividing a line into so many equal parts is troublesome and tedious, it is more convenient to have a scale of equal parts, by which the works may be constructed.

If therefore, in this case, the radius is taken equal to 180 toises, and the circle described with that radius being divided into six equal parts, or the radius being carried six times round, you will have an hexagon inscribed; AB being bisected by the perpendicular CD as before, set off 30 toises from C to D, and draw the indefinite lines ADG, BDF; in which take the parts AE, BH, each equal to 50 toises; from the centre E describe an arc through the point H, meeting AD in G, and from the centre H describe an arc through the point E, meeting BD in F; or, which is the same, make each of the lines EG, HF, equal to the distance EH; then the lines joining the points A, E, F, G, H, B, will be the principal or outline of the front.

If the same construction be performed on the other sides of the polygon, you will have the principal or outline of the whole fortification. If, with a radius of 20 toises, there be described circular arcs from the angular points B, A, M, T, and lines are drawn from the opposite angles E, H, &c. so as to touch these arcs, their parts *ab*, *bc*, &c. together with these arcs, will present the outline of the ditch.

Definitions.

1. The part FEALN is called the bastion.
2. AE, AL, the faces of the bastion.
3. EF, LN, the flanks.
4. FG, the curtin.
5. FN, the gorge of the bastion.
6. AG, BF, the lines of defence.
7. AB, the exterior side of the polygon.
8. CD, the perpendicular.
9. Any line which divides a work into two equal parts is called the capital of that work.
10. *a*, *b*, *c*, the counterscarp of the ditch.
11. A, M, the flanked angles.
12. H, E, L, the angles of the shoulder, or shoulder only.
13. G, F, N, the angles of the flank.
14. Any angle whose point turns from the place is called saliant angle, such as A, M: and any angle whose point turns towards the place, re-entering angle, such as *b*, F, N.
15. If there be drawn two lines parallel to the principal or outline, the one at 3 toises distance, and the other at 8 from it, then the space *yx* included between the principal one and that farthest distant is called the rampart.

And the space *x*, contained by the principal line and that near to it, and which is generally stained black, is called the parapet.

16. There is a fine line drawn within four feet of the parapet, which expresses a step called banquette.

All works have a parapet of three toises thick, and a rampart of from 8 to 10, besides their slopes. The rampart is elevated more or less above the level of the place, from 10 to 20 feet, according to the nature of the ground, and the particular constructions of engineers.

The parapet is a part of the rampart elevated from 6 to 7½ feet above the rest, in order to cover the troops which are drawn up there from the fire of the enemy in a siege; and the banquette is two or three feet higher than the rampart, or about four feet lower than the parapet; so that when the troops stand upon it, they may just be able to fire over the parapet.

17. The body of the place is all that which is contained within this first rampart; for which reason it is often said to construct the body of the place: which means, properly, the construction of the bastions and curtins.

18. All the works which are constructed beyond the ditch, before the body of the place, are called outworks.

II. Of irregular Fortification.

The most essential principle in fortification consists in making all the fronts equally strong, so that the enemy may find no particular advantage in attacking either of the sides. But this can only occur in a regular work, situated in a plain, or even ground; consequently there are but few places which are not irregular: and the great art here is, to remedy the defects and inconveniences occasioned by this circumstance.

If the situation to be fortified is an old town, inclosed by a wall or rampart, the engineer ought to consider well all the different circumstances of the figure, position, and nature of the ground, and to regulate his plan accordingly, so as to avoid as many disadvantages, on one hand, and to obtain as many advantages, on the other, as possible. If there is a rampart without towers, it must be decided whether bastions ought not to be added, and ravelins and counter-guards constructed. Special care must be taken to make all the sides of the polygon nearly equal, and that the length of the lines of defence do not exceed the reach of musket-shot. Wherever the sides are inaccessible, either on account of a precipice, or marshy ground, they may be made much larger than those which are easy of access.

If the place to be fortified is new, and the situation will not admit of a regular construction, particular care must be taken to choose such a spot of ground as is most advantageous. All hills, or rising grounds, should be avoided, as these might command some parts of the works; marshes, because such situations are unwholesome, and lakes and standing waters for the same reason, except they can be rendered navigable.

Places built on mountains or rocks should never be large; for their use is generally to guard passes or inlets into a country, and it is difficult to provide for a large garrison under such circumstances. When fortifications are to be placed in the neighbourhood of the sea, for the purposes of protecting trade, the first thing to be considered is their situation, which ought to afford a good harbour for shipping. When M. Vauban fortified near rivers, he always made the exterior side next to the water much longer than any of the others; for as that part is not so liable to be attacked, great and manifest advantages were of course derived from this circumstance.

To illustrate this method of M. Vauban's, we shall give the plan of Hunninghen. That place was built for the sake of having a bridge over the Rhine, for which reason he made it only a pentagon; the side AB (fig. 10) next to the river is 200 toises, and each of the others but 180.

About the space *abc*, which lies before the front AB, is a stone wall; and the passages, are shut up with sluices, to retain the water in the ditches in dry seasons; and to prevent an enemy from destroying the sluice near the point *c*, whereby the water would run out and leave the ditches dry, the redoubt *y* was built in the little island hard by, in order to cover that sluice; without which precaution the place might be insulted from the river side, where the water is shallow in dry seasons.

The hornwork K, beyond the Rhine, was built to cover the bridge; but as this work cannot be well defended across the river, the hornwork H was made to support the other.

Before finishing the description of this plan, we shall show how to find the long side

AB. After having inscribed the two sides GE, GF, in a circle, draw the diameter CD, so as to be equally distant from the line joining the points EF that is parallel to it. On this diameter set off 100 toises on each side of the centre; from these points draw two indefinite perpendiculars to the diameter; then if from the points, EF, as centres, two arcs are described with a radius of 180 toises, their intersections A and B, with the said perpendiculars, will determine the long side AB, as likewise the other two FB and EA. In like manner may be found the long or short side of any polygon whatsoever.

When a place near a river is to be fortified for the safety of commerce, particular care should be taken in leaving a good space between the houses and the waterside, to have a quay or landing-place for goods brought by water; it should also be contrived to have proper places for ships and boats to lie secure in stormy weather, and in time of a siege; and as water-carriage is very advantageous for transporting goods from one place to another, as likewise for bringing the necessary materials, not only for building the fortifications, but also the place itself, the expences will be lessened considerably when this convenience can be had: for which reason places should never be built any where but near rivers, lakes, or the sea, excepting in extraordinary cases, where it cannot be avoided.

The principal maxims of fortification are these, viz.

1. That every part of the works be seen and defended by other parts, so that the enemy cannot lodge any where without being exposed to the fire of the place.

2. A fortress should command all places round it; and therefore all the outworks should be lower than the body of the place.

3. The works furthest from the centre should always be open to those that are nearer.

4. The defence of every part should always be within the reach of musket-shot, that is, from 120 to 150 fathoms, so as to be defended both by ordnance and small fire-arms; for if it is only defended by cannon, the enemy may dismount them by the superiority of their own, and then the defence will be destroyed at once; whereas, when a work is likewise defended by small-arms, if the one is destroyed, the other will still subsist.

5. All the defences should be as nearly direct as possible; for it has been found by experience, that the soldiers are too apt to fire directly before them, without troubling themselves whether they do execution or not.

6. A fortification should be equally strong on all sides; otherwise the enemy will attack it in the weakest part, whereby its strength will become useless.

7. The more acute the angle at the centre is, the stronger will be the place.

8. In great places dry ditches are preferable to those filled with water, because sallies, retreats, succours, &c. are necessary; but, in small fortresses, wet ditches, that can be drained, are the best, as standing in need of no sallies.

Field-FORTIFICATION is the art of constructing all kinds of temporary works in the field, such as redoubts, field-forts, star-forts, triangular and square forts, heads of bridges, and various sorts of lines, &c. An army entrenched, or fortified in the field, produces, in many respects, the same effect as a fortress; for it covers a country, supplies the want of numbers, stops a superior enemy, or at least obliges him to engage at a disadvantage.

The knowledge of a field-engineer being founded on the principles of fortification, it must be allowed, that the art of fortifying is as necessary to an army in the field as in fortified places; and though the maxims are nearly the same in both, yet the manner of applying and executing them with judgment, is very different.

The materials used in the field are such as can be readily obtained, viz. sand-bags, earth, and fascines ten feet long and one foot thick, which are fastened to the parapet, by means of five pickets driven obliquely into the bank.

When wood cannot be obtained for the fascines, the parapet must be clothed with turf, four inches thick, and a foot and a half square.

The palisades for fortifying the ditch ought to be nine or ten feet long and six inches thick.

The beams belonging to chevaux-de-frize should be twelve feet long, and six inches broad; the spokes seven feet long, four inches thick, and six inches distant from each other.

Gabions must be three or four feet high, and two or three feet in diameter.

FORTIN, FORTLET, or *field-fort*, a sconce or little fort, whose flanked angles are generally distant one from another 120 fathoms.

FORTS, *vitrified*, a very singular kind of structures found in the Highlands and northern parts of Scotland, in which the walls have the appearance of being melted into a solid mass, so as to resemble the lava of a volcano, for which indeed they have been taken by several persons who have visited them.

These walls were taken notice of by Mr. Williams, an engineer, who wrote a treatise on the subject, and was the first who supposed them to be the works of art; other naturalists having attributed them to a volcanic origin. These works are commonly situated on the tops of small hills, commanding an extensive view of the adjacent valley or low country. The area on the summit, varying, as is supposed, according to the number of cattle the proprietor had to protect, or the dependants he was obliged to accommodate, is surrounded with a high and strong wall, of which the stones are melted, most of them entirely; while others, in which the fusion has not been so complete, are sunk in the vitrified matter in such a manner as to be quite inclosed with it; and in some places the fusion has been so perfect, that the ruins appear like masses of coarse glass. Mr. Williams has not only determined the walls in question to be the works of art, but has even hazarded a conjecture as to the manner in which they were constructed, and which, according to him, was as follows. Two parallel dikes of earth or sod being raised, in the direction of the intended wall, with a space between them sufficient for its thickness, the fuel was put in, and set on fire. The stones best adapted for the purpose, called the plum-pudding stone, are every where to be found in the neighbourhood. These were laid on the fuel, and, when melted, were kept by the frame of earth from running off; and by repeating the operation, the wall was raised to a sufficient height. This opinion of the stones being thrown in without any order, is thought to be confirmed by the circumstance of there not being any where a large one to be seen, nor a stone laid in any particular direction, nor one piece which has not in some degree been affected by the fire. Mr. Williams mentions a fact tending to confirm his hypothesis, viz. of a brick-kiln situated on the declivity of an eminence, so as to be exposed to the wind, which, happening to rise briskly one time when the kiln was burning, so increased the heat, that the bricks were melted, and ran like a lava, for a considerable way down the hill.

This opinion of Mr. Williams has been embraced by several other authors; particularly Mr. Freebairn and Dr. Anderson, the latter having published two treatises upon the buildings in the Archæologia. In the same work, however, we meet with a paper by the hon. Daines Barrington, in which the author expresses quite different sentiments. He observes, that Mr. Williams and the other antiquaries, who suppose the walls in question to be the works of art, imagine that the reason of their being constructed in this manner was the ignorance of cement, which in these remote ages prevailed in Scotland: but with respect to this circumstance he says, that if one side of the wall only was heated, and that to any considerable height, the matter in fusion would in all likelihood drop down to the bottom, without operating as any cement to the loose stones thrown in amongst it. This circumstance of the walls being vitrified only on one side is indeed remarkable, and takes place in most of the forts of this kind to be met with at present; but with regard to it Mr. Barrington observes that he himself has been twice in the Highlands of Scotland, and has found very few hills of any height which were clothed with wood: the trouble therefore of carrying it up to the top of such a mountain would be very considerable.

According to Mr. Cardonnel, the largest of these vitrified forts is situated on the hill of Knockfarril, to the south of the valley of Strathpeffer, two miles west from Dingwall in Ross-shire. The inclosure is 120 feet long and 40 broad within the walls; strengthened on the outside with works at each end. The fort next in consequence to that of Knockfarril is situated on the hill of Craig-Phadric near Inverness.

Besides these fortifications, the hill of Noth affords a remarkable appearance of the same kind: of which Mr. Cordiner gives the following description, not from his own observation, but those of a gentleman of credit who visited the place. "On the top of the hill there is an oblong hollow, as I could guess, of about an English acre, covered with a fine sward of grass: in the middle towards the east end of this hollow is a large and deep well. The hollow is surrounded on all sides with a thick rampart of stones. On three sides of this rampart, from eight to twelve feet thick, is one compact body of stones and minerals which have been in a state of fusion, resembling a mixture of stone and iron-ore, all vitrified, calcined, and incorporated. On the north side,

the rampart consists of broken pieces of rock, which have the appearance of having been torn to pieces by some extraordinary violence. If the calcined compact wall exists under them, it is not at present visible."

In the Phil. Trans. of the Royal Society of London for 1777, part II. is an account of Creck Faterick, there termed a volcanic hill near Inverness, in which the writer does not hesitate to pronounce this hill an extinguished volcano: and, having sent specimens of the burnt matter for the inspection of the Royal Society, the secretary subjoins a note to the paper, intimating that these specimens, having been examined by some of the members well acquainted with volcanic productions, were by them judged to be real lava.

Mr. Tytler agrees with those who think the vitrified structures to be artificial works; but he differs from Mr. Williams and others who think that they were vitrified on purpose for cementing the materials together. His reason for this is, that the number of forts that show marks of vitrification is inconsiderable when compared with those that do not. He therefore considers the vitrification as accidental, and describes the manner in which he conceives it must have been accomplished. Among other observations in confirmation of his opinion, he urges, that in the fortification on Craig-Phadric, a large portion of the outward rampart bears no marks of vitrifications. Mr. Cordiner, on the other hand, is of opinion that the vitrifications in question cannot have been the works of art, and ridicules the contrary hypothesis, though without adducing any argument against it.

Mr. Tytler concludes his dissertation with a conjecture, which indeed seems well supported, that the forts in question were constructed, not only before the Roman invasion, but before the introduction of the rites of the Druids into Britain; as "there appears no probability that the inhabitants either lived under such a government as we know to have prevailed under the influence of the Druids, or had any acquaintance with those arts which it is certain they cultivated." On a view of the disputes which have agitated the learned on this obscure subject, we can only observe, that their arguments seem to have placed it in a state of equiponderance, and that the fact remains open to the investigation of future speculators.

FOSS, in fortification, a hollow place, commonly full of water, lying between the scarp and counterscarp, below the rampart; and turning round a fortified place or a post that is to be defended.

FOSSA, in our antient customs, was used to signify a ditch full of water, wherein women, convicted of felony, were drowned.

Foss-way, one of the four principal highways of England, that antiently led through the kingdom; supposed to be made by the Romans, having a ditch upon one side.

FOSSARII, in antiquity, a sort of officers in the Eastern church, whose business it was to inter the dead.

FOSSIL, in natural history, denotes in general all things dug out of the earth: whether they be natives thereof, as metals, stones, salts, earths, and other minerals; or extraneous, reposited in the bowels of the earth by some extraordinary means, as earthquakes, the deluge, &c. See Metal, Stone, &c.

Native fossils, according to Dr. Hill, are substances found either buried in the earth, or lying on its surface, of a plain simple structure, and shewing no signs of having contained vessels or circulating juices. These are subdivided by the same author, 1. Into fossils naturally and essentially simple. Of these some are neither inflammable, nor soluble in water; as simple earths, talcs, fibrariæ, gypsum, selenitæ, crystals, and spars: others, though uninflammable, are soluble in water; as all the simple salts: and others, on the contrary, are inflammable, but not soluble in water; as sulphur, auripigmentum, zarnich, amber, ambergris, gagates, asphaltum, ampelites, lithanthrax, naphtha, and pissasphalta. 2. The second general subdivision of fossils comprehends all such as are naturally compound, but unmetallic. Of these some are neither inflammable, nor soluble in water; as compound earths, stones, septariæ, siderochita, semipellucid gems, &c.: others are soluble in water, but not inflammable; as all the metallic salts: and, lastly, some are inflammable, but not soluble in water; as the marcasites, pyritæ, and phlogonia. 3. The third and last general division of fossils comprehends all the metallic ores; which are bodies naturally hard, remarkably heavy, and fusible in fire. Of these some are perfectly metallic, as being malleable when pure; such are gold, lead, silver, copper, iron, and tin: others are imperfectly metallic, as not being malleable even in their purest state; such are antimony, bismuth, cobalt, zinc, &c. Of all the substances these reader will find a particular description under their respective heads.

Extraneous fossils are bodies of the vegetable or animal kingdoms accidentally buried in the earth. Of the vegetable kingdom there are principally three kinds, trees or parts of them, herbaceous plants, and corals; and of the animal kingdom there are four kinds, sea-shells, the teeth or bony palates and bones of fishes, complete fishes, and the bones of land-animals. See Bones, Tree, Wood, Plant, Shell, &c. These adventitious or extraneous fossils, thus found buried in great abundance in divers parts of the earth, have employed the curiosity of several of our latest naturalists, who have each a different system to account for the surprizing appearances of petrified sea-fishes, in places far remote from the sea, and on the tops of mountains; shells in the middle of quarries of stone; and of elephants' teeth, and bones of various animals, peculiar to the southern climates, and plants only growing in the East, found fossil in our northern and western parts.

Some will have these shells, &c. to be real stones, and stone plants, formed after the usual manner of other figured stones; of which opinion is the learned Dr. Lister. Another opinion is, that these fossil shells, with all their foreign bodies found within the earth, as bones, trees, plants, &c. were buried therein at the time of the universal deluge; and that, having been penetrated by the calcareous or siliceous matter abounding chiefly in watery places, and then in a state of solution they have been preserved entire, and sometimes petrified. Others think, that those shells, found at the tops of the highest mountains, could never have been carried thither by the waters, even of the Deluge; inasmuch as most of these aquatic animals, on account of the weight of their shells, always remain at the bottom of the water, and never move but close along the ground. They imagine, that a year's continuance of the waters of the Deluge, intermixed with the salt waters of the sea, upon the surface of the earth, might well give occasion to the production of shells of various kinds in different climates; and that the universal saltness of the water was the real cause of their resemblance to the sea-shells, as the lakes formed daily by the retention of rain or spring water produce different kinds. Others think, that the waters of the sea and the rivers, with those which fell from heaven, turned the whole surface of the earth upside down; after the same manner as the waters of the Loire, and other rivers, which roll in a sandy bottom, overturn all their sands, and even the earth itself, in their swellings and inundations; and that in this general subversion, the shells came to be interred here, fishes there, trees in another place, &c.

Dr. Woodward, in his Natural History of the Earth, pursuing and improving the hypothesis of Dr. Burnet, maintains the whole mass of earth, with every thing belonging to it, to have been so broken and dissolved at the time of the Deluge, that a new earth was then formed on the bosom of the water, consisting of different strata, or beds of terrestrial matter, ranged over each other usually according to the order of their specific gravities. By this means plants, animals, and especially fishes and shells, not yet dissolved among the rest, remained mixed and blended among the mineral and fossil matters; which preserved them, or at least assumed and retained their figures and impressions either indentedly, or in relievo.

FOTHER, or *fodder*, in mining. See Fodder.

FOTHERGILLA, a genus of the polyandria and digynia class and order. The calyx is an ament ovate; scales one-flowered; corolla calyx-form, one-petalled, five-cleft. There is one species, a tree of Caroline resembling the alder.

FOUL, in the sea-language, is used when a ship has been long untrimmed, so that the grass, weeds, or barnacles, grow to her sides under water. A rope is also foul when it is either tangled in itself, or hindered by another, so that it cannot run, or be overhawled.

Foul imports, also, the running of one ship against another. This happens sometimes by the violence of the wind, and sometimes by the carelessness of the people on board, to ships in the same convoy, and to ships in port by means of others coming in. The damages occasioned by running foul, are of the nature of those in which both parties must bear a part. They are usually made half to fall upon the sufferer, and half upon the vessel which did the injury: but in cases where it is evidently the fault of the master of the vessel, he alone is to bear the damage.

Foul-water. A ship is said to make foul-water, when being under sail, she comes into such shoal-water, that though her keel does not touch the ground, yet it comes so near it, that the motion of water under her raises the mud from the bottom.

FOUNDATION, in architecture, is that

part of a building which is under ground. See ARCHITECTURE.

FOUNDER, in a general sense, the person who lays a foundation, or endows a church, school, religious-house, or other charitable institution. The founder of a church may preserve to himself the right of patronage or presentation to the living.

FOUNDER, also implies an artist who casts metals, in various forms, for different uses, as guns, bells, statues, printing characters, candlesticks, buckles, &c. whence they are denominated gun-founders, bell-founders, figure-founders, letter-founders, founders of small works, &c. See FOUNDERY.

The most common implements used by the founder are, several different sized pairs of open frames, fig. 1, called flasks; two or three single-handled ladles, fig. 4; a large double-handled ladle, fig. 5; a wooden bar, fig. 6, called a striker; a flat iron rammer, fig. 7; several hand screws, fig. 8; a small trowel with a square end, fig. 9; also, a great quantity of damp loamy sand, and a small quantity of the same, which has been burnt in the furnace, and is kept dry. An exact pattern of the thing to be cast is, in most cases, made in wood: the workman selects a pair of flasks, whose size is best adapted to the size of the article, sets it on a board, H, fills the under one with sand, rams it in with the rammer, fig. 7, and scrapes off the loose sand with the striker, fig 6; he then with his trowel, fig. 9, digs out a space large enough to contain the pattern for the article (which we will in this case suppose to be a crow for a mill-stone, see FLOUR-MILL, and Figs. 2 and 3,) into this space the pattern is placed, and the sand is laid close round it, and pressed and flattened down with the trowel, so as to bury the lower half of it, as shewn in the flask GI; a thin layer of dry sand is then sprinkled over it, and the other empty flask, EF, is put upon the under one, its place being determined by the points, *h i k*, in the upper flask EF, which enter the holes, *m n*, in the under flask GI; a round stick is then held upright upon the pattern, and the sand filled and rammed round it; the stick is then withdrawn which leaves a hole, *d*, through the sand, through which the metal is to be poured. The upper flask, with the sand in it, is then lifted off, and laid upon its side, as shewn in fig. 1, the dry sand making the separation at the proper place, so as to leave an impression, *o p q r*, in the upper flask, of the same size and shape as the upper half of the pattern: the sand around the pattern, *s t v w*, in the flask GI is then slightly damped with a sponge, to make it adhere better together, and the pattern is lifted out, by screwing one or more of the screws, fig. 8, into it leaving an impression of the lower half of the pattern, so that when the two flasks are put together again, the cavity of the whole article is formed, into which the metal is poured, through the hole *d*. For small work, the metal is melted in a furnace, blown by bellows; it has a small hole near its bottom, which is stopped with clay: when the metal is melted, this clay is poked out, and the metal which runs out, is caught in the ladle, fig. 5; when this is nearly full, it is taken up by two men (one of whom walks first, between the handles, *a b*, and another at the end, *d*,) and is distributed to the different flasks: for still smaller work, this is done by one man, who uses the ladle, fig. 4. For large works, the metal is melted in an air or draft furnace; and is conveyed to the moulds, which are in that case sunk in the ground, by little channels made in the sand, of which the floor of the foundry is composed. When the article that has been cast, is first taken out of the sand, it has a knob or runner sticking to it, in the hole, *d*, fig. 1, and has usually thin pieces sticking out from the sides of it, where the two flasks did not exactly fit: these are all taken off with a chisel, the sand is shook off the surface by knocking, and the founder's business is done.

For some articles which have one side a plain surface, as square bars, &c. no flasks are used but the pattern is laid in a space large enough to bury it, which is made in the sand on the ground, and the sand is banked up round it; it is then taken out as above, and the metal is poured into the cavity formed by it, till the same is full enough. The mould for large articles, as bells, boilers, cylinders, pipes, &c. are made of wet tempered loam, and dried.

FOUNDER, in the sea-language, a ship is said to founder, when by an extraordinary leak: or by a great sea breaking in upon her, she is so filled with water, that she cannot be freed of it; so that she can neither veer nor steer, but lies like a log; and not being able to swim along, will at last sink.

FOUNDERY or *foundry*, the art of casting all sorts of metals into different forms. It likewise signifies the work-house, or smelting-hut, in which these operations are performed.

FOUNDERY *in small works, or casting in sand.* The sand used for casting small works is, at first, of a pretty soft, yellowish, and clammy nature; but it being necessary to strew charcoal dust in the mould, it at length becomes of quite a black colour. This sand is worked over and over, on a board, with a roller, and a sort of knife; being placed over a trough to receive it, after it is by these means sufficiently prepared.

This done, they take a wooden board of a length and breadth proportional to the things to be cast, and putting a ledge round it, they fill it with sand, a little moistened, to make it duly cohere. Then they take either wood or metal models of what they intend to cast, and apply them so to the mould and press them into the sand, as to leave their impression there. Along the middle of the mould is laid half a small brass-cylinder, as the chief canal for the metal to run through, when melted into the models, or patterns; and from this chief canal are placed several others, which extend to each model or pattern placed in the frame. After this frame is finished they take out the patterns, by first loosening them all round, that the sand may not give way.

They then proceed to work the other half of the mould with the same patterns in just such another frame, only that it has pins, which, entering into holes that correspond to it in the other, make the two cavities of the pattern fall exactly on each other.

The frame thus moulded, is carried to the melter, who, after extending the chief canal of the counterpart, and adding the cross canals to the several models in both, and strewing mill-dust over them, dries them in a kind of oven for that purpose.

Both parts of the mould being dry, they are joined together by means of the pins; and to prevent their giving way, on account of the melted metal passing through the chief cylindrical canal, they are screwed or wedged up like a kind of press.

While the moulds are thus preparing, the metal is fusing in a crucible of a size proportionate to the quantity of metal intended to be cast.

FOUNDERY *of statues.* See BRONZE and STATUE.

FOUNDERY OF BELLS. The metal, it is to be observed, is different for bells, from what it is for statues; there being no tin in the statue-metal: but there is a fifth, and sometimes more, in the bell-metal.

The dimensions of the core, and the wax, for bells, (if a ring of bells especially) are not left to chance, but must be measured on a scale, which gives the height, aperture, and thickness necessary for the several tones required.

It is on the wax that the several mouldings and other ornaments are formed to be represented in relievo, on the outside of the bell.

The business of bell-foundry is reducible to three particulars. 1. The proportion of a bell. 2. The forming of the mould; and, 3. The melting of the metal.

The proportions of our bells differ much from those of the Chinese: in ours the modern proportions are to make the diameter fifteen times the thickness of the brim, and twelve times the height.

There are two kinds of preparations, viz. the simple and the relative; the former are those proportions only that are between the several parts of a bell, to render it sonorous; the relative proportions establish a requisite harmony between several bells.

The particulars necessary for making the mould of a bell, are, 1, The earth: the most cohesive is the best: it must be well ground and sifted, to prevent any chinks. 2. Brick-stone; which must be used for the mine, mould, or core, and for the furnace. 3. Horse-dung, hair, and hemp, mixed with the earth, to render the cement more binding. 4. The wax for inscriptions, coats of arms, &c. 5. The tallow equally mixed with the wax, in order to put a slight lay of it upon the outer mould, before any letters are applied to it. 6. The coals to dry the mould.

For making the mould, they have a scaffold consisting of four boards, ranged upon tressels. Upon this, they carry the earth, grossly diluted, to mix it with horse-dung, beating the whole with a large spatula.

The compasses of construction is the chief instrument for making the mould, which consist of two different legs joined by a third piece. And last of all, the founders shelves on which are the engravings of the letters, cartridges, coats of arms, &c.

They first dig a hole, of a sufficient depth to contain the mould of the bell, together with the case or cannon, under-ground: and about six inches lower than the terreplain, where the work is performed. The hole must be wide enough for a free passage between the mould and walls of the hole; or between one mould and another, when several bells are to be cast. At the centre of

the hole is a stake erected, that is strongly fastened in the ground. This supports an iron peg, on which the pivot of the second branch of the compasses turns. The stake is encompassed with a solid brick-work, perfectly round, about half a foot high, and of the proposed bell's diameter. This they call a mill-stone. The parts of the mould are the core, the model of the bell, and the shell. When the outer surface of the core is formed, they begin to raise the core, which is made of bricks that are laid in courses of equal height upon a lay of plain earth. At the laying of each brick they bring near it the branch of the compasses, on which the curve of the core is shaped, so as that there may remain between it and the curve the distance of a line, to be afterwards filled up with layers of cement. The work is continued to the top, only leaving an opening for the coals to bake the core. This work is covered with a layer of cement, made of earth and horse-dung, on which they move the compasses of construction, to make it of an even smoothness every where.

The first layer being finished, they put the fire to the core, by filling it half with coals, through an opening that is kept shut, during the baking, with a cake of earth, that has been separately baked. The first fire consumes the stake, and the fire is left in the core half, or sometimes a whole day; the first layer being thoroughly dry, they cover it with a second, third, and fourth; each being smoothed by the board of the compasses, and thoroughly dried before they proceed to another.

The core being completed, they take the compasses to pieces, with intent to cut off the thickness of the model, and the compasses are immediately put in their place, to begin a second piece of the mould. It consists of a mixture of earth and hair, applied with the hand on the core, in several cakes that close together. This work is finished by several layers of a thinner cement of the same matter, smoothed by the compasses, and thoroughly dried, before another is laid on. The first layer of the model is a mixture of wax and grease spread over the whole. After which are applied the inscriptions, coats of arms, &c. besmeared with a pencil dipt in a vessel of wax in a chaffing-dish: this is done for every letter. Before the shell is begun, the compasses are taken to pieces, to cut off all the wood that fills the place of the thickness to be given to the shell.

The first layer is the same earth with the rest, sifted very fine; whilst it is tempering in water, it is mixed with cow's hair, to make it cohere. The whole being a thin cullis, is gently poured on the model, that fills exactly all the sinuosities of the figures, &c. and this is repeated till the whole is two lines thick over the model. When this layer is thoroughly dried, they cover it with a second of the same matter, but something thicker: when this second layer becomes of some consistence, they apply the compasses again, and light a fire in the core, so as to melt off the wax of the inscriptions, &c.

After this, they go on with other layers of the shell, by means of the compasses. Here they add to the cow's hair a quantity of hemp, spread upon the layers, and afterwards smoothed by the board of the compasses The thickness of the shell comes to four or five inches lower than the mill-stone before observed, and surrounds it quite close, which prevents the extravasation of the metal. The wax should be taken out before the melting of the metal.

The ear of the bell requires a separate work, which is done during the drying of the several incrustations of the cement. It has seven rings, the seventh is called the bridge, and unites the others, being a perpendicular support to strengthen the curves. It has an aperture at the top, to admit a large iron-peg bent at the bottom; and this is introduced into two holes in the beam, fastened with two strong iron-keys. There are models made of the rings, with masses of beaten earth, that are dried in the fire, in order to have the hollow of them. These rings are gently pressed upon a layer of earth and cow's hair, one half of its depth; and then taken out, without breaking the mould. This operation is repeated twelve times for twelve half-moulds, that two and two united make the hollows of the six rings: the same they do for the hollow of the bridge, and bake them all, to unite them together.

Upon the open place left for the coals to be put in, are placed the rings that constitute the ear. They first put into this open place the iron-ring to support the clapper of the bell; then they make a round cake of clay, to fill up the diameter of the thickness of the core. This case after baking, is clapped upon the opening, and soldered with a thin mortar spread over it, which binds the cover close to the core.

The hollow of the model is filled with an earth, sufficiently moist, to fix on the place which is strewed, at several times, upon the cover of the core; and they beat it gently with a pestle, to a proper height; and a workman smooths the earth at top with a wooden trowel dipped in water.

Upon this cover, to be taken off afterwards, they assemble the hollows of the rings. When every thing is in its proper place, they strengthen the outsides of the hollows with mortar, in order to bind them with the bridge, and keep them steady at the bottom, by means of a cake of the same mortar which fills up the whole aperture of the shell. This they let dry, that it may be removed without breaking. To make room for the metal they pull off the hollows of the rings, through which the metal is to pass, before it enters into the vacuity of the mould. The shell being unloaded of its ear, they range under the mill-stone five or six pieces of wood, about two feet long, and thick enough to reach almost the lower part of the shell; between these and the mould they drive in wooden wedges with a mallet, to shake the shell of the model whereon it rests, so as to be pulled up and got out of the pit.

When this and the wax are removed, they break the model and layer of earth, through which the metal must run, from the hollow of the rings, between the shell and the core. They smoke the inside of the shell, by burning straw under it that helps to smooth the surface of the bell. Then they put the shell in the place, so as to leave the same interval between that and the core; and before the hollows of the rings or the cap are put on again, they add two vents, that are united to the rings, and to each other, by a mass of baked cement. After which they put on this mass of the cap, the rings, and the vent, over the shell, and solder it with thin cement, which is dried gradually by covering it with burning coals. Then they fill up the pit with earth, beating it strongly all the time round the mould.

The furnace has a place for the fire, and another for the metal. The fire-place has a large chimney with a spacious ash-hole. The furnace which contains the metal, is vaulted, the bottom is made of earth, rammed down; the rest is built with brick. It has four apertures; the first, through which the flame reverberates; the second is closed with a stopple that is opened for the metal to run; the others are to separate the dross or scoriæ, of the metal by wooden rakes: through these last apertures passes the thick smoke. The ground of the furnace is built sloping, for the metal to run down.

FOUNDERY *of great guns and mortar pieces*. The method of casting these pieces is little different from that of bells: they are run massy, without any core, being determined by the hollow of the shell; and they are afterwards bored with a steel trapan which is worked either by horses, or a water-mill.

For the metal parts, proportions, &c. of these pieces. See CANNON.

FOUNDRY, *letter*, or casting of printing letters. See TYPE.

FOUNT, or *font*, among printers, a set or quantity of letters, and all the appendages belonging thereto, as numeral characters, quadrates, points, &c cast by a letter-founder, and sorted. Founts are large or small, according to the demand of the printer, who orders them by the hundred weight, or by sheets. When a printer orders a fount of five hundred, he means that the fount, consisting of letters, points, spaces, quadrates, &c. shall weigh 500 lb. When he demands a fount of ten sheets, it is understood, that with that fount he shall be able to compose ten sheets, or twenty forms, without being obliged to distribute, that is, take them to pieces. The founder proceeds accordingly: he reckons 120 lb. for a sheet, including the quadrates, &c. or 60 lb. for a form, which is only half a sheet: not that the sheet always weighs 120 lb. or the form 60 lb. on the contrary it varies according to the size of the form: besides, it is always supposed that there are letters left in the cases. As therefore every sheet does not comprehend the same number of letters, nor the same sort of letters, we must observe, that, as in every language some sounds recur more frequently than others, some letters will be in much more use, and oftener repeated than others, and consequently their cells or cases should be better stored than those of the letters which do not recur so frequently: thus, a fount does not contain an equal number of *a* and *b*, or of *b* and *c*, &c. the letter-founders have therefore a list or tariff, or, as the French call it, a police, by which they regulate the proportions between the different sorts of characters that compose a fount; and it is evident that this tariff will vary in different languages, but will remain the same for all sorts of characters employed in the same language. See PRINTING.

FOUNTAIN, or *artificial fountain* in hydraulics, called also a jet d'eau, is a contrivance by which water is violently spouted upwards. See HYDRAULICS.

FOURCHE'E, or fourchy, in heraldry, an appellation given to a cross forked at the ends.

FOURCHE'E, or *fourching*, in law, signifies the delaying or putting off an action, which might have been brought to determination in a shorter time.

FOURTEENTH, in music the octave, or replicate, of the seventh. A distance comprehending thirteen diatonic intervals.

FOURTH, in music, a distance comprising three diatonic intervals: *i. e.* two tones and a half. The fourth is the third of the consonances in the order of their generation.

Lesser FOURTH, an interval consisting of five semitones.

Greater or sharp FOURTH, an interval consisting of six semitones.

FOX. See CANIS.

FOX-GLOVE. See DIGITALIS.

FRACTION. See ALGEBRA and ARITHMETIC.

FRACTURE, in surgery, a rupture of a bone, or a solution of continuity in a bone, when it is crushed or broken by some external cause. See SURGERY.

FRAGARIA, the strawberry; a genus of the polygynia order, in the icosandria class of plants; and in the natural method ranking under the 35th order, senticosæ. The calyx is decemfid; the petals five; the receptacle of the seeds ovate, in the form of a berry and deciduous. There are three species, but only one is deserving of particular notice, viz. 1. the vesca, or cultivated strawberry. The principal varieties are, 1. The sylvestris, or wood strawberry, with oval sawed leaves, and small round fruit. 2. The Virginian scarlet, or Virginia strawberry with oblong oval sawed leaves, and a roundish scarlet coloured fruit. 3. The moschatta, or hautboy, or musky strawberry, having oval, lanceolate rough leaves, and large pale red fruit. 4. The chiloensis, or Chili strawbery, of which the carolina is a variety with large, oval, thick, downy leaves, large flowers, and very large firm fruit. 5. The alpina, alpine, or monthly strawberry, having small oval leaves, small flowers, and moderate-sized, oblong, pointed fruit. All these varieties are hardy, low, perennials, durable in root; but the leaves and fruit-stalks are renewed annually in spring. They flower in May and June, and their fruit comes to perfection in June, July, and August; the alpine kind continuing till the beginning of winter. They all thrive in any common garden soil, producing abundant crops annually without much trouble. They increase exceedingly every summer, both by off-sets or suckers from the sides of the plants, and by the runners or strings, all of these rooting and forming plants at every joint, each of which separately planted bears a few fruit the following year, and bear in great perfection the succeeding summer. Those of the alpine kind will even bear fruit the same year that they are formed. All the sorts are commonly cultivated in kitchen-gardens, in beds or borders of common earth, in rows lengthwise 15 or 18 inches distance; the plants the same distance from one another in each row. Patches of the different sorts, disposed here and there in the fronts of the different compartments of the pleasure-ground, will appear ornamental both in their flowers and fruit, and make an agreeable variety. Strawberries, eaten either alone, or with sugar and cream, are universally esteemed a most delicious fruit. They are grateful, cooling, subacid, and juicy. Though taken in large quantities, they seldom disagree. They promote perspiration, impart a violet smell to the urine, and dissolve the tartareous incrustations on the teeth. People afflicted with the gout or stone have found relief by using them very largely; and Hoffman says, he has known consumptive people cured by them. The bark of the root is astringent. Sheep and goats eat the plant: cows are not fond of it; horses and swine refuse it.

II. The monophylla, or simple leaved strawberry, produces also esculent fruit, and differs from the former species only in the leaf.

III. The sterilis, or barren strawberry, is destitute of fruit, though it perfects seed.

FRÆNUM, in anatomy, a term applied to some membranous ligaments of the body.

FRÆNUM LINGUÆ, the ligament under the tongue, which sometimes ties it down too close to the bottom of the mouth; and then requires to be incised or divided, in order to give this organ its proper and free motion.

FRAISE, in fortification, a kind of defence consisting of pointed stakes, six or seven feet long, driven parallel to the horizon into the retrenchments of a camp, a half-moon, &c. and to prevent any approach or scalade. See FORTIFICATION.

FRANCHISE, in a general sense, a privilege or exemption from ordinary jurisdiction; as that for a corporation to hold pleas among themselves to such a value, or the like.

Franchises and liberties being usually held by charter, are all said to be derived from the crown, but some lie in prescription without the help of any charter.

FRANCHISE ROYAL, seems to be that where the king's writ does not run; but Bracton says, that a franchise royal is where the king grants to one and his heirs an exemption of toll, &c.

FRANCHISE OF QUARTERS, a certain place or district at Rome, wherein are the houses of the ambassadors of the princes of Europe; and where such as retire cannot be arrested or seized by the sbirri or serjeants, nor prosecuted at law. Several of the popes published their bulls and ordinances against the abuse made of this privilege, which rescued so considerable a part of the city, by the enlargement of these places, from their authority, and rendered them a retreat for the most abandoned persons. At last Innocent XI. expressly refused to receive any more ambassadors, but such as would make a formal renunciation of the franchise of quarters.

FRANCISCAN MONKS, FRIARS' MINOR, or GREY FRIARS, religious of the order of St. Francis, founded by him in the year 1209.

The rule of the Franciscans, as established by St. Francis himself, is briefly this: they are to live in common, to observe chastity, and to pay obedience to the pope and their superiors. Before they can be admitted into the order they are obliged to sell all they have, and give it to the poor: they are to perform a year's noviciate, and when admitted, never to quit the order on any account. They are to fast from the feast of All Saints to the Nativity. This order has produced four popes, forty-two cardinals, and an infinite number of patriarchs. The Franciscans had sixty-three monasteries in England, one of which was in the parish of St. Nicholas in London. It is said this order possessed (before the French revolution) 40,000 monasteries, hermitages, or chapels, in the different quarters of the globe.

FRANK ALMOIGN, signifies a tenure by spiritual service, where lands or tenements were held by an ecclesiastical corporation, sole or aggregate, to them and their successors, of some lord and his heirs, in free and perpetual alms.

FRANK FEE, signifies the same thing as holding lands and tenements in fee simple; that is, to any person and his heirs, and not by such service as is required by antient demesne, but is pleaded at common law.

FRANK FERM, antiently signified lands charged in the nature of the fee by feoffment, &c. out of the knight's service for other certain yearly services.

FRANK FOLD, is where the lord has the liberty of folding his tenants' sheep within his manor.

FRANK-INCENSE, in chemistry. It is well known that a resinous juice exudes from the pinus sylvestris, or common Scotch fir, which hardens into tears. The same, or a similar exudation, appears in the spruce fir. These tears constitute the substance called *thus*, or common frankincense. See RESIN and PINUS.

FRANKLANGUAGE, or *lingua franca*, a kind of jargon spoken on the Mediterranean, and particularly throughout the coasts and parts of the Levant, composed of Italian, Spanish, French, vulgar Greek, and other languages.

FRANK LAW, a word applied to the free and common law of the land, or the benefit a person has by it.

FRANK MARRIAGE, is where a person, seized in fee of lands or tenements, has given them to another with his daughter, sister, or some woman otherwise of kin to him, in free marriage, by virtue of which the husband and wife have an estate in special tail, and shall hold the land of the donor, discharged of all services, except fealty, to the fifth degree.

FRANK PLEDGE, in our law, signifies a pledge or surety for the behaviour of freemen. According to the antient custom of England, for the preservation of the public peace, every free-born man, at the age of 14, except religious persons, clerks, knights, and their eldest sons, was obliged to give security for his truth and behaviour towards the king and his subjects, or else be imprisoned. Accordingly, a certain number of neighbours became interchangeably bound for each other, to see each person of their pledge forthcoming at all times, or to answer for the offence of any one gone away; so that whenever any person offended, it was presently inquired in what pledge he was; and there the persons bound either produced the offender in 31 days, or made satisfaction for his offence.

FRANK, or FRANC, an antient coin, either of gold or silver, struck and current in France. The value of the gold frank was somewhat more than that of the gold crown;

the silver frank was a third of the gold one: this coin is long out of use, though the term is still retained as the name of a money of account; in which sense it is equivalent to the livre, or 20 sols.

FRANKENIA, *sea-heath*, or *sea-chickweed*, a genus of the hexandria monogynia class of plants, the flower of which consists of five petals, with a plain limb: the fruit is an oval, unilocular capsule, covered by the cup, and containing a great many ovated very small seeds. There are three species of this weed.

FRATERNITY, in the Roman catholic countries, signifies a society for the improvement of devotion.

FRATERNITY, in a civil sense, a company or guild of certain artificers or traders.

FRATRICELLI, *little brothers*, in church history, a sect of heretics who appeared in Italy about the year 1298, and afterwards spread all over Europe. They wore the habit of the Franciscan order, and pretended that ecclesiastics ought to have no possessions of their own.

FRATRIAGE, the partition among brothers or coheirs, coming to the same inheritance or succession. It more particularly signifies a younger brother's inheritance; or whatever the younger sons possess of the father's estate, which, in our antient law, they are said to enjoy ratione fratriagii; and were to do homage for the same to the elder brother, he being bound to do homage to the superior lord for the whole.

FRAUD, in law. All deceitful practices in defrauding or endeavouring to defraud another of his own right, by means of some artful device, contrary to the plain rules of common honesty, are condemned by the common law, and punishable according to the heinousness of the offence. Co. Lit. b. 3.

The distinction laid down as proper to be attended to in all cases of this kind, is this, that in such impositions or deceits, where common prudence might guard persons from the offence, it is not indictable, but the party is left to his civil remedy; but where false weights or measures are used, or false tokens produced, or such measures taken to defraud or deceive, as people cannot by any ordinary care or prudence be guarded against, there it is an offence indictable. Burr. 1120.

Persons convicted of obtaining money or goods by false pretences, or sending threatening letters to extort money or goods, may be punished by fine and imprisonment, or by pillory, whipping, or transportation. 30 G. II. c. 24.

A fraudulent conveyance of lands or goods to deceive creditors, as to creditors is void in law. And a fraudulent conveyance in order to defraud purchasers, is also to such purchasers void; and the persons justifying or putting off such grants as good, shall forfeit a year's value of the lands, and the full value of the goods and chattels, and likewise shall be imprisoned. When, however, conveyances are fraudulently made, they are not void to all persons, but only to those that afterwards come to the land as purchasers on good consideration. A general gift made of all the goods of a person may be reasonably su pected to be by fraud, even though a true debt is owing to the party to whom made; and it is void against other creditors of the donor. Here the several marks of fraud in a gift or grant of goods, are as follow, viz. 1. If it is general, without any exception of some things of necessity. 2. If the donor continues to possess and use the goods. 3. If the deed is made in secret. 4. If there is a trust between the parties; or, 5. If made whilst the action is depending. Where a person is party to a fraud, all that follows thereupon will be intended to be done by him, though fraud shall not be presumed or adjudged to be so, until found by jury.

By the statute of frauds, 29 Car. II. agreements for the sale of lands, leases, &c. are required to be in writing. See 3 and 4 Will. and Mary, c. 14.

FRAXINUS, the *ash*, a genus of the dioecia order, in the polygamia class of plants, and in the natural method ranking under the 44th order, sepiariæ. There is no hermaphrodite calyx, or it is quadripartite; and there is either no corolla, or it is tetrapetalous; there are two stamina, one pistil, one lanceolated seed, and the pistil of the female is lanceolated. There are four species, of which the most useful is the common ash, which is so well known that it needs no description. If a wood of these trees is rightly managed, it will turn greatly to the advantage of the owner: for by the underwood, which will be fit to cut every eight or ten years, there will be a continual income, more than sufficient to pay the rent of the ground and all other charges; and still there will be a stock preserved for timber, which in 23 years will be worth 114*l.* per acre. This tree flourishes best in groves, but grows very well in rich soil in open fields. It bears transplanting and lopping. In the north of Lancashire they lop the tops of these trees to feed the cattle in autumn when the grass is on the decline, the cattle peeling off the bark as food. The wood has the singular property of being nearly as good when young as when old. It is hard and tough, and is much used to make the tools employed in husbandry. The ashes of the wood afford very good pot-ash. The bark is used in tanning calf-skin. A slight infusion of it appears of a pale-yellowish colour, when viewed betwixt the eye and the light; but when looked down upon, or placed betwixt the eye and an opaque object, appears blue. This blueness is destroyed by the addition of an acid, but recovered by alkalies. The seeds are acrid and bitter. In the church-yard of Lochabar in Scotland, Dr. Walker measured the trunk of a dead ash-tree, which, at five feet from the surface of the ground was 58 feet in circumference.

FREE, among seamen. The pump is said to free the ship, when it throws out more water than leaks into her. To free the boat, is baling or lading out the water therein.

FREE-BENCH, signifies that estate in copyhold which the wife, being espoused a virgin, has after the decease of her husband for her dower, according to the custom of the manor. In regard to this free-bench, different manors have different customs, and in the manor of east and west Enbourne in the county of Berks, and in other parts of England, there is a custom, that when a copyhold tenant dies, the widow shall have her free-bench in all the deceased husband's lands, dum sola et casta fuerit, while she lives single and chaste; but if she is found to be guilty of incontinency, she shall forfeit her estate. Nevertheless, upon her coming into the court of the manor riding backwards on a black ram, with his tail in her hand, rehearsing a certain form of words, the steward is bound by custom to restore her to her free bench.

FREEDOM OF A CORPORATION, the right of enjoying all the privileges and immunities belonging to it.

The freedom of cities, and other corporations, is regularly obtained by serving an apprenticeship of seven years; but it is also sometimes purchased with money, and sometimes conferred by way of compliment.

FREEHOLD, may be in deed or in law. A freehold in deed is actual seisin of lands or tenements in fee-simple, fee-tail, or for life. A freehold in law is a right to such lands or tenements before entry or seizure.

So there is a seisin in deed, and a seisin in law. A seisin in deed is when a corporal possession is taken; and a seisin in law is where lands descend before entry, or where something is done which amounts in law to an actual seisin. 1 Inst. 31.

Tenant in fee-simple, or fee-tail for life, is said to have a freehold, so called because it distinguishes it from terms of years, chattels upon uncertain interests, lands in villenage, or customary or copyhold lands. 1 Inst. 43.

A freehold cannot be conveyed to pass in future; for then there would be want of a tenant against whom to bring a præcipe; and therefore, notwithstanding such conveyance, the freehold continues in the vendor: but if livery of seisin is afterwards given, the freehold thence passes to the vendee. 2 Wils. 165.

A man is said to be seised of freehold, but to be possessed of other estates, as of copyhold lands, leases for years, or goods and chattels. See ESTATE and FEE SIMPLE.

FREEHOLDERS, such as hold any freehold estate.

FREESTONE, a whitish stone dug up in many parts of England, that works like alabaster, but is more hard and durable, being of excellent use in building, &c. It is a variety of the gritstone, but finer sanded, and a smoother stone, and is called free, from its being of such a constitution as to cut freely in any direction: such is the Portland-stone, and the freestone of Kent.

FREEZE, or FRIEZE, in commerce, a coarse kind of woollen stuff, or cloth for winter wear; so called as being freezed or naped on one side.

FREEZING, in philosophy, the same with congelation, or the fixing a fluid body into a firm or solid mass by the action of cold. See COLD.

In general cold contracts most bodies, and heat expands them: though there are some instances to the contrary, especially in the extreme cases or states of these qualities of bodies. Thus, though iron, in common with other bodies, expands with heat, yet, when melted, it is always found to expand in cooling again. So also, though water always is found to expand gradually as it is heated, and to contract as it cools, yet in the act of freezing it suddenly expands again, and that with a most enormous force, capable of rending rocks, or bursting very thick shells of metal, &c. A computation of the force of freezing water has been made by the Florentine academicians, from the bursting of a

very strong brass globe or shell, by freezing water in it; when, from the known thickness and tenacity of the metal, it was found that the expansive power of a spherule of water only one inch in diameter was sufficient to overcome a resistance of more than 27,000lbs. or 13 tons and a half. See the experiments on bursting thick bomb-shells, by freezing water in them, by major Edward Williams, of the royal artillery, in the Edin. Philos. Trans. vol. ii.

Such a prodigious power of expansion, almost double that of the most powerful steam-engines, and exerted in so small a mass, seemingly by the force of cold, was thought a very material argument in favour of those who supposed that cold, like heat, is a positive substance. Dr. Black's discovery of latent heat, however, has now afforded a very easy and natural explication of this phenomenon. He has shewn that, in the act of congelation, water is not cooled more than it was before, but rather grows warmer: that as much heat is discharged, and passes from a latent to a sensible state, as, had it been applied to water in its fluid state, would have heated it to 135°. In this process the expansion is occasioned by a great number of minute bubbles suddenly produced. Formerly these were supposed to be cold in the abstract; and to be so subtle that, insinuating themselves into the substance of the fluid, they augmented its bulk; at the same time that, by impeding the motion of its particles upon each other, they changed it from a fluid to a solid. But Dr. Black shews, that these are only air extricated during the congelation; and to the extrication of this air he ascribes the prodigious expansive force exerted by freezing water. The only question, therefore, now remaining is, By what means this air comes to be extricated, and to take up more room than it naturally does in the fluid? To this it may be answered, that perhaps part of the heat, which is discharged from the freezing water, combines with the air in its unelastic state, and, by restoring its elasticity, gives it that extraordinary force, as is seen also in the case of air suddenly extricated in the explosion of gunpowder.

Cold also usually tends to make bodies electric, which are not so naturally, and to increase the electric properties of such as are so. And it is farther found, that all substances do not transmit cold equally well; but that the best conductors of electricity, viz. metals, are likewise the best conductors of cold. It may farther be added, that when the cold has been carried to such an extremity as to render any body an electric, it then ceases to conduct the cold so well as before. This is exemplified in the practice of the Laplanders and Siberians; where, to exclude the extreme cold of the winters from their habitations the more effectually, and yet to admit a little light, they cut pieces of ice, which in the winter time must always be electric in those countries, and put them into their windows; which they find to be much more effectual in keeping out the cold than any other substance.

Cold, or rather the absence of heat, is the destroyer of all vegetable life, when increased to an excessive degree. It is found that many garden plants and flowers, which seem to be very stout and hardy, go off at a little increase of cold beyond the ordinary standard. And, in severe winters, nature has provided the best natural defence for the cornfields and gardens, namely, a covering of snow, which preserves such parts green and healthy as are under it, while such as are uncovered by it are either killed or greatly injured.

Although the thermometer in this country hardly ever descends so low as 0, yet, in the winter of 1780, Mr. Wilson, of Glasgow, observed, that a thermometer laid on the snow sunk to 25° below 0; and Mr. Derham, in the year 1708, observed in England that the mercury stood within one-tenth of an inch of its station when plunged into a mixture of snow and salt. At Petersburgh, in 1732, the thermometer stood at 28° below 0; and when the French academicians wintered near the polar circle, the thermometer sunk to 33° below 0; and in the Asiatic and American continents still greater degrees of cold are often observed.

The effects of these extreme degrees of cold are very surprising. Trees are burst, rocks rent, and rivers and lakes frozen several feet deep: metallic substances blister the skin like red-hot iron: the air, when drawn in by breathing, hurts the lungs, and excites a cough: even the effects of fire, in a great measure, seem to cease; and it is observed, that though metals are kept for a considerable time before a strong fire, they will still freeze water when thrown upon them. When the French mathematicians wintered at Tornea, in Lapland, the external air, when suddenly admitted into their rooms, converted the moisture of the atmosphere into whirls of snow; their breasts seemed to be rent when they breathed it, the contact of it was intolerable to their bodies; and the spirit of wine, which had not been highly rectified, burst some of their thermometers by the congelation of the aqueous part.

Extreme cold too often proves fatal to animals in those countries where the winters are very severe: thus 7000 Swedes perished at once in attempting to pass the mountains which divide Norway from Sweden. But it is not necessary that the cold, in order to prove fatal to human life, should be so very intense as has just been mentioned; it is only requisite to be a little below 32° of Fahrenheit, or the freezing point, accompanied with snow or hail, from which shelter cannot be obtained. The snow which falls upon the clothes, or the uncovered parts of the body, then melts, and by a continual evaporation carries off the animal heat to such a degree, that a sufficient quantity is not left for the support of life. In such cases, the person first feels himself extremely chill and uneasy; he turns listless, unwilling to walk or use exercise to keep himself warm, and at last turns drowsy, sits down to refresh himself with sleep, but wakes no more.

With regard to the term congelation, it is applied to water when it freezes into ice; to metals, when they resume their solid form after being melted by heat; or to glass, wax, pitch, tallow, &c. when they harden again after having been rendered fluid by heat. But it differs from crystallization, which is rather a separation of the particles of a solid from a fluid in which it had been dissolved more by the moisture than the action of heat.

The process of congelation is always attended with the emission of heat, as is found by experiments on the freezing of water, wax, spermaceti, &c.; for in such cases it is always found that a thermometer dipt into the fluid mass keeps continually descending as this cools, till it arrives at a certain point, being the point of freezing, which is peculiar to each fluid, where it is rather stationary, and then rises for a little, while the congelation goes on.

FREEZING-POINT, denotes the point or degree of cold, shewn by a mercurial thermometer, at which certain fluids begin to freeze, or, when frozen, at which they begin to thaw again. On Fahrenheit's thermometer this point is at + 32 for water, and at —40 for quicksilver, these fluids freezing at those two points respectively. It would also be well if the freezing points for other fluids were ascertained, and the whole arranged in a table. See THERMOMETER.

FREEZING-RAIN, or *raining ice*, a very uncommon kind of shower, which fell in the west of England, in December 1672, of which we have various accounts in the Philosophical Transactions. This rain, as soon as it touched any thing above ground, as a bough, &c. immediately settled into ice; and, by multiplying and enlarging of the icicles, broke all down with its weight. The rain that fell on the snow immediately froze into ice, without sinking in the snow at all. It made an incredible destruction of trees, beyond any thing in all history. "Had it concluded with some gust of wind (says a gentleman on the spot), it might have been of terrible consequence. I weighed the sprig of an ash-tree, of just three-quarters of a pound, the ice on which weighed 16 pounds. Some were frightened with the noise in the air, till they discerned it was the clatter of icy boughs, dashed against each other." This phenomenon, however, is not uncommon in a less degree, and depends wholly on the nice balance of temperatures in the rain and atmosphere. Dr. Beale observes, that there was no considerable frost observed on the ground during the whole; whence he concludes, that a frost may be very intense and dangerous on the tops of some hills and plains; while in other places it keeps at two, three, or four feet distance above the ground, rivers, lakes, &c. and may wander about very furious in some places, and remiss in others not far off. The frost was followed by glowing heats, and a wonderful forwardness of flowers and fruits.

FREEZING MIXTURE. See COLD.

FREIGHT, or FRAIGHT, in navigation and commerce, is the consideration of money agreed to be paid for the use or hire of a ship, or, in a larger sense, the burthen of such ship.

The freight is most frequently determined for the whole voyage, without respect to time: sometimes it depends on time; in the former case it is either fixed at a certain sum for the whole cargo, or so much per ton, barrel bulk, or other weight or measure, or so much per cent. on the value of the cargo.

If a certain sum is agreed on for the freight of the ship, it must all be paid, although the ship when measured should prove less, unless the burthen is warranted. If the ship is freighted for transporting cattle or slaves at so much per head, and some of them die on the passage, freight is only due for such as are deli-

vered alive; if for lading them, it is due for all put on board.

When a whole ship is freighted, if the master suffers any goods besides those of the freight to be put on board, he is liable for damages.

If the voyage is completed according to the agreement, without any accident, the master has a right to demand the freight before the delivery of the goods; but if such delivery is prevented by negligence or accidents, the parties will be reciprocally responsible in the following manner.

If the merchant should not load the ship within the time agreed on, the master may engage with another, and recover damages.

If the merchant recals the ship after she is laden and sailed, he must pay the whole freight; but if he unloads before the ship has actually sailed, he will in such case only be responsible for damages.

If the merchant loads goods which are not lawful to export, and the ship is prevented from proceeding on that account, he must nevertheless pay the freight.

If the master is not ready to proceed on the voyage at the time stipulated, the merchant may load the whole or part of the cargo on board another ship, and recover damages; but any real casualties will release the master from all damages.

If an embargo is laid on the ship before she sails, the charterparty is dissolved, and the merchant pays the expence of loading and unloading; but if the embargo is only for a short limited time, the voyage shall be performed when it expires; and neither party is liable for damages.

If the master sails to any other port than that agreed on, without necessity, he must sail to the port agreed on at his own expence, and is also liable for any damages in consequence of it.

If a ship is taken by the enemy, and retaken or ransomed, the charterparty continues in force.

If the master transfers the goods from his own ship to another, without necessity, and they perish, he is responsible for the full value, and all charges; but if his own ship is in imminent danger, the goods may be put on board another ship at the risk of the owner.

If a ship is freighted out and home, and a sum agreed on for the whole voyage, nothing becomes due until the return of such ship.

If a certain sum is specified for the homeward voyage, it is due, although the correspondent abroad should have no goods to send home.

A ship was freighted to a particular port and home, a particular freight agreed upon for the homeward voyage, with an option reserved for the correspondent to decline it, unless the ship arrived before a certain day. The master did not go to the port agreed on, and therefore became liable to damages; the obligation being absolute on his part, and conditional only on the part of the freighter.

If the goods are damaged without fault of the ship or master, the owner is not obliged to receive them and pay the freight, but he must either receive or abandon the whole; he cannot receive those that are not damaged, and reject the others.

If the goods are damaged through the insufficiency of the ship, the master is liable for the same; but if it is owing to stress of weather he is not accountable.

If part of the goods is thrown overboard, or taken by the enemy, the part delivered pays freight.

The master is accountable for all the goods received on board by himself and mariners, unless they perish by the act of God, or the king's enemies.

The master is not liable for leakage of liquors, nor accountable for contents of packages, unless packed in his presence.

FRESCO, a method of painting in relievo on walls, so as to endure the weather.

It is performed with water-colours on fresh plaster; or a wall laid with mortar not yet dry. This sort of painting has a great advantage by its incorporating with the mortar, and drying along with it, becomes very durable.

The antients painted on stucco; and we may remark in Vitruvius, what infinite care they took in making the incrustations or plastering of their buildings, to render them beautiful and lasting; though the modern painters find a plaster of lime and sand preferable to it. See PAINTING.

FRESHES, in sea language, denote the impetuosity of an ebb-tide, increased by heavy rains, and flowing out into the sea, often discolouring it to a considerable distance, and forming a line that separates the two colours, and which may be distinctly perceived for a great length along the coast.

FRET, or FRETTE, in architecture, a kind of knot, or ornament, consisting of two lists or small fillets variously interlaced or interwoven, and running at parallel distances equal to their breadth. See ARCHITECTURE.

FRET, in heraldry, a bearing composed of six bars, crossed, and variously interlaced. Some call it the true lover's knot.

FRET, in music, signifies a kind of stop on some instruments, particularly bass-viols and lutes. Frets consist of strings tied round the neck of the instrument, at certain distances, within which such and such notes are to be found.

FRET-WORK. See ARCHITECTURE.

FRETTY, in heraldry, an appellation given to bearings made up of six, eight, or more bars laid across each other in the manner of frets.

FRIAR, or FRIER, from the French *frère*, a brother, a term common to monks of all orders, founded on this, that there is a kind of fraternity, or brotherhood, between the several religious persons of the same convent or monastery. Friars are generally distinguished into these four principal branches, viz. 1. Minors, grey friars, or franciscans. 2. Augustines. 3. Dominicans, or black friars. 4. White friars, or carmelites. From these four the rest of the orders descend. See the articles FRANCISCANS, AUGUSTINES, &c.

FRIAR OBSERVANT, is a branch of the franciscan friars; thus called, because they are not combined together in any cloister, convent, or corporation, as the conventuals are; but have bound themselves only to observe the rules of their order more strictly than the conventuals do, from whom they separated, out of a singularity of zeal, living in certain places of their own choosing.

FRICTION, in mechanics, the rubbing of the parts of engines and machines against each other, by which means a great part of their effect is destroyed.

It is hardly possible to lay down general rules concerning the quantity of friction; since it depends upon a multiplicity of circumstances, as the structure, firmness, elasticity, &c. of the bodies rubbing against each other. Some authors make friction upon an horizontal plane, equal to one third of the weight to be moved; whilst others have found it to be considerably less.

Two objects must however be observed, viz. the loss of power which is occasioned by it, and the contrivances which have been made, and are in use, for the purpose of diminishing its effects.

A body of an horizontal plane should be capable of being moved by the application of the least force; but this is not the case, and the principal causes which render a greater or less quantity of force necessary for it are, 1st, the roughness of the contiguous surfaces; 2dly, the irregularity of the figure, which arises either from the imperfect workmanship, or from the pressure of one body upon the other; 3dly, an adhesion or attraction which is more or less powerful according to the nature of the bodies in question; and 4thly, the interposition of extraneous bodies; such as moisture, dust, &c.

Innumerable experiments have been made for the purpose of determining the quantity of obstruction, or of friction, which is produced in particular circumstances. But the results of apparently similar experiments, which have been made by different experimenters, do not agree; nor is it likely they should, since the least difference of smoothness or polish, or of hardness, or, in short, of any of the various concurring circumstances, produces a different result. Hence no certain and determinate rules can be laid down with respect to the subject of friction.

Mr. Vince, who has made many experiments on friction, infers,

1st, That friction is an uniformly retarding force in hard bodies, not subject to alteration by the velocity; except when the body is covered with cloth, woollen, &c. and in this case the friction increases a little with the velocity.

2dly, Friction increases in a less ratio than the quantity of matter or weight of the body. This increase, however, is different for the different bodies, more or less; nor is it yet sufficiently known, for any one body, what proportion the increase of friction bears to the increase of weight.

3dly. The smallest surface has the least friction, the weight being the same. But the ratio of the friction to the surface is not yet accurately known.

Mr. Vince's experiments consisted in determining how far the sliding bodies would be drawn in given times, by a weight hanging freely over a pulley. This method would both shew him if the friction was a constant retarding force, and the other conclusions above stated. For as the spaces described by any constant force, in given times, are as the squares of the times, and as the weight drawing the body is a constant force, if the friction, which acts in opposition to the weight, should also be a constant force, then their difference, or the force by which the body is urged, will also be constant, in which case the spaces described ought to be as the squares of the times, which happened accordingly in the experiments.

Mr. Vince adds some remarks on the nature of the experiments which have been made by others. These, he observes, the authors "have instituted to find what moving force would just put a body at rest in motion and they concluded thence that the accelerative force was then equal to the friction; but it is manifest, that any force which will put a body in motion must be greater than the force which opposes its motion, otherwise it could not overcome it: and hence, if there were no other objections than this, it is evident that the friction could not be very accurately obtained; but there is another objection, which totally destroys the experiment, so far as it tends to shew the quantity of friction, which is the strong cohesion of the body to the plane when it lies at rest." This he confirms by several experiments, and then adds: "From these experiments, therefore, it appears how very considerable the cohesion was in proportion to the friction when the body was in motion; it being in one case almost $\frac{1}{3}$, and in another it was found to be very nearly equal to the whole friction. All the conclusions, therefore, deduced from the experiments which have been instituted to determine the friction, from the force necessary to put a body in motion, (and I have never seen any described but upon such a principle) have manifestly been totally false; as such experiments only shew the resistance which arises from the cohesion and friction conjointly." Philos. Trans. vol. 75, pa. 165.

If a body is laid upon another body, and soon after is moved along the surface of it, a less force will be found sufficient for the purpose, than if the body be left some time at rest before it be moved. This arises principally from an actual change of figure, which is produced in a longer or shorter time, according to the nature of the bodies. Thus the maximum of adhesion between wood and wood takes place in a few minutes' time; between metal and metal it takes place almost immediately. A hard and heavy body laid upon a softer one will sometimes continue to increase its adhesion for days and weeks.

When a cubic foot of soft wood of eight pounds weight is to be moved upon a smooth horizontal plane of soft wood, at the rate of three feet per second, the power which is necessary to move it, and which is equivalent to the friction, amounts to between 1-4th and 1-3rd of the weight of the cube. When the wood is hard, the friction amounts to between 1-7th and 1-8th of the weight of the cube.

In general the softer or the rougher the bodies are, the greater is their friction. Yet when two pieces of metal, extremely well polished, are laid one upon the other with an ample surface of contact, they adhere to each other much more forcibly than when they are not so well polished.

Iron or steel moves easiest in brass. Other metals acting against each other produce more friction.

The friction, cæteris paribus, increases with the weight of the superincumbent body, and almost in the same proportion.

The friction or obstruction which arises from the bending of ropes about machines, is influenced by a variety of circumstances, such as their peculiar quality, the temperature of the atmosphere, and the diameter or curvature of the surface to which they are to be adapted. But when other circumstances remain the same, the difficulty of bending a rope increases with the square of its diameter, as also with its tension, and it decreases according as the radius of the curvature of the body to which it is adapted, increases.

Of the simple mechanical powers the lever is the least subject to friction.

In a wheel, the friction upon the axis is, as the weight that lies upon it, as the diameter of the axis, and as the velocity of the motion. But upon the whole, this sort of friction is not very great, provided the machine is well executed. In common pulleys, especially those of a small size, the friction is very great. It increases in proportion as the diameter of the axis increases, as the velocity increases, and as the diameter of the pulley decreases. With a moveable tackle, or block of five pulleys, a power of 150 pounds will barely be able to draw up a weight of 500 pounds.

The screw is subject to a great deal of friction; so much so that the power which must be applied to it, in order to produce a given effect, is at least double that which is given by the calculation independent of friction. But the degree of friction in the screw is influenced considerably by the nature of the construction; for much of it is owing to the tightness of the screw, to the distance between its threads, and to the shape of the threads; the square threads producing upon the whole, less friction than those which are sharp.

The friction which attends the use of the wedge, exceeds in general that of any other simple mechanical power. Its quantity depends so much upon the nature of the body upon which the wedge acts, besides other circumstances, that it is impossible to give even an approximate estimate of it.

The friction of mechanical engines not only diminishes the effect, or, which is the same thing, occasions a loss of power; but is attended with the corrosion and wear of the principal parts of the machine, besides producing a considerable degree of heat, and even actual fire; it is therefore of great importance in mechanics to contrive means capable of diminishing, if not of quite removing, the effects of friction.

In compound engines, the obstruction which arises from friction can be ascertained only by means of actual experiments. An allowance, indeed, may be made for each simple component mechanical power; but the error in estimating the friction of any one single power is multiplied and increased so fast by the other parts, that the estimate generally turns out very erroneous. Besides, much depends on the execution of the work; the quality of which cannot be learned but by experience. Novices are generally apt to expect too much or too little from any mechanism. In general it can only be said, that in compound engines, at least one-third of the power is lost on account of the friction.

The methods of obtaining the important object of diminishing the friction, are of two sorts, viz. either by the interposition of particular unctuous or oily substances between the contiguous moving parts, or by particular mechanical contrivances.

Olive-oil is the best, and perhaps the only substance that can be used in small works, as in watches and clocks, when metal works against metal. But in large works the oil is liable to drain off, unless some method is adopted to confine it. Therefore for large works tallow is mostly used, or grease of any sort; which is useful for metal, as well as for wood. In the last case tar is also frequently used.

In delicate works of wood, viz. when a piece of wood is to slide into or over wood, and when a wooden axis is to turn into wood, the fine powder of what is commonly called black-lead, when interposed between the parts, eases the motion considerably, and is at the same time a clean and durable substance.

Though olive-oil is the best and the only substance that is used for delicate mechanisms; yet it is far from being free from objections. Oil, when in contact with brass, is liable to grow rancid, in which state it slowly corrodes the brass. In different temperatures it becomes more or less fluid; but upon the whole it grows continually thicker, and of course less fit to ease the motion of the parts, &c. Trifling as those defects may at first sight appear, they are however of such moment in delicate works, that in the greatly improved state to which watchwork has been brought in this country, the changeable quality of the oil seems at present to be the principal, if not the only impediment to the perfection of chronometers.

The mechanical contrivances which have been made, and are in use, for the purpose of diminishing the effects of friction, consist either in avoiding the contact of such bodies as produce much friction, or in the interposition of rollers, viz. cylindrical bodies, between the moving parts of machines, or between moving bodies in general. Such cylinders derive, from their various size and application, the different names of rollers, friction-wheels, and friction-rollers.

Thus in mill-work and other large machines, the wooden axes of large wheels terminate in iron gudgeons, which turn in wood, or more frequently in iron or brass, which construction produces less friction than the turning of wood in wood. In the finest sort of watch-work the holes are jewelled, viz. many of the pivots of the wheels, &c. move in holes made in rubies, or topazes, or other hard stone, which, when well finished, are not liable to wear, nor do they require much oil.

In order to understand the nature of rollers, and the advantage with which their use is attended, it must be considered, that when a body is dragged over the surface of another body, the inequalities of the surfaces of both bodies meet and oppose each other, which is the principal cause of the friction or obstruction; but when one body, such as a cask, a cylinder, or a ball, is rolled upon another body, the surface of the roller is not rubbed against the other body, but is only successively applied to, or laid on, the other, and is then successively lifted up from it, Therefore, in rolling, the principal cause of friction is avoided, besides other advantages: hence a body may be rolled upon another body, when the shape admits of it, with incomparably less exertion than that which is required to drag it over the surface of that other body. In fact, we commonly see large pieces of timber, and enormous blocks of stone, moved

upon rollers, that are laid between them and the ground, with ease and safety, when it would be almost impossible to move them otherwise.

The form and disposition of friction-wheels is represented by fig. 94, Plate Miscel. which exhibits a front view of the axis of a large wheel, which moves between the friction-wheels A, B, C. Here the end of the axis (and the same thing must be understood of the opposite extremity of the axis) instead of moving in a hole, moves between the circumferences of three wheels, each of which is moveable upon its own axis, and is unconnected with the others. Now if the end of the axis turned in a hole, the surface of the hole would stand still, and the surface of the axis would rub against it; whereas, when the axis moves between the circumferences of the wheels A, B, C, its surface does not rub against, but is successively applied to the circumferences of those wheels; so that this sort of motion has the same advantage over the turning of the axis in a hole, that the moving of a heavy body upon rollers has over the simple method of dragging it upon the ground. In this construction the contact of the axis moves the wheels A, B, C, round their axis, where indeed some friction must unavoidably take place, but that friction is very trifling; for if the circumference of the axis be to that of each wheel as 1 to 20, the axis must make 20 revolutions whilst the friction-wheels will turn round once only.

A few years ago the same principle was applied in a very ingenious manner, by Mr. J. Garnett, then of Bristol, to pulleys, and other sorts of circular motion round an axis, for which he obtained a patent. The use of this application has proved very advantageous, especially on board of ships, where it has been found, that with a set of Mr. Garnett's pulleys, three men were able to draw as much weight as five men were barely able to accomplish with a similar set of common pulleys.

One of these pulleys is represented by fig. 95, Plate Miscel. where the shaded part B B B is the pulley, A is the axis, round which are the cylindrical rollers, which are situated between the axis and the inside cavity of the pulley. The ends of the axis A are fixed in a block, after the usual manner. Every one of the rollers has an axis, the extremities of which turn in holes made in two brass or iron flat rings.

After having given a general explanation of the action of rollers, the advantage which Mr. Garnett's pulleys must have over those of the common sort, needs no farther illustration. We shall, however, only observe, that the friction of the pivots of each roller in the holes of the brass rings is very inconsiderable; for those holes are made rather large, the use of the axes to the rollers being only to prevent their running one against the other. Nor does the addition of weight upon the pulley increase that friction, for the addition of weight upon the pulley will press the rollers harder upon the axis A, but not upon their own axes, as may be easily understood by inspecting the figure.

FRICTION may be considered chemically as a source of caloric. Fires are often kindled by rubbing pieces of dry wood smartly against one another. It is well known that heavy loaded carts sometimes take fire by the friction between the axle-tree and the wheel. Now in what manner is the caloric evolved or accumulated by friction? Not by increasing the density of the bodies rubbed against each other, as happens in cases of percussion, for heat is produced by rubbing soft bodies against each other, the density of which therefore cannot be increased by that means, as any one may convince himself by rubbing his hand smartly against his coat. It is true, indeed, that heat is not produced by the friction of liquids; but then they are too yielding to be subjected to strong friction. It is not owing to the specific caloric of the rubbed bodies decreasing; for Count Rumford found that there was no sensible decrease, nor, if there was a decrease, would it be sufficient to account for the vast quantity of heat which is sometimes produced by friction.

Count Rumford took a cannon cast solid and rough, as it came from the foundery; he caused its extremity to be cut off, and formed, in that part, a solid cylinder attached to the cannon $7\frac{3}{4}$ inches in diameter, and $9\frac{8}{10}$ inches long. It remained joined to the rest of the metal by a small cylindrical neck. In this cylinder a hole was bored 3.7 inches in diameter and 7.2 inches in length. Into this hole was put a blunt steel borer, which by means of horses was made to rub against its bottom; at the same time a small hole was made in the cylinder perpendicular to the bore, and ending in the solid part a little beyond the end of the bore. This was for introducing a thermometer to measure the heat of the cylinder. The cylinder was wrapt round with flannel to keep in the heat. The borer pressed against the bottom of the hole with a force equal to about 10,000lbs. avoirdupois, and the cylinder was turned round at the rate of 32 times in a minute. At the beginning of the experiment the temperature of the cylinder was 60°; at the end of 30 minutes, when it had made 960 revolutions, its temperature was 130°. The quantity of metallic dust or scales produced by this friction amounted to 837 grains. Now if we were to suppose that all the caloric was evolved from these scales, as they amounted to just $\frac{1}{948}$ part of the cylinder, they must have given out 948° to raise the cylinder 1°, and consequently 66360° to raise it 70° or to 130°, which is certainly incredible.

Neither is the caloric evolved during friction, owing to the combination of oxygen with the bodies themselves, or any part of them. By means of a piece of clock-work, Mr. Pictet made small cups (fixed on the axis of one of the wheels), to move round with considerable rapidity, and he made various substances rub against the outsides of these cups, while the bulb of a very delicate thermometer placed within them marked the heat produced. The whole machine was of a size sufficiently small to be introduced into the receiver of an air-pump. By means of this machine a piece of adamantine spar was made to rub against a steel cup in air: Sparks were produced in great abundance during the whole time, but the thermometer did not rise. The same experiment was repeated in the exhausted receiver of an air-pump (the manometer standing at four lines); no sparks were produced, but a kind of phosphoric light was visible in the dark. The thermometer did not rise. A piece of brass being made to rub in the same manner against a much smaller brass cup in air, the thermometer (which almost filled the cup) rose 0.3°, but did not begin to rise till the friction was over. This shews us that the motion produced in the air carried off the caloric as it was evolved. In the exhausted receiver it began to rise the moment the friction began, and rose in all 1.2° When a bit of wood was made to rub against the brass cup in the air, the thermometer rose 0.7°, and on substituting also a wooden cup, it rose 2.1°, and in the exhausted receiver 2.4°, and in air condensed to $1\frac{1}{4}$ atmospheres it rose 0.5°.

If these experiments should not be thought conclusive, there are others, which will not leave a doubt that the heat produced by friction is not connected with the decomposition of oxygen gas. Count Rumford contrived, with his usual ingenuity, to inclose the cylinder above described in a wooden box filled with water, which effectually excluded all air, as the cylinder itself and the borer were surrounded with water, and at the same time did not impede the motion of the instrument. The quantity of water amounted to 18.77 lbs. avoirdupois, and at the beginning of the experiment was at the temperature of 60°. After the cylinder had revolved for an hour at the rate of 32 times in a minute, the temperature of the water was 107°; in 30 minutes more it was 178°; and in two hours and 30 minutes after the experiment began, the water actually boiled. According to the computation of count Rumford, the caloric produced would have been sufficient to heat 26.58 lbs. avoirdupois of ice-cold water boiling hot; and it would have required nine wax candles of a moderate size, burning with a clear flame all the time the experiment lasted, to have produced as much heat. In this experiment all access of water into the hole in the cylinder where the friction took place was prevented. But in another experiment, the result of which was precisely the same, the water was allowed free access.

The caloric then, which appears in consequence of friction, is neither produced by an increase of the density, nor by an alteration in the specific caloric of the substances exposed to friction, nor is it owing to the decomposition of the oxygen of the atmosphere. Whence then is it derived? This question cannot at present be answered: but this is no reason for concluding with count Rumford, that there is no such substance as caloric at all, but that it is merely a peculiar kind of motion; because other facts demonstrate the existence of caloric as a substance. Was it possible to prove that the accumulation of caloric by friction is incompatible with its being a substance, in that case count Rumford's conclusion would be a fair one; but this surely has not been done. We are certainly not yet sufficiently acquainted with the laws of the motion of caloric, to be able to affirm with certainty that friction cannot cause it to accumulate in the bodies rubbed. This we know at least to be the case with electricity. Nobody has been hitherto able to demonstrate in what manner it is accumulated by friction; and yet this has not been

thought a sufficient reason to deny its existence.

Indeed there seems to be a very close analogy between caloric and electric matter. Both of them tend to diffuse themselves equally, both of them dilate bodies, both of them fuse metals, and both of them kindle combustible substances. See ELECTRICITY.

Mr. Achard has proved, that electricity can be substituted for caloric even in those cases where its agency seems peculiarly necessary; for he found that by constantly supplying a certain quantity of the electric fluid, eggs could be hatched just as when they are kept at the temperature of 103°. An accident indeed prevented the chickens from actually coming out, but they were formed and living, and within two days of bursting their shell. Electricity has also a great deal of influence on the heating and cooling of bodies. Mr. Pictet exhausted a glass globe, the capacity of which was 1200.199 cubic inches, till the manometer within it stood at 1.75 lines. In the middle of this globe was suspended a thermometer, which hung from the top of a glass rod fixed at the bottom of the globe, and going almost to its top. Opposite to the bulb of this thermometer two lighted candles were placed, the rays of which, by means of two concave mirrors, were concentrated on the bulb. The candles and the globe were placed on the same board, which was supported by a non-conductor of electricity. Two feet and a half from the globe there was an electrifying machine, which communicated with a brass ring at the mouth of the globe by means of a metallic conductor. This machine was kept working during the whole time of the experiment; and consequently a quantity of electric matter was constantly passing into the globe, which, in the language of Pictet, formed an atmosphere not only within it, but at some distance round, as was evident from the imperfect manner in which the candles burned. When the experiment began the thermometer stood at 49.8°. It rose to 70.2° in 732″. The same experiment was repeated, but no electric matter thrown in; the thermometer rose from 49.8° to 70.2° in 1050″; so that the electricity hastened the heating almost a third. In the first experiment the thermometer rose only to 71.3°, but in the second it rose to 77°. This difference was doubtless owing to the candles burning better in the second than the first experiment; for in other two experiments made exactly in the same manner, the maximum was equal both when there was and was not electric matter present. These experiments were repeated with this difference, that the candles were now insulated, by placing their candlesticks in vessels of varnished glass. The thermometer rose in the electrical vacuum from 52.2° to 74.7° in 1050″; in the simple vacuum in 965″. In the electrical vacuum the thermometer rose to 77°; in the simple vacuum to 86°. It follows from these experiments, that when the globe and the candles communicated with each other, electricity hastened the heating of the thermometer; but that when they were insulated separately, it retarded it. One would be apt to suspect the agency of electricity in the following experiment of Mr. Pictet: into one of the brass cups formerly described, a small quantity of cotton was put to prevent the bulb of the thermometer from being broken. As the cup turned round, two or three fibres of the cotton rubbed against the bulb, and without any other friction the thermometer rose five or six degrees. A greater quantity of cotton being made to rub against the bulb, the thermometer rose 15°.

FRIDSTOL, mentioned in our antient writers among the immunities granted to churches, signifies a seat, chair, or place of peace and security, where criminals might find safety and protection: of these there were many in England, but the most famous was at Beverley, and that in St. Peter's church at York, granted by charter of king Henry I.

FRIEND, or QUAKER. A society of dissenters from the church of England, obtained the latter appellation in the middle of the seventeenth century; the former they had before applied, and continue to apply, to themselves. The first preacher of this society was George Fox, a man of humble birth, and illiterate. The undertaking to which he considered himself called, that of promulgating a more simple and spiritual form of christianity than any of those which prevailed, and of directing the attention of christians to immediate Revelation, required little more reading than that of the Bible. A constant reference to the scriptures, with great zeal, courage, and perseverance, in preaching and suffering, did more than literature could have done, to spread his doctrine among the middle and lower classes. By those who treated religion scientifically, it was, with a few exceptions, more warmly opposed than sufficiently investigated. Arguments of civil coercion, of which the Friends had a full, and from their stiffness more than a common share, have been found to recommend, instead of repressing dissent. A more liberal and laudable treatment of conscientious scruples has succeeded; and it may be now said, in a better sense, respecting religion. Sub judice lis est.

The most prominent feature in the Friends' view of christianity is this: seeing, no man knoweth the Father but the Son, and he to whomsoever the Son will reveal him, and seeing the revelation of the Son is in and by the Spirit; therefore the testimony of the Spirit is that alone by which the true knowledge of God is revealed. In this doctrine they agree in substance with the church of England, and all others who acknowledge the efficacy of grace. For in whatever way this is afforded to christians, it is powerfully given to know and to do the will of God; and the communication of grace may be termed, in strict consistency with the sense of the New Testament, a revelation of Christ in the Spirit. The Friends receive the Holy Scriptures as having proceeded from the revelations of the Holy Spirit; they account them the secondary rule for christians, subordinate to the word, and therefore not the word of God. According to these they profess their belief in one God, as Father, Word, and Holy Spirit; in one mediator, the word made flesh, Jesus Christ; in the conception, birth life, miracles, death, resurrection, and ascension of Jesus; and in the remission of sins thereby purchased for the whole world of fallen mankind. Christ's redemption they believe to be perfected in us by his second coming in Spirit; in which they who obey him are, through the obedience of faith, restored from their state of alienation, and reconciled to God. They affirm, that for this end there is given to every man a measure of the light of Christ, (called by their early preachers the light within) a manifestation of the spirit to profit withal; which discovers sin, reproves for it, leads out of it, and if not resisted, will save from it, and lead on the christian to perfection. In public worship they profess to wait on God in this gift, in order to have their conditions made manifest, in silence and retirement of mind. They look for an extraordinary motion of it for vocal worship, and considering the qualification of a minister as a further gift which God confers, and of which the church ought to judge in the same spirit, they do not limit its exercise to any decription of persons. They suffer some inconvenience hereby, as they acknowledge, but they prefer bearing this to the establishing of any form of worship, save the forementioned, waiting in silence. They do not baptize formally, or use the sign of the communion; they say the one has ceased as to obligation, and that the true administration of the other is by the spirit alone.

They deem it unlawful for christians to swear at all; and their affirmation in civil causes is made legal, instead of an oath. They refuse to "learn war or to lift up the sword," as well as to contribute directly to military proceedings. Yet as they inculcate implicit submission, actively or passively, to Cæsar, they neither resist nor evade the legal appropriation of their substance by him, as well to these as to ecclesiastical purposes. Against the claims of the clergy, as well as many other things apparently lawful, they say in their phraseology they have a testimony to bear.

Some peculiarities, well enough known, mark them out from their fellow citizens. Simplicity in dress, in some instances, nearly amounting to an adherence to their original, though not prescribed, costume; simplicity of language, *thou* to one person, and without compliments; simplicity in their manners of living; the non-observance of fasts and feasts; the rejection of those which they call the unchristian names of days and months; and the renunciation of the theatres and other promiscuous amusements, gaming, and the usual outward signs of mourning and rejoicing, may be considered as their Shibboleth.

They marry among themselves by a ceremony or contract, religiously conducted, and bury their dead in the most simple manner. They maintain their poor, and enforce their own rules, by means of an excellent system of discipline, founded by G. Fox. They receive approved applicants into their society by an act of monthly meeting, or particular congregation, and without subscription of articles. They disown in the same manner, after repeated admonition, not officially only, but actually extended, to offenders against morality, or their peculiar rules. The latter may be seen in a book entitled, "Extracts from the Minutes and Advices of the Yearly Meeting of Friends, held in London, from its first institution:" their principles and doctrines in Barclay's Apology, and their history in a large work by William Sewel.

FRIEZE, FREEZE, or FRIZE. See ARCHITECTURE.

FRIGATE, among seamen, a ship of war, light built, and that is a good sailer. A frigate has commonly two decks, whence that called a light frigate is a frigate with only one deck. All ships of war that carry from 20 guns to 50 guns are called frigates.

FRIGATOON, a Venetian vesse', commonly used in the Adriatic sea, with a square stern, and carrying only a mainmast, mizen, and bowsprit.

FRILAZIN, the name of a class or rank of people among the Anglo-Saxons, consisting of those who had been slaves, but had either purchased, or by some other means obtained, their liberty. Though these were in reality free men, they were not considered as of the same rank and dignity with those who had been born free, but were still in a more ignoble condition, and dependent either on their former masters or on some new patrons. This custom the Anglo-Saxons seem to have derived from their ancestors in Germany, among whom those who had been made free did not differ much in point of dignity or importance in the state from those who continued in servitude. This distinction between those who have been made free, and those who enjoy freedom by descent from a long race of free men, still prevails in many parts of Germany; and particularly in the original seats of the Anglo-Saxons. Many of the inhabitants of towns and cities in England, in this period, seem to have been of this class of men, who were in a kind of middle state between slaves and freemen.

FRINGELLA, in ornithology, a genus belonging to the order of passeres. The bill is conical, straight, and sharp-pointed. There are no less than 108 species comprehended under this genus, distinguished principally by varieties in their colour. The following are the most remarkable.

1. The carduelis, or goldfinch, with the quill feathers red forwards, and the outermost without any spots; the two outermost are white in the middle, as the rest are at the point. The young bird, before it moults, is grey on the head; and hence it is termed by the bird-catchers a grey-pate. There is a variety of goldfinches called by the London bird-catchers a cheverel, from the manner in which it concludes its jerk. It is distinguished from the common sort by a white streak, or by two, sometimes three, white spots under the throat. The note of the goldfinch is very sweet, and they are much esteemed on that account, as well as for their great docility. Towards winter, they assemble in flocks, and feed on seeds of different kinds, particularly those of the thistle. They are fond of orchards, and frequently build in an apple or pear-tree; the nest is very elegantly formed of fine moss, liverworts, and bents, on the outside; lined first with wool and hair, and then with the goslin or cotton of the sallow. The goldfinch lays five white eggs, marked with deep purple spots on the upper end, and has two broods in the year. When kept in cages, they are commonly fed much on hemp-seed, which they eat freely, but which is said to make them grow black, and lose both their red and yellow. The goldfinch is a long-lived bird, often attaining the age of 20 years. This species is numerous throughout Europe; it is also met with both in Asia and Africa, but less common in those countries.

2. The cælebs, or chaffinch, has black limbs, and the wings white on both sides; the three first feathers of the tail are without spots, but two of the chief are obliquely spotted. It has its name from delighting in chaff. This species entertains us agreeably with its song very early in the year, but towards the latter end of the summer assumes a chirping note. Both sexes continue with us the whole year. What is very singular in Sweden, the female quits that country in September, migrating in flocks into Holland, leaving their mates behind: in the spring they return. In Hampshire Mr. White has observed sometimes vast flocks of females with scarcely any males among them. Their nest is as elegantly constructed as that of the goldfinch, and of much the same materials, only the inside has the addition of some large feathers. They lay four or five eggs of a dull white colour, tinged and spotted with deep purple. They are caught in plenty in flight-time.

3. The montifringilla, or brambling, has a yellow bill tipt with black; the head, hind part of the neck, and back, are black; the throat, fore part of the neck, and breast, pale rufous orange; lower part of the breast and belly white; the quill feathers brown, with yellowish edges; the tail a little forked; the legs grey. This species migrates into England at certain seasons, but does not build here. It is frequently found among chaffinches, and sometimes comes in vast flocks. They are also seen at certain times in vast clouds in France, insomuch that the ground has been quite convered with their dung, and more than 600 dozen were killed each night. They are said to be particularly fond of beech mast, but will also eat seeds of various other kinds. Their flesh is eaten by many, but is apt to prove bitter. They are said to breed about Luxemburgh, making their nests on the tall fir-trees, composed of long moss without, and lined with wool and feathers within; the eggs are four or five in number, yellowish, and spotted; and the young are fledged at the end of May. This species is found more or less throughout Europe, and is common in the pine forests of Russia and Siberia, but those of the last are darker in colour and less in size.

4. The domestica, or sparrow, has the prime feathers of the wings and tail brown, the body variegated with grey and black, and a single white streak on the wings. These well-known birds are proverbially salacious, and have three broods in a year. They are every where common about our houses, where they build in every place they can find admittance to; under the roof, at the corner of the brick-work, or in holes of the wall. They make a slovenly nest; generally a little hay ill put together, but lined well with feathers, where they lay five or six eggs of a reddish white colour spotted with brown. They will sometimes build in the neighbouring trees, in which case they take more pains with the nest; and not unfrequently they expel the martins from theirs, to save the trouble of constructing one of their own. The sparrow, from frequenting only habitations and parts adjacent, may be said to be chiefly fed from human industry; for, in spite of every precaution, it will partake with the pigeons, poultry, &c. in the food thrown out to them, grain of all kinds being most agreeable to its taste, though it will eat refuse from the kitchen of most kinds. It is a familiar but crafty bird, and will not so easily come into a snare as many others. In autumn they often collect into flocks, and roost in numbers on the neighbouring trees, when they may be shot by dozens, or at night caught in great numbers by a bat fowling-net.

5. The spinus, or siskin, has the prime feathers of the wings yellow in the middle, and the four first chief tail-feathers without spots; but they are yellow at the base, and black at the points. Mr. Willughby tells us, that this is a song-bird; that in Sussex it is called the barley-bird, because it comes to them in barley-seed time. We are informed that it visits these islands at very uncertain times, like the gross-beak, &c. It is to be met with in the bird-shops in London; and being rather a scarce bird, sells at a higher price than the merit of its song deserves: it is known there by the name of the aberdavine. It is a very tame and docile species, and is often kept and paired with the Canary-bird, with which it breeds freely. The bird-catchers have a notion of its coming out of Russia. Dr. Kramer informs us, that this bird conceals its nest with great art; and though there are infinite numbers of young birds in the woods on the banks of the Danube, which seem just to have taken flight, yet no one could discover the nest.

6. The linota, or linnet, has the bottom of the breast of a fine blood-red, which heightens as the spring advances. These birds are much esteemed for their song. They feed on seeds of different kinds, which they peel before they eat; the seed of the linum or flax is their favourite food; whence the name of the linnet tribe. They breed among furze and white thorn; the outside of their nest is made with moss and bents, and lined with wool and hair. They lay five whitish eggs, spotted like those of the goldfinch.

7. The cannabina, or greater red-pole, is less than the common linnet, and has a blood-coloured spot on the forehead, and the breast of the male is tinged with a fine rose-colour. It is a common fraud in the bird-shops in London, when a male bird is distinguished from the female by a red-breast, as in the case of this bird, to stain or paint the feathers, so that the deceit is not easily discovered, without at least close inspection. These birds are frequent on our sea-coasts, and are often taken in flight-time near London: it is a familiar bird, and is cheerful in five minutes after it is caught.

8. The linaria, or lesser red-pole, is about half the size of the last, with a rich spot of purplish red on the forehead; the breast is of the same colour, but less bright. Mr. Pennant mentions an instance of this bird being so tenacious of her nest, as to suffer herself to be taken off by the hand, and that when released she would not forsake it. This species is known about London by the name of stone red-pole. Linnæus, Kramer, and others, mention its being very fond of the seeds of alder. Whole flocks of them, mixed with the siskin, frequent places where alders grow, for the sake of picking the catkins: they generally hang like the titmouse, with the back downwards; and in this state are so intent on their work, that they may be entangled one after another by dozens, by means of a twig, smeared with bird-lime,

fastened to the end of a fishing-rod or other long pole. This species seems to be in plenty throughout Europe, from the extreme parts of Russia on the one hand to Italy on the other; is very common in Greenland, and was also met with by our late voyagers at Aoonalashka. In America it is likewise well known. Hence it seems to be a bird common to the whole of the northern part of the globe without exception.

9. The montium, or twite, is about the size of a linnet. It has the feathers of the upper part of the body dusky, those on the head edged with ash-colour, the others with brownish red: the rump is pale crimson; the wings and tail are dusky, the tips of the greater coverts and secondaries whitish; the legs pale brown. The female wants the red mark on the rump. Twites are taken in the flight-season near London, along with other linnets. It is probable that the name has been taken from their twittering note, having no music in it; and indeed the bird-catchers will tell, at some distance, whether there are any twites mixed among linnets merely from this circumstance. The twite is supposed to breed in the more northern parts of our island.

10. The amandava, or amaduvade bird, is about the size of a wren. The colour of the bill is of a dull red; all the upper parts are brown, with a mixture of red; the under the same, but paler, the middle of the belly darkest; all the feathers of the upper wing-coverts, breast, and sides, have a spot of white at the tip: the quills are of a grey brown; the tail is black, and the legs are of a pale yellowish white. It inhabits Bengal, Java, Malacca, and other parts of Asia.

11. The senagala, or Senegal finch, is a species very little larger than a wren. The bill is reddish, edged all round with brown, and beneath the under mandible a line of brown quite to the tip: the same also is seen on the ridge of the upper mandible; the upper parts of the body are of a vinaceous red colour; the lower parts, with the thighs and under tail-covers, of a greenish brown; the hind part of the head and neck, the back, scapulars, and wing-coverts, are brown; the tail is black; and the legs are pale grey. It inhabits Bengal; and, with the former species, feeds on millet. This affords the natives an easy method of catching them: they have no more to do than to support a large hollowed gourd, the bottom uppermost, on a stick, with a string leading to some covered place, and strewing under it some millet; the little birds, hastening in numbers to pick it up, are caught beneath the trap, by the stick being pulled away by the observer at a distance. The females are said to sing nearly as well as the males. They are familiar birds; and when once used to the climate, will frequently live five or six years in a cage. They have been bred in Holland by the fanciers of birds. See Plate Nat. Hist. fig. 209.

12. The canaria, or canary-bird, has a whitish body and bill, with the prime feathers of the wings and tail greenish. It was originally peculiar to those islands to which it owes its name; the same that were known to the antients by the addition of the Fortunate. Though the antients celebrate the island of Canaria for the multitude of birds, they have not mentioned any in particular. It is probable then, that our species was not introduced into Europe till after the second discovery of these islands, which was between the 13th and 14th centuries. We are uncertain when it first made its appearance in this quarter of the globe. Belon, who wrote in 1555, is silent in respect to these birds; Gesner is the first who mentions them; and Aldrovand speaks of them as rarities, observing that they were very dear, on account of the difficulty attending the bringing them from so distant a country, and that they were purchased by people of rank alone. They are still found on the same spot to which we were first indebted for the production of such charming songsters; but they are now become so numerous in our own country, that we are under no necessity of crossing the ocean for them. The canary-bird will prove fertile with the siskin and goldfinch; but in this case the produce, for the most part, proves sterile: the pairs succeed best when the hen-bird is the canary, and the cock of the opposite species. It will also prove prolific with the linnet, yellow-hammer, chaffinch, and even the house sparrow; but the male canary-bird will not assimilate with the female of these birds; the hen must be ever of the canary species, and the young of these mostly prove male birds. This bird is said by some to live 10 or 15 years; by others as far as 18.

13. The maja, or cubafinch, is about three and one quarter inches long, is found in Cuba, and feeds principally on rice. See Plate Nat. Hist. fig. 210.

FRIT, or FRITT, in the glass manufacture, is the matter or ingredients of which glass is to be made, when they have been calcined or baked in a furnace. A salt drawn from the ashes of the plant kali or from fern, or other plants, mixed with sand or flint, and baked together, makes an opaque mass, called by glass-men frit; probably from the Italian frittare, to fry; or because the frit when melted runs into lumps, like fritters, called by the Italians fritelli. Frit by the antients was called ammonitrum, from αμμος, sand, and νιτρον, nitre; under which name it is described by Pliny thus: Fine sand from the Volturnian sea, mixed with three times the quantity of nitre, and melted, makes a mass called ammonitrum; which being rebaked makes pure glass. Frit, Neri observes, is only the calx of the materials which makes glass; which, though they might be melted, and glass be made without thus calcining them, yet it would take up much more time. This calcining, or making of frit, serves to mix and incorporate the materials together, and to evaporate all the superfluous humidity. The frit, once made, is readily fused and turned into glass.

There are three kinds of frit: the first crystal frit, or that for crystal or clear glass, is made with salt of pulverine and sand. The second and ordinary frit is made of the bare ashes of pulverine or barilla, without extracting the salt from them. This makes the ordinary white or crystal glass. The third is frit for green glasses, made of common ashes, without any preparation. This last frit will require 10 or 12 hours baking. The materials in each are to be finely powdered, washed, and searced; then equally mixed, and frequently stirred together in the melting pot.

FRITH, in its most usual acceptation, signifies an arm of the sea: such are the frith of Forth or of Edinburgh, the frith of Clyde, Murray frith, &c.

FRITILLARIA, FRITILLARY, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 10th order, coronariæ. The corolla is hexapetalous and campanulated, with a nectariferous cavity above the heel in each petal; the stamina are as long as the corolla. There are five species, all of them bulbous-rooted flowery perennials, producing annual stalks from about one foot to a yard or more high, terminated by large, bell-shaped, liliaceous flowers, of a great variety of colours. They are all propagated by offsets, which they furnish abundantly from the sides of the roots, and which may be separated every second or third year; they are hardy plants, and will thrive in any of the common borders. The crown-imperial is well known.

FRIZING *of cloth*, a term in the woollen manufactory, applied to the forming of the nap of a cloth or stuff into a number of little hard burrs or prominences, covering almost the whole ground.

Some cloths are only frized on the back-side, as black cloths; others on the right side, as coloured and mixed cloths, rateens, bays, freezes, &c. Frizing may be performed two ways: one with the hand, that is, by means of two workmen, who conduct a kind of plank that serves for a frizing instrument. The other way is by a mill, worked either by water or a horse, or sometimes by men. This latter is esteemed the better way of frizing, the motion being uniform and regular, the little knobs of the frizing are formed more equably and regularly. The structure of this useful machine is as follows:

The three principal parts are the frizer or crisper, the frizing-table, and the drawer or beam. The two first are two equal planks or boards, each about 10 feet long, and 15 inches broad, differing only in this, that the frizing-table is lined or covered with a kind of coarse woollen stuff, of a rough sturdy nap; and the frizer is incrustated with a kind of cement composed of glue, gum arabic, and a yellow sand, with a little aqua vitæ or urine. The beam or drawer, thus called because it draws the stuff from between the frizer and the frizing-table, is a wooden roller, beset all-over with little, fine, short points, or ends of wire, like those of cards used in carding of wool.

The disposition and use of the machine is thus: The table stands immoveable, and sustains the cloth to be frized, which is laid with that side uppermost on which the nap is to be raised: over the table is placed the frizer, at such a distance from it as to give room for the stuff to be passed between them, so that the frizer, having a very slow semicircular motion, meeting the long hairs or naps of the cloth, twists and rolls them into little knobs or burrs, while at the same time the drawer, which is continually turning, draws away the stuff from under the frizer, and winds it over its own points.

All that the workman has to do while the machine is going, is to stretch the stuff on the table as fast as the drawer takes it off; and from time to time to take off the stuff from the points of the drawer. The design

of having the frizing-table lined with stuff of a short, stiff, stubby nap, is that it may detain the cloth between the table and the frizer long enough for the grain to be formed, that the drawer may not take it away too readily, which must otherwise be the case, as it is not held by any thing at the other end. It is unnecessary to say any thing particular of the manner of frizing stuffs with the hand, it being the aim of the workmen to imitate as near as they can, with their wooden instrument, the slow, equable, and circular motion of the machine: it needs only be added, that their frizer is but about two feet long and one broad; and that, to form the nap more easily, they moisten the surface of the stuff lightly with water mingled with whites of eggs or honey.

FROG. See RANA.

FROG-FISH of Surinam, a very singular animal, of which there is no specimen in the British or any public museum. In Surinam these fishes are called jakjés. They are cartilaginous, of a substance like our mustela, and exquisite food: they are formed with regular vertebræ, and small bones all over the body divided into equal parts; are first darkish, and then grey; their scales make a beautiful appearance. Whether this animal is, in its perfect state, a species of frog with a tail, or a kind of water-lizard, Mr. Edwards does not pretend to determine, but observes, that when its size is considered, if it should be deemed a tadpole at first produced from spawn and in its progress towards a frog, such an animal, when full grown, if it bears the same proportion to its tadpole as those in Europe do, must be of enormous size; for our full-grown frogs exceed the tadpoles at least 50 times.

FRONT *of a battalion*, among military men, is the first rank, or file-leaders. It is likewise called the face or head of a battalion.

FRONTAL, or FRONTLET, or BROW-BAND, is used in speaking of the Jewish ceremonies. It consists of four several pieces of vellum, on each whereof is written some text of scripture: they are all laid on a piece of calf's leather, with thongs to tie it by.

The Jews apply the leather with the vellum on their foreheads in the synagogue, and tie it round the head with the thongs.

FRONTAL MUSCLES. See ANATOMY.

FRONTIS os, in anatomy, called also os coronale, the bone of the forehead. See ANATOMY.

FROST. See COLD and FREEZING.

FROTH-SPIT, or CUCKOW-SPIT, a name given to a white froth or spume, very common in the spring. It forms the nidus of a species of cicada.

FRUCTIFICATION. See BOTANY.

FRUIT. Every person who shall bark any fruit-tree, shall forfeit to the party grieved treble damages by action at the common law, and also 10*l.* to the king. 37. H. VIII. c. 6.

Every person who shall rob any orchard or garden, or dig or pull up any fruit-trees, with intent to take the same away (the same not being felony by the laws of this realm), shall, on conviction before one justice, give to the party such satisfaction for damages as such justice shall appoint; and in default of payment to be whipped. 43 Eliz. c. 7.

And with respect to what shall be deemed felony by the laws of this realm, the distinction seems to be, that if they are any way annexed to the freehold, as trees growing, or apples growing upon the trees, then the taking and carrying them away is not felony, but trespass only, for a man cannot steal part of a freehold; but if they are severed from the freehold, as wood cut or apples gathered from the trees, then the taking of them is not a trespass only, but felony. Id.

Fine and imprisonment may be inflicted on persons destroying fruit-trees. 1 Geo. I. c. 48.

Robbing orchards or gardens of fruit growing therein, may be punished by fine, whipping, &c.

FRUIT-TREES. See GARDENING.

FRUMENTARII, a kind of soldiers or archers, under the western empire. The first time we read of these officers is in the time of the emperor Adrian, who made use of them to inform himself of whatever passed. They did not make any particular corps distinct from the rest of the forces, but there was a certain number of them in each legion. It is supposed that they were at first a number of young persons disposed by Augustus, throughout the provinces, particularly on all the grand roads, to acquaint the emperor, with all expedition, of every thing that happened.

FRUMENTATION, in Roman antiquity, a largess of corn bestowed on the people. This practice of giving corn to the people was very antient among the Romans, and frequently used to sooth the turbulent humour of the populace. At first the number of those to whom this largess was given was indeterminate, till Augustus fixed it at two hundred thousand.

FRUSTUM, in mathematics, a part of some solid body separated from the rest.

The frustum of a cone is the part that remains, when the top is cut off by a plane parallel to the base, and is otherwise called a truncated cone; for finding the surface and solidity of which, see GEOMETRY and MENSURATION.

The frustum of a globe or sphere is any part of it cut off by a plane, the solid contents of which may be found by this rule. To three times the square of the semidiameter of the base add the square of its height; then multiplying that sum by the height, and this product multiplied by .5236, gives the solidity of the frustum.

A frustum or portion of any solid, generated by the revolution of any conic section upon its axis, and terminated by any two parallel planes, may be thus compared to a cylinder of the same altitude, and whose base is equal to the middle section of the frustum made by a parallel plane. 1. The difference between such frustum and cylinder is always the same in different parts of the same or of similar solids; when the inclination of the planes to the axis, and the altitude of the frustum are given. 2. In the parabolic conoid, this difference vanishes; the frustum being always equal to a cylinder of the same height, upon the section of the conoid that bisects the altitude of the frustum, and is parallel to its bases. 3. In the sphere, the frustum is always less than the cylinder by one fourth part of a right-angled cone of the same height with the frustum, or, by one half of a sphere, of a diameter equal to that height: and this difference is always the same in all spheres whatever, when the altitude of the frustum is given. 4. In the cone the frustum always exceeds the cylinder by one fourth part of the content of a similar cone, that has the same height with the frustum.

FUCHSIA, a genus of plants of the octandria monogynia class and order. The calyx is one-leafed, coloured, bearing; the corolla very large; petals four, small. Berry inferior, four-celled, many seeds. There are five species, of which the fuchsia coccinea is very beautiful, and is now a common plant, though only introduced in 1788 from Chili. It will live in the open ground, though the stems will then die off annually. In the greenhouse it is a shrub, as are all the other species.

FUCUS, a name given by the antients to certain dyes and paints. By this name they called a purple sea-plant used by them to dye woollen and linen cloths of that colour. The dye was very beautiful, but not lasting; for it soon began to change, and in time went wholly off. This is the account Theophrastus gives of it.

The women of those times also used something called fucus to stain their cheeks red; and many have supposed, from the same word expressing both, that the same substance was used on both occasions. But this, on a strict inquiry, proves not to be the case. The Greeks called every thing fucus that would stain or paint the flesh. But this peculiar substance, used by the women to paint their cheeks, was distinguished from the others by the name of rizion among the more correct writers, and was indeed a root brought from Syria into Greece. The Latins, in imitation of the Greek name, called this root radicula; and Pliny very erroneously confounds the plant with the radix lunaria, or struthion of the Greeks.

The word fucus was in those times become such an universal name for paint, that the Greeks and Romans had a fucus metallicus, which was the cerus used for painting the neck and arms white; after which they used the purpurissum, or red fucus of the rizium, to give the colour to the cheeks. In after-times they also used a peculiar fucus or paint, for the purpose, prepared of the creta argentaria or silverchalk, and some of the rich purple dyes that were in use at that time: and this seems to have been very little different from our rosepink, a colour commonly sold at the colour-shops.

FUCUS, in the Linnæan system of botany, is a genus of the order of algæ, belonging to the cryptogamia class of plants. The most remarkable species are,

1. The serratus, serrated fucus, or sea-wrack. This is frequent at all seasons of the year upon the rocks at low-water-mark, but produces its seeds in July and August. It consists of a flat, radical, and dichotomous leaf, about two feet long; the branches half an inch wide, serrated on the edges with dents of unequal size, and at unequal distances, having a flat stalk or rib divided like the leaf, and running in the middle of it through all its various ramifications. A small species of coralline, called by Linnæus sertularia pumila, frequently creeps along the leaf. All the species of fucus afford a quantity of impure alkaline salts; but this much less

than some others, eight ounces of the ashes yielding only three of fixed salt. The Dutch cover their crabs and lobsters with this fucus, to keep them alive and moist, and prefer it to any other, as being destitute of those mucous vesicles with which some of the rest abound, and which would sooner ferment and become putrid.

2. The vesiculosus, bladder fucus, common sea-wrack, or sea-ware. It grows in great abundance on the sea-rocks about low-water-mark, producing its fructifications in July and August. It has the same habit, colour, and substance as the foregoing, but differs from it in the following respects: the edges of the leaf have no serratures, but are quite entire. In the disc or surface are immersed hollow, spherical, or oval air-bladders, hairy within, growing generally in pairs, but often single in the angles of the branches, which are most probably air-bladders destined to buoy up the plant in the water. Lastly, on the summits or extreme segments of the leaves appear tumid vesicles about three quarters of an inch long, sometimes oval and in pairs, sometimes single and bifid, with a clear viscid mucus interspersed with downy hairs. This species is an excellent manure for land; for which purpose it is often applied in the maritime parts of Scotland and other countries. In the islands of Jura and Skye it frequently serves as a winter food for cattle, which regularly come down to the shores at the recess of the tides to seek for it. And sometimes even the stags have been observed, after a storm, to descend from the mountains to the sea-sides to feed upon this plant.

Linnæus informs us, that the inhabitants of Gothland in Sweden boil this fucus in water, and, mixing with it a little coarse meal or flour, feed their hogs with it; for which reason they call the plant swinetang. And in Scania, he says, the poor people cover their cottages with it, and sometimes use it for fuel. In Jura, and some other of the Hebrides, the inhabitants dry their cheeses without salt, by covering them with the ashes of this plant, which abounds with such a quantity of salts, that from five ounces of the ashes may be procured two ounces and a half of fixed alkaline salts, that is, half to their whole weight. But the most beneficial use to which the fucus vesiculosus is applied, in the way of economy, is in making pot-ash or kelp, a work much practised in the Western Isles. There is great difference in the goodness and price of this commodity, and much care and skill required in properly making it. That is esteemed the best which is hardest, finest grained, and free from sand or earth. The price of kelp in Jura is 3*l.* 10*s.* per ton, and about 40 or 50 tons are exported annually from that island. So great a value is set upon this fucus by the inhabitants of that place, that they have sometimes thought it worth their while to roll fragments of rocks and huge stones into the sea, in order to invite the growth of it.

Its virtues in the medical way have been much celebrated by Dr. Russel, in his Dissertation concerning the use of Sea-water in the Diseases of the Glands. He found the saponaceous liquor or mucus in the vesicles of this plant to be an excellent resolvent, extremely serviceable in dispersing all scorbutic and scrophulous swellings of the glands. He recommends the patient to rub the tumour with these vesicles bruised in his hand, till the mucus has thoroughly penetrated the part, and afterwards to wash with sea water. Or otherwise, to gather two pounds of the tumid vesicles, in the month of July, when they are full of mucus, and infuse them in a quart of sea water, in a glass vessel, for the space of 15 days, when the liquor will have acquired nearly the consistence of honey. Then strain it off through a linen cloth, and rub this liquor with the hand, as before, three or four times a day, upon any hard or scrophulous swellings, washing the parts afterwards with sea water; and nothing can be more efficacious to disperse them. Even scirrhosities, he says, in women's breasts, have been dispelled by this treatment. The same author, by calcining the plant in the open air, made a very black salt powder, which he called vegetable æthiops; a medicine much in use as a resolvent and deobstruent, and recommended also as an excellent dentifrice to correct the scorbutic laxity of the gums, and to take off the foulness of the teeth.

3. The plicatus, matted or Indian-grass fucus, grows on the sea-shores in many places both of England and Scotland. It is generally about three or four, but sometimes six, inches long. Its colour, after being exposed to the sun and air, is yellowish or auburn; its substance pellucid, tough, and horny, so as to bear a strong resemblance to what anglers call Indian-grass, that is, the tendrils issuing from the ovary of the dog-fish.

4. The palmatus, palmated or sweet fucus, commonly called dulse or dilse. This grows plentifully on the sea-coasts of Scotland and the adjoining islands. Its substance is membranaceous, thin, and pellucid; the colour red, sometimes green with a little mixture of red; its length generally about five or six inches, but varies from three inches to a foot; its manner of growth fan-shaped, or gradually dilated from the base upwards. Its divisions are extremely various. The inhabitants both of Scotland and England take pleasure in eating this plant, without expecting any medical virtues from it. The inhabitants of the Archipelago also are fond of it, as we learn from Steller. They sometimes eat it raw, but esteem it most when added to ragouts, oglios, &c. to which it gives a red colour, and, dissolving, renders them thick and gelatinous. In the isle of Skye it is sometimes used in fevers to promote a sweat, being boiled in water with the addition of a little butter. In this manner it also frequently purges. The leaves, infused in water, exhale a scent like that of dried violets.

5. The esculentus, eatable fucus, or bladder-locks, commonly called tangle in Scotland, is likewise a native of the British shores. It is commonly about four feet long, and seven or eight inches wide; but is sometimes found three yards or more in length, and a foot in width. Small specimens are not above a cubit long, and two inches broad. The substance is thin, membranaceous, and pellucid; the colour green or olive. The root consists of tough cartilaginous fibres. The stalk is about six inches long, and half an inch wide, nearly square, and pinnated in the middle between the root and origin of the leaf, with ten or a dozen pair of thick, cartilaginous, oval-obtuse, foliaceous ligaments, each about two inches long, and crowded together. The leaf is of an oval-lanceolate, or long elliptic form, simple and undivided, waved on the edges, and widely ribbed in the middle from bottom to top, the stalk running through its whole length, and standing out on both sides of the leaf. This fucus is eaten in the north both by men and cattle. Its proper season is in the month of September, when it is in the greatest perfection. The membranous part is rejected, and the stalk only is eaten. It is recommended in the disorder called pica, to strengthen the stomach and restore the appetite.

6. The saccharinus, sweet fucus, or sea-belt, is very common on the sea-coast. The substance of this is cartilaginous and leathern, and the leaf is quite ribless. By these characters it is distinguished from the preceding, to which it is nearly allied. It consists only of one simple, linear, elliptic leaf, of a tawny green colour, about five feet long, and three inches wide in its full-grown state, but varies so exceedingly as to be found from a foot to four yards in length. The ordinary length of the stalk is two inches; but it varies even to a foot. The root is composed of branched fibres, which adhere to the stones like claws. This plant is often infested with the sertularia ciliata. The inhabitants of Iceland make a kind of pottage of this fucus, boiling it in milk, and eating it with a spoon. They also soak it in fresh water, dry it in the sun, and then lay it up in wooden vessels, where in a short time it is covered with a white efflorescence of sea-salt, which has a sweet taste like sugar. This they eat with butter; but if taken in too great a quantity, the salt is apt to irritate the bowels, and bring on a purging. Their cattle feed and get fat upon this plant, both in its recent and dry state; but their flesh acquires a bad flavour. It is sometimes eaten by the common people on the coast of England, being boiled as a pot-herb.

7. The ciliatus, ciliated or ligulated fucus, is found on the shores of Iona and other places, but is not common. The colour of this is red, the substance membranous and pellucid, without rib or nerve; the ordinary height of the whole plant about four or five inches. It is variable in its appearance, according to the different stages of its growth. This fucus is eaten by the Scots and Irish promiscuously with the fucus palmatus or dilse.

8. The prolifer, or proliferous fucus, is found on the shores of the western coast, adhering to shells and stones. The colour is red; the substance membranaceous, but tough, and somewhat cartilaginous, without rib or nerve, though thicker in the middle than at the edges. The whole length of the plant is about four or five inches, the breadth of each leaf about a quarter of an inch. The growth of this fucus, when examined with attention, appears to be extremely singular and wonderful. It takes its origin either from a simple, entire, narrow, elliptic leaf, about an inch and a half long; or from a dilated forked one of the same length. Near the extremity of the elliptic leaf, or the points of the forked one (but out of the surface, and not the edge), arises one or more elliptic or forked leaves, which produce other similar ones in the same manner near the summits;

and so on continually one or more leaves from near the ends of each other, in a proliferous and dichotomous order, to the top of the plant, which in the manner of its growth resembles in a good measure the cactus opuntia, or flat-leaved Indian fig. Sometimes two or three leaves or more grow out of the middle of the disc of another leaf; but this is not the common order of their growth. The fructifications are red, spherical, rough warts, less than the smallest pin's head, scattered without order on the surface of the leaves. These warts, when highly magnified, appear to be the curled rudiments of young leaves, which in due time either drop off and form new plants, or continue on and germinate upon the parent. This plant is very much infested with the flustra pilosa, the mandrepora verrucaria, and other corallines, which make it appear as if covered with with scabs.

9. The pinnatifidus, jagged fucus, or pepper-dilse, is frequent on sea-rocks which are covered by the tides both on the eastern and western coasts. It is of a yellow olive-colour, often tinged with red. The substance is cartilaginous, but yet tender and transparent; the height about two or three inches. This fucus has a hot taste in the mouth, and is therefore called pepper-dilse by the people in Scotland, who frequently eat it as a salad, in the same manner they do the fucus palmatus.

10. The plocamium, or pectinated fucus, is frequent on the sea-rocks, and in basins of water left by the recess of the tides. Its natural colour is a most beautiful bright red or purple, but is often variegated with white or yellow. Its substance is cartilaginous, but extremely thin, delicate, and transparent; its height commonly about three or four inches. The stalk is compressed, about half a line in diameter, erect, but waved in its growth, and divided almost from the base into many widely-expanded branches. These primary branches are very long, alternate, exactly like the stalk, and subdivided into alternate secondary branches, which are again frequently compounded in like manner, and these divisions decorated with subulated teeth growing in alternate rows, curiously pectinated or finely toothed on the upper side like a comb, the smallest of these teeth scarcely visible to the naked eye. The fructifications are minute spherical capsules, or smooth dark-red globules, scattered without order on the sides of the branches, generally sessile, but some few of them supported on short peduncles. This fucus, on account of its elegant colours and fine divisions, is the species most admired by the ladies who are fond of pictures and mimic landscapes composed of marine vegetables.

11. The filum, thread-fucus, or sea-laces, is found on the sea-rocks, and waving under the water like long strings, frequent on many parts of the coast. The substance of this is opaque and cartilaginous, but not difficult to be broken. The colour, when recent, a dull olive-green; when dry, fuscous or nearly black; and, when exposed for some time on the shores to the sun and air, it becomes yellow, straw-coloured, or white. It consists only of a simple, unbranched, naked, cylindrical stalk, three or four yards long, more or less, from the size of a large fiddle-string to that of a thick whip-cord; smallest at the base and summit, smooth on the outside, full of mucus within, often twisted, and always intercepted by numerous transverse diaphragms, visible when the plant is held between the eye and the light. The fructifications have not yet been discovered; but from the transverse septa in its structure, it is reasonable to suppose this plant to belong rather to the genus of conferva than that of fucus. The stalks, skinned when half dry, and twisted, acquire so considerable a degree of strength and toughness, that we are informed the Highlanders sometimes use them for the same purposes as Indian-grass.

12. The giganteus, or gigantic fucus, is a native of the Straits Le Maire, and grows on rocky ground, which in those countries is distinguished from sand or ooze by the enormous length of the sea-weeds that grow upon it. The leaves are four feet long, and some of the stalks, though not thicker than a man's thumb, are 120. Sir Joseph Banks and Dr. Solander sounded over some of them which were 84 feet long; and as they made a very acute angle with the bottom, they were thought to be at least one half longer.

FUEL. All faggots made for sale, shall contain in compass, besides the knot of the bond, 24 inches of assize; and every faggot-stick within the bond shall contain full three feet of assize, except only one stick to be but one foot long, to stop or harden the binding. 43 Eliz. c. 14.

All billets (except those made of beech) that lie exposed in the public places, where they are usually bought or sold, shall be assized and cut as directed by 9 Anne, c. 15.

FUGAM FECIT, is where it is found by inquisition that a person fled for treason or felony; as to which it is agreed, that wheresoever a person found guilty by such inquest, either as a principal or as an accessary before the fact, is found also to have fled for the same, he forfeits his goods absolutely, and the issues of his lands, till he is pardoned or acquitted.

But wherever the indictment against a man is insufficient, the finding a fugam fecit will not hurt him; and that in all cases the particulars of the goods found to be forfeited may be traversed. 2 Haw. 450.

FUGITIVE'S GOODS, are the proper goods of him that flies, which after the flight lawfully found, belong to the king or lord of the manor. 5 Co. Rep. 109. See FELON'S GOODS.

FUGUE, in music, a term derived from the Latin word fuga, a flight, and signifying a composition either vocal or instrumental, or both, in which one part leads off some determined succession of notes called the subject, which, after being answered in the fifth and eighth by the other parts, is interspersed through the movement, and distributed amid all the parts in a desultory manner, at the pleasure of the composer; sometimes accompanied by other adventitious matter, and sometimes by itself. There are distinct descriptions of fugues; the simple fugue, the double fugue, and the counter fugue. The

Simple FUGUE contains but one subject, is the least elaborate in its construction, and the easiest in its composition.

Double FUGUE, consists of two subjects, occasionally intermingled and moving together: and the

Counter FUGUE, is that fugue in which the subjects move in a direction contrary to each other. In all the different species of fugues, the parts fly, or run after each other, and hence the derivation of the general name fugue.

FULCRUM, in mechanics, the prop or support by which a lever is sustained. See MECHANICS.

FUIRENA, a genus of the triandria monogynia class and order. The ament is imbricate; calyx none; corolla with three petal-shaped orbicular glumes, ending in a tendril. There is one species, a grass of Surinam.

FULGORA, or lantern-fly, an insect belonging to the hemiptera order. The generic character is: head produced into an inflated hollow front; antennæ beneath the eyes, of two joints, the exterior larger and globose; snout inflected; feet formed for walking.

The fulgora lanternaria, or Peruvian lantern-fly, is undoubtedly one of the most curious of insects. It is of a very considerable size, measuring nearly three inches and a half from the tip of the front to that of the tail, and about five inches and a half from wing's end to wing's end when expanded: the body is of a lengthened oval shape, and divided into several rings or segments; the head is nearly equal to the length of the rest of the animal, and is oval, inflated, and bent slightly upwards; the ground-colour is an elegant yellow, with a strong tinge of green in some parts, and marked with numerous bright red-brown variegations in the form of stripes and spots; the wings are very large, of a yellow colour, most elegantly varied with brown undulations and spots, and the lower pair are decorated by a very large eye-shaped spot on the middle of each, the iris or border of the spot being red, and the centre half red and half semitransparent white; the head or lantern is pale yellow, with longitudinal red stripes. This beautiful insect is a native of Surinam and many other parts of South America, and during the night diffuses so strong a phosphoric splendor from its head or lantern, that it may be employed for the purpose of a candle or torch; and it is said that three or four of the insects, tied to the top of a stick, are frequently used by travellers for that purpose. The celebrated madam Merian, in her work on the Insects of Surinam, gives a very agreeable account of the surprize into which she was thrown by the first view of the flashes of light proceeding from these insects. "The Indians once brought me," says she, "before I knew that they shone by night, a number of these lantern-flies, which I shut up in a large wooden box. In the night they made such a noise that I awoke in a fright, and ordered a light to be brought, not knowing whence the noise proceeded. As we found that it came from the box, we opened it, but were still much more alarmed, and let it fall to the ground in a fright, at seeing a flame of fire come out of it; and as many animals as came out, so many flames of fire appeared. When we found this to be the case, we recovered from our fright, and again collected the insects, highly admiring their splendid appearance."

Dr. Darwin, in a note to some lines relative to luminous insects, in his beautiful poem the Loves of the Plants, makes madam Merian affirm, that she drew and finished her

figure of the insect by its own light. On examination, however, we cannot find the least authority for this declaration on the part of madam Merian, who relates only what is above stated, with the observation that the light of one of the insects is sufficient to read a common newspaper by. It may be proper to add, that this celebrated lady falls into a mistake in supposing that a species of cicada, which she represents on the same plate with the lantern-fly, was its larva; and that it gradually was transformed into the fulgora. This information indeed she merely gives as the popular report, but at the same time takes the liberty of representing the insect in its supposed half-complete state, with the head of the fulgora, and the wings and body of the cicada. See Plate Nat. Hist. fig. 211.

2. The fulgora candelaria is a much smaller species than the preceding, and is a native of China. It measures nearly two inches in length, and two inches and a half in breadth, with the wings expanded: the body is oval, and the head produced into a long horn-shaped process; the colours are very elegant, the head and horn being of a fine reddish brown or purple, and covered with numerous white specks of a mealy appearance; the thorax is of a deep or orange-yellow, and the body black above, but deep yellow beneath; the wings are oval, the upper pair blackish, with very numerous and close-set green reticulations, dividing the whole surface into innumerable squares or marks, and are farther decorated by several yellow bars and spots; the under wings are orange-coloured, with broad black tips.

3. Fulgora diadema is an Indian species, and is distinguished by having a long, spiny, or muricated front, with a triple division at the tip; its colour is brown, with red and yellow variegations; it seems to have been first described and figured in the work of Seba: in size it is nearly similar to that of the preceding species.

FULICA, the *gallinule* and *coot*, in ornithology, a genus of birds of the order of grallæ. It has a convex bill, with the upper mandible fornicated over the lower at the edge; the lower mandible is gibbous behind the tip. The forehead is bald, and the feet have four toes, subpinnated. There are 25 species, 18 of which belong to the gallinule division, distinguished by having the toes furnished with broad scalloped membranes, and seven comprehend the coots which have the toes divided to their origin. The following species are among the most distinguished:

1. The chloropus, or common gallinule, is in length about 14 inches, and has a bald forehead and broad flat toes. It gets its food on grassy banks, and borders near fresh waters, and in the very waters if they are weedy. It builds upon low trees and shrubs by the water-side, breeding twice or thrice in a summer, and, when the young are grown up, drives them away to shift for themselves. This bird strikes with its bill like a hen, and in the spring has a shrill call. In flying, it hangs down its legs; in running, it often flirts up its tail, and shows the white feathers. We may observe, that the bottoms of its toes are so very flat and broad that it seems to be the bird which connects the cloven-footed aquatics with the next tribe, viz. the fin-toed. It is pretty common on the continent, though in some parts more scarce than in others. It is also an inhabitant of America, from New York to Carolina, and is recorded as a native of Jamaica and other islands in the West Indies. It is said to feed on plants and small fish, and the flesh is for the most part pretty good. See Plate Nat. Hist. fig. 213.

2. The porphyrio, or purple gallinule, is about the size of a domestic fowl, or 17 inches in length. It is more or less common in all the warmer parts of the globe. On the coasts of Barbary they abound, as well as in some of the islands of the Mediterranean. In Sicily they are bred in plenty, and kept for their beauty; but whether indigenous there, is uncertain. It is frequently met with in various parts of the south of Russia and the western parts of Siberia, among reedy places: in the neighbourhood of the Caspian Sea it is not uncommon; but in the cultivated rice grounds of Ghilar in Persia, it is in great plenty and high plumage. The female makes her nest among the reeds in the middle of March; lays three or four eggs, and sits from three to four weeks. It will feed on many things, such as fruit, roots of plants, and grain; but will eat fish with avidity, dipping them into the water before it swallows them. It will frequently stand on one leg, and lift the food to its mouth with the other like a parrot. A pair of these kept in an aviary in France made a nest of small sticks mixed with a quantity of straw, and laid six white eggs, perfectly round; but the hen was careless of them, and they came to nothing. The flesh is said to be exquisite in flavour.

3. The atra or common coot, has a bald forehead, a black body, and lobated toes, and is about 15 inches in length. They frequent lakes and still rivers; making their nests among the rushes, with grass, reeds, &c. floating on the water, so as to rise and fall with it. They lay five or six large eggs, of a dirty whitish hue, sprinkled over with minute deep rust-coloured spots; and it is said that sometimes they will lay 14 or more eggs. The young, when just hatched, are very deformed, and the head mixed with a red coarse down. In winter they often repair to the sea; and the channel near Southampton is sometimes observed almost covered with them. They are often brought to that market, where they are exposed to sale without their feathers, and scalded like pigs. This species is not so numerous as might be expected; for we find that vast numbers fall a prey while young to the buzzards, which frequent the marshes. Their food is small fish and water-insects; but they will sometimes eat the roots of the bulrush, and with it feed the young: they are said likewise to eat grain. This species is supposed to extend throughout the old continent, and perhaps the new also.

4. The aterrima, or greater coot, is of a larger size than the last, and its plumage is blacker. This species is said to be found in Lancashire and Scotland; but is more plentiful on the continent, being found in Russia and the western parts of Siberia very common. See Plate Nat. Hist. fig. 212.

FULLER, a workman employed in the woollen manufactories to mill or scour cloths, serges, and other stuffs, in order to render them more thick, compact, and durable. See FULLING.

FULLER'S EARTH, in natural history, a species of clay, of a greyish ash-coloured brown, in all degrees from very pale to almost black, and it has generally something of a greenish cast. It is very hard and firm, of a compact texture, of a rough and somewhat dusty surface that adheres slightly to the tongue. It is very soft to the touch, not staining the hands, nor breaking easily between the fingers. It has a little harshness between the teeth, and melts freely in the mouth. Thrown into water, it makes no ebullition or hissing; but swells gradually in bulk, and falls into a fine soft powder. It makes no efferve-cence with nitrous acid.

A specimen from Hampshire, analysed by Bergman, contained

51.8	silica
25.0	alumina
3.3	carbonat of lime
3.7	oxyd of iron
0.7	carbonat of magnesia
15.5	moisture
100.0	

This earth is used by fullers to take grease out of their cloth before they apply soap. It is essential to fuller's earth that the particles of silica should be very fine, otherwise they would cut the cloth. Any clay possessed of this property may be considered as fuller's earth; for it is the alumina alone which acts upon the cloth, on account of its strong affinity for greasy substances.

FULLING, the art or act of cleansing, scouring, and pressing cloths, stuffs, and stockings, to render them stronger, closer, and firmer; called also milling. The fulling of cloths and other stuffs is performed by a kind of water-mill, thence called a fulling or scouring-mill. These mills, except in what relates to the mill-stones and hopper, are much the same with corn-mills: and there are even some which serve indifferently for either use; corn being ground, and cloths fulled, by the motion of the same wheel. Whence in some places, particularly in France, the fullers are called millers; as grinding corn and milling stuffs at the same time.

The principal parts of the fulling-mill are: the wheel, with its trundle; which gives motion to the tree or middle, whose teeth communicate it to the pestles or stampers, which are hereby raised and made to fall alternately, according as its teeth catch on or quit a kind of latch in the middle of each pestle. The pestles and troughs are of wood; each trough having at least two, sometimes three, pestles, at the discretion of the master, or according to the force of the stream of water. In these troughs are laid the cloths, stuffs, &c. intended to be fulled: then, letting the current of water fall on the wheel, the pestles are successively let fall thereon, and by their weight and velocity stamp and press the stuffs very strongly, which by this means become thickened and condensed. In the course of the operation, they sometimes make use of urine, sometimes of fuller's earth, and sometimes of soap. To prepare the stuffs to receive the first impressions of the pestle, they are usually laid in urine; then in fuller's earth and water; and, lastly,

in soap dissolved in hot water. Soap alone would do very well; but this is expensive: though fuller's earth, in the way of our dressing, is scarcely inferior to it; but then it must be well cleared of all stones and grittinesses, which are apt to make holes in the stuff. As to urine, it is certainly prejudicial, but ought to be entirely discarded; not so much on account of its ill smell, as of its sharpness and saltness, which qualities are apt to render the stuffs dry and harsh.

The method of fulling cloths and woollen stuffs with soap is this: A coloured cloth, of about 45 ells, is to be laid in the usual manner in the trough of a fulling-mill, without first soaking it in water, as is commonly practised in many places. To full this trough of cloth, 15 pounds of soap are required, one-half of which is to be melted in two pails of river or spring water, made as hot as the hand can well bear it. This solution is to be poured by little and little upon the cloth, in proportion as it is laid in the trough; and thus it is to be fulled for at least two hours; after which it is to be taken out and stretched. This done, the cloth is immediately returned into the same trough, without any new soap, and there fulled two hours more. Then taking it out, they wring it well, to express all the grease and filth. After the second fulling, the remainder of the soap is dissolved as in the former, and cast four different times on the cloth, remembering to take out the cloth every two hours to stretch it, and undo the plaits and wrinkles it has acquired in the trough. When they perceive it sufficiently fulled, and brought to the quality and thickness required, they scour it in hot water, keeping it in the trough till it is quite clean. As to white cloths, as these full more easily and in less time than coloured ones, a third part of the soap may be spared.

The fulling of stockings, caps, &c. should be performed somewhat differently, viz. either with the feet or the hands, or a kind of wooden rack, either armed with teeth of the same matter, or else horses or bullocks teeth. The ingredients made use of are, urine, green soap, white soap, and fuller's earth. But the urine also is reckoned prejudicial here. Woven stockings, &c. should be fulled with the soap alone: for those that are knit, earth may be used with the soap. Indeed it is common to full these kinds of works with the mill, after the usual manner of cloth, &c.; but that is too coarse and violent a manner, and apt to damage the work, unless it is very strong.

Plate Foundry, &c. fig. 10. is a perspective view of a fulling-mill. A is the shaft which works it by the power of horses, water, steam, &c. This shafthas four arms or lifters BD upon it, two of which are to raise the wooden beater E, and the other two are to raise the beater F. In well executed mills, the shaft is made of cast-iron, as shewn in fig. 12; and then the arms BDMN have rollers at their ends. The beaters E,F, are made of hard wood, as shewn in fig. 11; G is the centre on which it turns, made of wood; H is a large block of wood wedged to the bar IK, which passes through it; it has three pieces of board *abc* pegged to it. The part K of the piece IK is shod with iron at the underside, to preserve it from being worn by the lifters. Two of these beaters work in a frame, shewn open in fig. 13. OPQR is a large block of wood, hewn out as in the figure; to this are fastened the curved pieces ST, in which there is left two openings *de*, through which the parts K of the beaters, fig. 11. pass, and the centres lay in small holes *fghi*: when the beaters are in, as shewn in fig. 10. the outside of the heads H move as close to the curves ST as possible without touching, when they are in motion. The block is boarded up on both sides, as shewn in fig. 10.; but one side is not boarded so high as the other, and has a moveable board *lm*, which fits into a groove for the convenience of putting in and taking out the cloth. The operation is as follows: The board *lm* is removed, and the cloth put in so as to lay between the heads H of the beaters, and the curve part XY, fig. 13.; the beaters are then set to work, and the lifters first take up one beater, and as soon as it lets that fall, it begins to take up the other: this motion continually shoves the cloth round in the curve from Y to X; and by its falling again when the beater is lifted into the place it before occupied, a fresh surface is continually exposed to the action of the boards *abc*, fig. 11. and to small streams of water supplied by a pipe *no*, fig. 10. which is full of holes: the quantity is regulated by a cock *p*. When the beaters are to be stopped, the workman takes a handspike and lays it over the hook *q*, and when the beater is lifted to the highest, he shoves the end of the handspike under it, so as to prevent its falling down again; he then raises it enough to put an iron rod through the hole *r*: this operation is repeated to the other beater, and the iron is pushed farther in, so as to hold them both up. This machine is fixed down by two beams under the floor, between which the projector W of fig. 13. is bolted, and it is steadied by two struts, fig. 10.

FULMINATION, in chemistry. When three parts of nitre, two parts of potass, and one part of sulphur, all previously well dried, are mixed together in a warm mortar, the resulting compound is known by the name of *fulminating powder*.

If a little of this powder is put upon an iron spoon, and placed upon burning coals, or held above the flame of a candle, it gradually blackens, and at last melts. At that instant it explodes with a very violent report, and a strong impression is made upon the bottom of the spoon, as if it had been pressed down very violently. This sudden and violent combustion is occasioned by the rapid action of the sulphur on the nitre. By the application of the heat, the sulphur and potass form a sulphuret, which is combustible at a lower heat than even sulphur.

Sulphurated hydrogen gas, azotic gas, and perhaps sulphuric acid gas, are disengaged almost instantaneously. It is to the sudden action of these on the surrounding air that the report is to be ascribed. Its loudness depends upon the combustion of the whole powder at the same instant, which is secured by the previous fusion that it undergoes; whereas the grains of gunpowder burn in succession.

Fulminating gold. Dissolve pure gold in nitro-muriatic acid to saturation, and dilute the solution with three times its bulk of distilled water, and add to it gradually some pure ammonia, a yellow precipitate will be obtained, which must be repeatedly washed with distilled water, and dried on a chalk-stone or in a filter. When perfectly dry, it is called fulminating gold, and detonates by heat, as may be shewn by heating a few grains of it on the point of a knife over the candle.

Fulminating silver. Dissolve fine silver in pale nitric acid, and precipitate the solution by lime water; decant the fluid, mix the precipitate with liquid ammonia, and stir it till it assumes a black colour; then decant the fluid, and leave it in the open air to dry. This product is fulminating silver, which when once obtained cannot be touched without producing a violent explosion. It is the most dangerous preparation known, for the contact of fire is not necessary to cause it to detonate. It explodes by the mere touch. Its preparation is so hazardous, that it ought not to be attempted without a mask, with strong glass eyes, upon the face. No more than a single grain ought at any time to be tried as an experiment. This was invented by M. Berthollet.

M. Chenevix has invented a fulminating silver not so dangerous as that just mentioned. It explodes only by a slight friction in contact with combustible bodies. It is thus prepared: Diffuse a quantity of alumina through water, and let a current of oxygenated muriatic acid gas pass through it for some time. Then digest some phosphate of silver on the solution of the oxygenated muriate of alumina, and evaporate it slowly. The product obtained will be a hyper-oxygenated muriate of silver, a single grain of which, in contact with two or three of sulphur, will explode violently with the slightest friction.

Fulminating mercury. The mercurial preparations which fulminate, when mixed with sulphur, and gradually exposed to a gentle heat, are well known to chemists: they were discovered, and have been fully described, by Mr. Bayen.

"MM. Brugnatelli and Van Mons have likewise produced fulminations by concussion, as well by nitrate of mercury and phosphorus as with phosphorus and most other nitrates. Cinnabar likewise is amongst the substances which, according to MM. Fourcroy and Vauquelin, detonate by concussion with oxymuriate of potash.

"M. Ameilon had, according to M. Berthollet, observed, that the precipitate obtained from nitrate of mercury, by oxalic acid, fuses with a hissing noise.

"But mercury, and most if not all its oxyds, may, by treatment with nitric acid and alcohol, be converted into a whitish crystallized powder, possessing all the inflammable properties of gunpowder, as well as many peculiar to itself.

"I was led to this discovery (says Mr. Howard, the inventor) by a late assertion, that hydrogen is the basis of the muriatic acid: it induced me to attempt to combine different substances with hydrogen and oxygen. With this view I mixed such substances with alcohol and nitric acid as might (by predisposing affinity) favour as well as attract an acid combination of the hydrogen of the one, and the oxygen of the other. The pure red oxyd of mercury appeared not unfit for this purpose; it was therefore intermixed with alcohol, and upon both nitric

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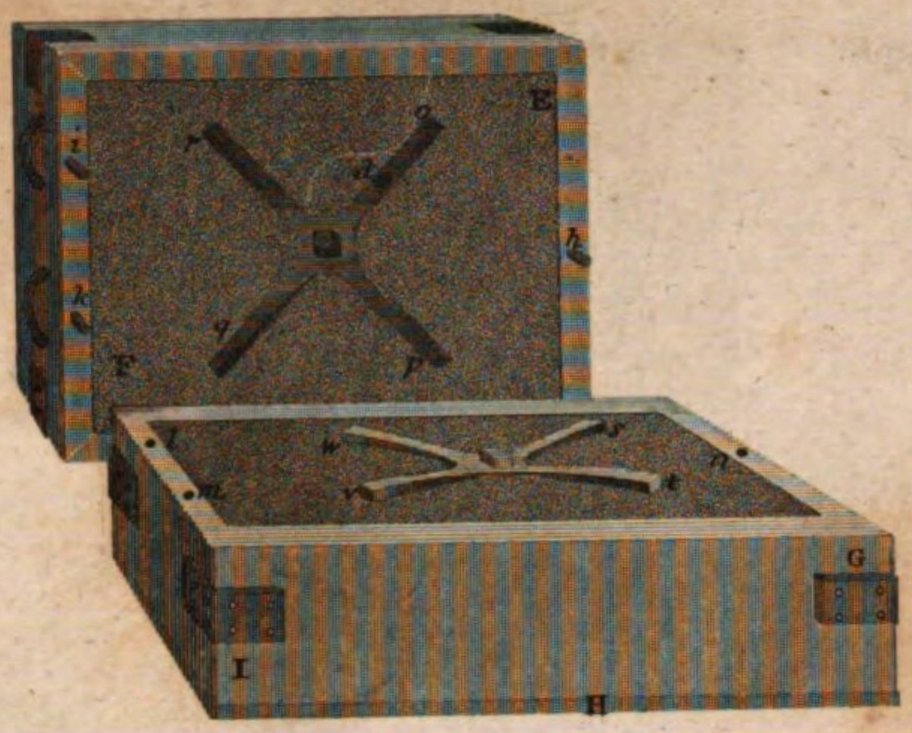

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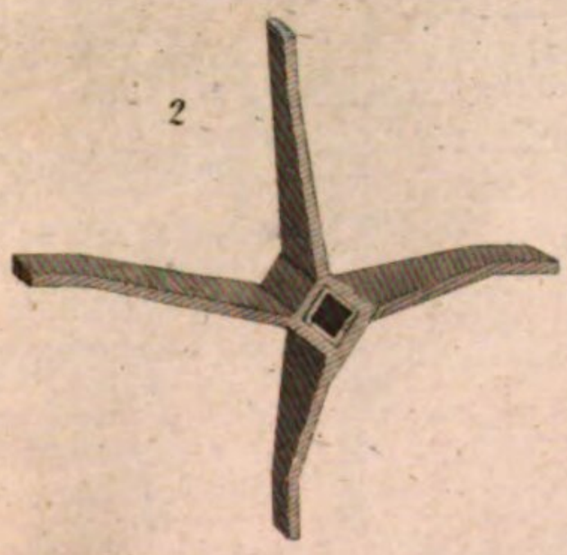

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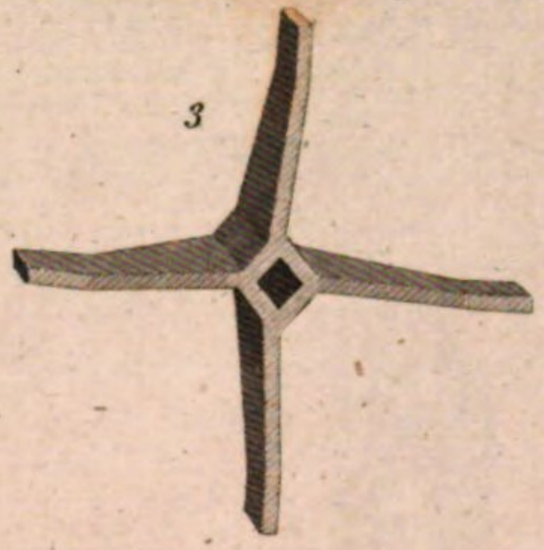

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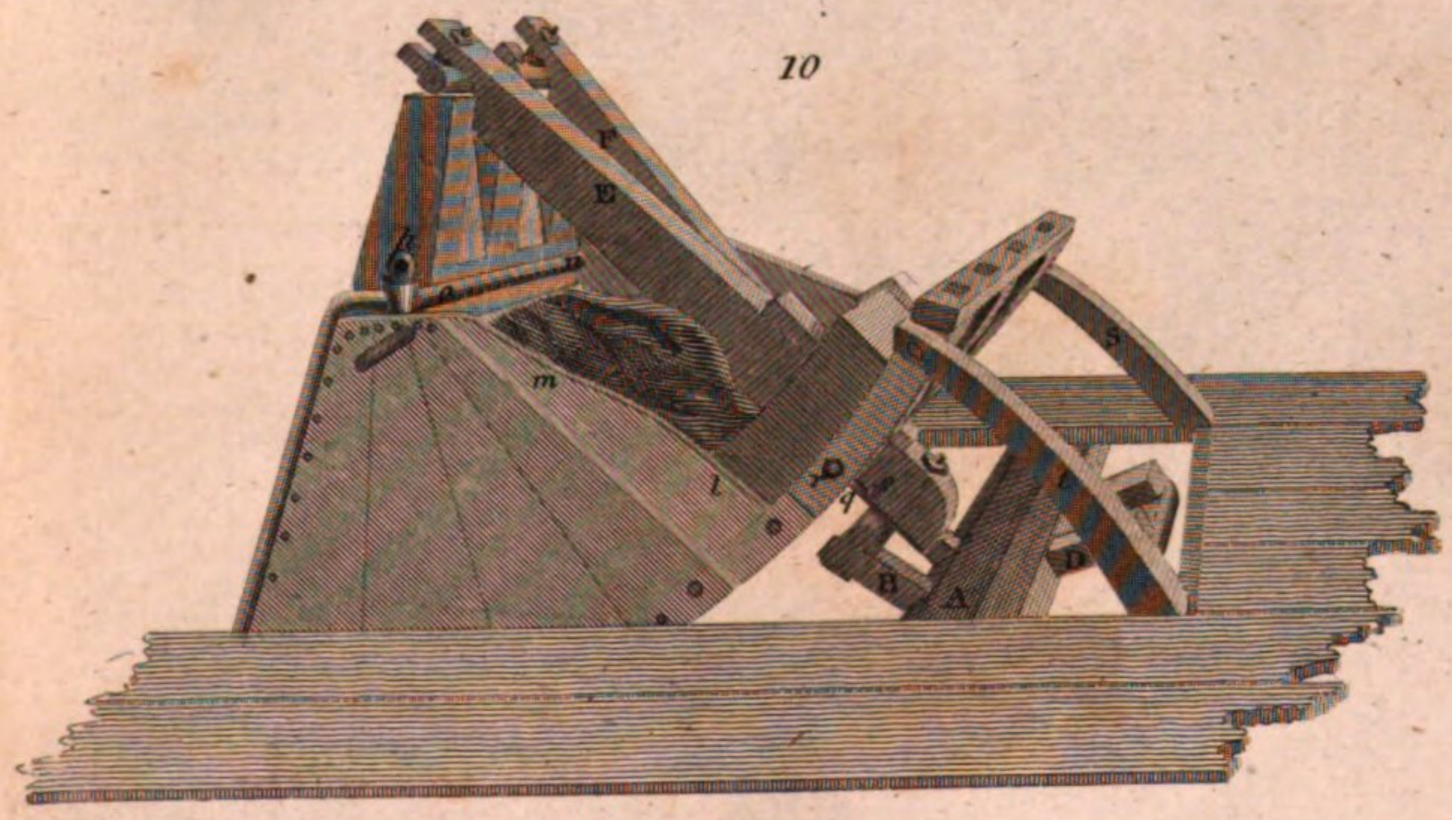

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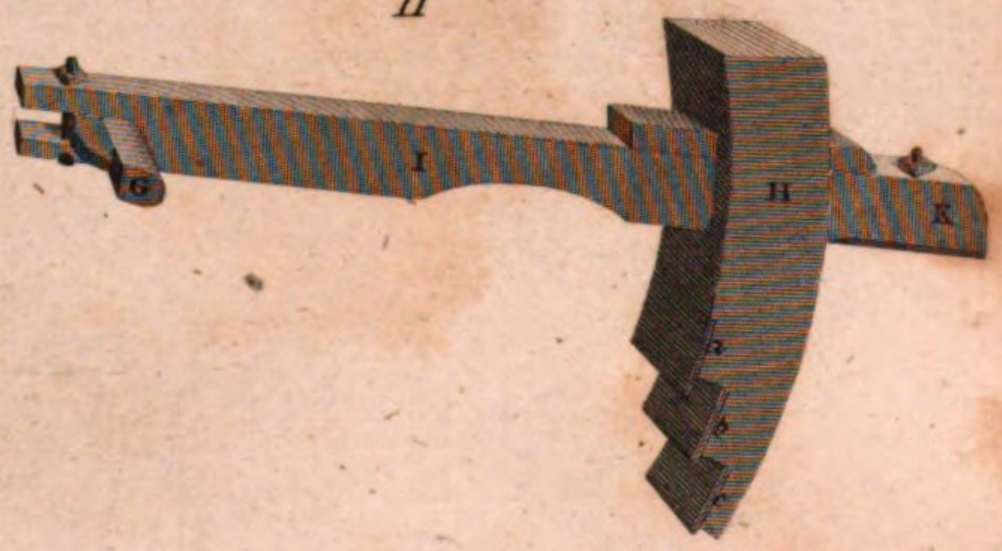

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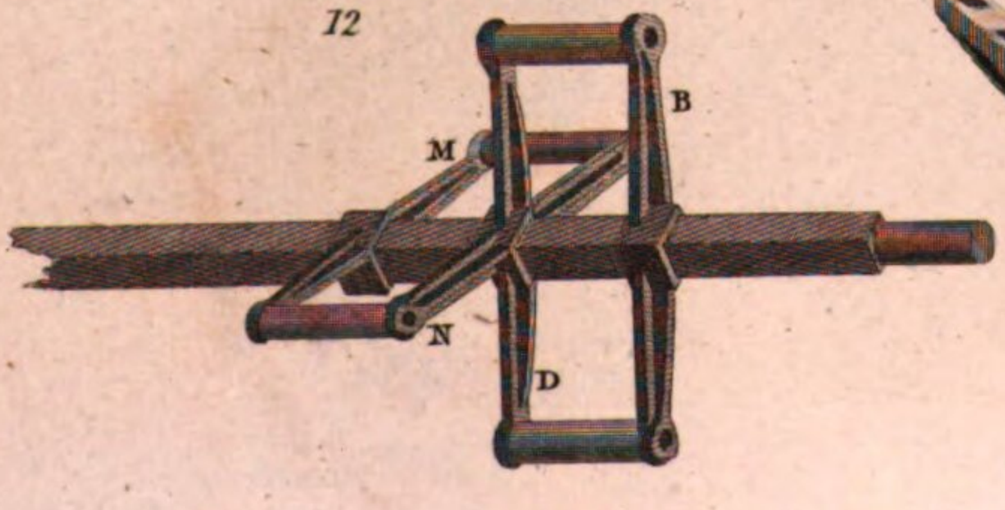

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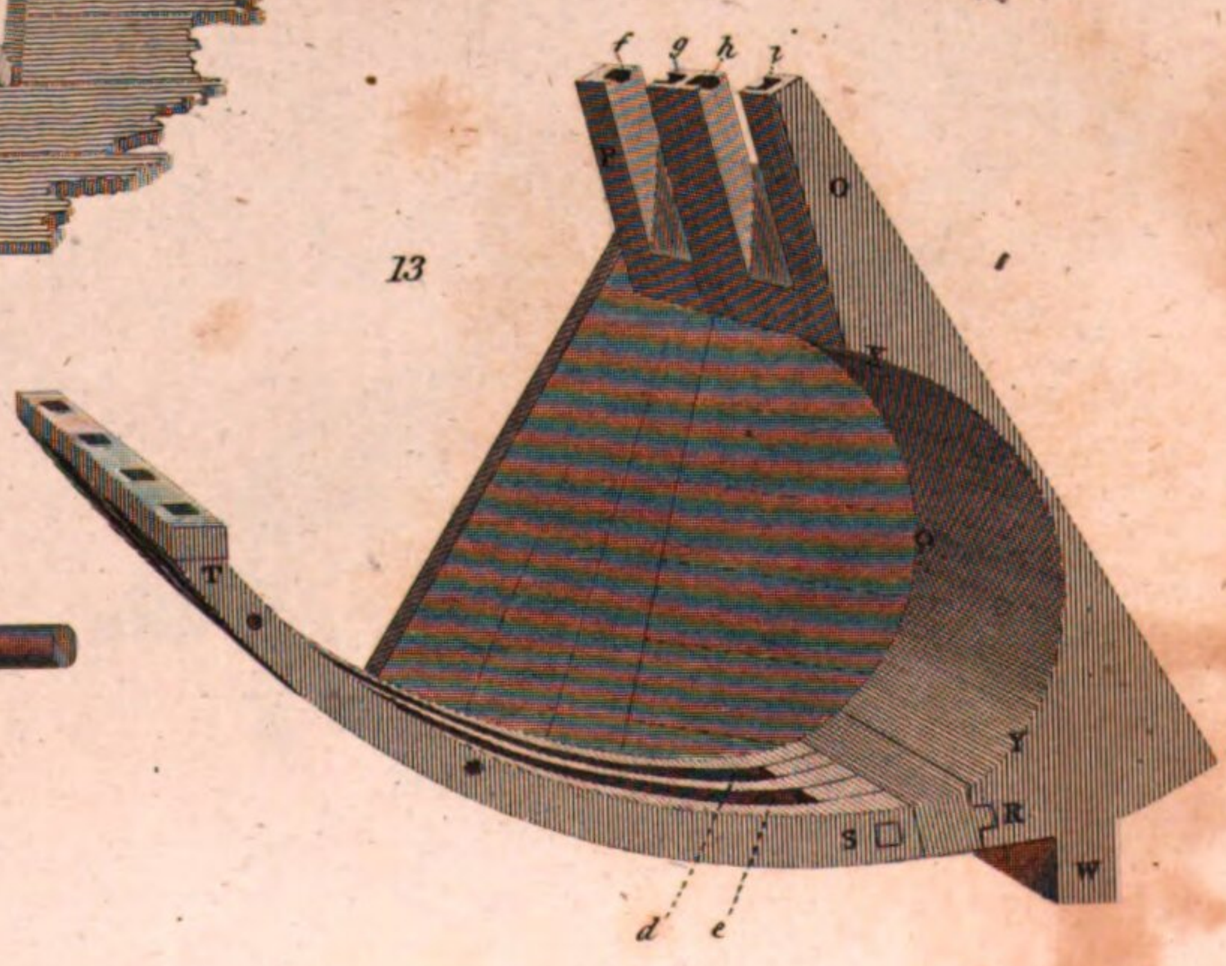

I. Farey Jun. del.

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S. Porter sc.

PL. IX

204

Felis tigris
Tiger

205

Felis tigris
Black Tiger

206

Ferula asoa foetida
Afsa foetida

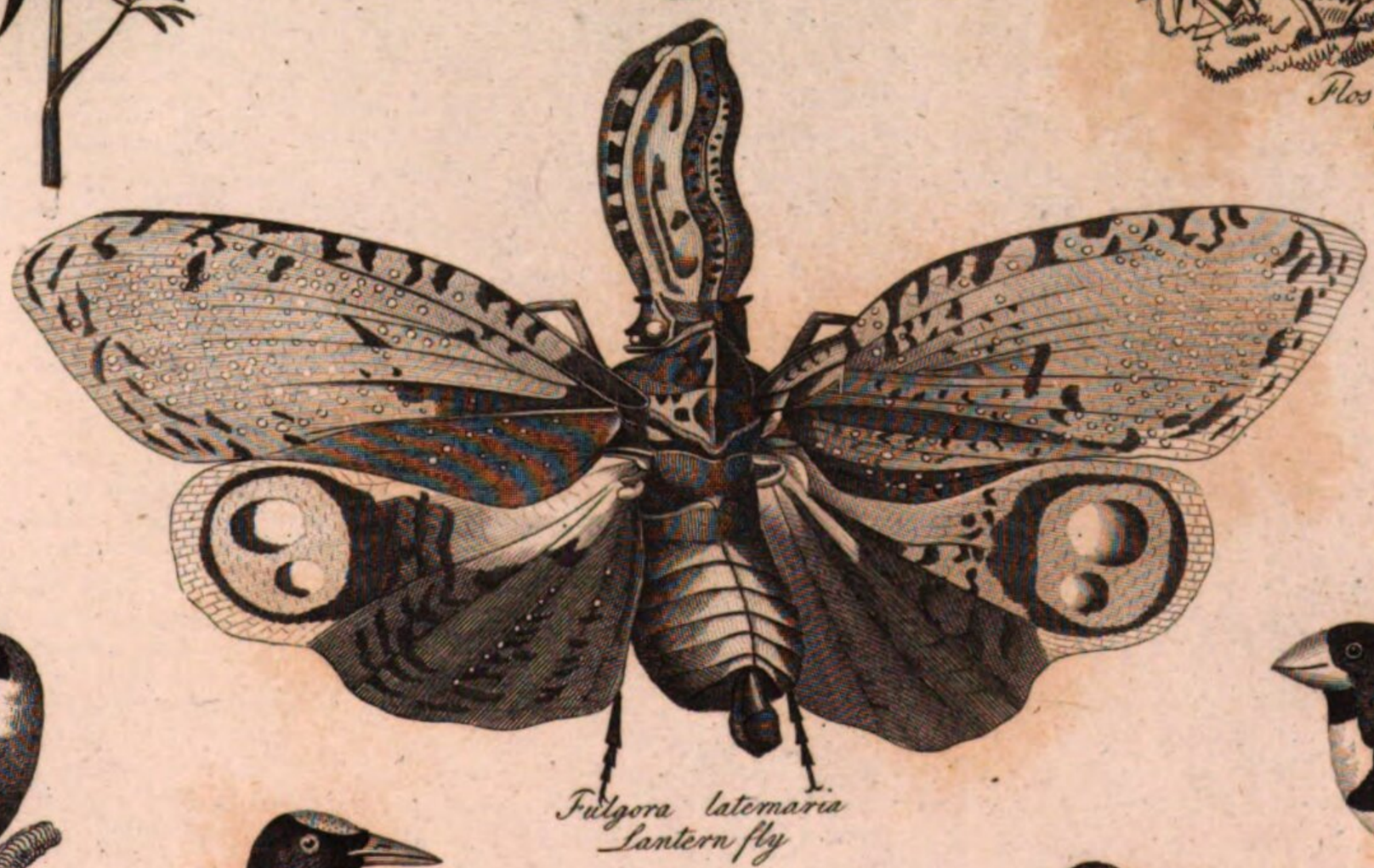
208

Formica rufa

207

Flos ferri

211



Fulgora latemaria
Lantern fly

209

Fringilla Senegala
Senegal Finch

210

Fringilla maja
Cuba Finch

212

Fulica aterrima
Greater coot

213

Fulica chloropus
Moor-hen

Heath Sc

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acid was affused. The acid did not act upon the alcohol so immediately as when these fluids are alone mixed together, but first gradually dissolved the oxide; however, after some minutes had elapsed, a smell of ether was perceptible, and a white dense smoke, much resembling that from the liquor fumans of Libavius, was emitted with ebullition. The mixture then threw down a dark-coloured precipitate, which by degrees became nearly white. This precipitate I separated by filtration; and observing it to be crystallized in smaller acicular crystals, of a saline taste, and also finding a part of the mercury volatilized in the white fumes, I must acknowledge I was not altogether without hopes that muriatic acid had been formed, and united to the mercurial oxide; I therefore, for obvious reasons, poured sulphuric acid upon the dried crystalline mass, when a violent effervescence ensued, and, to my great astonishment, an explosion took place. The singularity of this explosion induced me to repeat the process several times; and finding that I always obtained the same kind of powder, I prepared a quantity of it, and was led to make the series of experiments which I shall have the honour to relate in this paper.

"I first attempted to make the mercurial powder fulminate by concussion; and for that purpose laid about a grain of it upon a cold anvil, and struck it with a hammer, likewise cold. It detonated slightly, not being, as I suppose, struck with a flat blow; for upon using three or four grains, a very stunning disagreeable noise was produced, and the faces both of the hammer and the anvil were much indented.

"Half a grain, or a grain, if quite dry, is as much as ought to be used on such an occasion.

"The shock of an electrical battery, sent through five or six grains of the powder, produces a very similar effect. It seems, indeed, that a strong electrical shock generally acts on fulminating substances like the blow of a hammer. Messrs. Fourcroy and Vauquelin found this to be the case with all their mixtures of oxymuriate of potass.

"To ascertain at what temperature the mercurial powder explodes, two or three grains of it were floated on oil, in a capsule of leaf tin; the bulb of a Fahrenheit's thermometer was made just to touch the surface of the oil, which was then gradually heated till the powder exploded, as the mercury of the thermometer reached the 368th degree.

"Desirous of comparing the strength of the mercurial compound with that of gunpowder, I made the following experiment in the presence of my friend Mr. Abernethy.

"Finding that the powder could be fired by flint and steel, without a disagreeable noise, a common gunpowder proof, capable of containing eleven grains of fine gunpowder, was filled with it, and fired in the usual way: the report was sharp, but not loud. The person who held the instrument in his hand felt no recoil; but the explosion laid open the upper part of the barrel, nearly from the touch-hole to the muzzle, and struck off the hand of the register, the surface of which was evenly indented, to the depth of 0.1 of an inch, as if it had received the impression of a punch.

"The instrument used in this experiment being familiarly known, it is therefore scarcely necessary to describe it: suffice it to say, that it was of brass, mounted with a spring register, the moveable hand of which closed up the muzzle, to receive and graduate the violence of the explosion. The barrel was half an inch in caliber, and nearly half an inch thick, except where a spring of the lock impaired half its thickness.

"A gun belonging to Mr. Keir, an ingenious artist of Camden-Town, was next charged with 17 grains of the mercurial powder, and a leaden bullet. A block of wood was placed at about eight yards from the muzzle to receive the ball, and the gun was fired by a fuse. No recoil seemed to have taken place, as the barrel was not moved from its position, although it was in no ways confined. The report was feeble: the bullet, Mr. Keir conceived, from the impression made upon the wood, had been projected with about half the force it would have been by an ordinary charge, or 68 grains, of the best gunpowder. We therefore re-charged the gun with 34 grains of the mercurial powder; and as the great strength of the piece removed any apprehension of danger, Mr. Keir fired it from his shoulder, aiming at the same block of wood. The report was like the first, sharp, but not louder than might have been expected from a charge of gunpowder. Fortunately Mr. Kier was not hurt; but the gun was burst in an extraordinary manner. The breech was what is called a patent one, of the best forged iron, consisting of a chamber 0.4 of an inch thick all round, and 0.4 of an inch in caliber; it was torn open and flawed in many directions, and the gold touch-hole driven out. The barrel into which the breech was screwed was 0.5 of an inch thick; it was split by a single crack three inches long, but this did not appear to me to be the immediate effect of the explosion. I think the screw of the breech, being suddenly enlarged, acted as a wedge upon the barrel. The ball missed the block of wood, and struck against a wall, which had already been the receptacle of so many bullets, that we could not satisfy ourselves about the impression made by this last.

"As it was pretty plain that no gun could confine a quantity of the mercurial powder sufficient to project a bullet with a greater force than an ordinary charge of gunpowder, I determined to try its comparative strength in another way. I procured two blocks of wood, very nearly of the same size and strength, and bored them with the same instrument to the same depth. The one was charged with half an ounce of the best Dartford gunpowder, and the other with half an ounce of the mercurial powder; both were alike buried in sand, and fired by a train communicating with the powders by a small touch-hole. The block containing the gunpowder was simply split into three pieces; that charged with the mercurial powder was burst in every direction, and the parts immediately contiguous to the powder were absolutely pounded, yet the whole hung together, whereas the block split by the gunpowder had its parts fairly separated. The sand surrounding the gunpowder was undoubtedly most disturbed: in short, the mercurial powder appeared to have acted with the greatest energy, but only within certain limits.

"The effects of the mercurial powder, in the last experiments, made me believe that it might be confined, during its explosion, in the centre of a hollow glass globe. Having therefore provided such a vessel, seven inches in diameter, and nearly half an inch thick, mounted with brass caps, and a stop-cock, I placed ten grains of mercurial powder on thin paper, laid on iron wire, 149th of an inch thick, across the paper, through the midst of the powder, and, closing the paper, tied it fast at both extremities with silk to the wire. As the inclosed powder was now attached to the middle of the wire, each end of which was connected with the brass caps, the packet of powder became, by this disposition, fixed in the centre of the globe. Such a charge of an electrical battery was then sent along the wire, as a preliminary experiment (with Mr. Cuthbertson's electrometer) had shewn me would, by making the wire red hot, inflame the powder. The glass globe withstood the explosion, and of course retained whatever gases were generated; its interior was thinly coated with quicksilver, in a very divided state. A bent glass tube was now screwed to the stop-cock of the brass cap, which being introduced under a glass jar standing in the mercurial bath, the stop-cock was opened. Three cubical inches of air rushed out, and a fourth was set at liberty when the apparatus was removed to the water tub. The explosion being repeated, and the air all received over water, the quantity did not vary. To avoid an error from change of temperature, the glass globe was, both before and after the explosion, immersed in water of the same temperature. It appears, therefore, that the ten grains of powder produced four cubical inches only of air.

"To continue the comparison between the mercurial powder and gunpowder, 10 grains of the best Dartford gunpowder were in a similar manner set fire to in the glass globe: it remained entire. The whole of the powder did not explode, for some complete grains were to be observed adhering to the interior surface of the glass. Little need be said of the nature of the gases generated during the combustion of the gunpowder: they must have been carbonic acid gas, sulphureous acid gas, nitrogen gas, and (according to Lavoisier) perhaps hydrogen gas. As to the quantity of these, it is obvious that it could not be ascertained; because the two first were, at least in part, speedily absorbed by the alkali of the nitre, left pure after the decomposition of its nitric acid."

The following description will give the experimental philosopher a clear idea of the instrument used in this business.

The ball or globe of glass is nearly half an inch thick, and seven inches in diameter. It has two necks, on which are cemented two brass caps, each being perforated with a female screw, to receive the male ones; through the former a small hole is drilled; the latter is furnished with a perforated stud or shank. By means of a leather collar the neck can be air-tightly closed. When a portion of the powder is to be exploded, it must be placed on a piece of paper, and a small wire laid across the paper, through the midst of the powder: the paper being then closed, is to be tied at each end to the wire with a silken thread. One end of this wire is to be fast-

ened to the end of the shank, and the screw inserted to half its length into the brass cap; the other end of the wire, by means of a needle, is to be drawn through the hole. The screw being now fixed in its place, and the wire drawn tight, is to be secured by pushing the irregular wooden plug into the aperture of the screw, taking care to leave a passage for the air. The stop-cock is now to be screwed on. The glass tube is bent, that it may more conveniently be introduced under the receiver of a pneumatic apparatus.

"From some of the experiments in which the gunpowder proof and the gun were burst, it might be inferred, that the astonishing force of the mercurial powder is to be attributed to the rapidity of its combustion; and a train of several inches in length being consumed in a single flash, it is evident that its combustion must be rapid. But from other experiments it is plain that this force is restrained to a narrow limit, both because the block of wood charged with the mercurial powder was more shattered than that charged with the gunpowder, whilst the sand surrounding it was least disturbed, and likewise because the glass globe withstood the explosion of ten grains of the powder fixed in its centre; a charge I have twice found sufficient to destroy old pistol barrels, which were not injured by being fired when full of the best gunpowder. It also appears from the last experiment, that 10 grains of the powder produced by ignition four cubical inches only of air; and it is not to be supposed that the generation, however rapid, of four cubical inches of air, will alone account for the described force; neither can it be accounted for by the formation of a little water, which, as will hereafter be shewn, happens at the same moment; the quantity formed from ten grains must be so trifling, that I cannot ascribe much force to the expansion of its vapour. The sudden vaporition of a part of the mercury seems to me a principal cause of this immense yet limited force; because its limitation may then be explained, as it is well known that mercury easily parts with caloric, and requires a temperature of 600 degrees of Fahrenheit, to be maintained in the vaporous state. That the mercury is really converted into vapour, by ignition of the powder, may be inferred from the thin coat of divided quicksilver, which, after the explosion in the glass globe, covered its interior surface; and likewise from the quicksilver with which a tallow candle, or a piece of gold, may be evenly coated, by being held at a small distance from the inflamed powder. These facts certainly render it more than probable, although they do not demonstrate that the mercury is volatilized; because it is not unlikely that many mercurial particles are mechanically impelled against the surface of the glass, the gold, and the tallow.

"As to the force of the dilated mercury, Mr. Baumé relates a remarkable instance of it, as follows:

'Un alchymiste se présenta à Mr. Geoffroy, et l'assura qu'il avoit trouvé le moyen de fixer le mercure par une opération fort simple. It fit construire six boîtes rondes en fer fort épais, qui entroient les unes dans les autres: la dernière étoit assujettie par deux cercles de fer qui se croisoient en angles droits. On avoit mis quelques livres de mercure dans la capacité de la première: on mit cet appareil dans un fourneau assez rempli de charbon pour faire rougir à blanc les boîtes de fer; mais, lorsque la chaleur eut pénétré suffisamment le mercure, les boîtes crevèrent, avec une telle explosion qu'il se fit un bruit épouvantable: des morceaux de boîtes furent lancés avec tant de rapidité qu'il y en eut qui passèrent au travers de deux planchers; d'autres firent sur la muraille des effects semblables a ceux des éclats de bombes.'—Chymie Expérimentale et Raisonnée tom. ii. p. 393.

"Had the alchemist proposed to fix water by the same apparatus, the nest of boxes must, I suppose, have likewise been ruptured; yet it does not follow that the explosion would have been so tremendous: indeed, it is probable that it would not, for if (as Mr. Kirwan remarked to me) substances which have the greatest specific gravity have likewise the greatest attraction of cohesion, the supposition that the vapour of water, would agree with a position of sir Isaac Newton, that those particles recede from one another with the greatest force, and are most difficultly brought together, which upon contact cohere most strongly.

"Before I attempt to investigate the constituent principles of this powder, it will be proper to describe the process and manipulations which, from frequent trials, seem to be best calculated to produce it. 100 grains, or a greater proportional quantity of quicksilver, (not exceeding 500 grains), are to be dissolved, with heat, in a measured ounce and a half of nitric acid. This solution being poured cold upon two measured ounces of alcohol, previously introduced into any convenient glass vessel, a moderate heat is to be applied until an effervescence is excited. A white fume then begins to undulate on the surface of the liquor; and the powder will be gradually precipitated, upon the cessation of action and re-action. The precipitate is to be immediately collected on a filter, well washed with distilled water, and carefully dried in a heat not much exceeding that of a water bath. The immediate edulcoration of the powder is material, because it is liable to the re-action of nitric acid; and, whilst any of that acid adheres to it, it is very subject to the influence of light. Let it also be cautiously remembered, that the mercurial solution is to be poured upon the alcohol.

"I have recommended quicksilver to be used in preference to an oxide, because it seems to answer equally, and is less expensive; otherwise, not only the pure red oxide, but the red nitrous oxide, and turpeth, may be substituted; neither does it seem essential to attend to the precise specific gravity of the acid, or the alcohol. The rectified spirit of wine, and the nitrous acid of commerce, never failed, with me, to produce a fulminating mercury. It is indeed true, that the powder prepared without attention is produced in different quantities, varieties in colour, and probably in strength. From analogy, I am disposed to think the whitest is the strongest; for it is well known that the black precipitates of mercury approach the nearest to the metallic state. The variation in quantity is remarkable; the smallest quantity I ever obtained from 100 grains of quicksilver being 120 grains, and the largest 132 grains. Much depends on very minute circumstances. The greatest product seems to be obtained when a vessel is used which condenses and causes most ether to return into the mother liquor; besides which, care is to be had in applying the requisite heat, that a speedy and not a violent action be effected. 100 grains of an oxide are not so productive as 100 grains of quicksilver.

"As to the colour, it seems to incline to black when the action of the acid of the alcohol is most violent, and vice versa.

"I need not observe, that the gases which were generated during the combustion of the powder in the glass globe, were necessarily mixed with atmospheric air; the facility with which the electric fluid passes through a vacuum, made such a mixture unavoidable.

"The cubical inch of gas received over water was not readily absorbed by it; and, as it soon extinguished a taper without becoming red, or being itself inflamed, barytes water was let up to the three cubical inches received over mercury, when a carbonate of barytes was immediately precipitated.

"The residue of several explosions, after the carbonic acid had been separated, was found, by the test of nitrous gas, to contain nitrogen or azotic gas; which does not proceed from any decomposition of atmospheric air, because the powder may be made to explode under the exhausted receiver of an air-pump. It is therefore manifest that the gases generated during the combustion of the fulminating mercury, consist of carbonic acid and nitrogen gases.

"The principal re-agents which decompose the mercurial powder are the nitric, the sulphuric, and the muriatic acids. The nitric changes the whole into nitrous gas, carbonic acid gas, acetous acid, and nitrate of mercury. I resolved it into these different principles, by distilling it pneumatically with nitric acid: this acid, upon the application of heat, soon dissolved the powder, and extricated a quantity of gas, which was found, by well-known tests, to be nitrous gas mixed with carbonic acid gas. The distillation was carried on until gas no longer came over. The liquor of the retort was then mixed with the liquor collected in the receiver, and the whole saturated with potass; which precipitated the mercury in a yellowish brown powder, nearly as it would have done from a solution of nitrate of mercury. This precipitate was separated by a filter, and the filtrated liquor evaporated to a dry salt, which was washed with alcohol. A portion of the salt being refused by this menstruum, it was separated by filtration, and recognized, by all its properties, to be nitrate of potass. The alcoholic liquor was likewise evaporated to a dry salt, which, upon the effusion of a little concentrate sulphuric acid, emitted acetous acid, contaminated with a feeble smell of nitrous acid, owing to the solubility of a small portion of the nitre in the alcohol.

"The sulphuric acid acts upon the powder in a remarkable manner, as has already been noticed. A very concentrate acid produces an explosion nearly at the instant of contact, on account, I presume, of the sud-

den and copious disengagement of caloric from a portion of powder which is decomposed by the acid. An acid somewhat less concentrate likewise extricates a considerable quantity of caloric, with a good deal of gas; but, as it effects a complete decomposition, it causes no explosion. An acid diluted with an equal quantity of water, by the aid of a little heat, separates the gas so much less rapidly, that it may with safety be collected in a pneumatic apparatus. But, whatever be the density of the acid (provided no explosion be produced), there remains in the sulphuric liquor, after the separation of the gas, a white inflammable and uncrystallized powder mixed with some minute globules of quicksilver.

"To estimate the quantity, and observe the nature, of this uninflammable substance, I treated 100 grains of the fulminating mercury with sulphuric acid a little diluted. The gas being separated, I decanted off the liquor as it became clear, and freed the insoluble powder from acid by edulcoration with distilled water; after which I dried it, and found it weighed only 84 grains; consequently had lost 16 grains of its original weight. Suspecting, from the operation of the nitric acid in the former experiment, that these 84 grains (with the exception of the quicksilver globules) were oxalate of mercury, I digested them in nitrate of lime, and found my suspicion just. The mercury of the oxalate united to the nitric acid, and the oxalic acid to the lime. A new insoluble compound was formed; it weighed, when washed and dry, 48.5 grains. Carbonate of potass separated the lime, and formed oxalate of potass, capable of precipitating lime-water and muriate of lime; although it had been depurated from excess of alkali, and from carbonate acid, by a previous addition of acetous acid. That the mercury of the oxalate in the 84 grains had united to the nitric acid of the nitrate of lime was proved, by dropping muriatic acid into liquor from which the substance demonstrated to be oxalate of lime had separated; for a copious precipitation of calomel instantly ensued.

"The sulphuric liquor, decanted from the oxalate of mercury, was now added to that with which it was edulcorated, and the whole saturated with carbonate of potass. As effervescence ceased, a cloudiness and precipitation followed; and the precipitate being collected, washed and dried, weighed 3.4 grains: it appeared to be a carbonate of mercury. Upon evaporating a portion of the saturated sulphuric liquor, I found nothing but sulphate of potass; nor had it any metallic taste. There then remains, without allowing for the weight of the carbonic acid united to the 3.4 grains, a deficit from the 100 grains of mercurial powder of 12.6 grains, which I ascribe to the gas separated by the action of the sulphuric acid. To ascertain the quantity, and examine the nature of the gas so separated, I introduced into a very small tubulated retort 50 grains of the mercurial powder, and poured upon it three drachms, by measure, of sulphuric acid, with the assistance of a gentle heat. I first received it over quicksilver; the surface of which, during the operation, partially covered itself with a little black powder.

"The gas, by different trials, amounted to from 28 to 31 cubical inches: it first appeared to be nothing but carbonic acid, as it precipitated barytes water, and extinguished a taper, without being itself inflamed, or becoming red. But upon letting up to it liquid caustic ammonia, there was a residue of from 5 to 7 inches of a peculiar inflammable gas, which burnt with a greenish-blue flame. When I made use of the water-tub, I obtained from the same materials, from 25 to 27 inches only of gas, although the average quantity of the peculiar inflammable gas was likewise from 5 to 7 inches; therefore, the difference of the aggregate product, over the two fluids, must have arisen from the absorption, by the water, of a part of the carbonic acid in its nascent state. The variation of the quantity of the inflammable gas, when powder from the same parcel is used, seems to depend upon the acid being a little more or less dilute.

"With respect to the nature of the peculiar inflammable gas, it is plain to me, from the reasons I shall immediately adduce, that it is no other than the gas (in a pure state) into which the nitrous etherized gas can be resolved, by treatment with dilute sulphuric acid.

"The Dutch chemists have shewn, that the nitrous etherized gas can be resolved into nitrous gas, by exposure to concentrate sulphuric acid, and that, by using a dilute instead of a concentrate acid, a gas is obtained which enlarges the flame of a burning taper, so much like the gaseous oxide of azote, that they mistook it for that substance, until they discovered that it was permanent over water, refused to detonate with hydrogen, and that the fallacious appearance was owing to a mixture of nitrous gas with inflammable gas.

"The inflammable gas separated from the powder, answers to the description of the gas which at first deceived the Dutch chemists: 1st, in being permanent over water; 2dly, refusing to detonate with hydrogen; and, 3dly, having the appearance of the gaseous oxide of azote, when mixed with nitrous gas.

"The gas separable by the same acid, from nitrous etherized gas, and from the mercurial powder, have therefore the same properties. Every chemist would thence conclude, that the nitrous etherized gas is a constituent part of the powder, and the inflammable and nitrous gas, instead of the inflammable and carbonic acid gas, had been the mixed product extricated from it by dilute sulphuric acid.

"It however appears to me, that nitrous gas was really produced by the action of the dilute sulphuric acid; and that, when produced, it united to an excess of oxygen present in the oxalate of mercury.

"To explain how this change might happen, I must premise, that my experiments have shewn me that oxalate of mercury can exist in two, if not in three states. 1st. By the discovery of Mr. Ameilon, the precipitate obtained by oxalic acid, from nitrate of mercury, fuses with a hissing noise. The precipitate is an oxalate of mercury, seemingly with excess of oxygen. Mercury dissolved in sulphuric acid and precipitated by oxalic acid, and also the pure red oxide of mercury digested with oxalic acid, give oxalates in the same state. 2dly. Acetate of mercury, precipitated by oxalic acid, although a true oxalate is formed, has no kind of inflammability. I consider it as an oxalate with less oxygen than those above-mentioned. 3dly. A solution of nitrate of mercury, boiled with dulcified spirit of nitre, gives an oxalate more inflammable than any other; perhaps it contains most oxygen.

"The oxalate of mercury remaining from the powder in the sulphuric liquor is not only always in the same state as that precipitated from acetate of mercury, entirely devoid of inflammability, but contains globules of quicksilver, consequently it must have parted with even more than its excess of oxygen; and if nitrous gas was present, it would of course seize at least a portion of that oxygen. It is true, that globules of quicksilver may seem incompatible with nitrous acid; but the quantity of the one may not correspond with that of the other, or the dilution of the acid may destroy its action.

"As to the presence of the carbonic acid, it must have arisen either from a complete decomposition of a part of the oxalate; or admitting the nitrous etherized gas to be a constituent principle of the powder, from a portion of the oxygen, not taken up by the nitrous gas, being united with the carbon of the etherized gas.

"The muriatic acid, digested with the mercurial powder, dissolves a portion of it, without extricating any notable quantity of gas. The dissolution evaporated to a dry salt tastes like the corrosive sublimate; and the portion which the acid does not take up, is left in a state of an uninflammable oxalate.

"These effects all tend to establish the existence of the nitrous etherized gas, as a constituent part of the powder; and likewise corroborate the explanation I have ventured to give of the action of the sulphuric acid. Moreover, a measured ounce and a half of nitrous acid, holding 100 grains of mercury in solution and two measured ounces of alcohol, yield 90 cubical inches only of gas: whereas, without the intervention of mercury, they yield 210 inches. Upon the whole, I trust it will be thought reasonable to conclude, that the mercurial powder is composed of the nitrous etherized gas, and of oxalate of mercury with excess of oxygen. 1st. Because the nitric acid converts the mercurial powder entirely into nitrous gas, carbonic acid gas, acetous acid, and nitrate of mercury. 2dly. Because the dilute sulphuric acid resolves it into an uninflammable oxalate of mercury, and separates from it a gas resembling that into which the same acid resolves the nitrous etherized gas. 3dly. Because an uninflammable oxalate is likewise left, after the muriatic acid has converted a part of it into sublimate. 4thly. Because it cannot be formed by boiling nitrate of mercury in dulcified spirits of nitre; although a very inflammable oxalate is by this means produced. 5thly. Because the difference of the product of gas, from the same measures of alcohol and nitrous acid, with and without mercury in solution, is not trifling; and, 6thly. Because nitrogen gas was generated during its combustion in the glass globe.

"Should my conclusions be thought warranted by the reasons I have adduced, the

theory of the combustion of the mercurial powder will be obvious to every chemist. The hydrogen of the oxalic acid, and of the etherized gas, is first united to the oxygen of the oxalate, forming water; the carbon is saturated with oxygen, forming carbonic acid gas; and a part, if not the whole of the nitrogen of the etherized gas, is separated in the state of nitrogen gas; both which last gases, it may be recollected, were after the explosion present in the glass globe. The mercury is revived, and, I presume, thrown into vapour; as may well be imagined, from the immense quantity of caloric extricated, by adding concentrate sulphuric acid to the mercurial powder.

"I will not venture to state with accuracy in what proportions its constituent principles are combined. The affinities I have brought into play are complicated, and the constitution of the substances I have to deal with not fully known. But to make round numbers, I will resume the statement, that 100 grains of the mercurial powder lost 16 grains of its original weight, by treatment with dilute sulphuric acid: 84 grains of the mercurial oxalate, mixed with a few minute globules of quicksilver, remained undissolved in the acid. The sulphuric liquor was saturated with carbonic of potass, and yielded 3.4 grains of carbonate of mercury. If 1.4 grains should be thought a proper allowance for the weight of carbonic acid in the 3.4 grains, I will make that deduction, and add the remaining 2 grains to the 84 grains of mercurial oxalate and quicksilver; I shall then have,

Of oxalate and mercury -	86 grains.
And a deficit, to be ascribed to the nitrous etherized gas and excess of oxygen, -	14
	100

"It may perhaps be proper to proceed still further, and recur to the 48.5 grains, separated by nitrate of lime from the 84 grains of mercurial oxalate and globules of quicksilver. These 48.5 grains were proved to be oxalate of lime; but they contained a minute inseparable quantity of mercury, almost in the state of quicksilver, formerly part of the 84 grains from which they were separated. Had the 48.5 grains been pure calcareous oxalate, the quantity of pure oxalic acid in them would, according to Bergmann, be 23.28 grains. Hence, by omitting the 2 grains of mercury, in the 3.4 grains of carbonate, 100 grains of the mercurial powder might have been said to contain of pure oxalic acid 23.28 grains; of mercury 62.72 grains; and of nitrous etherized gas and excess of oxygen 14 grains. But as the 48.5 grains were not pure oxalate, inasmuch as they contained the mercury they received from the 84 grains, from which they were generated by the nitrate of lime, some allowance must be made for the mercury successively intermixed with the 84 grains and the 48.5 grains. In order to make corresponding numbers, and allow for unavoidable errors, I shall estimate the quantity of that mercury to have amounted to 2 grains, which I must of course deduct from the 33.28 grains of oxalic acid. I shall then have the following statement:

That 100 grains of fulminating mercury ought to contain of pure oxalic acid, - -		21.28 grains.
Of mercury formerly united to the oxalic acid	60.72	
Of mercury dissolved in the sulphuric liquor,	2	
And of mercury left in the sulphuric liquor after the separation of the gases, - -	2	
Total of mercury,		64.72
Of nitrous etherized gas, and excess of oxygen, -		14
		100

"Since 100 grains of the powder seem to contain 64.72 grains of mercury, it will be immediately enquired, what becomes of 100 grains of quicksilver, when treated as directed, in the description of the process for preparing the fulminating mercury.

"It has been stated that 100 grains of quicksilver produce, under different circumstances, from 120 to 132 grains of mercurial powder; and, if 100 grains of this powder contain 64.72 grains, 120 grains, or 132 grains, must, by parity of reasoning, contain 78.06 grains, or 85.47 grains; therefore 13.34 grains, or 20.75 grains, more of the 100 grains are immediately accounted for; because 64.72 grains + 13.34 grains = 78 06, and 64.72 grains + 20.75 grains = 85.47 grains. The remaining deficiency of 21.94 grains, or 14.53 grains, which with the 78.06 grains, or 85.47 grains, would complete the original 100 of quicksilver, remains partly in the liquor from which the powder is separated, and is partly volatilized in the white dense fumes, which in the beginning of this paper I compared to the liquor fumans of Libavius. The mercury cannot, in either instance, be obtained in a form immediately indicative of its quantity; and a series of experiments, to ascertain the quantities in which many different substances can combine with mercury, is not my present object. After observing that the mercury left in the residuary liquor can be precipitated in a very subtle dark powder, by carbonate of potass, I shall content myself with examining the nature of the white fumes.

"It is clear that these white fumes contain mercury: they may be wholly condensed in a range of Woulfe's apparatus, charged with a solution of muriate of ammonia. When the operation is over, a white powder is seen floating with ether on the saline liquor, which, if the bottles are agitated, is entirely dissolved. After the mixture has been boiled, or for some time exposed to the atmosphere, it yields to caustic ammonia a precipitate, in all respects similar to that which is separated by caustic ammonia from corrosive sublimate.

"I would infer from these facts, that the white dense fumes consist of mercury, or perhaps oxide of mercury, united to the nitrous etherized gas; and that, when the muriate of ammonia containing them is exposed to the atmosphere, or is boiled, the gas separates from the mercury; and the excess of nitrous acid, which always comes over with nitrous ether, decomposes the ammoniacal muriate of sublimate, and forms corrosive mercurial muriate or sublimate. This theory is corroborated by comparing the quantity of gas estimated to be contained in the fulminating mercury with the quantities of gas yielded from alcohol and nitrous acid, with and without mercury in solution; not to mention that more ether, as well as more gas, is produced without the intervention of mercury; and that, according to the Dutch chemists, the product of ether is always in the inverse ratio to the product of nitrous etherized gas. Should a further proof be thought necessary to the existence of the nitrous etherized gas in the fulminating mercury, as well as in the white dense fumes, it may be added, that if a mixture of alcohol and nitrous acid holding mercury in solution be so dilute, and exposed of a temperature so low, that neither ether nor nitrous etherized gas are produced, the fulminating mercury, or the white fumes, will never be generated; for, under such circumstances, the mercury is precipitated chiefly in the state of an inflammable oxalate. Further, when we consider the different substances formed by an union of nitrous acid and alcohol, we are so far acquainted with all, except the ether and the nitrous etherized gas, as to create a presumption, that no others are capable of volatilizing mercury, at the very low temperature in which the white fumes exist, since, during some minutes, they are permanent over water of 40° Fahrenheit.

"Hitherto, as much only has been said of the gas which is separated from the mercurial powder by dilute sulphuric acid, as was necessary to identify it with that into which the same acid can resolve the nitrous etherized gas: I have further to speak of its peculiarity.

"The characteristic properties of the inflammable gas seem to me to be the following: 1st. It does not diminish in volume, either with oxygen or nitrous gas. 2dly. It will not explode with oxygen by the electric shock, in a close vessel. 3dly. It burns like hydrocarbonate, but with a blueish-green flame; and, 4thly. It is permanent over water.

"It is of course either not formed, or is convertible into nitrous gas by the concentrate nitric and muriatic acids; because by those acids, no inflammable gas was extricated from the powder.

"Should this inflammable gas prove not to be hydrocarbonate, I shall be disposed to conclude that it has nitrogen for its basis; indeed, I am at this moment inclined to that opinion, because I find that Dr. Priestley, during his experiments on his dephlogistigated nitrous air, once produced a gas which seems to have resembled this inflammable gas, both in the mode of burning and in the colour of the flame.

"After the termination of the common solution of iron in spirit of nitre, he used heat, and got, says he, 'such a kind of air as I had brought nitrous air to be, by exposing it to iron, or liver of sulphur; for, on the first trial, a candle burned in it with a much enlarged flame. At another time, the application of a candle to air produced in this manner, was attended with a real, though not a loud explosion; and immediately after this a greenish-coloured flame

descended from the top to the bottom of the vessel in which the air was contained. In the next produce of air, from the same process, the flame descended blue, and very rapidly from the top to the bottom of the vessel.'

"These greenish and blue-coloured flames, descending from the top to the bottom of the vessel, are precisely descriptive of the inflammable gas separated from the powder. If it can be produced with certainty by the repetition of Dr. Priestley's experiments, or should it by any means be got pure from the nitrous etherized gas, my curiosity will excite me to make it the object of future research; otherwise, I must confess, I shall feel more disposed to prosecute other chemical subjects: for having reason to think that the density of the acid made a variation in the product of this gas, and having never found that any acid, however dense, produced an immediate explosion, I once poured 6 drachms of concentrate acid upon 50 grains of the powder. An explosion, nearly at the instant of contact, was effected: I was wounded severely, and most of my apparatus destroyed. A quantity moreover of the gas I had previously prepared, was lost by the inadvertency of a person who went into my laboratory, whilst I was confined by the consequences of this discouraging accident. But should any one be desirous of giving the gas a further examination, I again repeat, that as far as I am enabled to judge, it may with safety be prepared by pouring 3 drachms of sulphuric acid, diluted with the same quantity of water, upon 50 grains of the powder, and then applying the flame of a candle until gas begins to be extricated. The only attempt I have made to decompose it, was by exposing it to copper and ammonia; which during several weeks did not effect the least alteration.

"I will now conclude (says Mr. Howard), by observing, that the fulminating mercury seems to be characterised by the following properties:

"It takes fire at the temperature of 368 Fahrenheit; explodes by friction, by flint and steel, and by being thrown into concentrate sulphuric acid. It is equally inflammable under the exhausted receiver of an air-pump, as surrounded by atmospheric air; and it detonates loudly, both by the blow of a hammer, and by a strong electrical shock.

"Notwithstanding the compositions of fulminating silver and of fulminating gold differ essentially from that of fulminating mercury, all three have similar qualities. In tremendous effects, silver undoubtedly stands first, and gold perhaps the last. The effects of the mercurial powder and of gunpowder admit of little comparison. The one exerts, within certain limits, an almost inconceivable force: its agents seem to be gas and caloric, very suddenly set at liberty, and both mercury and water thrown into vapour. The other displays a more extended but inferior power: gas and caloric are, comparatively speaking, liberated by degrees; and water, according to count Rumford, is thrown into vapour.

"Hence it seems that the fulminating mercury, from the limitation of its sphere of action, can seldom, if ever, be applied to mining; and, from the immensity of its initial force, cannot be used in fire-arms, unless in cases where it becomes an object to destroy them; and where it is the practice to spike cannon, it may be of service, because I apprehend it may be used in such a manner as to burst cannon without dispersing any splinters.

"The inflammation of fulminating mercury by concussion offers nothing more novel or remarkable than the inflammation, by concussion, of many other substances. The theory of such inflammations has been long since exposed by the celebrated Mr. Berthollet, and confirmed by Messieurs Fourcroy, and Vauquelin: yet, I must confess, I am at a loss to understand why a small quantity of mercurial powder made to detonate by the hammer, or the electric shock, should produce a report so much louder than when it is inflamed by a match, or by flint and steel. It might at first be imagined, that the loudness of the report could be accounted for, by supposing the instant of the inflammation, and that of the powder's confinement between the hammer and anvil, to be precisely the same; but, when the electrical shock is sent through or over a few grains of the powder, merely laid on ivory, and a loud report in consequence, I can form no idea of what causes such a report.

"The operation by which the powder is prepared, is perhaps one of the most beautiful and surprising in chemistry; and it is not a little interesting to consider the affinities which are brought into play. The superabundant nitrous acid of the mercurial solution must first act on the alcohol, and generate ether, nitrous etherized gas, and oxalic acid. The mercury unites to the two last in their nascent state, and relinquishes fresh nitrous acid, to act upon any unaltered alcohol. The oxalic acid, a predisposing affinity seems exerted in favour of its quantity, is evidently not formed fast enough to retain all the mercury; otherwise, no white fumes during a considerable period of the operation, but fulminating mercury alone will be produced.

"Should any doubt still be entertained of the existence of the affinities which have been called predisposing or conspiring, a proof that such affinities really exist, will, I think, be afforded, by comparing the quantity of oxalic acid which can be generated from given measures of nitrous acid and alcohol, with the intervention of mercury, and the intervention of other metals. For instance, when two measured ounces of alcohol are treated with a solution of 100 grains of nickel in a measured ounce and a half of nitrous acid, little or no precipitate is produced; yet, by the addition of oxalic acid to the residuary liquor, a quantity of oxalate of nickel, after some repose, is deposited. Copper affords another illustration; 100 grains of copper dissolved in a measured ounce and a half of nitrous acid, and treated with alcohol, yielded me about 18 grains of oxalate, although cupreous oxalate was plentifully generated by dropping oxalic acid into the residuary liquor. About 21 grains of pure oxalic acid seem to be produced from the same materials, when 100 grains of mercury are interposed. Besides, according to the Dutch paper, more than once referred to, acetous acid is the principal residue after the preparation of nitrous ether. How can we explain the formation of a greater quantity of oxalic acid from the same materials, with the intervention of 100 grains of mercury, than with the intervention of 100 grains of copper, otherwise than by the notion of conspiring affinities, so analogous to what we see in other phenomena of nature?

"I have attempted, without success, to communicate fulminating properties, by means of alcohol, to gold, platina, antimony, tin, copper, iron, lead, zinc, nickel, bismuth, cobalt, arsenic, and manganese; but I have not yet sufficiently varied my experiments to enable me to speak with absolute certainty. Silver, when 20 grains of it were treated with nearly the same proportions of nitrous acid and alcohol as 100 grains of mercury, yielded, at the end of the operation, about three grains of a grey precipitate, which fulminated with extreme violence. Mr. Cruickshank had the goodness to repeat the experiment: he dissolved 40 grains of silver in two ounces of the strongest nitrous acid diluted with an equal quantity of water, and obtained (by means of two ounces of alcohol) 60 grains of a very white powder, which fulminated like the grey precipitate above described. It probably combines with the same principles as the mercury, and of course differs from Mr. Berthollet's fulminating silver, before alluded to. I observe, that a white precipitate is always produced in the first instance; and that it may be preserved by adding water as soon as it is formed; otherwise, when the mother liquor is abundant, it often becomes grey, and is re-dissolved."

Several trials of the mercurial powder were afterwards made at Woolwich, in conjunction with colonel Bloomfield and Mr. Cruickshank, upon heavy guns, carronades, &c. from which Mr. Howard generally infers, that any piece of ordnance might be destroyed, by employing a quantity of the mercurial powder equal in weight to one half of the service-charge of gunpowder; and, from the seventh and last experiment, we may also conclude, that it would be possible so to proportion the charge of mercurial powder to the size of different cannons, as to burst them without dispersing any splinters. But the great danger attending the use of fulminating mercury, on account of the facility with which it explodes, will probably prevent its being employed for that purpose.

"In addition to the other singular properties of the fulminating mercury (says Mr. Howard), it may be observed, that two ounces inflamed in the open air seem to produce a report much louder than when the same quantity is exploded in a gun capable of resisting its action. Mr. Cruickshank, who made some of the powder by my process, remarked that it would not inflame gunpowder. In consequence of which, we spread a mixture of coarse and fine-grained gunpowder upon a parcel of the mercurial powder; and after the inflammation of the latter, we collected most, if not all, of the grains of gunpowder. Can this extraordinary fact be explained by the rapidity of the combustion of fulminating mercury? or is it to be supposed (as gunpowder will not explode at the temperature at which mercury is thrown into vapour) that sufficient caloric is not extricated during this combustion? From the late opportunity I have had of conversing with Mr. Cruickshank, I find that he has made many accurate experi-

ments on gunpowder; and he has permitted me to state, that the matter which remains after the explosion of gunpowder consists of potass united with a small proportion of carbonic acid, sulphate of potass, and a very small quantity of sulphuret of potass, and unconsumed charcoal. That 100 grains of good gunpowder yielded about 53 grains of this residuum, of which three are charcoal. That it is extremely deliquescent, and when exposed to the air, soon absorbs moisture sufficient to dissolve a part of the alkali; in consequence of which the charcoal becomes exposed, and the whole assumes a black or very dark colour. Mr. Cruickshank likewise informs me, that after the combustion of good gunpowder under mercury, no water is ever perceptible."

FULMINATION, in the Romish canon law, a sentence of a bishop, official, or other ecclesiastic appointed by the pope, by which it is decreed, that some bull sent from the pope shall be executed.

FULMINATION is also used for the denunciation, or execution of a sentence of anathema, made public with due solemnity.

FUMARIA, *fumitory*, a genus of the pentandria order, belonging to the diadelphia class of plants, and in the natural method ranking under the 24th order, corydales. The calyx is diphyllous, the corolla ringent, and there are two membranaceous filaments, each of which has three antheræ. There are a number of different species, all of them low, shrubby, and deciduous and evergreen plants, growing from two to six or seven feet high, adorned with small simple leaves, and papilionaceous flowers of different colours. The most remarkable is the officinalis or common fumitory, which grows naturally in shady cultivated grounds, and produces spikes of purplish flowers in May and June. It is very juicy, of a bitter taste, without any remarkable smell. The medical effects of this herb are, to strengthen the tone of the bowels, gently loosen the belly, and promote the urinary and other natural secretions. The old physicians recommended it in melancholic, scorbutic, and cutaneous disorders, for opening obstructions of the viscera, attenuating and promoting the evacuation of viscid juices. Frederic Hoffman had a very great opinion of it as a purifier of the blood; and assures us that in this intention scarce any plant exceeds it. Cows and sheep eat this plant; goats are not fond of; horses and swine refuse it.

FUMIGATION, in chemistry, a kind of calcination, when metals, or other hard bodies, are corroded or softened, by receiving certain fumes for that purpose.

FUMIGATION, in medicine and surgery, the application of fumes to particular parts of the body; as those of factitious cinnabar to venereal ulcers. See SURGERY.

FUNCTION, the act of fulfilling the duties of any employment.

FUNCTION, *animal*, applied to the actions of the body, is by physicians divided into vital, animal, and natural. The vital functions are those necessary to life, and without which the individual cannot subsist; as the motion of the heart, lungs, &c. The natural functions are such as it cannot subsist any considerable time without them, as the digestion of the aliment, and its conversion into blood. Under animal functions are included the senses of touching, tasting, &c. memory, judgment, and voluntary motion, without any, or all of which an animal may live, but not very comfortably.

The animal functions perform the motion of the body by the action of the muscles, and this action consists chiefly in shortening the fleshy fibres, which is called contraction, the principal agents of which are the arteries and nerves distributed in the fleshy fibres.

In short, all parts of the body have their own functions, or actions peculiar to themselves. Life consists in the exercise of these functions, and health in the free and ready exertion of them. See PHYSIOLOGY, DIGESTION, RESPIRATION, PERSPIRATION.

FUND, in anatomy, signifies the bottom of any cavity in the body: thus, the fund of the eye is that part possessed by the choroides and retina.

FUNDS, *public*. When the practice was first adopted of borrowing money of individuals for defraying the extraordinary expences of the state, the produce of some particular tax was generally appropriated as the fund out of which the principal and interest of the debt was to be discharged. The possession of the acknowledgment given by government for the money advanced, establishing a right to receive the payments from the fund originally agreed upon, the sale of these securities was considered as a sale of the claim upon the fund, and as the acknowledgments given were of different kinds, the general appellation of the provision on which they rested was found more convenient for purposes of business: thus the sale and purchase of the government securities was commonly called the sale or purchase of the public funds, till at length the expression has so far varied from its original signification, that instead of meaning the revenue out of which public debts or the interest of them is payable, it denominates the capital of such debts, in which sense it is generally used. Variations in the saleable value of the public funds at first were caused chiefly by political events, which were supposed to affect either the authority of those by whom the debts were contracted, or the means of paying them; but since their great increase has induced many persons to make buying and selling shares therein a regular trade, the fluctuations of the current price in general depends principally on the proportion of buyers to sellers, and on the schemes and combinations in which they engage in support of their respective speculations.

The chief part of the public funds consists of perpetual annuities, or those debts on which a stipulated rate of interest is to continue to be paid, unless the principal should be redeemed; the other parts consist of annuities for a certain number of years, and life annuities. The perpetual annuities are distinguished by different titles, according to the rate of interest they pay or the time and purpose of their creation; and when government, by a new loan, contracts an additional debt, bearing a certain fixed interest, it is usual to add the capital thus created to the amount of that part of the public debt which bears the same interest and denomination, and to add the produce of the taxes imposed for payment of the interest of such new debt to the fund provided for paying the interest of the former capital, thus consolidating the old and new debts, and making the interest payable out of the general produce of the same fund; hence we have 3 per cent. 4 per cent. and 5 per cent. consolidated annuities. The reduced 3 per cent. annuities take their title from having originally consisted of sums which had been borrowed at higher rates of interest, and reduced at different periods to 3 per cent. The navy 5 per cents are so called from having been created by funding navy and victualling bills. The long annuities have been granted at different periods, and for different terms, but all extending to 5th January 1860. The present short annuities expire 5th January 1808. The imperial 3 per cent. annuities, and annuities for 25 years, arose from loans to the emperor of Germany, the dividends on which are guaranteed by the government of this country.

The public funds were formerly all payable and transferrable at the exchequer; but, except a few annuities, of which the term is nearly expired, and some life and tontine annuities, they are all now payable at the Bank or South Sea house.

The funds transferrable at the Bank of England are at present the following, viz.

	Transfer days	Dividends due.
5 per cent. navy ann.	Monday, Wednesday, and Friday	Jan. 5 and July 5.
3 per cent. consols	Tuesday, Wednesday, Thurs. and Frid.	
3 per cent. 1726	Tuesday and Thurday	
3 per cent. deferred	Monday, Wednesday, and Friday	
Bank-stock	Tuesday, Thursday, and Friday	April 5 and Oct. 10.
5 per cent. 1797 and 1802	Tuesday, Thursday, and Friday	
4 per cent. consols	Tuesday, Thursday, and Saturday	
3 per cent. reduced	Tuesday, Wednesday, Thurs. and Frid.	
Long annuities	Monday, Wednesday, and Saturday	
Short annuities	Monday, Wednesday, and Saturday	
3 per cent. imperial ann.	Monday, Wednesday, and Friday	May 1 and Nov. 1.
Imperial annuity, 25 years	Tuesday, Thursday, and Saturday	
Irish 5 per cent.	Tuesday, Thursday, and Saturday	Mar. 25 & Sept. 25.
Irish annuities	Tuesday, Thursday, and Saturday	

Transferrable at the South-Sea house.

South-Sea stock	Monday, Wednesday, and Friday	Jan. 5. and July 5.
3 per cent. new S. S. ann.	Tuesday, Thursday, and Saturday	
3 per cent. 1751	Tuesday and Thursday	
3 per cent. old S. S. ann.	Monday, Wednesday, and Friday	April 5 & Oct. 10.

The dividend payable to the proprietors of bank-stock is 7 per cent.; on South-Sea stock 3½ per cent. India stock can no longer be classed among the public funds, as the debt due from the public to the company was cancelled on the last renewal of their charter; the dividend payable to the proprietors is 10½ per cent. Transfers of stock in any of the government funds, if made on the appointed transfer days, are free from any expence to the parties, but the same stock cannot be transferred twice on the same day. The person who transfers property in the funds, or his broker, must be known to the witnessing clerk, or some person known must be produced to vouch for his being the identical person he is represented to be. The seller's receipt should be kept by the buyer, as a voucher for the transfer, till one dividend has been received.

Dividends on bank-stock, South-Sea stock, and India-stock, after acceptance, are payable to a written order; but those respecting India-stock must be on stamps. The dividends on bank-stock are payable the day after they become due; but the dividends on the stock of other companies, and on the government funds, are not payable till about a week after. The space between the shutting and opening the books of any stock is usually about six weeks. At the time of shutting, the dividends due are carried to a separate account, and cannot be transferred with the stock of a proprietor, the warrants being filled up in the name the stock stands in when the books shut, and of course are payable only to him or his attorney. All letters of attorney, to sell or accept stock or to receive dividends, should be taken out at the respective offices, in order that the description may exactly accord with that in the bank-books, and there must be a separate letter of attorney for each different stock. Letters to sell must be deposited in the proper office prior to sale, as must also probates of wills, till registered. Acting personally, after granting a letter of attorney, revokes the power of the letter. Any one trustee, after the acceptance of the whole trust, may receive dividends; and, upon the death of any of the trustees being proved by producing their wills or a certificate of burial, the survivor may transfer the stock.

Persons having occasion to invest money in the public funds generally employ a broker, to whom the party must give his name, place of abode, and usual addition, with the sum intended to be purchased. The broker soon finds a seller of the sum wanted; and having agreed upon the rate per cent. to be paid, according to the current price of the day, the particulars of the bargain are delivered to a clerk in the office in the Bank in which the description of stock intended to be purchased is transferrable. The clerk on finding that such stock stands in the seller's name, fills up a form of transfer, which is signed by the seller, conveying all his right and title to the stock to the purchaser, his heirs or assigns. A form of acceptance is then signed by the purchaser, and the seller having given him a receipt expressing the consideration paid, which is witnessed by the bank-clerk, the business is concluded.

As the prices of the several funds are continually fluctuating, and there is frequently a considerable difference in the interest produced by investing money in different funds, the following table of the prices which each fund should be at to produce an equal interest, will be found very useful to persons investing their money in these securities.

TABLE,

Shewing the Comparative Value per Cent. of the several Public Funds, and the Annual Interest produced by £.100 invested at different Prices.

3 per Cents.	4 per Cents.	5 per Cents.	Bank Stock, 7 per c.	Ind. St. 10½ per Cent.	Annual Interest.
45	60	75	105	157½	6 13 4
45¾	61	76¼	106¾	160⅛	6 11 1
46½	62	77½	108½	162¾	6 9 0
47¼	63	78¾	110¼	165⅜	6 6 11
48	64	80	112	168	6 5 0
48¾	65	81¼	113¾	170⅝	6 3 0
49½	66	82½	115½	173¼	6 1 2
50¼	67	83¾	117¼	175⅞	5 19 4
51	68	85	119	178½	5 17 7
51¾	69	86¼	120¾	181⅛	5 15 11
52½	70	87½	122½	183¾	5 14 3
53¼	71	88¾	124¼	186⅜	5 12 8
54	72	90	126	189	5 11 1
54¾	73	91¼	127¾	191⅝	5 9 6
55½	74	92½	129½	194¼	5 8 1
56¼	75	93¾	131¼	196⅞	5 6 7
57	76	95	133	199½	5 5 3
57¾	77	96¼	134¾	202⅛	5 3 10
58½	78	97½	136½	204¾	5 2 6
59¼	79	98¾	138¼	207⅜	5 1 3
60	80	100	140	210	5 0 0
60¾	81	101¼	141¾	212⅝	4 18 9
61½	82	102½	143½	215¼	4 17 6
62¼	83	103¾	145¼	217⅞	4 16 4
63	84	105	147	220½	4 15 2
63¾	85	106¼	148¾	223⅛	4 14 0
64½	86	107½	150½	225¾	4 13 0
65¼	87	108¾	152¼	228⅜	4 11 11
66	88	110	154	231	4 10 10
66¾	89	111¼	155¾	233⅝	4 9 10
67½	90	112½	157½	236¼	4 8 10
68¼	91	113¾	159¼	238⅞	4 7 10
69	92	115	161	241½	4 6 11
69¾	93	116¼	162¾	244⅛	4 6 0
70½	94	117½	164½	246¾	4 5 1
71¼	95	118¾	166¼	249⅜	4 4 2
72	96	120	168	252	4 3 3
72¾	97	121¼	169¾	254⅝	4 2 5
73½	98	122½	171½	257¼	4 1 7
74¼	99	123¾	173¼	259⅞	4 0 9
75	100	125	175	262½	4 0 0

Tables of all the intermediate prices, and for comparing the value of the terminable Annuities with the other Funds, are given in Fairman's Guide to Purchasers in the Public Funds. Some useful information respecting the Funds, and the mode of transacting business at the Bank and Stock Exchange, will also be found in Mortimer's Every Man his Own Broker.

FUNDAMENTAL NOTE, in music, the principal note in a song, or composition, to which all the rest are in some measure adapted, and by which they are swayed: it is otherwise called the key to the song.

FUNERAL EXPENCES, are allowed previous to all other debts and charges; but if the executor or administrator be extravagant, it is a species of devastation or waste of the substance of the deceased, and shall only be prejudical to himself and not to the creditors or legatees of the deceased. 2 Bl. 508.

But in strictness, no funeral expences are allowed against a creditor, except for the shroud, coffin, ringing the bell, parson, clerk, grave-digger, and bearers' fees, but not for pall or ornaments. 1 Salk 190.

And in general it is said, that no more than 40*s.* in the whole for funeral expences, shall be allowed against creditors. 3 Atk. 249.

FUNGI, from σφογγος, fungus, the name of the 4th order of the 24th class of vegetables, in the Linnæan system; comprehending all those which are of the mushroom kind, and which, in Tournefort, constitute the 2d, 3d, 4th 5th, 6th, 7th, and 8th genera of the first section in the class xvii. This order in Linnæus contains 10 genera. See AGARICUS, BOLETUS, CLAVARIA, LYCOPERDON, &c.

The antients called fungi children of the earth, meaning, no doubt, to indicate the obscurity of their origin. The moderns have likewise been at a loss in what rank to place them; some referring them to the animal, some to the vegetable, and others to the mineral kingdom. Messrs. Wilck and Munchausen have not scrupled to rank these bodies in the number of animal productions; because when fragments of them or their seeds were macerated in water, these gentlemen perceived a quantity of animalcules discharged, which they supposed capable of being changed into the same substance. It was the antient opinion that beef could produce bees; but it was reserved for Messrs. Wilck and Munchausen to suppose, that bees could produce beef. Wilck asserts, that fungi consist of innumerable cavities, each inhabited by a polype; and he ascribes the formation of them to their inhabitants, in the same way as it has been said that the coral, the lichen, and the mucor were formed. Hedwig has lately shown how ill founded this opinion is with respect to the lichen; and M. Durande has demonstrated its falsity with regard to the corallines. "Indeed (says M. Bonnet, talking of the animality of fungi) nothing but the rage for paradox could induce any one to publish such a fable; and I regret that posterity will be able to reproach our times with it. Observation and experiment should enable us to overcome the prejudices of modern philosophy, now that those of the antient have disappeared and are forgotten."

It cannot be denied that the mushroom is one of the most perishable of all plants, and it is therefore the most favourable for the generation of insects. Considering the quickness of its growth, it must be furnished with a power of copious absorption; the extremities of its vessels must be more dilated than in other plants. Its root seems, in many cases, to be merely intended for its support; for some species grow upon stones or moveable sand, from which it is impossible that they can draw much nourishment. We must therefore suppose, that it is chiefly by the stalk that they absorb. These stalks grow in a moist and tainted air, in which float multitudes of eggs, so small, that the very insects they produce are with difficulty seen by the microscope. These eggs may be compared to the particles of the byssus, 100.000 of which, as M. Gleditsch says, are not equal to the fourth of a grain. May we not suppose that a quantity of such eggs are absorbed by the vessels of the fungus, that they remain there, without any change, till the plant begins to decay?

FUNGITÆ, in natural history, a kind of fossile coral, of a conic figure, though sometimes flatted and striated longitudinally.

FUNGUS, in surgery, denotes any spongy excrescence. See SURGERY.

FURCA and FOSSA, in our old customs,

the power of gallows and pit, or a jurisdiction of punishing felons, viz. the men by hanging, and the women by drowning.

FURCA, in antiquity, a piece of timber resembling a fork, used by the Romans as an instrument of punishment, which was of three kinds: the first only ignominious, when a master, for small offences, forced his servant to carry a furca on his shoulders about the city. The second was penal, when the party was led about the circus, or other place, with the furca about his neck, and whipped all the way. The third was capital, when the malefactor, having his head fastened to the furca, was whipped to death.

FURCAM, ET FLAGELLUM, the meanest of all servile tenures, the bondman being at the lord's disposal for life and limb.

FURCHE', in heraldry, a cross forked at the ends.

FURIA, in zoology, a genus of insects belonging to the order of vermes zoophyta. There is but one species, viz. the infernalis. This has a linear smooth body ciliated on each side, with reflexed feelers pressed to its body. In Finland, Bothnia, and the northern provinces of Sweden, it is not unfrequently that people are seized with a pungent pain, confined to a point, in the hand or other exposed part of the body, which presently increases to a most excruciating degree and even sometimes prove suddenly fatal. This disorder, caused by the insect dropping out of the air, and in a moment burying itself in the flesh, is relieved by a poultice of curds or cheese.

FURLING, in the sea-language, signifies the wrapping up and binding any sail close to the yard; which is done by hauling upon the clew-lines, bunt-lines, &c. which wraps the sail close together, and being bound fast to the yard, the sail is furled.

FURLONG a long measure, equal to $\frac{1}{8}$ of a mile, or forty poles. It is also used, in some law-books, for the eighth part of an acre.

FURLOUGH, in the military language, a licence granted by an officer to a soldier, to be absent for some time from his duty.

FURNACE, an utensil to raise and maintain a vehement fire in, whether of coal or wood.

In order to apply fire, to manage and to direct it where it is to act, furnaces are convenient, and they are the most necessary and indispensible instruments to chemists. The materials of which they are constructed ought to be sufficiently proof against that degree of heat, which they are intended to be exposed to. Commonly they are built of bricks, made of sand and clay, or of cast-iron, or of iron plates, which, the better to be defended against the fire, are coated (in the inside) to the thickness of an inch with Windsor loam. According to Lewis, various kinds of fire-proof furnaces, for small experiments, may be prepared from black-lead crucibles.

The burning of the fuel is kept up in the furnace either by a natural current of air, which is caused by the fire itself, and such a furnace is called an air wind-furnace; or it is done by compressed air, conveyed to the furnace by a large bellows, as in blast-furnaces.

Every wind-furnace consists of two essential parts: the fire-place hearth, or that where the material destined for the fuel is placed; and the ash-pit, that receives the ashes of the consumed fuel, admits the air through its aperture (the ash-hole), and is separated from the hearth by the grate.

If the bodies to be examined are not immediately placed upon the fire, but either on iron bars, or in vessels to be heated by the fire, then a third space, the laboratory, is formed in the wind-furnace. If by the laboratory the fire-place is thoroughly closed, it must be provided with some vent-holes, or registers, to allow access of air.

Such wind-furnaces as are closed by a vaulted cover, and have either at top or on the side, a narrow vent-pipe, or chimney, are called reverberatory furnaces, cuppelling furnaces. Sometimes the fire-place is a part of a separate furnace, from which, however, by the draught of air, the flame of the fuel is forced over, striking upon the hearth of the cuppelling-furnace, which then is to be considered as the laboratory.

The current of air in wind-furnaces arises from the increased elasticity of that portion of air which is contained in the upper cavity of the fire-place, it being there heated by the fire, and naturally caused to expand. When this air rises by its increased elasticity, the denser and colder air below the grate must, of course, force its way to the hearth, blow up the fire, and thus maintain the combustion. It is obvious that, the air being rarer in the upper regions of the atmosphere, the higher the chimney in a close air or wind-furnace, the stronger will be the draught; that is, the air in the upper part of the chimney being exceedingly rarefied by the heat, and the atmospheric air at the vent or upper orifice of the chimney being rarer than the air below, there will be less resistance to the stream of rarefied air. The cold and dense air from below will therefore rush violently towards the ash-pit, to restore the equilibrium, and will penetrate through the fire, which it thus furnishes with a constant supply of fresh oxygen gas (the proper food of fire), and becoming rarefied in its turn by the accession of caloric, will force its way up the chimney, and thus a continual circulation is maintained, which will support almost any degree of heat while there is a regular supply of fuel, if the chimney is of a considerable height. It is evident that the size of the ash-hole should not be too large, but bear a proportion to the height of the chimney.

The perfection of a wind-furnace therefore consists, 1, in a good current of air; 2, in keeping the heat together, without losing too great a quantity of it unused; and, 3, in the facility with which the heat may be increased or weakened. The heat in wind-furnaces is increased, partly by an additional supply of fuel, partly by accelerating the draught of air. The last is effected by opening the door of the ash-pit wider, by shutting that of the fire-place, by opening the registers, and lengthening the chimney by additional vent-pipe, and also occasionally by applying the action of the bellows. The heat again is diminished by diminishing the quantity or celerity of the current of air; hence, by shutting the ash-hole, the registers, and vent-pipes, and by the proper application of these means the action of fire is weakened, or thoroughly suppressed.

Blast-furnaces increase the heat upon the same principle, by bringing in contact with the fuel a fresh supply of oxygen, but this being effected by mechanical means, viz. by bellows, they are of a simpler construction than wind-furnaces, and their ash-pit, hearth, and laboratory, are commonly but one and the same part. The blowing is most frequently effected by bellows, which for small experiments are always made of leather, and to act without interruption, should be double. At the smelting works, wooden bellows are used; but these being single, there are always at the same time two of them employed, alternately opening and shutting. The cylinder-bellows are a discovery of modern times, and exceed the common by many advantages. Water-drums, as they are called, may likewise serve for these purposes.

When the vessels in which bodies are exposed to the action of heat are not placed in immediate contact with the fire in the wind-furnace, but receive the required degree of heat by another intermediate body, such apparatus is called a bath. The proper instrument for this purpose is the sand-furnace, or a wind-furnace, whose upper aperture is shut by the sand-pot. Sand-pots are cylindrical vessels, having an outwardly convex bottom, and made of cast or sheet-iron, and at times of baked clay. Glass vessels, however, containing bodies that are to be exposed to heat, are not placed in the pot while empty; but in order that they may be heated uniformly, this last is filled with some other body, into which the vessels are lodged. The matter most commonly employed in this case is dry, finely sifted sand; and the pot filled with it is called a sand-bath. Of all baths the sand-bath is the most convenient, and sufficient to apply any degree, from gentle warmth to red-heat. Crucibles placed between coals, are also used for a sand-bath instead of sand-pots.

If vessels are heated by means of hot water, in which they are immersed, it is called a water-bath, balneum mariæ; but if they are heated merely by the steam of boiling water, it is called a vapour-bath. Since water boiling in the open air is capable of receiving only a determinate degree of heat, it becomes thereby a sure means to impart heat, without danger of exceeding a certain degree.

FURNACE, *glass painters*, is made of brick, nearly square, and about 2½ feet each way. It is cut horizontally in the middle by a grate, which sustains the pan or shovel the glass is baked in. This furnace has two apertures, one below the grate, to put the fuel in at; the other above it, through which the workman spies how the action of the colours goes on.

FURNACES, *hatters*, are of three kinds: a little one under the mould, whereon they form their hats; a larger in the scouring-room, under a little copper, full of lees; and a very large one under the great copper, wherein they dye their hats.

FURR, in commerce, signifies the skin of several wild beasts, dressed in alum with the hair on, and used as a part of dress by princes, magistrates, and others. The kinds most in use are those of the ermine, sable, castor, hare, rabbit, &c.

FURRS, in heraldry, a bearing which represents the skins of certain beasts, used as well in the doublings of the mantles belonging to the coat-armours, as in the coat-armour themselves.

FURZE, or *furze-bush*. See ULEX.

FUSANUS, a genus of the polygamia monœcia class and order. The herm. cal.

lyx is five-cleft; corolla none; stamina four; germen inferior; stigma four drupe. Male calyx, &c. the same. Fruit abortive. There is one species, a tree of the Cape.

FUSEE, in clock-work, is that part drawn by the spring, and about which the chain or string is wound. See CLOCK and WATCH-WORK.

FUSES, in artillery, according to capt. George Smith, formerly inspector to the military academy at Woolwich, are chiefly made of very dry beech wood, and sometimes of horn-beam taken near the root. They are turned rough and bored at first, and then kept for several years in a dry place. The diameter of the whole is about $\frac{1}{4}$ of an inch; the hole does not go quite through, having about $\frac{1}{4}$ of an inch at the bottom; and the head is made hollow in the form of a bowl.

The composition for fuses is, saltpetre 3, sulphur 1, and mealed powder 3, or 4, and sometimes 5. This composition is driven in with an iron driver whose ends are capped with copper, to prevent the composition from taking fire; and to keep it equally hard; the last shovel-full being all mealed powder, and 2 strands of quick match laid across each other, being driven in with it, the ends of which are folded up into the hollow top, and a cap of parchment tied over it until it is used.

FUSILEERS, in the British service, are soldiers armed like the rest of the infantry, with this difference only, that their musquets are shorter and lighter than those of the battalion and the grenadiers. They wear caps which are somewhat less, in point of height, than common grenadier caps. There are three regiments in the English service: the royal regiment of Scotch fusileers, raised in 1678; the royal regiment of Welch fusileers, raised in 1685; and the royal regiment of Welch fusileers, raised in 1688-9.

FUSILY, or *fusile*, in heraldry, signifies a field or ordinary, entirely covered over with, or divided into fusils.

FUSION, the action of fire, or more properly, of caloric, on solid bodies, by which they are caused to pass into the state of fluidity; and a body rendered liquid by fire is said to be in fusion, to flow, to melt.

From the difference between solid and fluid bodies, it follows, that the active expansive power of the caloric is the principal or true cause of fusion; since, by combining, with the solid substance, it diminishes and destroys, in a high degree, the attractive force of its particles. The fluidity of all liquid bodies, we know at present, is merely derivative, and the effect of the influx of caloric.

If we attend to the different strength of the attractive power which the particles of substances, specifically different, exert on one side amongst themselves, and on the other towards the caloric, we find no ground to wonder why some bodies require a lower, others a higher, temperature to be fused; and that it is possible to meet with some bodies, which at any degree of temperature we hitherto know in our atmosphere, continue in the liquid state. According to the various degrees of fusibility, bodies are discriminated into refractory, or of difficult fusion, which require the utmost violence of fire to be melted; and simply fusible, or of easy fusion, that will flow in less heat; yet the limits between these have not yet been ascertained by any fixed scale.

Some mixtures melt with greater ease than the single substances of which they are composed.

Some bodies cannot be rendered fluid by any degree of heat which we are able to produce. These are called infusible, apyrous or fire-proof. Several of them may, however, be fused by adding other bodies, which on account of this property are called fluxes. Such addition is called at the smelting-works dressing of the ores. It is worth remarking, that sometimes these additions are of themselves infusible.

The true fusion ought not to be confounded with the melting of some salt crystals by heat. The last is caused by the aqueous particles contained in them dissolving the salt at an increased heat, which they cannot at a weaker.

When melted bodies, by a circumambient medium of a lower temperature, are deprived of so much caloric that the original attractive forces of the bodies of which they are compounded, acquire again the degree of intensity requisite to produce the form of solidity; or when by this loss of caloric, the native attraction among the surfaces of the primitive molecules becomes again active, they concrete, or congeal.

All bodies must, in consequence of the explanation given of fusion, assume in fusion a greater volume than that which they had in their former state of solidity. This is in every respect confirmed by experience. The exception which some bodies, as ice, bismuth, antimony, sulphur, seem to make, may be easily explained by the crystallization of their parts on concreting.

Since no solution takes place without liquidity, fusion becomes one of the most effectual operations for solutions and precipitations in the dry way. Fusion is, besides, of importance in separating heterogeneous parts simply mingled by means of their different degrees of fusibility; as also by the circumstance, that various shapes may be given to bodies by casting them into moulds while in a fluid state.

Fusion is sometimes performed without any vessels at all, and then in small quantities, by the flame of a candle or lamp, with the assistance of the blow-pipe: but, in larger quantities, by placing the bodies to be fused amongst the coals in a melting furnace. At other times, the operation is done in vessels, subjected to the requisite heat, in the furnace.

When the blow-pipe made of glass or metal, is employed, the air compressed by the mouth is directed on the flame; and the heat, by that means increased, is communicated to the substance to be fused, which generally rests on a support, in a cavity made in a lump of charcoal. The apparatus by which the air is made to stream through the blow-pipe, by means of double bellows, renders this useful instrument capable of being employed by persons whose lungs do not permit them to continue the blowing long, or who are not sufficiently skilled in its management. Lastly, the heat of a lamp-flame may be raised to the highest degree, by conducting oxygen gas through the blow-pipe, by means of a peculiar apparatus.

In smelting-houses, the fusion without vessels is performed in a very simple way, by placing the substances to be fused immediately betwixt burning charcoal in the melting-furnaces. In these the fusion is urged by bellows; and they are of various constructions, to suit a variety of purposes. Hence also they have received different denominations.

Other kinds of fusion, especially in small quantities, are performed in vessels of various shape and materials. Their most essential properties, are their being infusible at any degree of heat required for melting the bodies to be fused in them; and, besides, their insolubility in that body when melted.

FUSTIAN, in commerce, a kind of cotton stuff, which seems as if it was whaled on one side.

FUTTOCKS, in a ship, the timbers raised over the keel, or the encompassing timbers that make her breadth. Of these are first, second, third, and fourth, denominated according to their distance from the keel, those next it being called first or ground futtocks, and the others upper futtocks: those timbers, being put together, make a frame-bend.

G.

G, the seventh letter of our alphabet; as a numeral was antiently used to denote 400; and with a dash over it thus, $\overline{G}$, 40,000. In music it is the character or mark of the treble cliff; and from its being placed at the head, or marking the first sound in Guido's scale, the whole scale took the name gamut. As an abbreviature, G. stands for Gaius, Gellius, gens, genius, &c. G. G. for gemina, gessit, gesserunt, &c. G. C. genio civitatis, or Cæsaris. G. L. for Gaius libertus, or genio loci. G. V. S. for genio urbis sacrum. G. B. for genio bono. And G. T. for genio tutelari.

GABARA, or *gabbara*, in antiquity, the dead bodies which the Egyptians embalmed, and kept in their houses, especially those of such of their friends as died with the reputation of great piety and holiness, or as martyrs.

GABEL, a word met with in old records, signifying a tax, rent, custom, or service, paid to the king, or other lord.

GABIONS, in fortification, baskets made of ozier-twigs, of a cylindrical form, six feet high, and four wide; which being filled with earth, serve as a shelter from the enemy's fire. See Fortification.

GABRES, or *gaurs*, in the religious custom of Persia. See Gaurs.

GAD, among miners, a small punch of iron, with a long wooden handle, used to break up the ore. One of the miners holds this in his hand, directing the point to a proper place, while the other drives it into the vein, by striking it with a sledge-hammer.

Gad-fly, or *breeze-fly*. See Oestrus.

GADOLINITE, a mineral first found in a white felspar in the quarry of Ytterby in Sweden, and received the name gadolinite, because Gadolin was the chemist who first ascertained its composition. Colour perfect black, passing sometimes to brown. Found in mass. Fracture conchoidal. Scratches quartz. Brittle. Specific gravity 4.0497. Gelatinizes with hot diluted nitric acid. Before the blow-pipe decrepitates, and assumes a whitish-red colour, but does not melt. With borax it melts into a topaz-yellow glass. Affects the magnetic needle. According to the analysis of Vauquelin, it is composed of.

35.0	yttria
25.5	silica,
25.0	oxide of iron
2.0	lime
2.0	oxide of manganese
10.5	water and carbonic acid
100.0	

Klaproth, on the other hand, found

59.75	yttria
21.25	silica
18.00	oxide of iron
0.50	alumina
99.50	

This last analysis does not differ much from that which Ekeberg had before published.

GADUS, cod, in ichthyology a genus of fishes belonging to the order of jugulares. The generic character is, head smooth; gill-membrane, seven-rayed; body oblong, covered with deciduous scales; fins all covered by the common skin; dorsal and anal generally more than one; the rays unarmed; ventral fins slender, ending in a point. There are 17 species the principal of which are,

1. Gadus morhua, or common cod. This highly important and prolific species, which furnishes employment for so many thousands, and forms so considerable a part of the subsistence of mankind, is an inhabitant of the northern seas, where it resides in immense shoals, performing various migrations at stated seasons, and visiting in succession the different coasts of Europe and America. Its history is so well detailed by Mr. Pennant, that little can be added to what that author has collected in his British and Arctic Zoology.

"The general rendezvous of the cod-fish," says Mr. Pennant, "is on the banks of Newfoundland, and the other sand-banks that lie off the coasts of Cape Breton, Nova Scotia, and New England. They prefer those situations on account of the quantity of worms produced in those sandy bottoms, which tempt them to resort thither for food; but another cause of this particular attachment to those spots is their vicinity to the polar seas, where they return to spawn: there they deposit their roe in full security, but want of food forces them, as soon as the first more southern seas are open, to repair thither for subsistence. Few are taken north of Iceland, but on the south and west coasts they abound: they are again found to swarm on the coasts of Norway, in the Baltic, off the Orkney and the Western isles; after which their numbers decrease, in proportion as they advance towards the south, when they seem quite to cease before they reach the mouth of the Straits of Gibraltar."

Before the discovery of Newfoundland, the greater fisheries of cod were on the seas of Iceland and our own Western isles, which were the grand resort of the ships of all the commercial nations; but it seems that the greatest plenty was met with near Iceland.

Newfoundland, a name in the infancy of discovery common to all North America, was discovered in the year 1496, by the celebrated Venetians Sebastian Cabot and his three sons; who, at their own charges, under a grant of Henry the seventh, giving them possession, as vassals of his, of all lands they might discover, coasted from lat. 67° 30′ to the Cape of Florida.

The isle of Newfoundland is of a triangular form, and lies between lat. 46° 40′ and 51° 30′: visited occasionally, but not inhabited, by savages from the continent. The boasted mine of this land, viz. its sand-bank, is represented as a vast sub-marine mountain, of above 500 miles long, and near 300 broad, and seamen know when they approach it by the great swell of the sea, and the thick mists that impend over it. The water on the bank is from twenty-two to fifty fathoms; on the outside from sixty to eighty; and on the smaller banks much the same: the increase of shiping that resort to these fertile banks is now unspeakable: our own country still enjoys the greatest share, and it ought to be esteemed one of our chiefest treasures, bringing wealth to individuals, and strength to the state. All this immense fishery is carried on by the hook and line only: the principal baits are herring, the small fish called a capelin, the shell-fish called clams, and pieces of sea-fowl; and with these are caught sufficient to find employ for fifteen thousand British seamen, and to afford subsistence to a much more numerous body of people at home, who are engaged in the various manufactures which so vast a fishery demands. The fish, when taken, are properly cleaned, salted, and dried, and in this state sent into various parts of the European continent.

The cod grows to a very large size. Mr. Pennant commemorates a specimen taken on the British coast which weighed 78 lbs. and measured 5 feet 8 inches in length, and 5 feet in girth round the shoulders; but the general size, at least in the British seas, is far less, and the weight from about 14 to 40 pounds; and such as are of middling size are most esteemed for the table.

The cod is of a moderately long shape, with the abdomen very thick and prominent: the head is of moderate size, and the eyes large: the jaws of equal length, the lower one bearded at the tip by a single cirrus; in the jaws and palate are numerous sharp teeth: the dorsal and anal fins are rather large, the pectoral rather small: the ventral small and slender: the tail of moderate size and even at the end, the first ray on each side being short, strong, and bony. The usual colour of this fish is cinereous on the back and sides, and commonly spotted with dull yellow: the belly white or silvery; but the colours occasionally vary very considerably, and instances are often seen in which a yellow, orange, or even red tint prevails on the upper parts of the body, while the spots are lighter or deeper according to the different seasons in which the fish is taken: the lateral line, which is one of the principal distinctive marks of the species, is broad and whitish, and the scales are somewhat larger than in others of the genus.

The food of the cod is either small fish, worms, testaceous or crustaceous animals, such as crabs, large whelks, &c. its digestion is so powerful as to dissolve the greatest part of the shells it swallows; it is very voracious, catching at any small body it perceives moved by the water, even stones and pebbles, which are often found in the stomach. The fishermen are well acquainted with the use of the air bladder or sound of this fish, and dexterously perforate the living fish with a needle, in order to let out the air contained

in that part; for without this operation the fish could not be kept under water in the well-boats, and brought fresh to market. The sounds when salted, are reckoned a delicacy, and are often brought in this state from Newfoundland. A species of isinglass is also prepared from this part of the fish by the natives of Iceland.

2. Gadus æglefinus, or haddock, is distinguished from the rest of this genus by having a forked tail, and the lower jaw longer than the upper: the colour of the body is silvery or white, with a dusky cast on the back: the lateral line is black, and on each side at some distance beyond the head, and above the pectoral fins, is a moderately large, squarish black spot: the tip of the lower jaw is furnished with a cirrus: the eyes are large; the scales small, round, and pretty closely attached to the skin.

This species is a native of the northern seas, where, like the cod, it assembles in prodigious shoals, visiting particular coasts at stated seasons; the shoals are sometimes near six miles in length, and more than a mile in breadth. "The grand shoal of haddocks," says Mr. Pennant, "comes periodically on the Yorkshire coasts. It is remarkable that they appeared in 1766 on the 10th of December, and exactly on the same day 1767. These shoals extended from the shore near three miles in breadth, and in length from Flamborough Head to Tinmouth castle, and perhaps much farther northwards. An idea may be given of their numbers by the following fact: three fishermen within the distance of a mile from Scarborough harbour frequently loaded their coble or boat with them twice a day, taking each time about a ton of fish: when they put down their lines beyond the distancce of three miles from the shore they caught nothing but dog-fish, which shews how exactly these fish keep their limits. The best were sold from eight pence to a shilling per score, and the poor had the smaller sort at a penny, and sometimes a halfpenny per score." The haddock is taken in vast quantities about Heligoland, and thence sent to Hamburgh. In stormy weather this fish is said to imbed itself in the ooze at the bottom of the sea, none being taken in such weather; and those which are taken afterwards are observed to be covered with mud on their backs.

The haddock is, in general, of moderate size, measuring about eighteen inches or two feet in length: those which are most esteemed for the table weighing from two to four pounds; but it sometimes arrives at the length of three feet, and the weight of fourteen pounds. Its food consists of small fishes, worms, and sea-insects. It spawns in the month of February.

3. Gadus callarias, or dorse, is a somewhat smaller species than the haddock, those which are usually taken rarely exceeding the weight of two pounds.

The head is smaller than that of the haddock, and is marked by several spots, which in the summer are generally brown, and in the winter black: the general colour of the fish is cinereous above, and white beneath, several brown spots being scattered over the body, which, in the young fish, are often of an orange-colour: the scales are small, thin, and soft: the upper jaw is longer than the lower, and is furnished with more rows of teeth: at the tip of the lower jaw is a cirrus or beard.

The dorse is a native of the northern seas, as well as of the Mediterranean and the Baltic. It is taken both by the line and the net, and is highly esteemed as an article of food. It lives, like most others of this genus, on the smaller fishes, and sea-insects. Instances are adduced by authors in which this fish, like the haddock, has been found greatly to exceed the usual size, and to weigh seven, eight, ten, or even fourteen pounds. It spawns in the month of February.

4. Gadus barbatus, or whiting-pout, according to Mr. Pennant, never grows to a large size, rarely exceeding a foot in length, and is distinguished from all others by its great depth; one of the size above mentioned being near four inches deep in the broadest part: the back is very much arched, and carinated: the scales larger than those of the cod-fish: the mouth small, and the head short: on each side the lower jaw are seven or eight punctures: the first dorsal fin is triangular, and terminates in a long fibre: the colour of the fins and tail are dusky or blackish, and at the bottom of the pectoral fins is a black spot: the body is white, but more obscure on the back than the belly, and tinged with yellow: the lateral line is white, broad, and crooked. This fish is in high estimation as a food, and is found in the Mediterranean and northern seas.

5. Gadus minutus, or poor, is a small species, seldom exceeding six or seven inches in length, and of a more slender form than any of the preceding kinds. It is found in the Baltic and the Mediterranean, as well as in some parts of the northern seas. Its appearance in the Mediterranean, is considered by the fishermen as the precursor of the cod, and the haddock, of which it is supposed to indicate very plentiful shoals. It is reckoned a wholesome food, and is taken both by the line and net. It is supposed to feed chiefly on worms and sea-insects, and deposits its spawn among the stones and sea-plants towards the borders of the shore.

6. Gadus merlangus, or whiting, with three dorsal fins, as in the preceding kinds, but with a beardless mouth. The whiting is, according to Mr. Pennant, the most delicate as well as the most wholesome of the genus, but does not grow to a large size, the usual length being about ten or twelve inches, and the largest scarcely exceeding that of twenty. It is a fish of an elegant make: the body is rather long, and covered with small, round silvery scales: the head and back are of a pale brown, and the sides slightly streaked with yellow. This fish is an inhabitant of the Baltic, and the northern seas, and is found in some parts of the Mediterranean. Vast shoals appear in the British seas during the spring; keeping at the distance of from about half a mile to that of three from the shore: they are caught in vast numbers by the line, and afford excellent diversion: their food consists of small fishes, sea insects and worms: they are said to be particularly fond of sprats and young herrings, with which the fishermen generally bait for them, and in defect of these with pieces of fresh herring, one being sufficient, when cut, for twenty baits. According to Dr. Bloch, the chief time of the whiting fishery in France is in the months of January and February, though in England and Holland it is practised at a much later period. It spawns in December and January.

7. Gadus carbonarius, or coal-fish, when full grown, is, in general, readily distinguished from its congeners by its very dark or black colour, though in this respect it sometimes varies: it is of a moderately long and elegant shape, with a small head, sharpened snout, and lower jaw exceeding the upper in length: when full grown the head, dorsal fins, tail and upper parts of the body are of a dusky black, which gradually softens into a silvery tinge as it approaches the abdomen. It is an inhabitant of the Baltic, the northern and Mediterranean seas: it is common on the most of our rocky and deep coasts, but particularly on those of Scotland and the Orkneys, where, according to Mr. Pennant, it swarms, and where the young or fry forms a great part of the support of the poor.

8. Gadus merluccius, or hake, with two dorsal fins. The hake is of a considerably lengthened form: the head is rather large, broad and flat at the top, but compressed on the sides; the opening of the mouth wide, and the jaws armed with two rows of long, sharped-pointed, curved teeth, intermixed alternately with smaller ones: the palate is also furnished with a row of teeth on each side; the pectoral and ventral fins are of moderate size, and of a sharpened shape, and the tail is nearly even at the end; the lateral line commences by several small warts beyond the head, and is continued in a straight direction to the tail: the usual length of the hake is from one to two feet, but it is sometimes found of the length of three feet.

This fish is an inhabitant of the Mediterranean and northern seas, in both of which its fishery is very considerable: it is salted and dried in the manner of cod, haddock, &c. but is not considered as a delicate fish, either in its fresh or salted state, and is rarely admitted to the tables of the rich and luxurious: it forms however a very useful article of food for the lower orders in many parts both of our own and other countries. It is found in vast abundance on many of our coasts, as well as those of Ireland. We are informed by Mr. Pennant that there was formerly a vast stationary fishery of the hake on the Nymph Bank, off the coast of Waterford, immense quantities appearing there twice a year; the first shoal coming in June, during the mackrel season, and the other in September, at the beginning of the herring season, probably in pursuit of those fish: it was no unusual thing for six men with hooks and lines to take a thousand hake in one night, besides a considerable quantity of other fish. At present, as we are informed by Dr. Bloch, one of the greatest hake-fisheries is carried on about the coasts of Britanny, both by the hook and net. It is carried on chiefly by night, in boats properly manned for the purpose: the principal baits for such as are taken by the line are launces, sardines, and other small fishes.

9. Gadus molva, or the ling, takes its name from its length, being corrupted from the word long: the body is very slender; the head flat. The usual size of the ling is from three to four feet, but is said to have been sometimes seen of the length of seven feet: in colour it varies, being sometimes of an olive hue on the sides and back, and sometimes cinereous: the abdomen is white, as are also the ventral fins, and the dorsal and anal are edged with white: the tail is marked

near the end with a transverse black bar, and tipped with white.

The ling is an inhabitant of the northern seas, and forms in many places a considerable article of commerce. It chiefly frequents the depths of the sea, living on small fishes, shrimps, &c. It spawns in June, depositing its eggs among the fuci on the oozy bottoms. In the Yorkshire seas the ling is in perfection from the beginning of February to the beginning of May, and come till the end of that month: as long as they continue in season the liver is very white, and abounds with fine flavoured oil; but as soon as the fish goes out of season the liver becomes red, and affords no more oil: the same circumstance is observable in several other fish in a certain degree, but not so remarkably as in the ling.

Vast quantities of this fish are salted for exportation as well as for home consumption. When it is cut or split for curing it must measure twenty-six inches, or upwards, from the shoulder to the tail; if less than that it is not reckoned a sizeable fish, and consequently not entitled to the bounty on exportation.

11. Gadus lota, or the burbot, highly esteemed for its superior delicacy, is an inhabitant of clear lakes and rivers, and is found in many parts of Europe and Asia. In our own country it occurs chiefly in the lakes of the northern counties, in some of the fens of Lincolnshire, and the rivers Witham and Trent; but it is said to arrive at its greatest perfection in the Lake of Geneva, where it is found in great plenty. In its habit or general appearance the burbot makes an obscure approach to the muræna, having a remarkably lengthened body of a subcylindric shape.

The burbot is considered as a very voracious fish, preying on all the smaller fishes, as well as on frogs, worms, and aquatic insects: it grows to a considerable size: the largest however of those which are taken in England have been rarely known to exceed the weight of three pounds, but in some parts of Europe they are found of more than double that weight, and of the length of three feet or more. The reputation of this fish as a food has long been established, but its liver is celebrated as an article of peculiar luxury; and we are informed by Aldrovandus, that an old German countess carried her epicurism so far as to expend the greatest part of her income in the purchase of this dish. The gall has been famed, like that of the stargazer, the barbel, and some other fishes, for its supposed efficacy in external disorders of the eyes.

GÆRTNERE, a genus of the decandria monogynia class and order. The calyx is five-parted; corolla five-petalled; seed-vessel nearly globose, with wings. There is one species, a shrub of the East Indies.

GAGE, in law-books, the same with surety or pledge.

Gage, in the sea-language. When one ship is to windward of another, she is said to have the weather-gage of her. They likewise call the number of feet that a vessel sinks in the water, the ship's gage: this they find by driving a nail into a pike near the end, and putting it down beside the rudder till the nail catches hold under it; then as many feet as the pike is under water, is the ship's gage.

Gage, among letter-founders, a piece of box, or other hard wood, variously notched; the use of which is to adjust the dimensions, slopes, &c. of the different sorts of letters. There are several kinds of these gages, as the flat-gage, the face gage, and italic-gage, &c.

Gage *sliding*, a tool used by mathematical instrument-makers, for measuring and setting off distances. It is also of use in letter-cutting, and making of moulds.

Gage, *sea*, an instrument invented by Dr. Hayles, and Dr. Desaguliers, for finding the depth of the sea, the description of which is this. A B, (Plate fig. 96. Miscel.) is the gage-bottle, in which is cemented the gage-tube E *f*, in the brass-cap at G. The upper end of the tube E, is hermetically sealed, and the open lower end *f*, is immersed in mercury, marked C, on which swims a small thickness or surface of treacle. On the top of the bottle is screwed a tube of brass H G, pierced with several holes, to admit the water into the bottle A B. The body K, is a weight, hanging by its shank L, in a socket N, with a notch on one side at *m*, in which is fixed the catch *l* of the spring *s*, and passing through the hole L, in the shank of the weight K, prevents its falling out, when once hung on. On the top, in the upper part of the brass-tube at H, is fixed a large empty ball, or full-blown bladder I, which must not be so large, but that the weight K may be able to sink the whole under water.

The instrument, thus constructed, is used in the following manner. The weight K being hung on, the gage is let fall into deep water, and sinks to the bottom; the socket N, is somewhat longer than the shank L, and therefore, after the weight K comes to the bottom, the gage will continue to descend, till the lower part of the socket strikes against the weight; this gives liberty to the catch to fly off the hole L, and let go the weight K; when this is done, the ball or bladder I, instantly buoys up the gage to the top of the water. While the gage is under water, the water having free access to the treacle and mercury in the bottle, will by its pressure force it up into the tube E *f*, and the height to which it has been forced by the greatest pressure, viz. that at the bottom, will be shewn by the mark in the tube which the treacle leaves behind it, and which is the only use of the treacle. This shews into what space the whole air in the tube E *f* is compressed; and consequently the height or depth of the water, which by its weight produced that compression, which is the thing required.

If the gage-tube E *f*, is of glass, a scale might be drawn on it with the point of a diamond, shewing by inspection, what height the water stands above the bottom. But the length of 10 inches is not sufficient for fathoming depths at sea, since that, when all the air in such a length of tube is compressed into half an inch, the depth of water is not more than 634 feet, which is not half a quarter of a mile.

If to remedy this, we make use of a tube 50 inches long, which for strength may be a musquet-barrel, and suppose the air compressed into an hundredth part of half an inch; then by saying as 1 : 99 :: 400 : 39600 inches, or 3300 feet; even this is but little more than half a mile, or 2640. But since it is reasonable to suppose the cavities of the sea bear some proportion to the mountainous parts of the land, some of which are more than three miles above the earth's surface, therefore, to explore such great depths, the Doctor contrived a new form for his sea-gage, or rather for the gage-tube in it, as follows: B C D F (fig. 97.) is a hollow metallic globe communicating on the top with a long tube A B, whose capacity is a ninth part of that globe. On the lower part at D, it has also a short tube D E, to stand in the mercury and treacle. The air contained in the compound gage-tube is compressed by the water as before; but the degree of compression, or height to which the treacle has been forced, cannot here be seen through the tube; therefore, to answer that end, a slender rod of metal or wood, with a knob on the top of the tube A B, will receive the mark of the treacle, and shew it, when taken out.

If the tube A B be 50 inches long, and of such a bore that every inch in length shall be a cubic inch of air, and the contents of the globe and tube together 500 cubic inches; then, when the air is compressed within an hundredth part of the whole, it is evident the treacle will not approach nearer than 5 inches of the top of the tube, which will agree to the depth of 3300 feet of water as above. Twice this depth will compress the air into half that space nearly, viz. 2½ inches, which correspond to 6600, which is a mile and a quarter. Again, half that space, or 1¼ inch, will shew double the former depth, viz. 13200 feet, or 2½ miles, which is probably very nearly the greatest depth of the sea.

Bucket-sea-Gage, an instrument contrived by Dr. Hales, to find the different degrees of coolness and saltness of the sea, at different depths; consisting of a common household pail or bucket, with two heads to it. These heads have each a round hole in the middle, near four inches diameter, and covered with valves opening upwards; and that they might both open and shut together, there is a small iron-rod fixed to the upper part of the lower valve, and at the other end to the under part of the upper valve; so that as the bucket descends with its sinking weight into the sea, both the valves open by the force of the water, which by that means has a free passage through the bucket. But when the bucket is drawn up, then both the valves shut by the force of the water at the upper part of the bucket; so that the bucket is brought up full of the lowest sea-water to which it had descended.

When the bucket is drawn up, the mercurial thermometer, fixed in it, is examined; but great care must be taken to observe the degree at which the mercury stands, before the lower part of the thermometer is taken out of the water in the bucket, else it would be altered by the different temperature of the air.

In order to keep the bucket in a right position, there are four cords fixed to it, reaching about four feet below it, to which the sinking weight is fixed.

Wind-Gage, an instrument for measuring

the force of the wind upon any given surface. It was invented by Dr. Lind, who gives the following description of it, Phil. Trans. vol. lxv. This instrument consists of two glass tubes, A *a*, C D, Plate Miscel. fig. 98. of five or six inches in length. Their bores, which are so much the better for being equal, are about four-tenths of an inch in diameter. They are connected together like a siphon, by a small bent glass-tube marked *a b*, the bore of which is about one-tenth of an inch in diameter. On the upper end of the leg A *a* there is a tube of latten brass, which is kneed or bent perpendicularly outwards, and has its mouth open towards F. On the other leg C D is a cover with a round hole G in the upper part of it, two-tenths of an inch in diameter. This cover and the kneed tube are connected together by a slip of brass *c d*, which not only gives strength to the whole instrument, but also serves to hold the scale H I. The kneed tube and cover are fixed on with hard cement or sealing-wax. To the same tube is soldered a piece of brass *e*, with a round hole in it to receive the steel spindle K L: and at *f* there is just such another piece of brass soldered to the brass-hoop *g*, which surrounds both legs of the instrument. There is a small shoulder on the spindle at *f*, upon which the instrument rests, and a small nut at *i*, to prevent it from being blown off the spindle by the wind. The whole instrument is easily turned round upon the spindle by the wind, so as always to present the mouth of the kneed tube towards it. The end of the spindle has a screw on it, by which it may be screwed into the top of a post or a stand made on purpose. It has also a hole at L, to admit a small lever for screwing it into wood with more readiness and facility. A thin plate of brass *k* is soldered to the kneed tube, about half an inch above the round hole G, so as to prevent rain from falling into it. There is likewise a crooked tube A B, fig. 99. to be put occasionally upon the mouth of the kneed tube F, in order to prevent rain from being blown into the mouth of the wind-gage when it is left out all night or exposed in the time of rain.

The force or momentum of the wind may be ascertained by the assistance of this instrument, by filling the tubes half full of water, and pushing the scale a little up or down, till the 0 of the scale, when the instrument is held up perpendicularly, be on a line with the surface of the water in both legs of the wind-gage. The instrument being thus adjusted, hold it up perpendicularly, and, turning the mouth of the kneed tube towards the wind, observe how much the water is depressed by it in the one leg, and raised in the other. The sum of the two is the height of a column of water which the wind is capable of sustaining at that time; and every body that is opposed to that wind will be pressed upon by a force equal to the weight of a column of water, having its base equal to the altitude of a column of water, sustained by the wind in the wind-gage. Hence the force of the wind upon any body where the surface opposed to it is known may be easily found; and a ready comparison may be made betwixt the strength of one gale of wind and that of another.

The force of the wind may be likewise measured with this instrument, by filling it until the water runs out at the hole G. For if we then hold it up to the wind as before, a quantity of water will be blown out; and if both legs of the instrument are of the same bore, the height of the column sustained will be equal to double the column of water in either leg, or the sum of what is wanting in both legs. But if the legs are of unequal bores, neither of these will give the true height of the column of water which the wind sustained. But the true height may be obtained by the following formulæ.

Suppose that after a gale of wind which had blown the water from A to B, fig. 100, forcing it at the same time through the other tube out at E, the surface of the water should be found standing at some level as DG, and it were required to know what was the height of the column EF or AB, which the wind sustained. In order to obtain this, it is only necessary to find the height of the columns DB or GF, which are constantly equal to one another; for either of these, added to one of the equal columns AD, EG, will give the true height of the column of water which the wind sustained. 1. Let the diameters AC, EH, of the tubes, be respectively represented by *cd*; and let $a =$ AD or EG, and $x =$ DB or GF; then it is evident, that the column DB is to the column EG, as c^2x to d^2a. But these columns are equal. Therefore $c^2x = d^2a$; and consequently $x = \frac{d^2a}{c^2}$. 2. But if, at any instant of time whilst the wind was blowing, it was observed, that when the water stood at E, the top of the tube out of which it is forced, it was depressed in the other to some given level BF, the altitude at which it would have stood in each had it immediately subsided, may be found in the following manner. Let $b =$ AB or EF. Then it is evident that the column DB is equal to the difference of columns EF, GF. But the difference of these columns is as $d^2b - d^2x$; and consequently $x = \frac{d^2b}{c^2 + d^2}$.

For the cases when the wind blows in at the narrow leg of the instrument: Let AB $=$ EF $= b$, EG or AD $= a$, GF $=$ DB $= x$, and the diameters EH, GA respectively $= d$, c, as before. Then it is evident, that the column AD is to the column GF as ac^2 to d^2x. But these columns are equal; therefore $d^2x = ac^2$; and consequently $x = \frac{ac^2}{d^2}$. It is also evident, that the column AD is equal to the difference of the columns AB, DB; but the difference of these columns is as $bc^2 - c^2x$. Therefore $d^2x = bc^2 - c^2x$. Whence we get $x = \frac{bc^2}{d^2 + c^2}$.

The use of the small tube of communication *a b*, fig. 98. is to check the undulation of the water, so that the height of it may be read off from the scale with ease and certainty. But it is particularly designed to prevent the water from being thrown up to a much greater or less altitude, than the true height of the column which the wind is able at that time to sustain, from its receiving a sudden impulse whilst it is vibrating either in its ascent or descent. As in some cases fresh water in this instrument might be liable to freeze, and thus break the tubes, Dr. Lind recommends a saturated solution of sea-salt to be used instead of it, which does not freeze till Fahrenheit's thermometer falls to 0.

Tide-GAGE, an instrument used for determining the height of the tides by Mr. Bayley, in the course of a voyage towards the south pole, &c. in the Resolution and Adventure, in the years 1772, 1773, 1774, and 1775. This instrument consists of a glass tube, whose internal diameter was 7-10ths of an inch, lashed fast to a 10 foot fir rod, divided into feet, inches, and parts; the rod being fastened to a strong post fixed firm and upright in the water. At the lower end of the tube was an exceedingly small aperture, through which the water was admitted. In consequence of this construction, the surface of the water in the tube was so little affected by the agitation of the sea, that its height was not altered the 10th part of an inch when the swell of the sea was 2 feet; and Mr. Bayley was certain, that with this instrument he could discern a difference of the 10th of an inch in the height of the tide.

GAHNIA, a genus of the monogynia order, in the hexandria class of plants. The calyx is an involucrum with two or five flowers; the corolla is two-valved; the stamina six capillary and very short filaments; the antheræ linear, sharp-pointed at the apex, and as long as the corolla; there is no pericarpium: the seed is single and oblong. There are two species, herbs of New Zealand and Otaheite.

GAIANITES, *gainaitæ*, in church history, a branch of eutychians.

GALBULA, in ornithology, a genus of the order picæ, bill straight, very long, quadrangular, pointed; nostrils oval, at the base of the bill; tongue short, sharp-pointed; thighs downy on the forepart. The viridis inhabits the moist woods of Guinea and Brazil; the size of a lark: it feeds on insects. There are three other species, viz. the grandis, the paradisca, and albirostris.

GALANGALS, the name of two roots kept in the shops, a greater and a smaller; of which the smaller is by far most esteemed. See MATERIA MEDICA.

GALANTHUS, the SNOW-DROP, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the ninth order, spathaceæ. There are three concave petals; and the nectarium consists of three small emarginated petals; the stigma is simple. There is but one species, viz. the nivalis; which is a bulbous rooted flowery perennial, rising but a few inches in height, and adorned at top with small tripetalous flowers of a white colour. There are three varieties, viz. the common single-flowered snow-drop, the semi double snow-drop, and the double snow-drop. They are beautiful little plants, and are much valued on account of their early appearance, often adorning the gardens in January or February, when scarcely any other flower is to be seen, and continue very often till the beginning of March, making a very ornamental appearance, especially when disposed in clusters towards the fronts of the borders, &c. The single kind comes first into bloom, then the semi-double, and after that the double. They will succeed any where, and multiply exceedingly by off-sets from the roots.

GALARDIA, a genus of the class and order syngenesia polygamia frustranea. The recept. is chaffy; seed crowned with five-leaved calycle; cal. two-rows of scales, almost equal. There is one species; an annual of Louisiana.

GALAX, a genus of the pentandria monogynia class and order. The cal. is ten-

leaved; cor. silver-shaped; caps. one-celled, two-valved, and elastic. There is one species, an herb of Virginia.

GALAXIA, a genus of the monodelphia triandria class and order. The spethe. is one-valved; cor. one-petalled, six-cleft; tube capillary; stigma many parted. There are two species, herbs of the Cape.

GALAXY, in astronomy, the via lactea, or milky way in the heavens: a tract of a whitish colour, and considerable breadth, which runs through a great compass of the heavens, sometimes in a double, but for the greatest part of its course in a single stream; and is composed of a vast number of stars, too minute or too remote from the earth, to be distinguished by the naked eye; but are discovered in all parts of it, in great numbers, by the assistance of the telescope. See ASTRONOMY.

GALBANUM, a gum issuing from the stem of an umbelliferous plant, growing in Persia and many parts of Africa.

It is sometimes met with in the shops in loose granules, called drops or tears, and sometimes in large masses, formed of a number of these blended together; but in these masses some accidental foulness is often mixed with the gum. The single drops usually approach to a roundish, oblong, pear-like form. Galbanum is soft like wax, and, when fresh drawn, white; but it afterwards becomes yellowish or reddish: it is of a strong smell, of an acrid and bitterish taste; it is inflammable in the manner of a resin, and soluble in water like a gum. It attenuates and dissolves tough phlegm, and is therefore of service in asthmas and inveterate coughs: it is also of great service in hysteric complaints; it dissipates flatulencies. It is given in pills and electuaries, and is used externally in form of a plaster, applied to the abdomen, against habitual hysteric complaints, and on many other occasions.

GALEASSE, a large low-built vessel, using both sails and oars, and the largest of all the vessels that make use of the latter. It may carry twenty guns, and has a stern capable of lodging a great number of marines. It has three masts, which are never to be lowered or taken down. It has also thirty-two benches of rowers, and to each bench six or seven slaves, who sit under cover. This vessel has latterly been only used by the Venetians.

GALEGA, a genus of the class and order diadelphia decandria. The cal. has tubulate teeth nearly equal; legume with streaks between the seeds. There are 19 species, some of them known by the name of goats' rue.

GALENIA, a genus of the digynia order, the octandria class of plants, and in the natural method ranking under the 13th order, succulentæ. The calyx is trifid; there is no corolla; the capsule is roundish and dispermous. There are two species, shrubs of the Cape.

GALENIC, or GALENICAL, in pharmacy, a manner of treating diseases founded on the principles of Galen. The distinction of galenical and chemical, was occasioned by a division of the practitioners of medicine into two sects, which happened on the introduction of chemistry into medicine; then the chemists, arrogating to themselves every kind of merit and ability, stirred up an opposition to their pretensions, founded on the invariable adherence of the other party to the antient practice. And although this division into two sects of galenists and chemists has long ceased, yet the distinction of medicines which resulted from it is still retained.

Galenical medicines are those which are formed by the easier preparations of herbs, roots, &c. by infusion, decoction, &c. and by combining and multiplying ingredients; while those of chemistry draw their more intimate and remote virtues by means of fire and elaborate preparations, as calcination, digestion, fermentation, &c.

GALENISTS, in church-history, a branch of anabaptists, who are said to have adopted several arian opinions concerning the divinity of our Saviour.

GALENA, in mineralogy, sulphuret of lead, is very common, and is found both in masses and crystallized. The primitive form of its crystals is a cube. The most common varieties are the cube, sometimes with its angles wanting, and the octahedron, composed of two four-sided pyramids applied base to base. The summits of these pyramids are sometimes cuneiform, and sometimes their solid angles are wanting.

Its colour is commonly blueish grey like lead, but brighter. Streak blueish grey and metallic. Lustre metallic. Sometimes stains the fingers. Texture foliated. Fragments cubical. Soft; but brittle. Specific gravity 7.22 to 7.587. Effervesces with nitric and muriatic acids. Before the blow-pipe decrepitates, and melts with a sulphureous smell; part sinks into the charcoal. It is composed of from .45 to .83 lead, and from .086 to .16 of sulphur. It generally contains some silver, and sometimes also antimony and zinc.

To this species is to be referred a mineral which occurs but rarely, called

Compact galena. Found in mass; sometimes in specular plates. Texture compact. Fracture even. Softer than common galena. Specific gravity 7.444. Streak lead grey, brighter, and metallic. Feels soft, and stains the fingers. Fragments indeterminate. Found in Derbyshire, and in different parts of Germany and Italy. Often mistaken for plumbago or molybdena. Another species is

Blue lead ore. This ore has hitherto been observed only at Zschopau in Saxony. It occurs rarely in mass, usually chrystallized in small six-sided prisms. Colour between indigo blue and lead grey; sometimes inclining to black. Usually striated longitudinally. Internal lustre metallic. Streak brighter. Texture compact. Specific gravity 5.461. Before the blow-pipe melts with a low blue flame and a sulphureous smell, and is easily reduced. It has not been analysed. Its crystals resemble those of phosphat of lead; but its component parts seem to be the same as those of galena. Brochan supposes it a phosphat converted into a galena by some unknown process. A third species is

Black lead ore. This ore is found in Saxony, Poland, Siberia, and in different parts of Britain. It occurs in mass, disseminated and cellular; but more frequently crystallized in six-sided prisms, which are generally truncated and confused. Colour greyish black. Streak greyish black. Brittle. Specific gravity from 5.744 to 5.77. Before the blow-pipe it decrepitates, melts easily and is reduced.

GALEOPITHECUS. COLUGO. A genus of quadrupeds. The generic character is front-teeth in the upper jaw none; in the lower six, short, broad, distant, pectinated; canine-teeth very short, triangular, broad, sharp, serrated; grinders four, truncated, and muricated with conical protuberances; flying-skin surrounding the body, limbs, and tail.

This singular animal, which, from its size and extraordinary conformation, claims a conspicuous place among the productions of nature, has but lately been examined with the degree of exactness necessary for ascertaining clearly its generic characters. It is to Dr. Pallas that we owe the exact knowledge of these particulars, and an accurate description, accompanied by good figures, may be found in the Transactions of the Academy of Petersburg for the year 1780.

Galeopithecus volans, the flying colugo, is a native of the Molucca and Philippine islands, where it is said to frequent woody places, and to feed principally on fruits. It almost constantly resides on trees, and makes use of its membranes in the same manner as the flying squirrel. In descending from the top of a tree, it spreads its membranes, and balances itself to the place it aims at in a gentle manner; but in ascending it uses a leaping pace. It has two young, which are said to adhere to its breasts by the mouth and claws. The whole length of the animal is about three feet: the breadth, when expanded, nearly the same: the tail is slender and about a span long. The membrane, or expansile skin, by which it is enabled to fly, is continued, on each side, from the neck to the fore feet; thence to the hind feet; and again to the tip of the tail: it is not naked, like the skin of a bat's wing, but covered with fur, in the same manner as the body: the inner or lower side, however, appears membranaceous, and is marked by numerous veins and fibres dispersed through it. The whole upper side of the animal is generally of a deep ash-colour, most so in those which are full-grown, and blacker in the younger or less advanced specimens: the back also, in the full-grown animals, is crossed transversly with blackish lines; towards the edges, is commonly a tinge of yellowish, and the whole under side, both of the body and membrane, is of a yellowish colour. The head is long; the mouth rather small; the tongue, according to Dr. Pallas, fleshy, broad, rounded, attenuated on the edges, and ciliated with papillæ, as in the opossums: it is also slightly beset with papillæ on its surface. There are no fore-teeth in the upper jaw, but in the lower are six, which are short, broad, and pretty deeply pectinated, so as to resemble little combs on their upper part: the canine teeth, or at least those which Dr. Pallas considers as such, are shaped somewhat like the petrifactions known by the name of glossopetræ, being triangular, very broad at their base, very short, sharp-pointed, and serrated: the grinders, or molares, which are generally four, both above and below, are of an abrupt or truncated form, and roughened with conical protuberances. The ears are small, round, membranaceous, and marked internally by nu-

merous semicircular transverse streaks, as in a bat. The legs are clothed with a soft yellow down: there are five toes on each foot, united by a common membrane, and terminating in large, thin, broad, very sharp crooked claws. This animal is said to be called by the Indians caguang, colugo, and gigua. It was first described by Bontius, in his History of Java. He informs us that it is found in Guzarat, in India; that it is a gregarious animal, and flies principally in the evening; and that its body is of the size of a cat, and is covered above with a soft, grey fur, like that of a rabbit; that the head is oblong, the ears small and round, and that it has five strong claws on each foot, by which it holds firmly whatever it seizes, and that it feeds chiefly on fruits. Camelli, in his enumeration of the animals of the Philippine isles, published by Petiver in the Philosophical Transactions, describes it as about the size of a cat, shaped like a monkey, but more slender, and of the length of about three spans from head to tail; but adds, that in some parts it arrives at a far larger size, so as to equal a Chinese umbrella in expanse. He describes the colour on the upper parts as dusky, and elegantly variegated with whitish streaks on the back, running beyond the body over the flying membrane; the face he compares to that of a monkey, and the manner of flight to that of a flying squirrel: Camelli adds, that the young adhere to the teats of the parent by their mouth and claws; but it is remarkable, that in his manuscript on this subject now preserved in the British Museum, he expressly asserts that the female is furnished with two sacs or pouches on her belly, in which she carries her young while sucking.

Linnæus, judging of this animal's place in systematic arrangement, from the figures and descriptions of authors, but not having had an opportunity of examining its generic characters himself, placed it in the genus Lemur, to which he supposed it most allied; but was careful, at the same time to observe, that, as its teeth had not been examined, its real genus was, of course, not determinable. By the count de Buffon it was, with unpardonable negligence, entirely omitted; nor was it till Dr. Pallas's description in the Petersburgh Transactions appeared, that its generic characters were ascertained.

GALILEANS, a sect of the Jews. Their founder was one Judas, a native of Galilee, from which place they derived their name. Their chief, esteeming it an indignity for the Jews to pay tribute to strangers, excited his countrymen against the edict of the emperor Augustus, which had ordered a taxation or enrolment of all the subjects of the Roman empire. They pretended that God alone should be owned as master and lord; and in other respects were of the opinion of the pharisees: but, as they judged it unlawful to pray for infidel princes, they separated themselves from the rest of the Jews, and performed their sacrifices apart.

GALIUM, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 47th order, stellatæ. The corolla is monopetalous and plain; and there are two roundish seeds. There are 48 species, of which the most remarkable are, the verum or yellow lady's bed-straw, and the aperine, clivers or goose-grass. The former has a firm, erect, brown, square, stem; the leaves generally eight in each whorl, linear, pointed, brittle, and often reflex; branches short, generally two from each joint, terminating in spikes of small yellow flowers. It grows commonly in dry ground and on road-sides. The flowers will coagulate boiling milk; and the best Cheshire cheese is said to be prepared with them. The French prescribe them in hysteric and epileptic cases. Boiled in alum-water, they tinge wool yellow. The roots dye a red not inferior to madder; for which purpose they are used in the island of Jura. In the Edinburgh Medical Commentaries we have accounts of some violent scorbutic complaints being cured by the juice of this plant. Sheep and goats eat the plant; horses and swine refuse it; cows are not fond of it. The aperine or clivers has a square, very rough, jointed, very weak stem, two, three, or four feet long, and adhesive: the branches are opposite; the joints hairy at the base. The expressed juice of this plant taken internally, and the bruised leaves applied by way of poultice, are said to have been used with success as a cure for the cancer. The effects are, however, uncertain: the course, it is said, often requires to be continued for nine or ten months.

GALL, in the animal œconomy, the same with bile. See PHYSIOLOGY.

GALL-BLADDER, called vesicula, and cystis fellea, is usually of the shape of a pear, and of the size of a small hen's egg. It is situated in the concave side of the liver, and lies upon the colon, part of which it tinges with its own colour. It is composed of four membranes, or coats: the common coat; a vesicular one; a muscular one, consisting of straight, oblique, and transverse fibres; and a nervous one, of a wrinkled or reticulated surface within, and furnished with an unctuous liquor. See ANATOMY.

The use of the gall-bladder is to collect the bile, first secreted in the liver, and mixing with its own peculiar produce, to perfect it farther, to retain it together a certain time, and then to expel it.

GALL, in natural history, denotes any protuberance or tumour produced by the puncture of the insects on plants and trees of different kinds. Galls are of various forms and sizes, and no less different with regard to their internal structure. Some have only one cavity, and others a number of small cells communicating with each other. Some of them are as hard as the wood of the tree they grow on, whilst others are soft and spongy; the first being termed gall-nuts, and the latter berry-galls, or apple-galls.

The general history of galls is this: an insect of the fly-kind (See CYNIPS), is instructed by nature to take care for the safety of her young, by lodging her eggs in a woody substance, where they will be defended from all injuries: she for this purpose wounds the branches or leaves of a tree, and the lacerated vessels, discharging their contents, soon form tumours about the holes thus made. The hole in each of these tumours, through which the fly has made its way, may for the most part be found; and when it is not, the maggot inhabitant or its remains, are sure to be found within, on breaking the gall. It is to be observed, however, that in those galls which contain several cells, there may be insects found in some of them, though there is a hole by which the inhabitant of another cell has escaped.

Oak-galls put, in a very small quantity, into a solution of vitriol in water, though but a very weak one, give it a purple or vitriol colour; which, as it grows stronger, becomes black; and on this property depends the art of making our writing-ink, as also a great deal of those of dying and dressing leather, and other manufactures. See INK, &c.

GALL-STONES. See CONCRETIONS.

GALLATS, in chemistry: whether gallic acid is capable of forming crystallizable salts with the different bases, is still a problem which chemists have not resolved.

1. When the alkalies are dropt into a solution of gallic acid in water, or into a solution containing gallic acid, it assumes a green colour. This change is considered by Proust as the most decisive test of the presence of gallic acid. The same change of colour takes place when gallic acid is poured into barytes water, strontian water, or lime water, and at the same time a powder of a greenish brown colour precipitates. The green liquid which remains contains only gallic acid combined with the earth employed in the experiment. But if we attempt to evaporate it to dryness, the green colour disappears, and the acid is almost completely decomposed.

2. When magnesia is boiled with the infusion of nut-galls, the liquid becomes almost limpid, and assumes the same green colour as the former mixtures. From the experiments of Mr. Davy, it appears, that in this case all the extract of tan is separated from the infusion, together with a portion of the gallic acid; and that the liquid holds in solution nothing but a combination of that acid and magnesia. But in this case also the acid is decomposed, and the green colour disappears when we attempt to obtain the composition in a dry state.

3. When a small portion of alum is mixed with the infusion of nut-galls, it separates the whole of the tan and extract, and leaves the liquid limpid and of a very pale yellowish green colour. This liquid, by spontaneous evaporation, yields small transparent prismatic crystals, which, according to Mr. Davy, are supergallats of allumina. They afford the only instance of a gallat capable of existing in the state of crystals. The quantity of allumina is very small; too small to disguise the properties of the acid.

GALLEON, in naval affairs, a sort of ships employed by Spain in the commerce of the West Indies. The Spaniards send annually two fleets; the one for Mexico, which they call the flota; and the other for Peru, which they call the galleons. By a general regulation made in Spain, it has been established, that there should be twelve men of war, and five tenders annually fitted out for the armada or galleons; eight ships of 600 tons burden each, and three tenders, one of 100 tons, for the island Margarita, and two of 80 each, to follow the armada: for the New Spain fleet, two ships of 600 tons each, and two tenders of 80 each; and for the Honduras fleet, two ships of 500 tons each: and in case no fleet happened to sail any

year, three galleons and a tender should be sent to New Spain for the plate. They are appointed to sail from Cadiz in January, that they may arrive at Porto Bello about the middle of April; where, the fair being over, they may take on board the plate, and be at Havannah with it about the middle of June; where they are joined by the flota, that they may return to Spain with the greater safety.

GALLERY, in fortification, a covered walk, across the ditch of a town, made of strong beams, covered over head with planks, and loaded with earth: sometimes it is covered with raw hides to defend it from the artificial fires of the besieged. See FORTIFICATION.

GALLERY *of a mine*, is a narrow passage, or branch of a mine carried on under-ground to a work designed to be blown up. Both the besiegers and the besieged also, carry on galleries in search of each others mines, and these sometimes meet and destroy each other.

GALLERY, in a ship, that beautiful frame, which is made in the form of a balcony, at the stern of a ship without board; into which there is a passage out of the admiral's or captain's cabin, and is for the ornament of the ship.

GALLEY, in naval affairs, a low-built vessel using both sails and oars, and commonly carrying only a main-mast and foremast, be struck or lowered at pleasure.

GALLIAMBIC VERSE, in antient poetry a verse consisting of six feet, viz. an anapest or a spondee; an iambus, or an anapest, or a tribrach; an iambus; a dactyl; an anapest.

GALLIC acid, in chemistry, is obtained from the nut-gall which grows on some species of oak. In an infusion of galls made with cold water, a sediment is formed which on examination is found to have a crystalline form and an acid taste. By letting an infusion of galls remain a long time exposed to the air, and removing now and then the mouldy skin which formed on its surface, a large quantity of this sediment was obtained; which being edulcorated with cold water, redissolved in hot water, filtrated and evaporated very slowly, yielded an acid salt in crystals as fine as sand.

Mr. Davy has lately pointed out another method which yields gallic acid in a state of considerable purity. Boil for some time a mixture of carbonat of barytes and infusion of nut-galls. A blueish green liquid is obtained, which consists of a solution of gallic acid and barytes. Filter and saturate with diluted sulphuric acid. Sulphat of barytes is deposited in the state of an insoluble powder, and a colourless solution of gallic acid remains behind.

Gallic acid, when pure, is in the form of transparent plates or octahedrons. Its taste is acid, and somewhat astringent; and when heated it has a peculiar and rather unpleasant aromatic odour.

It is soluble in one and a half parts of boiling water, and in 12 parts of cold water. When this solution is heated, the acid undergoes a very speedy decomposition. Alcohol dissolves one-fourth of its weight of this acid at the temperature of the atmosphere. When boiling hot, it dissolves a quantity equal to its own weight. It is insoluble in ether. When exposed to the action of heat, it is sublimed without alteration: but a strong heat decomposes it in part, and converts it into an acid water, carbureted hydrogen gas, carbonic acid gas, oil, and charcoal. When distilled, a quantity of oxygen gas is disengaged, an acid liquor is found in the receiver, with some gallic acid not decomposed, and there remains in the retort a quantity of charcoal. If what has passed into the receiver is again distilled, more oxygen gas is obtained, some gallic acid still sublimes, and a quantity of charcoal remains in the retort. By repeated distillations the whole of the acid may be decomposed. This decomposition may be more easily accomplished by distilling repeatedly a solution of gallic acid in water. The products are oxygen gas, charcoal, and an acid liquor.

From these experiments it was concluded, that gallic acid is composed of oxygen, and a much larger proportion of carbon than enters into the composition of carbonic acid. But this conclusion is not warranted by the analysis: for the quantity of oxygen gas and carbon obtained was not equal to that of the gallic acid decomposed; and in the acid liquor which came over, there evidently existed a quantity of water, which doubtless was formed during the distillation. Scheele, by treating gallic acid with nitric acid in the usual manner, converted it into oxalic acid. Now it is certain that oxalic acid contains hydrogen as well as carbon. It cannot be doubted, then, that gallic acid is composed of oxygen, hydrogen, and carbon, in proportions not yet ascertained. But Mr. Deyeux has proved, that the quantity of carbon is very great, compared with that of the hydrogen.

Gallic acid is not altered by exposure to the air. Neither oxygen gas, the simple combustibles, nor azote, seem to have any particular action on it. Its action on the metals has not been examined. It combines with alkalies, earths, and metallic oxides, and forms compounds called gallats, most of which are still but very imperfectly known.

As the greater number of its combinations with metallic oxides are insoluble, it for the most part occasions a precipitate when poured into a solution containing a metal; and this precipitate differs in colour, according to the metal which occasions it. Hence this acid, or at least the infusion of nut-galls, is very much used by chemists to detect the presence of metals when held in solution. The formation of a precipitate, with infusion of nut-galls, is even considered as a property almost peculiar to metallic oxides. It ought to be remarked, however, that all the metals are by no means precipitated from their solutions by gallic acid. The following must be excepted:

1. Platinum,
2. Tin,
3. Zinc,
4. Cobalt,
5. Manganese,
6. Arsenic.

The following Table exhibits a view of the colours of the precipitates of different metals by means of this acid:

Gold - -	Brown
Silver - -	Brown
Mercury -	Orange yellow
Copper - -	Brown
Iron - -	Black
Lead - -	White
Nickel - -	Grey
Bismuth -	Orange
Antimony -	White
Tellurium -	Yellow
Uranium -	Chocolate
Titanium -	Reddish brown
Chromium -	Brown
Columbium -	Orange

Molybdic acid acquires a dark yellow colour, but does not precipitate.

But the colour of these metallic precipitates varies considerably according to the state of oxydizement, and the acid with which they are composed. These differences are especially remarkable in the solutions of mercury and copper.

Gallic acid produces no change in the solutions of alkaline salts: But when dropt into barytes water, strontian water, or lime water, it gives them a blueish-red colour, and occasions a flaky precipitate, composed of the acid combined with the earths.

Gallic acid occasions a precipitate when poured into solutions of glucina, yttria, and zirconia in acids. This property distinguishes these three bodies from all the other earths, none of which are precipitated from their solutions in acids by gallic acid.

The affinities of gallic acid are still undetermined. Mr. Richter has shewn, that it is not capable of taking iron from sulphuric acid, as has been hitherto supposed, unless it is assisted by the action of some other body which has an affinity for sulphuric acid. He has endeavoured to shew, too, contrary to the experiments of Proust, that it strikes a black with all the oxides of iron; but his proofs are by no means sufficient to decide that point.

GALLINÆ, in ornithology, the fifth order of birds: the upper mandible is channelled, extending with a margin above the lower, and a little bowed; the nostrils are covered with a cartilaginous membrane; they live upon grain, dust themselves, make an artless nest and lay many eggs. Under this order are comprehended the peacock, pheasant, turkey, the common dunghill cock, partridge, grous, dodo, curissoa, &c.

GALLIUM, *ladies bed-straw*. See GALIUM.

GALLON, a measure of capacity both for dry and liquid articles, containing four quarts; but these quarts, and consequently the gallon itself, are different, according to the quality of the thing measured; for instance, the wine gallon contains 231 cubic inches, and holds eight pounds five ounces and two-thirds avoirdupois, of pure water: the beer and ale gallon contains 282 solid inches, and holds ten pounds three ounces and a quarter avoirdupois, of water: and the gallon for corn, meal, &c. two hundred and sixty eight cubic inches and four fifths, and holds nine pounds eleven ounces and a half of pure water.

GALLON, in commerce, a narrow thick kind of ferret or lace, used to edge or border clothes, sometimes made of wool, and at others of gold or silver.

GALOPINA, a genus of the tetandria digynia class and order. Cal. none; cor. four-cleft; seeds two, naked. A plant of the Cape.

GALVANISM, a term used to denote the influence of metals by mere external contact with the animal body. In the year

1791, a very remarkable discovery made by Dr. Galvani of Bologna was announced to the scientific world in a publication entitled, Aloysii Galvani de Viribus Electricitatis in motu musculari Commentarius. Bononiæ 1791.

The discoveries of Galvani were made principally with dead frogs. He in the first place discovered that a frog dead and skinned, is capable of having its muscles brought into action by means of electricity, even in exceedingly small quantities.

Secondly, that independant of any apparent electricity, the same motions may be produced in the dead animal, or even in a detached limb, merely by making a communication between the nerves and the muscles, with substances that are conductors of electricity. If the circuit of communication consists of non-conductors of electricity, as glass, sealing-wax, and the like, no motion will take place. Similar experiments were also successfully instituted upon other animals; and as the power seemed to be inherent in the animal parts, those experiments, or the power which produces the motion of the muscles in those experiments, were denominated animal electricity. But it being now fully ascertained, that by the mere contact of metallic and other conducting substances, some electricity is generated, it is evident that the muscular motions in the above-mentioned experiments are produced by that electricity; hence we have confined the name of animal electricity to denote the power of the fishes which give the shock, &c, as described in a preceding article. (See ELECTRICITY.) And, at least for the present, we shall examine the electricity which is produced by the contact, or by the action, of metallic and other conducting substances upon each other, under the title of galvanism; though in truth Galvani's discoveries go no farther than what relates to certain effects of the contact of animal parts principally with metallic. We shall briefly describe the several facts which relate to the above-mentioned sort of muscular motion, and shall then proceed to those which refer to the wonderful effects of the mere contact or action of one conducting substance upon another, amongst which the metallic are the most conspicuous.

The action of electricity on a frog, recently dead and skinned, (and indeed on other animals more or less) occasions a tremulous motion of the muscles, and generally an extension of the limbs.

Dr. Galvani used to skin the legs of a frog recently dead, and to leave them attached to a small part of the spine, but separated from the rest of the body. Any other limb may be prepared in a similar manner; viz. the limb is deprived of its integuments, and the nerve which belongs to it is partly laid bare.

If the limbs thus prepared, for instance the legs of a frog, are situated so that a little electricity may pass through them, be it by the immediate contact of an electrified body, or by the action of electric atmospheres (as when the preparation is placed within a certain distance of an electrical machine, and a spark is taken from the prime conductor); the prepared legs will be instantly affected with a kind of spasmodic contraction, sometimes so strong as to jump a considerable way.

When the electricity is caused to pass through the prepared frog by the immediate contact of the electrified body, a much smaller quantity of it is sufficient to occasion the movements, than when it is made to pass from one conductor to another, at a certain distance from the prepared animal.

The movements are much stronger when the electricity is caused to pass through a nerve to the muscle or muscles, than through any other part.

The sensibility of the prepared animal is greatest at first, but it diminishes by degrees till it vanishes entirely. Animals with cold blood, and especially frogs, retain that sensibility for several hours, sometimes even for a day or two. With other animals the sensibility does not last long after death, and sometimes not above a few minutes.

The like movements may be produced in the prepared animal without the aid of any apparent electricity. In an animal recently dead, detach one end of a nerve from the surrounding parts, taking care to cut it not too near its insertion into the muscle; remove the integuments from over the muscles which depend on that nerve; take a piece of metal, as a wire, and touch the nerve with one extremity of it, and the muscles with its other extremity; on doing which you will find that the prepared limbs move in the same manner as when some electricity is passed through them. This, however, is not the most effectual way of forming the communication; yet it will generally succeed, and the experiment will answer whether the preparation is laid upon conductors or upon electrics.

If the communication between the nerve and the muscle is formed by the interposition of non-conductors of electricity, such as glass, sealing-wax, &c. then no movements will take place.

When the application of the metal or metals is continued upon the parts, the contractions will cease after a certain time, and on removing the metal, seldom, if ever, any contraction is observed.

The conducting communication between the muscle and the nerve may consist of one or more pieces, and of the same or, much better, of different bodies connected together, as metals, water, a number of persons, and even wood. But it must be observed, that the various bodies, which form this circuit, must be placed in full and perfect contact with each other, which is done by pressure, or by the interposition of water, &c. The less perfect conductors will answer only at first, when the prepared animal is vigorous; but when the power begins to diminish, then the more perfect conductors only will answer, and even these will produce various effects.

The most effectual way of producing those movements in prepared animal parts is by the application of two metals, of which silver and zinc seem upon the whole to be best, though silver and tin, or copper and zinc, and other combinations, are not much inferior. If part of the nerve proceeding from a prepared limb is wrapped up in a bit of tin foil, or only laid upon zinc, and a piece of silver laid with one end upon the bare muscle, and with the other upon the above-mentioned tin or zinc, the motion of the prepared limb will be very vigorous. The two metals may be placed not in contact with the preparation, but in any other part of the circuit, which may be completed by means of other conductors, as water, &c.

The best preparation for this experiment is made in the following manner:

Separate with a pair of scissars the head and upper extremities of a frog from the rest of the body. Open the integuments and muscles of the abdomen, and remove the entrails, by which means you will lay bare the crural nerves. Then pass one blade of the scissars under the nerve, and cut off the spine with the flesh close to the thighs, by which means the legs will remain attached to the spine by the nerves alone. This done, leave a small bit only of the spine attached to the crural nerves, and cut off all the rest. Thus you will have the lower limbs G, H, (fig. 1, Plate Galvanism) of the frog adhering to the bite of spine A B, by means of the crural nerves C, D. These legs must be flayed in order to lay bare the muscles; and a bit of tin foil should be wrapped round the spine A B. With this preparation the experiment may be performed in various ways, but the two which follow are the best.

Hold the preparation by the extremity of one leg, the other leg hanging down, with the armed bundle of nerves and spine lying upon it. In this situation interpose a piece of silver, as a half-crown, between the lower thigh and the nerves, so that it may touch the former with one surface, and the metallic coating of the latter with the other surface, or with its edge; and you will find that the hanging leg will vibrate very powerfully, sometimes so far as to strike against the hand of the operator, which holds the other leg.

Otherwise, place two wine-glasses, both full of water, contiguous to each other, but not actually touching. Put the thighs and legs of the preparation in the water of one glass, and laying the nerves over the edges of the two glasses, let the bit of spine with its armour (viz. tin foil) touch the water of the other glass. Things being thus prepared, if you form the communication between the waters of the two glasses, by means of silver, or put the fingers of one hand into the water of the glass that contains the legs, and holding a piece of silver in the other, you touch the coating of the nerves with it, you will find that the prepared legs move so powerfully as sometimes to jump fairly out of the glass.

Fig. 2 represents a prepared frog suspended on a metallic wire, and parallel to the animal, a metallic chain. When the receiver *x* is exhausted, on pushing down th erod so that the nerve of the frog and the chain may touch the metallic plate *z* at the bottom, the frog is convulsed as in the open air.

By the application of armours of different metallic substances, and forming a communication between them, the motions may be excited even in an entire living frog, as also in some other living animals, particularly eels and flounders. The living frog is placed upon a piece of zinc, with a slip of tin foil pasted upon its back. This done, whenever the communication is formed between that zinc and the tin foil, especially if silver is used, the spasmodic convulsions are excited, not only in the muscles which touch the metallic substances, but likewise in the neighbouring

muscles. This experiment may be performed entirely under water.

Fig. 3 represents a living frog placed in an exhausted receiver, the animal being tied to a plate of silver by a silken string, and having a piece of tin foil on its back. As often as the circuit is completed, the convulsions ensue.

The experiment may be performed with a flounder in a similar easy and harmless manner. Take a living flounder; wipe it pretty dry, and lay it flat on a pewter plate, or upon a sheet of tin foil; and place a piece of silver, as a shilling, a crown piece, &c. upon the fish. Then, by means of a piece of metal, complete the communication between the pewter plate or tin foil and the silver piece: on doing which the animal will give evident tokens of being affected.

It seems that such movements may be excited by the contact of metallic substances in all the animals; at least they have succeeded, but in different degrees, in a great variety of animals from the ox to the fly.

Fig. 4 shows the method of producing convulsions in cold-blooded animals, by the influence of warm-blooded animals. The right hand of the experimentalist is placed in the ear, previously moistened with salt and water, of an ox's head, while in the other hand a prepared frog is suspended by the foot, and the sciatic nerves brought into contact with the ox's tongue. Convulsions are immediately produced in the muscles of the frog.

The human body, whilst undergoing certain chirurgical operations, or its amputated limbs, have been convulsed by the application of metals. But the living animal body may be rendered sensible of the action of metallic application in an harmless way, and both the senses of taste and sight may be affected by it, but in different degrees according to the various constitutions of individuals.

Let a man lay a piece of metal, as zinc, upon his tongue, and a piece of some other metal, as silver, under the tongue; on forming the communication between those two metals, either by bringing their outer edges in contact, or by the interposition of some other piece of metal, he will perceive a peculiar sensation, a kind of irritation, accompanied with a sort of cool and subacid taste, not exactly like, and yet not much different from, that which is produced by artificial electricity. The sensation seems to be more distinct when the metals are of the usual temperature of the tongue. The silver or gold may be applied to any other part of the mouth, to the nostrils, to the ear, or to other sensible parts of the body, whilst the zinc is applied to the tongue; and on making the communication between the two metals, the taste will be perceived upon the tongue. The effect is rather more remarkable when the zinc touches the tongue in a small part, and the silver in a great portion of its surface, than vice versa. Instead of the tongue, the two metals may also be placed in contact with the roof of the mouth, as far back as possible; and on completing the communication, the taste or irritation will be perceived.

Different persons are variously affected by this application of metals; with some the sensation or taste is so slight as to be hardly perceived, whilst with others it is very strong and even disagreeable. Some persons feel merely a pungency, and not properly a taste.

In order to affect the sense of sight by means of metals, let a man in a dark place put a slip of tin foil upon the bulb of one of his eyes, and let him put a piece of silver, as a spoon or the like, in his mouth. On completing the communication between the spoon and the tin foil, a faint flash of white light will appear before his eyes. This experiment may be performed in a more convenient manner, by placing a piece of zinc between the upper lip and the gums, as high up as possible, and a silver piece of money upon the tongue; or else by putting a piece of silver high up in one of the nostrils, and a piece of zinc in contact with the upper part of the tongue; for in either case the flash of light will appear whenever the two metals are made to communicate, either by the immediate contact of their edges, or by the interposition of other good conductors.

By continuing the contact of the two metals, the appearance of light is not continued, it being only visible at the moment of making the contact, and sometimes, though rarely, at the instant of separation: it may therefore be repeated at pleasure, by disjoining, and again connecting; the two metals. When the eyes are in a state of inflammation, the appearance of light is much stronger.

When the science was advanced no farther than the knowledge of the above-mentioned facts, it was doubtful whether the convulsions of prepared animal limbs, and the sensations which are produced by the application of metallic substances, were owing to some electrical property peculiar to the animal parts, which might perhaps be conducted through the metals from one part to the other; or to a small quantity of electricity, which might be supplied by the metals themselves. The latter supposition however was soon verified by the result of various experiments, which prove in the most convincing manner that electricity is produced by the mere contact, not only of metallic substances, but likewise of other bodies.

The electricity thus produced by the mere contact of two bodies is so very small as not to be perceived without great care, and without using some of those artifices for discovering small quantities of electricity, which have been mentioned above. But the discoveries of the ingenious Mr. Volta have shewn a method of increasing that electricity to a most extraordinary degree. We shall now proceed to state those facts in as compendious a manner as the nature of the subject will admit of.

The action of metallic substances upon the organs of living, or of recently dead animals, has been fully manifested by the above-mentioned discoveries of Galvani and others; but, previously to those discoveries, a variety of facts, frequently asserted, imperfectly known, and often disbelieved, indicated a peculiar action arising from a combination of different metallic bodies in certain cases.

It had been long asserted, that when porter (and some other liquors also) is drunk out of a pewter pot, it has a taste different from what it has when drunk out of glass or earthenware.

It has been observed, that pure mercury retains its metallic splendour during a long time; but its amalgam with any other metal is soon tarnished or oxidated.

The Etruscan inscriptions, engraved upon pure lead, are preserved to this day; whereas some medals of lead and tin, of no great antiquity, are much corroded. Works of metal, whose parts are soldered together by the interposition of other metals, soon tarnish about the places where the different metals are joined.

When the copper sheeting of ships is fastened on by means of iron nails, those nails, but particularly the copper, are readily corroded about the place of contact.

It had been observed that a piece of zinc might be kept in water for a considerable time, with hardly oxidating at all; but that the oxidation would soon take place if a piece of silver happened to touch the zinc, whilst standing in water.

Since Galvani's discoveries, the action arising from the combination of three conductors has been examined with great care, and with considerable success, especially by Mr. Volta, who lately discovered that the slight effect of such a combination may be increased to a prodigious degree by repeating the combination; for instance, if a combination of silver, zinc, and water, produce a certain effect, a second combination (viz. another piece of silver, another piece of zinc, and another quantity of water) added to the first, will increase the effect; the addition of a third combination will increase the effect still more, and so on.

Previously to the description of the construction of the very remarkable effects of those repeated combinations, which are now generally called galvanic batteries, it will be necessary to state the principal laws, which have been pretty well ascertained with respect to the simple combinations.

1. The conductors of electricity, which, strictly speaking, do almost all differ from each other in conducting power, are nevertheless divided into two principal classes. Those of the first class, otherwise called dry and perfect conductors, are the metallic substances and charcoal. Those of the second class, or the imperfect conductors, are water and other oxidating fluids, as also the substances which contain those fluids. But as the substances of the second class differ in conducting power much more than those of the first class, so they may be subdivided into species.

Mr. Volta arranges those substances in the following order, commencing with the least active; observing, however, that this order is subject to a considerable deviation, especially with respect to the latter species, and according as they are combined with certain bodies of the first class.

"1. Pure water; (It may be observed, that water holding in solution common air, and especially oxygen gas, is much more active than water deprived of air by boiling or otherwise.) 2. Water mixed with clay or chalk; 3. A solution of sugar; 4. Alcohol; 5. Milk; 6. Mucilaginous fluids; 7. Animal gelatinous fluids; 8. Wine; 9. Vinegar and other vegetable juices and acids; 10. Saliva; 11. Mucus from the nose; 12. Blood; 13. Brains; 14. Solution of salt; 15. Soap suds; 16. Chalk-water; 17. Concentrated mineral acids; 18. Strong alkaline leys; 19. Alkaline fluids; 20. Livers of sulphur."

2. The simplest combinations capable of producing galvanic effects, (viz. to convulse the prepared limbs of a frog, or to excite the taste upon the tongue, &c.) must consist of three different conductors; for two conductors only will not produce any sensible effect. If the three conductors are all of the first class, or all of the second, then the effect is seldom sensible. In this case such conductors of the second class as differ more from each other, are more likely to produce a sensible effect than those of the first class. But a proper active simple combination must consist of three different bodies; viz. of one conductor of one class, and two different conductors of the other class. Thus (denoting the bodies of the first class by means of large capital letters, and those of the second class by small letters) the combinations of fig. 5 and 6, are active; but those of fig. 7, 8, 9, 10, and 11, are not active; because that of fig. 7, 8, or 9, consists of two bodies only, and that of fig. 10, or 11, consists of three bodies, of which two are of the same sort, and of course act as a single body.

When two of the three bodies are of the first class, and one is of the second, the combination is said to be of the first order; otherwise it is said to be of the second order.

In a single active galvanic combination, or, as it is commonly called, in a simple galvanic circle, the two bodies of one class must touch each other in one or more points, at the same time that they are connected together at other points by the body of the other class. Thus, when a prepared frog is convulsed by the contact of the same piece of metal in two different places; then the fluids of those parts, which must be somewhat different from each other, are the two conductors of the second class, and the metal is the third body, or the conductor of the first class. If two metals are used, then the fluids of the prepared animal, differing but little from each other, may be considered as one body of the second class. Thus also, when a person drinks out of a pewter mug, the saliva or moisture of his under lip is one fluid or one conductor of the second class, the liquor in the mug is the other, and the metal is the third body, or conductor of the first class.

3. It seems to be indispensably requisite, that in a simple galvanic circle, the conductor or conductors of one class should have some chemical action upon the other conductor or conductors; without which circumstance the combination of three bodies will have either no galvanic action at all, or a very slight one. Farther, the galvanic action seems to be proportionate to the degree of chemical agency; which seems to shew that such chemical action is the primary cause of the electric phenomena.

The most active galvanic circles of the first order, are when two solids of different degrees of oxidability are combined with a fluid capable of oxidating at least one of the solids. Thus gold, silver, and water, do not form an active galvanic circle; but the circle will become active if a little nitric acid, or any fluid decomposable by silver, is mixed with the water.

A combination of zinc, silver, and water, forms an active galvanic circle; and the water is found to oxidate the zinc, provided the water holds some atmospherical air, as it commonly does, and especially if it contains oxygen gas. But zinc, silver, and water containing a little nitric acid, form a more powerful galvanic circle, the fluid being capable of acting both upon the zinc and upon the silver.

The most powerful galvanic combinations of the second order, are when two conductors of the second class have different chemical actions on the conductors of the first class, at the same time that they have an action upon each other. Thus copper, or silver, or lead, with a solution of an alkaline sulphuret, and diluted nitrous acid, forms a very active galvanic circle.

The present state of knowledge relative to this subject, does not enable us accurately to determine the particular powers of all sorts of galvanic combinations; the following lists, however, contain an useful arrangement of the best combinations, disposed in the order of their powers, and commencing with the most powerful.

Table of galvanic circles of the first order, viz. which consist of two conductors of the first class, and one of the second.

Zinc, with gold, or charcoal, or silver, or copper, or tin, or iron, or mercury; and water containing a small quantity of any of the mineral acids.

Iron, with gold, or charcoal, or silver, or copper, or tin, and a weak solution of any of the mineral acids, as above.

Tin, with gold, or silver, or charcoal, and a weak solution of any of the mineral acids, as above.

Lead, with gold, or silver, and a weak acid solution, as above.

Any of the above metallic combinations, and common water, viz. water containing atmospheric air, or especially water containing oxygen air.

Copper, with gold, or silver, and a solution of nitrate of silver and mercury; or the nitric acid; or the acetous acid.

Silver, with gold, and the nitric acid.

Table of galvanic circles of the second order, viz. which consist of one conductor of the first class, and two of the second.

Charcoal, or Copper, or Silver, or Lead, or Tin, or Iron, or Zinc,	with water, or with a solution of any hydrogenated alkaline sulphurets, capable of acting on the first three metals only;	and a solution of nitrous acid, or oxygenated muriatic acid, &c. capable of acting upon all the metals.

The action of a simple galvanic circle seems to be in some measure dependant upon the quantity of surface of contact between the acting bodies. A higher temperature, within certain limits, renders the activity of the circle greater than a lower temperature.

The activity of a galvanic circle is not altered by the interposition of such conductors as have no action upon the adjoining conductors of the circle. Thus, if a circle consists of zinc, gold, and water; and if you interpose a piece of iron, or of silver, or both, between the zinc and the gold; the activity of the circle will not be altered. Hence it appears that the action of a galvanic circle may be conveyed through extraneous conductors to a considerable distance; but it must be observed, that the activity is weakened by the great length of the conductors, especially if they are of an imperfect nature.

4. When the three bodies which form a galvanic circle of the first order are laid one upon the other, but the lower and the upper one do not touch each other; then these two extremes are in opposite electric states, viz. the extremity which is next to that metallic surface that touches the body of the second class, is positive, and the opposite extremity is negative. Thus let copper, zinc, and moistened leather, be laid one upon the other, as in fig. 12, and the upper end W, viz. the wetted leather, will be found possessed of positive electricity; whilst the lower end C, or the copper, will be found negative.

5. The galvanic effects may be increased to almost any degree, by connecting several of the above-mentioned active combinations, or by a repetition of the same simple galvanic combination (the most active simple combinations forming the most powerful batteries, and vice versa) provided the simple combinations are disposed so as not to counteract each other.

Those batteries are said to be of the first or of the second order, according as the simple combinations, of which they consist, are of the first or of the second order. Thus, if a piece of zinc is laid upon a piece of copper, and a piece of moistened card upon the zinc; then a similar arrangement of three other such pieces laid upon them, and a third arrangement upon this, &c. all in the same order; the whole will form a battery of the first order. But if the arrangement is made by connecting a piece of copper with a piece of cloth moistened with water; the latter with a piece of cloth moistened with a solution of sulphuret of potass, and this again with another piece of copper, &c. the whole will form a battery of the second order.

Mr. Davy distinguishes the batteries of the second order into the following three classes:

1. The most feeble is composed, whenever single metallic plates, or arcs, are arranged in such a manner, that two of their surfaces, or ends opposite to each other, are in contact with different fluids, one capable and the other incapable of oxidating the metal. And regular series of such combinations are formed.

2. When the single combinations or elements of the series consist each of a single plate or arc of a metallic substance capable of acting upon sulphurated hydrogen, or upon sulphuret dissolved in water, accompanied with portions of a solution of sulphurets of potass on one side, and water on the other.

3. The most powerful class is formed when metallic substances oxidable in acids, and capable of acting on solutions of sulphurets, are connected, as plates, with oxidating fluids and solutions of sulphuret of potass, in such a manner that the opposite sides of every plate may be undergoing different chemical changes, the mode of alternation being regular.

The above-mentioned restriction, viz. that the parts of a battery must not counteract each other, will be easily understood by considering that every simple, but interrupted galvanic combination, has a positive and

a negative end; or that in every complete galvanic circle, the electric fluid circulates in one way only. Thus, if two simple combinations are disposed as in fig. 14, this arrangement will not have any galvanic power, because the actions of the two simple combinations, or the two currents of electricity, are opposed to each other; the two positive ends being called *p*, and the two negative ends *n*. But if those fixed bodies are disposed as in fig. 15, then the combination will be very active; because, according to the hypothesis, the direction of the electric fluid in each simple arrangement tends the same way, and probably the one accelerates the other.

What has been said above of the arrangement of two simple galvanic combinations, must be likewise understood to hold good with respect to the connection of any number of the same; viz. that they must not counteract each other; or, if a certain number of them counteract each other, then the remaining only form the active part of the battery. For instance, if a battery consists of 40 simple combinations, and if 12 of them are placed in a direction contrary to the others; then these 12 will counteract 12 others, and of course the whole battery will have no more power than if it consisted of 16 simple combinations properly disposed.

This points out a method of comparing the powers of two batteries; for if those batteries are connected in an inverted order, viz. the positive end of one to touch the negative end of the other; then, on connecting the two other extremities, or on applying them to proper instruments, the whole power will be annihilated, if the separate batteries had equal power; otherwise the power of the whole will be the excess of the power of the most powerful battery above that of the weakest; and the direction, viz. its being positive or negative, will shew to which battery it belongs. It must be observed, with respect to the inactive arrangement of fig. 14, that if one of the separate bodies Z, is removed, then the remaining five bodies will form an active combination; for in that case, W, W, become one body, and S, S, likewise act as one body.

It is almost superfluous to observe, that (as has been said with respect to simple circles) in a galvanic battery the interposition of conductors that have no particular action, or of the conductors of the same class as the adjoining bodies, does not alter the effect of the battery.

Thus far we have stated the general laws, which have been pretty well ascertained with respect to galvanic combinations. We shall now proceed to describe the practical construction, and the effects of those combinations, especially of the compound arrangements or batteries.

The simplicity of single galvanic circles is so great, that nothing more need be said with respect to their construction; for when the three bodies are selected, the operator needs only take care that their contact is perfect.

Galvanic batteries have been constructed of various shapes, and they may be endlessly diversified. But the most usual forms are represented by figs. 16, 17, and 19. Those of figs. 16 and 17 are more easily constructed; that of fig. 16, however, is the most commodious.

The battery, fig. 16, consists of several glasses, or china cups, full of water, or of water containing salt, &c.; and two plates unconnected with each other, viz. a plate of zinc and a plate of silver, are plunged in the fluid of each cup, excepting the first and last cups; but each of those plates must have a sort of tail or prolongation, by which they are so connected that the silver plate of one cup communicates with the zinc plate of the next, and so on.

The battery, fig. 17, consists of pieces of silver, about as big as half-crowns, pieces of zinc, of an equal size to those of silver, and pieces of card, or cloth, or leather, or other bibulous substance, a little smaller in diameter than the metallic pieces, and soaked in water or in other proper fluid.

Those pieces are disposed in the order of silver, zinc, and wet cloth, &c. as indicated by the letters S, Z, W. The pieces of card, or cloth, &c. must be well soaked in the fluid; but before they are applied, they should be squeezed, in order that the superfluous fluid may not run down the outside of the pile, or insinuate itself between the contiguous pieces of silver and zinc. Those pieces, especially if soaked in plain water, lose their moisture pretty soon, so that they can hardly serve longer than for a day or two; after which time the pile must be decomposed, the metallic pieces cleaned, those of cloth or card soaked again, and the whole arranged as before.

The three rods R, R, R, are of glass or of baked wood; and the piece of wood, O, slides freely up or down the rods. This serves to prevent the falling of the pieces.

When such battery is to be very powerful, viz. is to consist of numerous pieces, the best way is to form two or three or more piles, and to join them by pieces of metal, as *c c* in fig. 18, where two piles are joined together, so that *a* is the negative extremity, and *b* is the other or positive extremity of the whole arrangement, or of the two piles considered as one.

The battery, fig. 19, consists of a strong oblong vessel of baked wood, about three inches deep and about as much broad. In the sides of this vessel grooves are made opposite to each other, and about one-eighth of an inch in depth. In each pair of opposite grooves a double metallic plate, viz. a plate of zinc and a plate of silver soldered together at their edges, are cemented; by which means the wooden vessel is divided into several partitions, or cells, about half an inch broad, as is sufficiently indicated by the figure. The cementation of the metallic pieces into the sides and the bottom of the wooden vessel, must be so accurate as not to permit the passage of any fluid from one cell into the next. The cement proper for this purpose is made by melting together 5 parts of resin, 4 parts of bees'-wax, and 2 parts of powdered red ochre.

Those cells are afterwards filled almost to the top with water, or any other fluid, according to the foregoing table; and thus the whole will form a battery, consisting of various repetitions of silver, zinc, and fluid. Two or more of such batteries may be joined, as has been said of the preceding battery. See fig. 24.

It need hardly be observed, that instead of zinc, copper, and water, other combinations may be made according to the table. At present the last-described batteries are constructed with copper, zinc, and water mixed with a small proportion of nitric or muriatic acid. For the construction of such batteries it is immaterial whether the metals are quite pure or slightly alloyed.

The action of all these batteries is greatest when they are first completed or filled with the fluid; and it declines in proportion as the metal is oxidated, or the fluid loses its power. Hence, after a certain time, not only the fluid must be changed, but the metallic pieces must be cleaned by removing the oxidated surface; which is done either by filing or by rubbing them with sand or sand-paper, or by immersing them for a short time in diluted muriatic acid, and then wiping them with a coarse cloth. The metallic pieces of the battery, fig. 19, may be cleaned by the last method, and may be wiped by introducing a stick with a rag into the cells.

Thus much may be sufficient with respect to the construction of simple and compound galvanic arrangements. It is now necessary to state the effects of those combinations. Indeed, the mode of applying single galvanic circles, and their principal effects, have already been described; yet, for the sake of assisting the memory, it will be useful to collect those effects under the four following heads, in explanation of which we shall add such farther experiments and observations as could not with propriety be mentioned before.

(1) The action of a single galvanic circle affects the organs of living animals, or of animals recently dead, especially when one end of the combination is connected with a nerve, and the other end is connected with a muscle of the same limb.

(2) That action may be transmitted thro' good conductors of electricity, but not thro' electrics, or through less perfect conductors.

(3) It affects the electrometer by the intermediation of other instruments.

(4) That action increases, or otherwise modifies, the chemical agency of the bodies concerned, upon each other.

The limbs of animals, especially of frogs recently dead, are the most sensible instruments of galvanic powers; and, in fact, the simplest galvanic circles will affect them, when they will not produce any other decisive electrical effect.

The various powers of different simple circles may be ascertained by applying them to such animal preparations as have their vitality or irritability more or less exhausted. Thus Mr. Volta, in his letter to Gren, says, "If you take a frog, the head of which has been cut off, and which has been deprived of all life by thrusting a needle into the spinal marrow, and immerse it without skinning, taking out the bowels, or any other preparation, into two glasses of water, the rump into one, and the legs into the other as usual; it will be strongly agitated and violently convulsed when you connect the water in both glasses by a bow formed of very different metals, such as silver and lead, or, what is better, silver and zinc; but this will by no means be the case when the two metals are less different in regard to their powers, such

as gold and silver, silver and copper, copper and iron, tin and lead. But what is more, the effect will be fully produced on this so little prepared frog, when you immerse in one of the two glasses the end of a bow merely of tin or zinc, and into the other glass the other end of this bow which has been rubbed over with a little alkali. You may perform the experiment still better with an iron bow, one end of which has been covered with a drop or thin coating of nitrous acid; and beyond all expectation, when you take a silver bow, having a little sulphuret of potass adhering to its extremity."

When a single powerful galvanic combination of the second order is applied with one end to the tongue, and with the other fluid end to some other sensible part of the body, an acid taste is perceived on the tongue, which taste, by continuing the contact, becomes less distinct, and is even changed into an alkaline taste.

If a tin bason is filled with soap-suds, lime-water, or a strong ley, which is still better; and if you then lay hold of the bason with both your hands, having first moistened them with pure water, and apply the tip of your tongue to the fluid in the bason, you will immediately be sensible of an acid taste upon your tongue, which is in contact with the alkaline liquor. This taste is very perceptible, and, for the moment, pretty strong; but it is changed afterwards into a different one, less acid, but more saline and pungent, until at last it becomes alkaline and sharp, in proportion as the fluid acts more upon the tongue.

Mr. Davy observes, that if zinc and silver are made to form a circle with distilled water, holding in solution air, for many weeks, a considerable oxidation of the zinc is perceived, without the perceptible evolution of gas; and the water, at its point of contact with the silver, becomes possessed of the power of tinging green, red cabbage juice, and of rendering turbid, solution of muriate of magnesia.

The chemical action of bodies upon each other is increased by the galvanic arrangement so much, that some of them are by that means enabled to act upon bodies that otherwise they would have no action upon. Fig. 20. represents a glass tube about four inches long. Two corks are thrust into its apertures A and B. An oblong piece of zinc, CD, is fixed into one of the corks, and is made to project within and without the tube. EFG is a silver wire, which, being fixed into the other cork, projects with the extremity E within the tube; and its other extremity is bent so as to come near the projecting part of the zinc C.

Remove one of those corks, and fill the tube with water, in which you must mix a drop or two of muriatic acid; then replace the cork, and you will find that the zinc is acted upon by the diluted acid, is oxidated by it, and bubbles of gas are evolved from it; but the silver wire E remains untouched, and no gas whatever is evolved from it. Now, if you bend the silver wire FG, so that its end G may touch the zinc at C, then the galvanic circle of silver, zinc, and diluted acid is completed, in consequence of which the diluted acid is enabled to act stronger upon the zinc D, which is manifested by the more copious evolution of gas, and is besides enabled to act upon the silver wire; for now you will observe the evolution of gas from the silver E also. Break the contact between G and C, and the silver E will cease to yield gas. Form it again, and gas will again proceed from the silver.

Instead of silver, zinc, and diluted muriatic acid, you may in the same manner use gold, tin, and diluted nitric acid; and by completing the circle, the acid will be enabled to act upon the gold.

It has been observed, that whenever an oxidating influence is exerted at one of the places of contact of the perfect and imperfect conductors, a deoxidating action appears to be produced at the other place. Thus when iron, which oxidates rapidly when forming a circle with silver and common water, is arranged with zinc and common water, it remains perfectly unaltered, whilst the zinc is rapidly acted upon.

Such are the facts which have as yet been discovered with respect to the power of single galvanic circles. They form a remarkable addition to the science of electricity, and open a vast field of speculation and experimental investigation; yet we are unable to form a theory sufficient to account for the original cause, or for the action of that very remarkable power; and we can only wait with patience for the probable elucidation, which may be afforded by farther discoveries.

If the effects of single circles are very remarkable, the collected power of several single circles, or of the battery, cannot fail of surprising the least reflecting mind.

The battery not only convulses the prepared limbs of a frog, or produces the appearance of a flash of light before the human eye; but it shews all the phenomena of electricity in a very considerable degree. It gives the shock; it affects the electrometer; shews a luminous spark, accompanied with an audible report; it burns metallic and other combustible bodies; and continues in action for a very long time, viz. until the chemical action between the component parts of the battery is quite exhausted. The following paragraphs contain a more particular, yet concise, enumeration of those wonderful effects.

When the galvanic battery of the first order consists of 20 repetitions of simple combinations, if you touch with one hand one extremity of the battery, as at *b*, in any one of the above-described batteries (see figs. 17, 18, 19.), and apply your other hand to the other extremity of the battery, as at *a*, you will feel a very slight shock, like that which is communicated by a Leyden phial weakly charged, and it will be hardly felt beyond the fingers, or at most the wrists. This shock is felt as often as you renew the contact. If you continue the hands in contact with the extremities *b* and *a*, you will perceive a slight but continued irritation; and, when the hand or other part of the body, which touches the extremity of the battery, is excoriated or wounded, this sensation is disagreeable and rather painful.

The dry skin of the human body is seldom capable of conducting this shock; therefore the touching fingers should be well moistened with water. It will be better to immerse a wire that proceeds from one extremity of the battery, in a bason of water, wherein you may plunge one of your hands; then grasping with your other hand well moistened a large piece of metal, for instance a large silver spoon, touch the other end of the battery with it, and the shock will be felt more distinctly. By this means the shock has been felt when the battery consisted of less than 20 repetitions.

Instead of one person, several persons may join hands (which must be well moistened with water), and on completing the circuit, they will all feel the shock at the same instant. But the strength of the shock is much diminished by its passing through the several persons, or, in general, by passing through less perfect conductors.

The shock from a battery consisting of 50 or 60 repetitions of the most active combinations of the first order may be felt as far as the elbows; and the combined force of five or six such batteries will give a shock perhaps much stronger than most men would be willing to receive. The prepared limbs of a frog or other animal are violently convulsed, but soon exhausted of their irritability by the action of a galvanic battery.

This shock is similar to that of a large common electrical battery weakly charged, and not to that of a small Leyden phial fully charged. The difference consists in this, viz. that the latter contains a small quantity of electric fluid highly condensed; hence its discharge will force its way through perhaps an inch of air; whereas the former contains a vast quantity of electricity but little condensed; hence its spark, viz. its course thro' the air, is so very short, that the fingers must be brought almost into perfect contact in order to receive the shock; and such is the case with the galvanic battery: for the shock from a very powerful battery of this sort will hardly ever force its way through the air, when the extremities of the circle of communication are more than a fortieth of an inch distant, even when those extremities consist of perfect conductors. In this case a small but very vivid spark is seen at that extremity, accompanied with an audible but not strong report. There is no perceptible difference of appearance between the spark of the positive and that of the negative end of the battery.

If a wire proceeding from one extremity of a pretty strong battery is made to communicate with the inside coating, and a wire, which proceeds from the other extremity of the battery, is made to communicate with the outside coating of a common large jar or electrical battery; the latter will become weakly, but almost instantaneously, charged, in the same manner as if it had been charged by a few turns of a common electrical machine; and with that charge you may either give the shock or affect on electrometer, &c.

In short, every thing conspires to prove that a galvanic battery produces a vast quantity of electric fluid, but which is little condensed; and indeed it would be impossible to suppose that the electric fluid could proceed in a very condensed state from an arrangement of bodies, which, whether more or less, are however all good conductors of electricity; for if the fluid was much condensed at one extremity of the battery, and much rarefied at the other extremity, the condensation would soon be made through the pile itself. Indeed, it is difficult to com-

prehend how this compensation does not take place in all cases.

Having mentioned above, that the charge of a battery may be communicated to a common electrical battery, it is almost superfluous to observe, that the same may be communicated to a condenser, or to a multiplier, and from it to the electrometer. If the battery consists of 200 repetitions, the electrometer will be affected by the simple contact.

The spark, or the discharge of a galvanic battery, when sent through thin inflammable bodies that are in contact with common or oxygen air, sets them on fire, and consumes them with wonderful activity. It fires gunpowder, hydrogen gas, phosphorus, and other combustibles; it renders red-hot, fuses, and consumes very slender metallic wires and metallic leaves. The mode of applying the power of the battery for such purposes is shewn in fig. 21, where AB represents a powerful galvanic battery; ACDF is a wire which communicates with the last plate of the battery at A; BKIHG is another wire which communicates with the last plate at B. DE, HI, are two glass tubes, through which those wires pass, and into which they are fastened sufficiently steady. Those tubes serve to move the wires by; for if the operator applies his fingers to the middlemost parts of those tubes, he may move the wires whereever he pleases, without the fear of receiving a shock. If the two extremities F,G, are brought sufficiently near to each other, the spark will be seen between them. It is between those extremities that the combustible substances, or metallic leaf, &c. is to be placed, in order to be fired or consumed. This figure represents the situation of the wires in the act of inflaming gunpowder. A battery consisting of 200 pairs of metallic plates (viz. copper and zinc, each five inches square) melted 23 inches of very fine iron wire. A platina wire about $\frac{1}{175}$ inch in diameter, was melted into a globule. Fig. 24 is the representation of a compound battery of the same kind, fastened together with iron cramps *a*, *b*, *c*.

Under the exhausted receiver of the air-pump, the galvanic battery acts less powerfully than in the open air; but in oxygen air it acts with increased power.

The flash of light which appears before the eye of the experimenter, when the eye itself, or some other part not very remote from it, is put in the circuit of a galvanic combination, does not appear much greater when a battery is employed than when two plates are applied in the manner which has been already mentioned; but when the battery is used, the sensation of a flash may be produced in various ways. If one hand or both be placed in perfect contact with one extremity of the battery, and almost any part of the face brought into contact with the other extremity of the battery, the flash will appear very distinctly, the experimenter being in the dark, or keeping his eyes shut. This flash appears very strong, when a wire which proceeds from one extremity of the battery is held between the teeth, and rests upon the tongue, whilst the other wire is held in the hand. In this case the lips and the tongue are convulsed, the flash appears before the eyes, and a very pungent taste is perceived in the mouth.

If any part of the human body, forming part of the circuit of a galvanic battery, is kept sometime in that situation, the irritation or numbness is more or less distinct, and more or less painful, according to the sensibility of the parts concerned. This application is likely to prove most useful as a remedy in various disorders. It is said that it has already proved beneficial in deafnesses and in rheumatisms. It highly deserves to be tried by medical persons. See fig. 25.

The most extraordinary phenomena of a galvanic battery are the chemical effects and the modifications which are produced by it upon the bodies concerned, or upon such as are placed in the circuit. We shall first describe the simplest mode of exhibiting the principal of those phenomena, namely, the evolution of gas from water, from which the mode of conducting similar experiments is easily derived; then shall transcribe the various particulars which relate to those chemical effects, from the Journals of the British Royal Institution, where they are concisely expressed.

AB, fig. 22, exhibits a glass tube full of distilled water, and having a cork at each extremity. EF is a brass or copper wire, which proceeds from one extremity of a galvanic battery, and, passing through the cork A, projects within the tube. HG is a similar wire, which proceeds from the other extremity of the battery, and comes with its extremity G within the distance of about an inch or two from the wire F.

In this situation of things, you will find that bubbles of gas proceed in a constant stream from the surface G of the wire which proceeds from the negative end of the battery; these bubbles of gas, ascending to the upper part of the tube, accumulate by degrees. This gas is the hydrogen, and may be inflamed. At the same time the other wire F deposits a stream of oxide in the form of a stream or cloud, which gradually accumulates in a greenish form in the water, or on the sides of the tube, and is a perfect oxide of the brass. The wire F is readily discoloured and corroded. If you interrupt the circuit, the production of gas and of oxide ceases immediately. Complete the circuit, and the production of gas re-appears.

This production of gas may be observed even where the battery consists of not more than six or eight repetitions of silver, zinc, and water. In short, if the power of the battery is sufficient to oxidate one of the wires of communication, the other wire will afford hydrogen gas; both extremities of the wires being in water.

In this experiment it seems that the hydrogen is separated from the water, and is converted into a gaseous state by the wire connected with the negative extremity of the battery; whilst the oxygen unites with and oxidates the wire connected with the positive end of the battery. If you connect the positive end of the battery with the lower wire of the tube, and the negative with the upper, then the hydrogen proceeds from the upper wire, and the lower wire is oxidated.

If two wires of gold or platinum are used, which are not oxidable; then the stream of gas issues from each, the water is diminished, and the collected gas is found to be a mixture of hydrogen and oxygen. It explodes violently.

Those two different elastic fluids may be obtained separate from each other by the following means: Let the extremities of the two wires which proceed from the battery, be immersed in water, at the distance of about an inch from each other, and place over each of them a small glass vessel inverted and full of water, as in fig. 23. Dr. Priestley, however, who denies the convertibility of water into hydrogen and oxygen air, thinks that the elastic fluid in these experiments originates from the air which is contained in the water; "since," says he, "if by means of oil upon the water, or a vacuum, access to the atmosphere is cut off, the whole production of gas ceases." Nor is any air produced when the water has been exhausted of it.

In the above described apparatus, a little hole must be made in the lower cork B, for the purpose of giving exit to the water in proportion as the gas is formed.

In all batteries of the first order, when the connexion is completed, changes take place which denote the evolution of influences capable of producing from common water oxygen and hydrogen, acid and alkali, in different parts of the body.

Thus in the battery with a series of zinc plates, silver wires, and common water, oxide of zinc is formed on all the plates of zinc, whilst hydrogen is produced from the silver wires; and if the water in contact with them is tinged with red cabbage juice, it becomes green.

And in the battery with silver, gold, and weak nitric acid, the silver is dissolved, whilst the acid becomes green, and slowly evolves gas at its points of contact with the gold.

The chemical agencies exerted in the compound batteries of the first order can be best observed by the substitution of single metallic wires for some of the plates; for, in this case, the changes taking place in the series with wires, will be exactly analogous to those produced in the series with plates; silver, and all the more oxidable metals, oxidating in water, in the usual place, and gold and platina evolving oxygen gas.

Thus, when into two small glass tubes, connected by a moist animal substance, and filled with distilled water, two gold wires are introduced from a large battery in the proper order, oxygen is produced in one quantity of water, and hydrogen in the other, nearly in the proportions in which they are required to form water by combustion: and if the process is continued for some time, the apparatus being exposed to the atmosphere, the water, in the oxygen-giving tube, will become impregnated with an acid (apparently the nitrous); whilst that in the hydrogen-giving tube will be found to hold in solution an alkali, which, in certain cases, has appeared to be fixed.

From some experiments it would appear probable, that the quantities of hydrogen, produced in series, are small, and the quantities of alkali great, in proportion as the surfaces of contact of the least oxidable metals with the water are more extended.

All the oxygenated solutions of bodies possessing less affinity for oxygen than nascent hydrogen, are decomposed when exposed to the action of the metal occupying the place of the least oxidable part of the series in the compound circle.

Thus, sulphur may be produced from sulphuric acid; and copper and other metals precipitated in the metallic form from their solvents.

GALVANISM.

Fig. 1.

Fig. 3.

Fig. 2.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

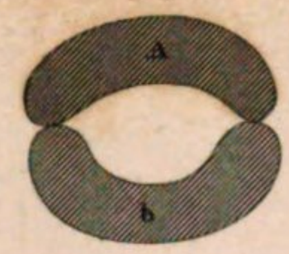


Fig. 8.

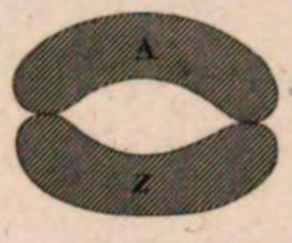


Fig. 9.

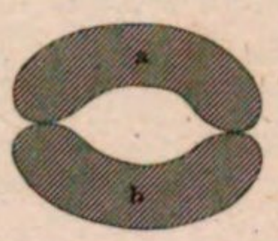


Fig. 10.

Fig. 11.

Fig. 13.

Fig. 12.

Fig. 14.

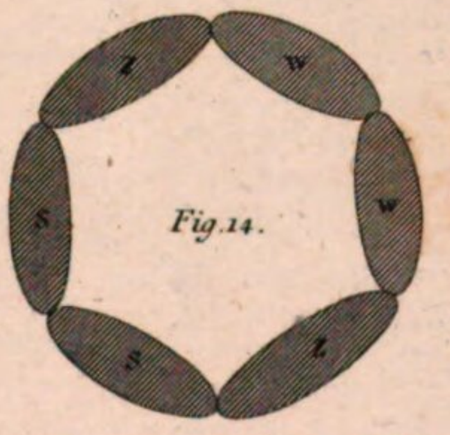


Fig. 15.

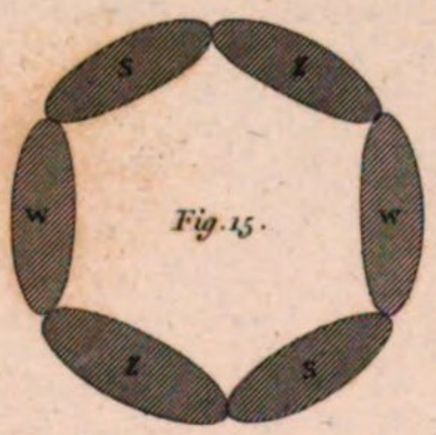


Fig. 17.

Fig. 18.

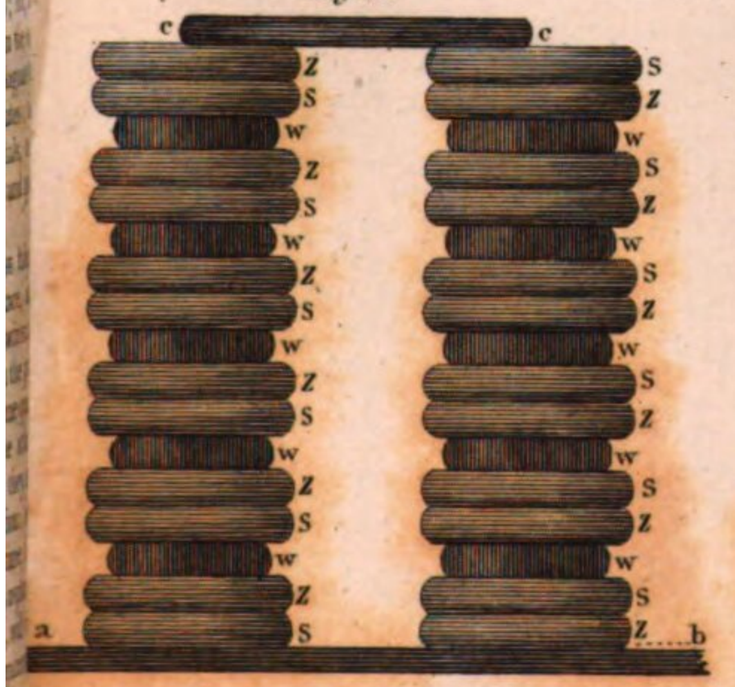


Fig. 20.

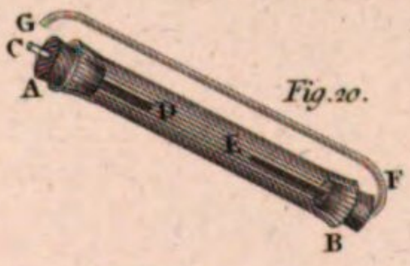


Fig. 22.

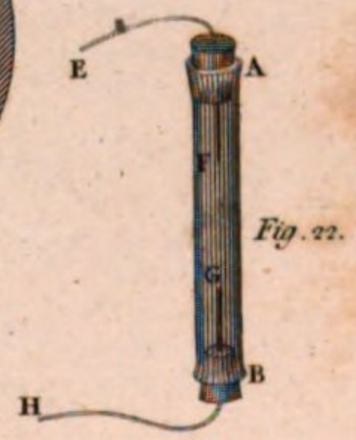


Fig. 16.

Fig. 24.

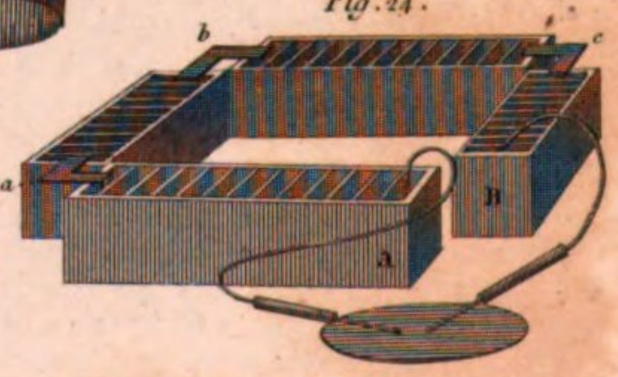


Fig. 19.

Fig. 25.

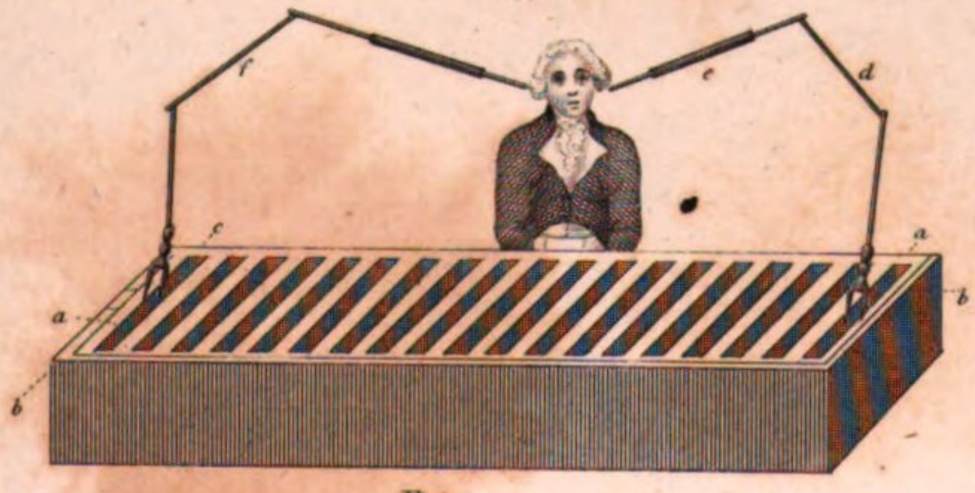


Fig. 21.

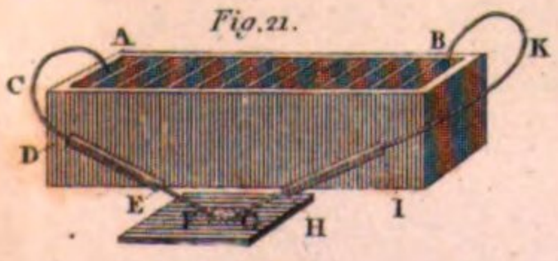


Fig. 23.

London: Published July 1st 1802 by Brindley & Co. New Bond Street & Phillips Bridge Strand.

Cooper Sculp.

It is well known that hydrogen gas, in its nascent state, reduces the oxides of metals. Accordingly, when the tube, fig. 22. is filled with a solution of acetite of lead in distilled water, and a communication is made with the battery as above described, no gas is perceived to issue from the wire which proceeds from the negative end of the battery; but, in a few minutes, beautiful metallic needles are perceived on the extremity of this wire; these soon increase, and assume the form of a fern or other vegetable. The lead thus separated is in its perfect metallic state, and very brilliant.

When a solution of sulphat of copper is employed, the copper is precipitated in its metallic state; but instead of appearing in crystals, it forms a kind of button, which adheres firmly to the end of the wire.

On making the experiment with a solution of nitrate of silver, the silver is precipitated in the form of a beautiful metallic brush, the metal shooting into fine needle-like crystals.

If iron is immersed in a solution of sulphate of copper, the latter metal will be precipitated in a metallic form, and will adhere to the surface of the former. Upon silver merely immersed in the same solution, no such effect is produced; but as soon as the two metals, viz. the silver and the copper, are brought into contact, the silver receives a coating of copper.

Little knowledge has yet been obtained concerning the chemical changes taking place in the batteries of the second order. But from several experiments it would appear that they are materially different in the laws of their production from those taking place in the first order.

Thus, when single metallic wires with water are placed as series in powerful batteries of the second order, the influence producing oxygen seems to be transmitted by the point in the place of that part of the plate which was apparently incapable of undergoing oxidation; whilst the hydrogen is evolved from that point where the oxidating part of the primary series appeared to exist.

The agency of the galvanic influence, which occasions chemical changes and communicates electrical charges, is probably in some measure distinct from that agency which produces sparks and the combustion of bodies.

The one appears (all other circumstances being similar) to have little relation to surface in compound circles, but to be great in some unknown proportion, as the number of series are numerous. The intensity of the other seems to be as much connected with the extension of the surfaces of the series as with their number.

Thus, though eight series composed of plates of zinc and copper, about 10 inches square, and of cloths of the same size, moistened in diluted muriatic acid, give sparks so vivid as to burn iron wire, yet the shocks they produce are hardly sensible, and the chemical changes indistinct; whilst 24 series of similar plates and cloths, about two inches square, which occasion shocks and chemical agencies more than three times as intense, produce no light whatever.

A measure of the intensity of the power in galvanic batteries, producing chemical changes, may be derived from the quantity of gas it is capable of evolving from water in a given time.

The preceding facts can hardly leave any doubt with respect to the identity of the galvanic power and the electricity which is produced by means of a common electrical machine, or that is brought down from the clouds; but, what is still more remarkable, it reconciles to the same principle the animal electricity, viz. the power of the torpedo, gymnotus electricus, &c. since all the phenomena of the animal electricity agree with those of the galvanic battery. See ELECTRICITY.

But the most striking circumstance is, that the electric organ of any of the above-mentioned fishes seems to be constructed exactly like a galvanic battery; for it consists of little laminæ or pellicles arranged in columns, and separated by moisture. It seems, in short, to be a galvanic battery, consisting of conductors of the second order only, but undoubtedly of different conducting powers.

Though the galvanic battery exhibits all the leading properties of common electricity, such as the attraction, the spark, &c. yet in some effects, viz. the decomposition of water, oxygenation of metals, &c. the former seem to differ considerably from the latter; but those apparent differences have been sufficiently reconciled by some very ingenious experiments and observations of Dr. W. H. Wollaston. See Phil. Trans. 1801.

With respect to the decomposition of water, which was thought to require very powerful electrical machines, he justly suspected, that by reducing the surface of communication, the decomposition of water might be effected with less powerful means; and this was verified by actual experiments. "Having," he says, "procured a small wire of fine gold, and given it as fine a point as I could, I inserted it into a capillary glass tube; and after heating the tube so as to make it adhere to the point, and cover it in every part, I gradually ground it down, till, with a pocket-lens, I could discern that the point of the gold was exposed.

"The success of this method exceeding my expectations, I coated several wires in the same manner, and found that when sparks from the conductors were made to pass through water by means of a point so guarded, a spark passing to the distance of one-eighth of an inch would decompose water, when the point exposed did not exceed $\frac{1}{700}$ of an inch in diameter. With another point which I estimated at $\frac{1}{1500}$ of an inch, a succession of sparks, $\frac{1}{20}$ of an inch in length, afforded a current of small bubbles of air.

"I have since found that the same apparatus will decompose water with a wire $\frac{1}{40}$ of an inch diameter, coated in the manner before described, if the spark from the prime conductor passes to the distance of $\frac{4}{10}$ of an inch of air.

He also found that with a gold point similar to, but much smaller than any of the above-mentioned, and similarly situated in water, the mere current of electricity, without any sparks, would occasion a stream of very small bubbles to rise from the extremity of the gold.

"Having coloured a card," he adds, "with a strong infusion of litmus, I passed a current of electric sparks along it, by means of two fine gold points, touching it at the distance of an inch from each other. The effect, as in other cases, depending on the smallness of the quantity of water, was most discernible when the card was nearly dry. In this state, a very few turns of the machine were sufficient to occasion a redness at the positive wire, very manifest to the naked eye. The negative wire being afterwards placed on the same spot, soon restored it to its original blue colour."

Dr. Wollaston likewise remarks another strong point of analogy between the electricity of the galvanic battery and that of a common electrical machine, viz. that they both seem to depend upon oxidation. In fact, a common electrical machine will act more or less powerfully, according as the amalgam which is applied to its rubber consists of metals that are more or less oxidable.

GAMBEZON, or GAMBA, in antiquity, a kind of soft quilted waistcoat, worn under the coat of mail to prevent its hurting the body. It was made of wool or cotton, quilted between two stuffs, and was also called counterpoint.

GAMBOGE, is a concreted vegetable juice, and is partly of a gummy and partly of a resinous nature. It is brought to us either in form of orbicular masses, or of cylindrical rolls of various sizes, and is of a dense, compact, and firm texture, and of a beautiful yellow. It is chiefly brought to us from Cambaja, in the East Indies, called also Cambodja and Cambogia; and thence it has obtained its names of cambadium, cambogium, and gambogium.

It is a very rough and strong purge; it operates both by vomit and stool, and both ways with much violence, almost in the instant in which it is swallowed, but yet without griping. It requires caution and judgment in administering it; but those who know how to give it properly, find it an excellent remedy in dropsies, cachexies, jaundice, asthmas, catarrhs, and in the worst cutaneous eruptions.

Its dose is from two or three grains to six, eight, or ten: four grains generally operate briskly without vomiting, and eight or ten grains usually vomit briskly, and afterwards purge downwards.

It is at present much more esteemed by painters in water-colours than by physicians.

GAME, in general, signifies any diversion or sport that is performed with regularity, and restrained to certain rules.

Games are usually distinguished into those of address and those of hazard. To the first belong chess, tennis, billiards, wrestling, &c. and to the latter those performed with cards or dice, as back-gammon, ombre, picquet, whist, &c.

It would be a most salutary maxim to be adopted generally, that no game should be pursued but such as afforded exercise, and consequently contributed to the health of the body. In this view we greatly prefer such as tennis and billiards to the pernicious sedentary games at present pursued, which are only productive of gouts, palsies, &c.

GAMES, in antiquity, were public diversions, exhibited on solemn occasions. Such,

among the Greeks, were the Olympic, Pythian, Isthmian, Nemæan, &c. games; and, among the Romans, the Apollinarian, Circensian, Capitoline, &c. games.

It was also customary among the Greeks for persons of quality to institute games, with all sorts of exercises, as running, wrestling, boxing, &c. at the funerals of their friends, to do them honour, and render their death more remarkable. This practice is frequently mentioned by antient writers, as Miltiades's funeral in Herodotus, Brasidas's in Thucydides, Timoleon's in Plutarch, with many more. Nor was this custom peculiar to later ages, since we find the description of Patroclus's funeral games takes up the greatest part of one of Homer's Iliads; and even prior to this, the funeral of Œdipus is said to have been solemnized with sports.

Among the Romans, there were three sorts of games, viz. sacred, honorary, and ludicrous. The first were instituted immediately in honour of some deity or hero; of which kind were those already mentioned, together with the augustales, florales, palatini, &c. The second class were those exhibited by private persons at their own expence, in order to please the people, and ingratiate themselves with them, to make way for their own preferment: such were the combats of gladiators, the scenic games, and other amphitheatrical sports. The ludicrous games were much of the same nature with the games of exercise and hazard among us: such were the ludus trojanus, tesseræ, tali, trochus, &c.

By a decree of the Roman senate, it was enacted, that the public games should be consecrated and united with the worship of the gods; whence it appears, that feasts, sacrifices, and games, made up the greatest part, or rather the whole, of the external worship offered by the Romans to their deities. Others distinguish the Roman games into 1. The equestrian, or curule games, which were the same with the circensian. 2. The gymnic games, wherein were exhibited gladiatorial and other shews of the like nature: these were sacred to Mars and Minerva. 3. The theatrical entertainments, consisting of tragedies, comedies, &c.: these were sacred to Apollo, Bacchus, Minerva, Venus, &c.

GAME. It is a maxim of the common law, that goods of which no person can claim any property belong to the king by his prerogative. Hence those animals feræ naturæ, which come under the denomination of game, are styled in our laws his majesty's game; and that which he has he may grant to another; in consequence of which another may prescribe to have the same, within such a precinct or lordship. And hence originated the right of lords of manors or others to the game within their respective liberties.

As the sole right of taking and destroying game belongs exclusively to the king, as such he may authorize the only persons who can acquire any property, however fugitive and transitory, in the animals coming under that denomination.

For the preservation of these species of animals; for the recreation and amusement of persons of fortune, to whom the king, with the advice and assent of parliament, has granted the same; and to prevent persons of inferior rank from misemploying their time, the following acts of parliament have been made. The common people are not injured by these restrictions, no right being taken from them which they ever enjoyed; but privileges are granted to those who have certain qualifications therein mentioned, which before rested solely in the king. 2 Bac. Abr. 612.

For the sake of perspicuity, we have arranged the different acts of parliament in alphabetical order.

Certificates to be dated the day of the month when issued, and shall be in force till the 1st of July following and no longer; and if any clerk of the peace, his deputy or steward, clerk, &c. issue certificates otherwise than directed, to forfeit 20*l*. 25 G. III. sess. 2.

No person to destroy game until he has delivered an account of his name and place of abode to the clerk of the peace, or his deputy, or to the sheriff or steward clerk of the county, riding, shire, stewartry, or place where such person shall reside, and annually take out a certificate thereof, which must have a stamp-duty of 3*l*. 3*s*. 25 Geo. III. sess. 2.

Any person counterfeiting or forging any seal or stamp directed to be used by this act, with intent to defraud the revenue, or shall utter and sell such counterfeit, on conviction thereof shall be adjudged a felon, and shall suffer death without benefit of clergy; and all provisions of former acts relative to stamp duties to be in force in executing this act. *Id.*

Every qualified person shooting at, killing, taking, or shooting any pheasant, partridge, heath-fowl, or black-game, or any grouse or red game, or any other game, or killing, taking or destroying any hare with any greyhound, hound, pointer, spaniel, setting-dog, or other dog, without having obtained such certificate, shall forfeit the sum of 20*l*. *Id.*

Clerks of the peace or their deputies, or the sheriff or steward clerks, in their respective counties, ridings, shires, stewartries, or places, shall, on or before November 1, 1785, or sooner if required by the commissioners of his majesty's stamp duties, transmit to the head office of stamps in London, a correct list in alphabetical order of the certificates by them issued between the 25th day of March, in the year 1785, and the 1st of October in the same year; and shall also in every subsequent year, on or before the 1st of August in each year, make out and transmit to the stamp-office in London, correct alphabetical lists of the certificates so granted by them, distinguishing the duties paid on each respective certificate so issued; and on delivery thereof, the receiver-general of the stamp duties shall pay to the clerk of the peace, &c. for the same one halfpenny a name; and in case of neglect or refusal, or not inserting a full, true, and perfect account, he shall forfeit 20*l*. *Id.*

Lists may be inspected at the stamp-office for 1*s*. each search; *id.* which lists shall once or oftener in every year, be inserted in the newspapers in each respective county.

If any qualified person, or one having a deputation, shall be found in pursuit of game, with gun, dog, or net, or other engine for the destruction of game, or taking or killing thereof, and shall be required to shew his certificate by the lord or lady of the manor, or proprietor of the land whereon such person shall be using such gun, &c. or by any duly-appointed game-keeper, or by any qualified or certified person, or by any officer of the stamps, properly authorized by the commissioners, he shall produce his certificate; and if such person shall refuse, upon the production of the certificate of the person requiring the same, to shew the certificate granted to him for the like purpose; or in case of not having such certificate to produce, shall refuse to tell his christian and surname, and his place of residence, and the name of the county where his certificate was issued, or shall give in any false or fictitious name, he shall forfeit 5*l*. *Id.*

Certificates do not authorize any person to shoot at, kill, take or destroy any game at any time that is prohibited by law, nor give any person a right to shoot at, &c. unless he is duly qualified by law. *Id.*

No certificate obtained under any deputation shall be pleaded or given in evidence, where any person shall shoot at, &c. any game out of the manors or lands for which it was given. The royal family are exempted from taking out certificates for themselves or their deputies. *Id.*

Conies.—Destroying conies, transportation. 5 G. III. c. 14.

Robbing warrens, felony without clergy. 9 G. I. s. 22.

Killing them in the night, or endeavouring to kill them, fine of 10*s*. or commitment. 22 and 23 Car. II. c. 25.

Unqualified person using a gun to kill them, the same may be seized. 3 Jac. I. c. 13.

Deer.—Stalking deer without leave, 10*l*. 19 H. VII. c. 11.

Hunting or killing them, 10*l*., costs, and sureties for good behaviour. 5 Eliz. c. 21.

Buck stalls or engines kept by unqualified persons may be seized. 3 Jac. I. c. 13.

Selling, or buying them to sell again, 40*l*. 3 Jac. I. c. 27.

Coursing or killing them without consent, 20*l*. 13 Car. II. c. 10.

Hunting, taking, killing, or wounding, 30*l*. or transportation. 3 W. III. c. 10.; 5 G. I. c. 15.; 9 G. I. c. 22.; 10 G. II. c. 32.

Destroying pales or walls of inclosed grounds, without consent, 30*l*. 5 G. I. c. 15.

Keeper of parks privately killing or taking them, 50*l*. *Id.*

Robbing places where kept, felony without clergy. 9 G. I. c. 22.

Game-keepers.—All lords of manors, or other royalties, may appoint game-keepers, and empower them to kill game. 22 and 23 Car. II. c. 25.

But if game-keeper dispose of the game without the lord's consent, he shall be committed for three months, and kept to hard labour. 5 Anne, c. 14.

But no lord shall make above one game-keeper within one manor, with power to kill game, and his name shall be entered with the clerk of the peace; certificate whereof shall be granted by the clerk of the peace on payment of 10*s*. 6*d*. Unqualified game-keeper killing or selling hare, pheasant, partridge, moor, heath-game, or grouse, he shall forfeit 5*l*. by distress, or commitment for three months for the first offence, and every other four. 9 Anne, c. 21.

No lord shall appoint an unqualified game-keeper, or one who is not bona fide servant

to such lord, or immediately employed and appointed to take and kill game for the sole use of the lord; other persons, under colour of authority for taking and killing game, or keeping any dogs or engines whatsoever for that purpose, shall forfeit 5*l.* in like manner. 3 G. I. c. 11.

Every deputation of a game-keeper to be registered with the clerk of the peace, or in the sheriff's or steward's court-books of the county, &c. where the lands lie, and annually take out certificate thereof, stamped with a half-guinea stamp (now 1*l.* 1*s.*). 25 Geo. III. sess. 2.

Every game-keeper, from and after the passing of this act, who shall deliver his name and place of abode as aforesaid, and require a certificate, shall be annually entitled thereto, stamped as before directed, from the clerk of the peace or his deputy, sheriff or steward, clerk, &c. to the effect of the form in the act set forth. *Id.*

Clerk of the peace, &c. after signing certificate, shall issue the same stamped, to the person registering the deputation, on requiring the same, for which he may receive 1*s.* *Id.*

If any person to whom any deputation or appointment of a game-keeper shall have been, or at any time thereafter shall be, granted, by any lord or lady of a manor, &c. shall, for the space of 20 days after the deputation or appointment shall be granted, neglect or refuse to register the same, and take out a certificate as aforesaid, he shall forfeit and pay the sum of 20*l.* to be applied as the law directs. *Id.*

Neglect or refusal of issuing certificates, incurs a forfeiture of 20*l.* recoverable in the courts of Westminster, court of session, of justiciary, or exchequer in Scotland, by action of debt or information, for the use of the plaintiff, with double costs of suit. *Id.*

Clerk of the peace, &c. may issue his certificate to any game-keeper first appointed in any year after 1st of July in that year. *Id.*

If any lord or lady of a manor, or proprietor of land, shall make any new appointment of a game-keeper, and shall register the deputation with the clerk of the peace, &c. and shall obtain a new certificate thereon, the first shall be void; and any person acting under the same, after notice, shall be liable to all the penalties of the game-laws, and those against unqualified persons. *Id.*

Hares.—Every person tracing or coursing hares in the snow shall be committed for one year (31 Eliz. c. 5.), unless he pay to the churchwardens, for the use of the poor, 20*s.* for every hare, or become bound by recognizances, with two sureties in 20*l.* apiece, not to offend again; and every person taking or destroying hares with any sort of engine, shall forfeit for every hare 20*s.* in like manner. 1 Jac. I. c. 27. Persons found using engines, liable to the punishment inflicted as above, by 31 Eliz. c. 5. Unqualified persons keeping or using sporting-dogs, or engines to kill or destroy hares, shall forfeit 5*l.* to the informer, with double costs (2 Geo. III. c. 19.), by distress, or be committed for three months for the first offence, and for every other four. 5 Anne, c. 14. Taking or killing hares in the night-time, forfeits 5*l.* (9 Anne, c. 25.), the whole to the informer, with double costs. 2 Geo. III. c. 19. Killing or taking with gun, dog, or engine, a hare in the night, between the hours of seven at night and six in the morning, from October 12 to February 12, and between the hours of nine at night and four in the morning, from Feb. 12. to Oct. 12, or in the day-time upon Sunday or Christmas-day, to forfeit not less than 10*l.* nor more than 20*l.* for the first offence; nor less than 20*l.* nor more than 30*l.* for the second offence; and 50*l.* for the third offence, with costs and charges; and, upon neglect or refusal, be committed for six or twelve calendar months, and may be publicly whipped: final appeal to the quarter-sessions. 13 Geo. III. c. 80. Persons armed and disguised stealing them, felony without clergy. Geo. I. c. 22. Higler, chapman, carrier, inn-keeper, victualler, or alehouse-keeper, having in his custody, or buying, selling, or offering to sale, any hare, unless sent up by some person qualified (or any person selling, exposing, or offering for sale hares, &c. 28 Geo. II. c. 22.) shall forfeit for every hare 5*l.*, the whole to the informer. 2 Geo. III. c. 92.

Heath-fowl.—For preserving heath-cocks or polts, no person whatsoever, on any waste, shall presume to burn, between Feb. 2 and June 24, any grig, ling, heath, furze, goss, or fern, on pain of commitment for a month or ten days, to be whipped and kept to hard labour. 4 and 5 W. and M. c. 23. Shooting heath-cocks, grouse, or moor-game, contrary to 1 Jac. I. c. 27. and killing any of them in the night, or using gun, dog, or engine, with such intent, contrary to 9 Anne, c. 25. and 13 Geo. III. c. 80.; and carriers and others having such in their possession, contrary to 9 Anne, c. 14. are all liable to the same penalties, and recoverable in the same manner, as those offences are subjected to shooting, &c. hares.

Partridges.—Taking partridges by nets or other engines, upon another's freehold, without special leave of the owner of the same, penalty 10*l.* half to him who shall sue, and half to the owner or possessioner. 11 H. VIII. c. 17. Shooting, &c. at partridges with gun or bow, or taking them, &c. with dogs or nets, by 7 Jac. I. c. 11. or taking their eggs out of their nest, liable as persons shooting, &c. at hares, and also 20*s.* for every bird or egg. Selling, or buying to sell again, a partridge (except reared and brought up in houses, or from beyond sea), forfeits for every partridge 10*s.* half to him who will sue, and half to the informer. 1 Jac. I. c. 27. Taking, killing, or destroying partridges in the night, forfeits for every partridge 10*l.* half to him who will sue, and half to the lord of the manor, unless he license or cause the said taking or killing, in which case his half shall go to the poor, recoverable by churchwardens; and if not paid in ten days, to be imprisoned for one month; and moreover shall give bond to the justice, with good sureties, not to offend again for two years. 23 Eliz. c. 10. to kill a partridge in the night, penalty 5*l.* 9 Anne, c. 25. The whole whereof is given to the informer (2 Geo. III. c. 19.) and may be recovered within three months (5 Anne, c. 14.), before a justice of peace, or within six months, by action in the courts of record at Westminster (9 Anne, c. 25.) with double costs. 2 Geo. III. c. 19. Keeping or using any greyhounds, setting dogs, or any engine for destroying partridges, penalty 5*l.* to be levied and recovered as the like penalty for killing hares. Penalties for using gun, dog, snare, net, or other engine, with intent to take or destroy partridges in the night, or on Sunday, or Christmas-day, same as using them against hares, by 13 G. III. c. 80. Carriers and others having partridges in their possession, liable to the same forfeitures and penalties as having hares; and the same law against shooting them by unqualified persons as for killing hares.

Pheasants.—All the laws respecting the penalties and recovery of them, for taking them by nets, snares, or other engines, without licence of the owner, by 11 H. VIII. c. 17. and for shooting or destroying them with dogs or snares, &c. by 7 Jac. 1. c. 11. or taking their eggs, by 1 Jac. I. c. 27. and for selling, and buying them to sell again, by last-cited act (except that the penalty for a pheasant is 20*s.*), and for destroying them in the night (except as aforesaid), by 23 Eliz. c. 10. 9 Anne, c. 25. and 13 G. III. c. 80. and for keeping or using sporting-dogs or engines for destroying them on Sunday or Christmas-day, by 13 G. III. c. 80. and for carriers and others having them in their possession. All these laws are, mutatis mutandis, verbatim the same as those respecting partridges.

Prosecutions.—Any one prosecuted for any thing done in pursuance of this act may plead the general issue, and give the special matter in evidence for his defence; and if upon trial verdict pass for the defendant, or plaintiff become nonsuited, defendant shall have treble costs of plaintiff. 25 Geo. III. sess. 2. s. 28.

Qualifications for killing game are, 1. having a freehold estate of 100*l.* per annum, 22 and 23 Car. II. c. 25.; 2. a leasehold estate for 99 years, of 150*l.* per annum; 3. the eldest son or heir apparent to an esquire, or person of superior degree; 4. the owner or keeper of a forest, park, chace, or warren. Unqualified person keeping dogs or engines to destroy game, to forfeit 5*l.* 5 Anne, c. 14.

No person (other than the king's son), unless he has lands of freehold to the value of five marks a year, shall have any game of swans, on pain of forfeiting them, half to the king, and half to any person so qualified, who shall seize the same. 22 Ed. IV. c. 6.

Any gentleman or other that may dispend 40*s.* a year freehold, may hunt and take wild fowls with their spaniels only, without using a net or other engine, except the long bow. 25 Hen. VIII. c. 11. From persons not having lands of 40*s.* a year, or not worth in goods 200*l.* using gun or bow to kill deer, any person having 100*l.* may seize the same to his use. 3 Jac. I. c. 13.

Every person qualified to kill game, shall, previous to his shooting at, killing, or destroying any game, take out a certificate. See CERTIFICATE.

Sporting seasons.—The time for sporting in the day is from one hour before sun-rising, until one hour after sun-setting. 10 G. III. c. 19.

For bustards, the sporting season is, from December 1 to March 1.

For grouse or red grouse, from August 11 to December 10.

Hares may be killed all the year, under the restriction, as to the hours of the day, in 10 Geo. III. c. 19.

Heath-fowl, or black game, from August 20 to December 20.

Partridges, from September 1 to February 12.

Pheasants, from October 1 to February 1.

Widgeons, wild ducks, wild geese, wild fowls, at any time but in June, July, August, and September.

Summary proceedings.—From and after March 1, 1785, in all cases where the penalty by this act does not exceed 20*l.* a justice of peace shall, upon information or complaint, summon the party and witnesses to appear, and proceed to hear and determine the matter in a summary way; and upon due proof by confession, or upon the oath of one witness, give judgment for the forfeiture, and issue his warrant for levying the same on the offender's goods, and to sell them, if not redeemed within six days, rendering to the party the overplus; and if his goods are insufficient to answer the penalty, shall commit the offender to prison, there to be for six calendar months, unless the penalty is sooner paid; and if the party is aggrieved by the judgment, he may, upon giving security amounting to the value of the forfeitures, with the costs of the affirmance, appeal to the next general quarter-sessions, when it is to be heard and finally determined; and in case the judgment is affirmed, the sessions may award such costs, incurred by the appeal, as to themselves shall seem meet. 25 Geo. III. sess. 2.

Witnesses neglecting or refusing to appear, without reasonable excuse to be allowed of by the justice, shall respectively forfeit for every offence 10*l.* to be levied and paid as other penalties by this act. *Id.*

Justice to cause conviction to be made out to the effect of the form set forth in the act. *Id.*

Justice may mitigate penalties as he thinks fit, so that reasonable costs and charges of the officers and informers for discovery and prosecution be always allowed, over and above mitigation, and so as the same does not reduce the penalties to less than a moiety, over and above the costs and charges, any thing therein contained to the contrary notwithstanding; and no such conviction shall be removable by certiorari into any court whatsoever.

No offender against this act to be imprisoned more than three months. *Id.*

The duties to be paid to the receiver-general of the stamp-duties, and by him paid into the exchequer. *Id.*

Swans.—It is felony to take any swans that are lawfully marked, though they should be at large; and so it is unmarked swans, if they are domestical or tame, so long as they keep within a man's manor, or within his private river, or if they happen to escape from them, and are pursued and taken, and brought back again; but if they are abroad, and attain their natural liberty, then the property of them is lost, and so long felony cannot be committed by taking them. Burn's Just. tit. Game.

Wild fowl.—Same laws against shooting wild-fowl as for shooting hares, by 1 Jac. I. c. 27.

GAME-COCK, a fighting-cock, or one kept for sport, in the choice of which four things are chiefly to be regarded, viz. shape, colour, courage, and sharp heel.

1. As to shape, a game-cock must not be chosen either too large or too small: the first being generally unwieldy and inactive; the other weak and tedious in fighting. The middle-sized cock is therefore most proper for this purpose, as being strong, nimble, and easily matched; his head ought to be small, with a quick large eye, and a strong beak, which should be crooked, and in colour suitable to the plume of his feathers; the beam of his leg should be strong, and of the colour of his plume; his spurs should be rough, long, and sharp, a little bending, and pointing inward. 2. The best colour for a game-cock is either grey, yellow, or red: the pyed pile may pass indifferently; but the white and dun are rarely known to be good for any thing. If his neck is invested with a scarlet complexion, it is a sign of his being strong, lusty, and courageous; whereas a pale and wan complexion denotes him faint and unhealthy. 3. His courage may be known by his proud, upright standing, and stately tread in walking; and if he crows frequently in the pen, it is a proof of spirit. 4. His sharpness of heel is known only from observations in fighting: that is, when at every rising he hits so that he draws blood from his adversary; gilding his spurs continually, and at every blow threatening him with immediate death.

To prepare a cock to fight: 1. With a pair of fine shears cut all his mane off, close to his head, from the head to the setting of the shoulders. 2. Clip off all the feathers from the tail close to his rump, and the redder it appears, the better is the cock in condition. 3. Spread his wings by the length of the first rising feather; and cut off the rest slopewise, with sharp points, that in his rising he may therewith endanger an eye of his adversary. 4. See that there be no feathers on the crown of his head for his opponent to take hold of; and moisten his head all over with your spittle.

GAME-KEEPERS. See GAME.

GAMELION, in antient chronology, was the eighth month of the Athenian year, containing 29 days, and answering to the latter part of our January and beginning of February. It was thus called, as being, in the opinion of the Athenians, the most proper season of the year for marriage.

GAMING, the art of playing or practising any game, particularly those of hazard, as cards, dice, tables, &c.

It appears that by the antient common law all games were lawful. But so early as the reign of Richard II. the legislature found it necessary to interfere, and to make several games illegal. This was levelled at labourers and artificers. The next statute was the 2nd Hen. IV. which inflicted six days imprisonment on those who offended against the act of Richard II. The 17th Edw. IV. imposes a penalty of two years imprisonment and a fine against various games there enumerated; and by the 11th Hen. VII. labourers and artificers are prohibited from playing at unlawful games, but in Christmas only. The principal object of these early statutes was, to encourage archery, and to make that the only lawful sport for the lower ranks of the people. But the earliest act against gaming now in force is the 33d Henry VIII. which gives justices of peace and head officers in corporations a power to enter all houses suspected of unlawful games, and to arrest the gamesters till they give security not to play for the future. Persons keeping any unlawful gaming-house, are fined 40*s.* and the gamesters 6*s.* 8*d.* a time. If any person by fraud, deceit, or unlawful device, in playing either at cards or dice, tables, bowls, cock-fighting, horse-races, foot-races, &c. or bearing a share in the stakes or betting, shall win any money or valuable thing of another, he shall forfeit treble the value thereof: likewise if any person shall play at any of the said games upon tick, and not for ready money, and lose the sum of 100*l.* on credit, at one meeting, if the money is not paid down, his security taken for it shall be void, and the winner becomes liable to a forfeiture of treble value of such money won. 16 Car. II. c. 7. Not only all notes, bills, bonds, mortgages, or other securities given for money won at gaming, are declared void; but also where lands are granted, they shall go to the next person intitled, after the decease of the person so incumbering the same. Persons losing by gaming at one time 10*l.* may recover the money lost from the winner, by an action of debt brought within three months; and on the loser's not prosecuting, any other person may lawfully do it, and recover treble the value, with costs. 9 Anne, c. 14. Those who cheat at cards, dice, &c. besides their forfeitures, have inflicted on them such infamy and corporal punishment, as in cases of perjury; and beating, or challenging any other person to fight, on account of money won by gaming, shall forfeit all their goods, and be imprisoned two years: and where persons play that have no visible estates, and do not make it appear that the principal part of their maintenance is got by other means than gaming, they may be bound to their good behaviour by two justices of the peace, &c. Stat. ibid. See 2 Geo. II. c. 28. The ace of hearts, pharaoh, basset, &c. are judged to be lotteries by cards or dice; and persons who set up those games, are subject to 200*l.* penalty. And every adventurer, who shall play, stake, or punt at them, forfeits 50*l.* Also any sales of houses, goods, plate, &c. in such a way, are void, and the things forfeited to any who will sue for the same. 12 Geo. II. c. 28. See Disney's Laws of Gaming, Wagers, &c.

GAMING, *laws of.* These are founded on the doctrine of chances. See CHANCE.

Mr. de Moivre, in a treatise De Mensura Sortis, has computed the variety of chances in several cases that occur in gaming, the laws of which may be understood by what follows.

Suppose p the number of cases in which an event may happen, and q the number of cases wherein it may not happen, both sides have the degree of probability, which is to each other as p to q.

If two gamesters, A and B, engage on this footing, that if the cases p happen, A shall win; but if q happen, B shall win, and the stake be a; the chance of A will be $\frac{pa}{p+q}$, and that of B $\frac{qa}{p+q}$; consequently, if they sell the expectancies, they should have that for them respectively.

If A and B play with a single die, on this condition, that if A throw two or more aces at eight throws, he shall win; otherwise B shall

win; what is the ratio of their chances? Since there is but one case wherein an ace may turn up, and five wherein it may not, let $a = 1$, and $b = 5$. And again, since there are eight throws of the die, let $n = 8$; and you will have $\overline{a+b}^n - b^n - nab^{n-1} - 1$, to $b^n + nab^{n-1} - 1$: that is, the chance of A will be to that of B, as 663991 to 10156525, or nearly as 2 to 3.

A and B are engaged at single quoits, and after playing some time, A wants 4 of being up, and B 6; but B is so much the better gamester, that his chance against A upon a single throw would be as 3 to 2; what is the ratio of their chances? Since A wants 4, and B 6, the game will be ended at nine throws; therefore, raise $a+b$ to the ninth power, and it will be $a^9 + 9a^8b + 36a^7bb + 84a^6b^3 + 126a^5b^4 + 126a^4b^5$, to $84a^3b^6 + 36aab^7 + 6ab^8 + b^9$; call a 3, and b 2, and you will have the ratio of chances in numbers, viz. 1759077 to 194048.

A and B play at single quoits, and A is the best gamester, so that he can give B 2 in 3, what is the ratio of their chances at a single throw? Suppose the chances as z to 1, and raise $z+1$ to its cube, which will be $z^3 + 3z^2 + 3z + 1$. Now, since A could give B 2 out of 3, A might undertake to win three throws running; and, consequently, the chances in this case will be as z^3 to $3z^2 + 3z + 1$. Hence $z^3 = 3z^2 + 3z + 1$; or, $2z^3 = z^3 + 3z^2 + 3z + 1$. And therefore, $z\sqrt[3]{2} = z + 1$; and, consequently, $z = \frac{1}{\sqrt[3]{2} - 1}$. The chances, therefore, are $\sqrt[3]{2} - 1$, and 1, respectively.

Again, suppose I have two wagers depending, in the first of which I have 3 to 2 the best of the lay, and in the second 7 to 4, what is the probability I win both wagers?

1. The probability of winning the first is $\frac{3}{5}$, that is, the number of chances I have to win, divided by the number of all the chances: the probability of winning the second is $\frac{7}{11}$: therefore, multiplying these two fractions together, the product will be $\frac{21}{55}$, which is the probability of winning both wagers. Now, this fraction being subtracted from 1, the remainder is $\frac{34}{55}$, which is the probability I do not win both wagers: therefore the odds against me are 34 to 21.

2. If I would know what the probability is of winning the first, and losing the second, I argue thus: the probability of winning the first is $\frac{3}{5}$, the probability of losing the second is $\frac{4}{11}$; therefore multiplying $\frac{3}{5}$ by $\frac{4}{11}$, the product $\frac{12}{55}$ will be the probability of my winning the first, and losing the second; which being subtracted from 1, there will remain $\frac{43}{55}$, which is the probability I do not win the first, and at the same time lose the second.

3. If I would know what the probability is of winning the second, and at the same time losing the first, I say thus: the probability of winning the second is $\frac{7}{11}$; the probability of losing the first is $\frac{2}{5}$: therefore, mutiplying these two fractions together, the product $\frac{14}{55}$ is the probability I win the second, and also lose the first.

4. If I would know what the probability is of losing both wagers, I say, the probability of losing the first is $\frac{2}{5}$, and the probability of losing the second $\frac{4}{11}$; therefore, the probability of losing them both is $\frac{8}{55}$; which being subtracted from 1, there remains $\frac{47}{55}$: therefore, the odds of losing both wagers is 47 to 8.

This way of reasoning is applicable to the happening or failing of any events that may fall under consideration. Thus, if I would know what the probability is of missing an ace four times together with a die, this I consider as the failing of four different events. Now the probability of missing the first is $\frac{5}{6}$, the second is also $\frac{5}{6}$, the third $\frac{5}{6}$, and the fourth $\frac{5}{6}$; therefore the probability of missing it four times together is $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{625}{1296}$; which being subtracted from 1, there will remain $\frac{671}{1296}$ for the probability of throwing it once or oftener in four times; therefore the odds of throwing an ace in four times, is 671 to 625.

But if the flinging of an ace was undertaken in three times, the probability of missing it three times would be $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{125}{216}$; which being subtracted from 1, there will remain $\frac{91}{216}$ for the probability of throwing it once or oftener in three times; therefore the odds against throwing it in three times are 125 to 91.

Again, suppose we would know the probability of throwing an ace once in four times, and no more: since the probability of throwing it the first time is $\frac{1}{6}$, and of missing it the other three times is $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6}$, it follows that the probability of throwing it the first time, and missing it the other three successive times, is $\frac{1}{6} \times \frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{125}{1296}$; but because it is possible to hit it every throw as well as the first, it follows, that the probability of throwing it once in four throws, and missing the other three, is $\frac{4 \times 125}{1296} = \frac{500}{1296}$; which being subtracted from 1, there will remain $\frac{796}{1296}$ for the probability of throwing it once, and no more, in four times. Therefore, if one undertake to throw an ace once, and no more, in four times, he has 500 to 796 the worst of the lay, or 5 to 8 very near.

Suppose two events are such, that one of them has twice as many chances to come up as the other, what is the probability that the event which has the greater number of chances to come up, does not happen twice before the other happens once, which is the case of flinging 7 with two dice before 4 once? Since the number of chances are as 2 to 1, the probability of the first happening before the second is $\frac{2}{3}$, but the probability of its happening twice before it, is but $\frac{2}{3} \times \frac{2}{3}$, or $\frac{4}{9}$; therefore it is 5 to 4 seven does not come up twice before four once.

But if it were demanded, what must be the proportion of the facilities of the coming up of two events, to make that which has the most chances come up twice, before the other comes up once, the answer is 12 to 5 very nearly: whence it follows, that the probability of throwing the first before the second is $\frac{12}{17}$, and the probability of throwing it twice is $\frac{12}{17} \times \frac{12}{17}$, or $\frac{144}{289}$; therefore, the probability of not doing it is $\frac{145}{289}$: therefore the odds against it are as 145 to 144, which comes very near an equality.

Suppose there is a heap of thirteen cards of one colour, and another heap of thirteen cards of another colour, what is the probability that, taking one card at a venture out of each heap, I shall take out the two aces?

The probability of taking the ace out of the first heap is $\frac{1}{13}$, the probability of taking the ace out of the second heap is $\frac{1}{13}$; therefore the probability of taking out both aces is $\frac{1}{13} \times \frac{1}{13} = \frac{1}{169}$, which being subtracted from 1, there will remain $\frac{168}{169}$: therefore the odds against me are 168 to 1.

In cases where the events depend on one another, the manner of arguing is somewhat altered. Thus, suppose that out of one single heap of thirteen cards of one colour, I should undertake to take out first the ace; and, secondly, the two: though the probability of taking out the ace be $\frac{1}{13}$, and the probability of taking out the two be likewise $\frac{1}{13}$; yet, the ace being supposed as taken out already, there will remain only twelve cards in the heap, which will make the probability of taking out the two to be $\frac{1}{12}$; therefore the probability of taking out the ace, and then the two, will be $\frac{1}{13} \times \frac{1}{12}$.

In this last question the two events have a dependance on each other, which consists in this, that one of the events being supposed as having happened, the probability of the other's happening is thereby altered. But the case is not so in the two heaps of cards.

If the events in question be n in number, and be such as have the same number a of chances by which they may happen, and likewise the same number b of chances by which they may fail, raise $a+b$ to the power n. And if A and B play together, on condition that if either one or more of the events in question happen, A shall win, and B lose, the probability of A's winning will be $\frac{\overline{a+b}^n - b^n}{\overline{a+b}^n}$; and that of B's winning will be $\frac{b^n}{\overline{a+b}^n}$; for when $a+b$ is actually raised to the power n, the only term in which a does not occur is the last b^n: therefore, all the terms but the last are favourable to A.

Thus, if $n = 3$, raising $a+b$ to the cube $a^3 + 3a^2b + 3ab^2 + b^3$, all the terms but b^3 will be favourable to A; and therefore the probability of A's winning will be $\frac{a^3 + 3a^2b + 3ab^2}{\overline{a+b}^3}$, or $\frac{\overline{a+b}^3 - b^3}{\overline{a+b}^3}$; and the probability of B's winning will be $\frac{b^3}{\overline{a+b}^3}$. But if A and B play on condition, that if either two or more of the events in question happen, A shall win; but in case one only happen, or none, B shall win; the probability of A's winning will be $\frac{\overline{a+b}^n - nab^{n-1} - b^n}{\overline{n+b}^n}$; for the only two terms in which aa does not occur, are the two last, viz. nab^{n-1} and b^n. See Chance.

GAMMONING, among seamen, denotes several turns of rope taken round the bowsprit, and reeved through holes in knees of the head, for the greater security of the bowsprit.

GAMMUT, in music, the name given to the table or scale laid down by Guido, and to the notes of which he applied the monosyllables *ut, re, mi, fa, sol, la.* Having added a note below the proslambanomenos, or lowest tone of the antients, he adopted for its sign the gamma, or third letter of the Greek alphabet; and hence his scale was afterwards called gammut. This gammut consisted of twenty notes, viz. two octaves and a major-sixth. The first octave was distinguished by capital letters, as G, A, B, &c. the second by small letters, as *g, a, b,* &c. and the supernumerary sixth by double letters, as *gg, aa, bb,* &c. By the word gammut, we now generally understand the whole present existing scale; and to learn the names and situations of its different notes is to learn the gammut. It, however, sometimes simply signifies the lowest note of the Guidonian or common compass.

GANG, in the sea language, the same with crew. The company with which a ship's boat is manned is called the cockswain's crew or gang.

GANG, or GANGUE, in mineralogy. The word gang is used by German mineralogists to denote a metallic vein. Now, it is not often that these veins consist entirely of ore; in general they contain stony matter besides. For instance, in the copper-mine at Airthry, near Stirling, the copper ore is merely a narrow stripe in the middle of the vein, and the rest of it is filled up with sulphat of barytes. We use the word *gangue* as the French do, to denote not the metallic vein, but the stony matter which accompanies the ore in the vein. The gangue of the copper ore at Airthry is sulphat of barytes.

GANG-WAY, is the several passages or ways from one part of the ship to the other; and whatever is laid in any of those passages is said to lie in the gang-way.

GANGLIO, or GANGLION. See SURGERY.

GANGRENE. See SURGERY.

GANTLET, or GAUNTLET, a large kind of glove made of iron, and the fingers covered with small plates. It was formerly worn by cavaliers, when armed at all points.

GAOL. Gaols are of such universal concern to the public, that none can be erected by any less authority than an act of parliament. 2 Inst. 705.

All prisons and gaols belong to the king, although a subject may have the custody or keeping of them. 2 Inst. 100.

The justices of the peace at their general quarter-sessions, or the major part of them, provided that such major part shall not be less than seven, upon presentment made by the grand jury at the assizes of the insufficiency, inconvenience, or want of repair of the gaol, may contract for the building, repairing, or enlarging the same, together with the yards, courts, and outlets thereof, and adding such other building, and making such conveniences, as shall be thought requisite; or for erecting any new gaol within any distance not exceeding two miles from the site, and in that case for selling the old gaol and the site thereof, and also the materials of the old gaol; the contractors giving security to the clerk of the peace for the performance of the contract. 24 Geo. III. c. 54.

The expence of building, rebuilding, or enlarging such gaols, and such other necessary incidental expences as aforesaid, shall be paid out of the county-rate; and when the account of such expence shall exceed half the amount of the ordinary annual assessment for the county-rate (to be computed at a medium for the last preceding five years), the justices in session may borrow in mortgage of the said rates any sum not less than 50*l.* nor exceeding 100*l.* and may order the growing interest and so much of the principal sum as shall be equal at least to such interest, to be paid off yearly, till the whole thereof shall be discharged, and an account thereof shall be kept in a book provided for that purpose; and such book shall be delivered into court at every quarter-session to be inspected by the justices, who shall make such orders relating thereto as to them shall seem meet: provided that the whole sum of money borrowed be fully paid within fourteen years from the time of borrowing it. *Id.*

As there are several persons confined in the county and city gaols under sentence and order made by one or more justices at their sessions, or otherwise, upon conviction in a summary way without the intervention of a jury; it is therefore, by 24 Geo. III. c. 56., enacted, that any judge of assize, or two justices, within whose jurisdiction such gaol is situated, may remove such persons to any house of correction within the same jurisdiction, there to be confined, and to remain in execution of such sentence or order.

For the relief of prisoners in gaols, justices of the peace in sessions have power to tax every parish in the county, not exceeding 6*s.* 8*d.* per week, leviable by constables, and distributed by collectors, &c. 12 Car. II. c. 29.

But it is observed by lord Coke, that the gaoler cannot refuse the prisoner victuals, for he ought not to suffer him to die for want of sustenance. 1 Inst. 295.

If any subject of this realm shall be committed to prison for any criminal or supposed criminal matter, he shall not be removed thence, unless by habeas corpus, or some other legal writ; or where he is removed from one prison or place to another within the same county, in order to his trial or discharge; or in case of sudden fire or infection, or other necessity; on pain that the person signing any warrant for such removal, and he who executes the same, shall forfeit to the party grieved 100*l.* for the first offence, and 200*l.* for the second, &c.

GAOL or PRISON BREAKING, at the common law, was felony, for whatever cause the party was imprisoned; but by 1 Ed. II. st. 2. the severity of the common law is mitigated, which enacts, that no person shall have judgment of life or member, for breaking prison, unless committed for some capital offence; so that, unless the commitment is for treason or felony, the breaking of prison is not felony, but is otherwise punishable as a misdemeanor only, by fine and imprisonment. 4 Black. 130.

Any place whatever, wherein a person under a lawful arrest for a supposed crime is restrained of his liberty, whether in the stocks or street, or in the common gaol, or the house of a constable, or a private person, is a prison in this respect, for a prison is nothing else but a restraint of liberty; and therefore this extends as well to a prison in law, as to a prison in deed. 2 Inst. 589.

He that breaks prison may be proceeded against for such a crime, before he is convicted of the crime for which he is committed, because the breach of prison is a distinct independant offence; but the sheriff's return of a breach of prison is not a sufficient ground to arraign a man without an indictment. 2 Haw. 197.

It is not sufficient to indict a man generally for having feloniously broken prison; but the case must be set forth specially, that it may appear that he was lawfully in prison, and for a capital offence. 2 Inst. 591. Hale's P. C. 109.

GAOLER. Besides the duties enjoined on gaolers by act of parliament, and the abuses for which by statute they are punishable, the common law subjects them to fine and imprisonment, as also to the forfeiture of their offices, for gross and palpable abuses in the execution of their offices. 2 Inst. 381.

Also gaolers are punishable by attachment, as all other officers are, by the courts to which they more immediately belong, for any gross misbehaviour in their offices, or contempt of the rules of such courts, and punishable by any other courts for disobeying writs of habeas corpus awarded by such courts, and not bringing up the prisoner at the day prefixed by such writs. 2 Haw. 151.

If the gaoler, by keeping the prisoner more strictly than he ought, occasions the prisoner's death, this is felony in the gaoler by the common law. Therefore, if a prisoner dies in gaol, the coroner ought to sit upon him; and if the death was occasioned by cruel and oppressive usage on the part of the gaoler, or any officer of his, it will be deemed wilful murder in the person guilty of such duress. 3 Inst. 91.

But if a criminal endeavouring to break gaol, assaults the gaoler, he may be lawfully killed by him in the affray. Jenk. 23. 1 Haw. 71.

A gaoler is considered as an officer relating to the administration of justice, and is under the same special protection of the law that other ministers of justice are. If a person threatens him for keeping a prisoner in safe custody, he may be indicted, and fined and imprisoned for it. 2 Rol. Abr. 71.

If in the necessary discharge of his duty he should meet with resistance, whether from prisoners in civil or criminal suits, or from others in behalf of such prisoners, he is not obliged to retreat as far as he can with safety, but may freely and without retreating repel force with force; and if the party so resisting happens to be killed, this will be justifiable homicide in the gaoler or his officer, or any person coming in aid of him. On the other hand, if the gaoler or his officer, or any person in aid of him, should fall in the conflict, this will amount to wilful murder in all persons joining in such resistance; for it is homicide in defiance of the justice of the kingdom. Fost. 321.

The justices in their sessions, or in any special adjournment held for such express purpose, may, if they shall think it necessary or proper, appoint salaries or allowances to gaolers, in lieu of the profits derived from the sale of liquors, as to them shall seem meet, and order the same to be paid out of the county-rate, by a certificate of such allowance being signed by the chairman of the sessions; but no chairman shall sign such certificate, unless notice of such intended application, signed by the clerk of the peace, has been given 14 days at least before the holding of such session or adjournment thereof, by two several advertisements in some newspaper which shall be printed and circulated in such county. 24 Geo. III. c. 54.

It seems clearly agreed, that a gaoler, by suffering voluntary escapes, by abusing his prisoners, by extorting unreasonable fees from them, or by detaining them in gaol after they have been legally discharged, and paid their just fees, forfeits his office; for that in the grant of every office it is implied, that the grantee executes it faithfully and diligently. Co. Lit. 233.

GAOL-DELIVERY. By the law of the land, that men might not be long detained in prison, but might receive full and speedy

justice, commissions of gaol-delivery are issued out, directed to two of the judges, and the clerk of assize associate; by virtue of which commission, they have power to try every prisoner in the gaol, committed for any offence whatsoever.

GARBE, in heraldry, a sheaf of any kind of grain, said to represent summer, as a bunch of grapes does autumn.

GARBOARD-STRAKE, the plank next the keel of a ship, one edge of which is run into the rabbit made in the upper edge of the keel on each side.

GARCINIA, a genus of the monogynia order, in the dodecandria class of plants, and in the natural method ranking under the 18th order, bicornes. The calyx is tetraphyllous inferior: there are four petals: the berry is octospermous, and crowned with a shield-like stigma. There are three species. The mangostana is a tree of great elegance, and producing the most pleasant fruit of any yet known.

This tree has been very accurately described by Dr. Garcin, in honour of whom, as its most accurate describer, Linnæus gave it the name Garcinia, in the 35th volume of the Philosophical Transactions. It grows, he informs us, to about 17 or 18 feet high, "with a straight taper stem like a fir," having a regular tuft in form of an oblong cone, composed of many branches and twigs, spreading out equally on all sides without leaving any hollow. Its leaves, he observes, are oblong, pointed at both ends, entire, smooth, of a shining green on the upper side, and of an olive on the back. Its flower is composed of four petals almost round or a little pointed: their colour resembles that of a rose, only deeper and less lively. The calyx of this flower is of one piece, expanded, and cut into four lobes. The two upper lobes are something larger than the lower ones: they are greenish on the outside, and of a fine deep red within: the red of the upper ones is more lively than that of the lower ones. This calyx incloses all the parts of the flower; it is supported by a pedicle, which is green, and constantly comes out of the end of a twig above the last pair of leaves. The fruit is round, of the size of a small orange, from an inch and a half to two inches diameter. The body of this fruit is a capsule of one cavity, composed of a thick rind a little like that of a pomegranate, but softer, thicker, and fuller of juice. Its thickness is commonly a quarter of an inch. Its outer colour is of a dark-brown purple, mixed with a little grey and dark-green. The inside of the peel is of a rose-colour, and its juice is purple. Last of all, this skin is of a styptic or astringent taste, like that of a pomegranate; nor does it stick to the fruit it contains. The inside of this fruit is a furrowed globe, divided into segments much like those of an orange, but unequal in size, which do not adhere to each other. The number of these segments is always equal to that of the rays of the top which covers the fruit. The fewer there are of these segments the larger they are. There are often in the same fruit segments as large again as any of those that are on the side of them. These segments are white, a little transparent, fleshy, membranous, full of juice like cherries or raspberries, of a taste of strawberries and grapes together. Each of the segments incloses a seed of the figure and size of an almond stripped of its shell, having a protuberance on one of its sides. These seeds are covered with two small skins, the outermost of which serves for a basis to the filaments and membranes of which the pulp is composed. The substance of these seeds comes very near to that of chesnuts, as to their consistency, colour, and astringent quality.

"This tree (according to our author) originally grows in the Molucca islands, where it is called mangostan, but has been transplanted to the islands of Java and Malacca, at which last place it thrives very well. Its tuft is so fine, so regular, so equal, and the appearance of its leaves so beautiful, that it is at present looked upon at Batavia as the most proper for adorning a garden, and affording an agreeable shade. There are few seeds, however, (he observes) to be met with in this fruit that are good for planting, most part of them being abortive." He concludes his description by mentioning that one may eat a great deal of this fruit without any inconvenience; and that it is the only one which sick people may be allowed to eat without any scruple.

Other writers concur in their praises of this fruit. Rumphius observes, that the mangostan is universally acknowledged to be the best and wholesomest fruit that grows in India; that its flesh is juicy, white, almost transparent, and of as delicate and agreeable a flavour as the richest grapes; the taste and smell being so grateful that it is scarcely possible to be cloyed with eating it. He adds, that when sick people have no relish for any other food, they generally eat this with great delight; but should they refuse it, their recovery is no longer expected. "It is remarkable (says he) that the mangostan is given with safety in almost every disorder. The dried bark is used with success in the dysentery and tenesmus, and an infusion of it is esteemed a good gargle for a sore mouth or ulcers in the throat. The Chinese dyers use this bark for the ground or basis of a black colour, in order to fix it the firmer."

According to captain Cook, in his Voyage round the World, vol. iii. p. 737, the garcinia mangostana of Linnæus is peculiar to the East Indies. It is about the size of the crab-abble, and of a deep red-wine colour. On the top of it is the figure of five or six small triangles joined in a circle, and at the bottom are several hollow green leaves, which are remains of the blossom. When they are to be eaten, the skin or rather flesh must be taken off, under which are found six or seven white kernels, placed in a circular order; and the pulp with which these are enveloped is the fruit, than which nothing can be more delicious. It is a happy mixture of the tart and the sweet, which is no less wholesome than pleasant, and, as well as the sweet orange, is allowed in any quantity to those who are afflicted with fevers either of the putrid or inflammatory kind.

GARDENIA, a genus of the pentandria monogynia class and order. The corolla is one-petalled, contorted or twisted; stigma lobed; berry inferior, two or four celled, many-seeded. There are 15 species, chiefly shrubs of the Cape and Japan. They are known in our stoves by the name of Cape jasmin, and some of them are highly ornamental. They are propagated by cuttings, plunged in a hotbed, &c.

GARDENING. This art, so natural to man, so improving to health, so conducive to the comforts and the best luxuries of life, may properly be divided into two branches; practical, and picturesque or landscape gardening.

The former is what every person, except the inhabitants of populous cities, has more or less occasion to practise; the latter is a privilege which only the very opulent can enjoy, and which must consequently be the elegant amusement of a chosen few.

Picturesque or landscape gardening should certainly never be attempted on a small scale. Indeed we are not certain that we may not be incurring a solecism in applying the term gardening to this department of agriculture. It is properly the art of laying out grounds; and the park or the farm, not the garden, is its object. It never can be attempted with success on a smaller scale than 20 acres; but 50 or 100, or even more, are better adapted to the design.

That style of gardening which would unite both objects, and which would give a picturesque effect to an acre or two of ground, is truly absurd. Many an improvident citizen wastes unprofitably the morsel of earth which should grow cabbages for his family, on an unprofitable grass-plat or shrubbery, on serpentines and mazes, and fish-ponds; or even on cascades, to the infinite annoyance of his visitors, the prejudice of his own health, and the merriment of all persons of true taste. This mania for the picturesque would have been not less deserving the ridicule of an Addison, than the perverse taste which displayed our first parents in yew, and the Graces and muses in Portugal laurel.

A garden, properly speaking, is a small spot of ground attached to the house. As the house is itself a regular and formal object, so we naturally expect something of the same regularity in this appendage. Neatness too is one of the chief excellences of a garden, and this is found to be wholly inconsistent with this rage for the picturesque. Littered walks, and parched and cankered vegetables, with a wretched patch of green in the middle where a weekly exhibition is made from the buck-basket, are the usual effects of this rus-in-urbe taste; while all the real beauty, neatness, and utility, which a small spot of ground is really capable of affording, are preposterously neglected.

It is also fashionable to make a separation between the pleasure and the kitchen garden. This may indeed preserve the few shrivelled fruit which the latter, on a diminutive scale, is capable of affording, from the hands of rapacious visitors; but the range of the proprietor becomes by this appointment most deplorably limited and diminished; and the vegetables will want what alone can render them fine and flourishing, the free circulation of air.

For our own parts we cannot enter into that fastidiousness of taste, which can see no beauty in the esculent vegetables. There is a variety, and often a beauty, in their foliage, not inferior to the furniture of a shrubbery. The common pea, was it an exotic, would be admired for its milk-white blossom; and the bean for its agreeable fragrance. Few hot-

house plants can vie in colour, or even in habit and growth, with the scarlet runner; and even the plants of more humble growth are not wholly destitute of beauty.

The garden of which we shall in the first place treat, as taking that practical view of the subject which is consistent with our design, is one in which vegetables, fruits, and flowers, are cultivated under the same inclosure. The work of making a new garden can happen to few; and when it does, soil, situation, and space, all favourable, are happy circumstances not always at command. It often happens, however, that pieces of ground are taken into use as additions; and some judgment should be exercised in the choice, that the business may be well effected.

With respect to the extent, a general idea may be given in observing, that an acre with wall-trees, hot-beds, pots, &c. will furnish employment for a man, who at some busy times will even need assistance. The size of the garden should, however, be proportioned to the house, as to the number of inhabitants it does or may contain. This is naturally dictated; but yet it is better to have too much ground allotted than too little, and there is nothing monstrous in a large garden annexed to a small house.

Some families use few, others many vegetables, and it makes a great difference whether the owner is curious to have a long season of the same production, or is content to have a supply only at the more common times. But to give some rule for the quantity of ground to be laid out, a family of four persons (exclusive of servants) may have a rood of good working open ground, and so in proportion.

But if possible let the garden be rather extensive according to the family; for then a useful sprinkling of fruit-trees can be planted in it, which may be expected to do well, under the common culture of the ground about them; a good portion of it also may be allotted for that agreeable fruit the strawberry in all its varieties; and the very disagreeable circumstance of being at any time short of vegetables will be avoided. It should be considered also, that artichokes, asparagus, and a long succession of peas and beans, require a good deal of ground. Hotbeds will also take up some room, if any thing considerable is done in the way of raising cucumbers, melons, flowers, &c.

The situation of a garden should be dry, but rather low than high, and as sheltered as can be from the north and east winds. These points of the compass should be guarded against by high and good fences; by a wall of at least ten feet high; lower walls do not answer so well for fruit-trees, though one of eight may do. A garden should be so situated, to be as much warmer as possible than the general temper of the air is without, or ought to be made warmer by the ring and subdivision fences. This advantage is essential to the expectation we have from a garden locally considered.

As to trees planted without the wall, to break the wind, we cannot expect to reap much good this way, except from something more than a single row, *i.e.* a plantation. Yet the fall of the leaves by the autumnal winds is troublesome, and a high wall is therefore advisable. Spruce firs have been used in close-shorn hedges; which, as evergreens, are proper enough to plant for a screen in a single row, though not very near to the wall; but the best evergreens for this purpose are the evergreen oak and the cork-tree. The witch elm, planted close, grows quick, and has a pretty summer appearance behind a wall; but is of little use then as a screen, except to the west; where still it may shade too much (if planted near), as it mounts high. In a dry hungry soil the beech also is very proper; and both bear cutting. The great maple, commonly called the sycamore, is handsome, of quick growth, and being fit to stand the rudest blasts, will protect a garden well in a very exposed situation: the wind to be chiefly guarded against as to strength, in most places, being the westerly.

The form of a garden may be a square, but an oblong is preferred, and the area rather a level; or if there is any slope it should be southward, a point either to the east or west not much signifying; but not to the north, if it can be avoided, because crops come in late, and plants do not stand the winter so well, in such a situation. A garden with a northern aspect has, however, its advantages, being cooler for some summer productions, as strawberries, spring-sown cauliflowers, &c. and therefore to have a little ground under cultivation so situated is desirable, especially for late sucession crops.

The soil that suits general cultivation best is a loam, rather the red than the black; but there are good soils of various colours, and this must be as it happens. The worst soil is a cold heavy clay, and the next a light sand; a moderate clay, however, is better than a light soil, though not so pleasant to work. If the soil is not good, *i.e.* too poor, too strong, or too light, it is to be carefully improved without delay. Let it first, at least, be thoroughly broken and cleaned of all rubbish, to a regular level depth at bottom as well as at top, so as to give full eighteen inches of working mould, if the good soil will admit of it; none that is bad should be thrown up for use, but rather moved away. This rule of bottom levelling is particularly necessary when there is clay below, as it will secretly hold up wet, which should not stand in any part of the garden. (See DRAINING.) When a piece of ground is cleared of roots, weeds, stones, &c. it would be of advantage to have the whole thrown into two-feet-wide trenches, and lie thus as long as conveniently may be. The ground cannot be too well prepared; for when this business is not performed to the bottom at first, it is often neglected, and is not conveniently done afterwards; and so it happens, that barely a spade's depth (or less) is too often thought sufficient to go on with. There is this great advantage of a deep staple, that in the cultivation of it the bottom may be brought to the top every other year, by double trenching; and being thus renewed, less dung will do, and sweeter vegetables be grown. Tap-rooted things, as carrots and parsnips, require a good depth of soil.

The aspect of the wall designed for the best fruits may be full south; or rather inclining to the east, by which it will catch the sun's rays at its rise, the cold night-dews be earlier and more gently dissipated, and the scorching rays of the afternoon summer's sun are sooner off. By thus having the walls of a garden not directly to the four points, the north wall is greatly advantaged by having more sun.

The border next this wall should be of very good earth, about two feet deep, rising a little towards the wall. A free moderate loam, or some fresh maiden soil, not too light, is necessary: and if it is not naturally there, let no trouble be spared to procure it, if it can be had, so as to make all the borders promising good; and in order to this, if manure is necessary, let it rather be that of rotted vegetables, or turf, with a small quantity of wood-ashes; for the roots of fruit-trees should not meet with much dung, at least of horses: that of cows is the best, or that of sheep or hogs will do well rotted, well-mixed, &c. being worked in the borders as long as possible before the trees are to be planted. Let the holes be some time opened beforehand, that they may be improved by exposure to the atmosphere. Thus due care will be taken, and all things be ready to go about the work of planting properly.

The borders for peaches, &c. cannot be too wide, for in a few years the roots will spread a considerable way: and that they may do it without impediment of rubbish in the walks, and without meeting with a bad soil, is of the greatest consequence to the future health and fruitfulness of the trees.

If a garden is large and square, a second south wall, running down the middle of it, would be very useful; and so, if large and long, a cross wall or two might be adopted, as giving opportunity for the cultivation of more trained fruit-trees; and if there is any idea of forcing fruits, these intersecting walls, ranging east and west, are proper for it (as situated within the ring-fence), furnished with flues, &c.

The best fruit-border being prepared for peaches, nectarines, and apricots, or vines and figs, the trees should take their residence there (if the leaf is falling) about the latter part of October, or as soon after as can be. If the middle of December is past, February is then the time; though gardeners plant all winter, if the weather is open enough at the time to work the ground. March, however, may do, or even the beginning of April.

Wall-trees should not be older than two years from grafting or budding. Much disappointment has been the consequence of planting old trained trees, through their being accustomed (perhaps) to a contrary soil, or by damage done to the roots in taking the trees up; and thus, instead of saving time, it has frequently been lost, being obliged (after years) to be replaced with young ones. But if trained trees are to be made use of, let them be planted as early, and with as full roots as possible, and in a good soil. Except in fine situations as to sun, shelter, and climate, never plant early and late peaches; as the first may be cut off, and the latter not ripen. October peaches are generally poor fruit much north of London.

The distance to plant should be about 12 inches from the wall: and let apricots, peaches, and nectarines, be twenty feet asunder, more or less, according to the height of the wall; though for the small early sorts fifteen or sixteen feet will do. As the larger apricots, however, grow freely, and do not well endure the knife, they ought to have twenty-five feet allowed them. This is for a wall of nine or ten feet high; if higher, the distance may

be less, and if lower, the contrary. This room may seem to some too great; but when trees are planted in too confined a space, after a few years it is troublesome to keep them pruned within bounds: and the cutting they must have makes them run to wood, and thus to become less fruitful. Fig-trees require as much room as the apricot, or rather more; as they grow freely, and are to extend without shortening. Though other trees are best planted in October, the fig should not be till March.

The intermediate spaces between peaches, nectarines, and apricots, may have a vine, a dwarf cherry, or currant or goosberry tree of the early sorts, as the smooth green and small red, to come in early; and will be improved in the beauty, size, and flavour, of their fruit, by the advantage of situation. But wherever grapes can be expected to ripen, there let a young plant, or cutting, be set, though the space should be confined; for the vine, freely as it shoots, bears the knife well to keep it within bounds. If the wall is high, the cherry or plum may be half-standards; which being after a while kept above, will be more out of the way of the principal trees; though dwarfs may be trained so as not to interfere. Some have planted half-standards of the same kind of fruit as the dwarfs: but whichever mode is adopted, let the intermediate trees be pruned away below in good time, in order to accommodate the principals freely as they mount and extend. The better way however is, when the wall is tolerably covered, to extirpate the intermediate trees; as, when large, they impoverish the border, and rob the principals of nutriment. If taken up well in season, and pruned properly, they may be planted elsewhere. Something merely ornamental may occupy the vacancies also, as some double-blossomed fruit-tree, passion-tree, roses, &c. or in a fine situation a pomegranate; any of which may be removed when their room is wanted.

Plums, cherries, and pears, may occupy the other walls; the two former at about fifteen feet, or it may be twenty feet asunder. Cherries, except the morella, will not do well in a full north aspect; but any sort of plum (rather a late one) and summer pears, and also nut-trees, will, if you chuse to train them. There should always be some currants and gooseberries in an east and north situation, at the distance of eight feet, where they will be easily matted, when ripe, to come in late, as October, November, or perhaps December. Pear-trees of free growth are hardly to be kept within tolerable compass on low walls; but if attempted, should have at least thirty feet allowed them. The best sorts of winter pears deserve a southerly wall to ripen them well, and improve them in size and flavour. The gable end of a house is well adapted for a pear-tree, as it affords room, which they require. Apples may do on a wall (and if any on a good wall, let it be the golden-pippin), yet the practice is seldom adopted. The same may be said of mulberries, though they come to bearing much sooner against a wall; but they need not have a south aspect, indeed it has been asserted that they succeed the best in a north one. For furnishing walls chuse trees of moderate wood, young, well rooted, clean, and healthy.

When the planting of a garden is finished, it will be a good way to have a plan of it taken, with the name of every peculiar tree marked on it in their place, to be assured of the sorts when they come to bear. Some have the names of the trees painted on boards, and placed behind them; to which if added the time of ripening, (fixed late enough) it would tend to prevent a premature plucking by visitors, &c.

Here it may be observed, that if any evergreen hedges are desired in or about the garden, yew, box, alaternus, celastrus, phillyrea, and pyracantha, may be kept low, and clipped in form, if so desired; in addition to which, if a few roses were intermixed, it would have a very pretty effect. A deciduous hedge for subdivision, or screen, &c. may be made of elms or limes, setting the larger plants at five feet feet asunder, and a smaller one between. Or an ordinary fence, or subdivision, may be quickly formed of elder cuttings, stuck in at two feet asunder, which may be kept cut within bounds.

A wide border next the south wall, as was said, is best for the trees; and moreover for the many uses that may be made of it for the smaller early, or late tender esculents, and a few early cauliflowers. For the sake of a pleasant warm walk in spring, to have the south border narrow may be desirable; but on no account let it be less than six feet. Take care that this walk is not sunk too much; and that it have a bottom of good earth, as deep as where the trees are planted. Let the body of gravel be thin, and then the roots of the trees will be admitted to run properly under the walk, and find wholesome nourishment; where, if they were stopped by rubbish, they would be apt to canker, and irrevocably disease the trees.

The number and breadth of the walks must in a measure be determined by the quantity of allotted ground; exceeding in these particulars where there is room. But few and wide walks are better than many and contracted. If the garden is small, one good walk all round is sufficient; and if long and narrow, the cross walks should not be many; six or eight feet walks are not too wide for a moderate-sized garden.

If the ground is laid out in autumn, defer the making of the walks till spring, when the earth will be settled. Gravel laid towards winter would be disturbed by the frost, and the necessary work about the quarters and borders. But whenever made, the garden ought to be brought to an exact level, or slope; then the walks should be stumpt, keeping the tops of the stumps very level (as guides) to the true pitch of the quarters by a light line, made of good hemp, that will bear pulling tight. Proceed to take the earth out of the alleys about eight inches deep, which may be thrown towards the middle of the quarters, to give them a small convexity, which makes them look well.

Rake the bottom of the walk level, and lay the gravel to within two inches of the top of the stumps. The gravel will settle a little, but the walks should always be about three or four inches at their edge, below the quarters, or these will have a flat, and so a mean appearance.

If edgings are to be made, in order to separate between the earth and gravel, especially if of stone, or wood, or box, they should be done first, and they will be a good rule to lay the box by.

If you have plenty of gravel, lay it moderately fine; if little, some small stones, or rubbish of any kind, may be laid in first, and rammed down level with a broad rammer; but do not spare for a little expence, if gravel can be had, as a thick coat of fine gravel will bear relaying, or turning over, to refresh it occasionally in the spring. As the gravel is laid, let the operator neatly rake the larger parts down to the bottom, leaving a fine surface, in a small degree convex, *i. e.* just barely sufficient to throw off wet; walks that lie very high in the middle are unpleasant to both eye and feet, and cannot be so well rolled and kept in order.

When deep walks of gravel are designed, for the sake of the mould dug out of the alleys, it should be forborne, and laid thin, if any trees are intended to be planted near the edge: for if the roots of trees have not a good soil to strike into, when they reach the walks, they will not prosper. In laying gravel very thick it is a good way to do it at two courses; the first of which may be rough, as it comes from the pit, yet still raking the larger parts down, and then ramming or treading it; and the last course should be all of screened materials.

It is best to lay a few yards of gravel only at a time, before ramming or treading; after which it may be necessary to go over it with a fine iron rake, tooth and back; and then a whole walk being finished, it should be repeatedly pressed with a moderately heavy roller; and again soon after the next rain that falls. So will the walks become nicely level and firm, in which their excellence consists.

Grass walks may answer where gravel is scarce; but the latter is so clearly preferable, that except for a little variety in large gardens where there are many walks, they will hardly be made choice of. They are troublesome to keep in order, and if much used are apt to get bare, and out of level, especially when narrow; they are also frequently damp to the feet.

Camomile has been used also to form green or carpet walks, planting it in sets about nine or ten inches asunder; which naturally spreading, the runners are fixed by walking on them, or rolling.

Sand may be adopted for walks, and there is a binding sort of it that does very well; but lay not any of it too thick, as it is the less firm for it. Drift sand is a good substitute for gravel.

Coal-ashes strewed thinly in the alleys are better than nothing, as they at least serve to keep the feet dry and clean. If the garden is of a strong soil, these ashes, when worn down, may be thrown out of the walks, with a little of the earth, and will prove a good manure for the quarters.

Sea-shells make very good walks.

All trees designed to be planted are to be thought of before winter. Those of the wall have been spoken of; and as to standards, they must have a fair depth of good soil to grow in; for it should be remembered, that tree-roots in a garden are prevented from running over the surface, as they do in an undisturbed orchard. It is necessary that some caution should be used not to dig the ground too near and too deep about garden trees, lest loosening the roots they should not be able to stand the wind; and because the nearer the

surface any root grows, the more and choicer fruit the tree bears.

But the fewer standard trees in a garden the better, as they take up much room, and by their shade prevent the proper growth of vegetables that are near them; so that if a garden is small, there should be no trees except those of the wall. The case is different where there is ample room; and the blossoms of fruit-trees (apples particularly) are so delightful, that if they produced nothing for the palate, there would be a sufficient inducement to plant them for ornament; but let them be dwarf standards in preference to espaliers.

Dwarf-standards occasion less trouble to keep them in order than espaliers, and are generally more productive; for espalier trees are seldom managed well, and thus appear unsightly: at best they are stiff and formal, and obstruct the sight in viewing the quarters of a garden, which, if in order, are worthy of coming under the eye; the violence done to nature, to keep espaliers in form, is commonly paid by disappointment. A writer of repute observes, apples on French paradise stocks, planted at eight or nine feet distance, pruned and kept in an easy manner, make a fine appearance, and produce better fruit, and in greater quantities, than when they are in espaliers. Dutch paradise stocks however last longer, and are altogether superior.

If espaliers are planted, let them be only fruit of the best sorts, and in spacious gardens, where they may have a good length and height allowed them them to grow freely; and let it be resolved to do the business neatly. If they may have nothing better than poles or stakes to be trained to, let them at least be straight, and of some equality in size as to height and thickness, smooth, and not too clumsy for the purpose; fix them well in the ground, upright, and about nine inches asunder; at first only four feet from the ground, and raised as the trees advance in height. Apples on paradise stocks best suit for espaliers in small gardens, and pears on quince stocks, as they maintain a small size; but they are apt to decay by the cutting they must have, and so do not prove enduring trees.

Espalier trres should rather be trained to sawed materials properly framed together, smoothed, and painted. But for a year or two they may be fastened to light stakes, when they will have formed a head, to begin to train them for bearing in the neat manner proposed, that is, to slips of deal joined to light oak posts, as trellises. Whether the slips are placed perpendicularly, or longitudinally, seems indifferent. If the longitudinal mode of training is the best approved, strong iron wire may be recommended to run through the posts instead of slips of wood, as it shades less, and is stronger and neater. If upright slips are used, they should be slender, and from six to eight inches distance, according to the greater or less freedom of the natural growth of the tree. The height may be also according to the nature of the tree, from five to six feet, and it will not answer to have them lower. Only a moderate length of trellis (on each hand) need be fixed at first, and so additions made as the tree extends. The posts may be about four feet asunder; the first on each hand being two feet, or a yard, from the stem of the tree.

Apples should be allowed 24 feet, and pears 30; except those grafted on paradise or quince stocks, for which little more than half this distance may answer. Cherries and plums should have about 18 or 20 feet allowed them. Quinces, medlars, mulberries, and filberds, may also be espaliered. The trees should be planted about a yard from the edge, but farther off is better, if the walks lie deep of gravel or poor materials.

The Breda and Brussels apricots have succeeded in espaliers, as also in dwarf and full standards; but the general climate of the place must be mild, and the situation they are planted in must be very sunny and well sheltered. The fruit from standard apricots is very fine, and abundant; but they come not to bearing under several (sometimes 10 or 12) years.

Currants, gooseberries, and raspberries, do well espaliered, as to a production of early and fine fruit.

Trees of a more humble nature, and shrubs, next occupy attention in furnishing a garden. Currants and gooseberries (as bushes) should be planted three feet from the edge, and full six feet asunder. Some of these very useful shrubs should grow in every aspect of the garden, in order to have a succession of their fruits, as long as may be. Those who choose to plant whole quarters of currants and gooseberries ought to do it at six feet asunder in the rows, and the rows eight feet from one another.

Raspberries may be set in plantations, in rows five feet asunder, allowing three feet between the plants. These shrubs are always best by themselves, as otherwise their suckers over-run the quarters. Between rows of raspberries planted at the above distance, coleworts, early cabbages, cauliflowers, and lettuces, may be set, or spinach sowed in drills; the raspberries having had their pruning and dressing early in autumn, for the purpose. Every year a little short manure, dug in close about the roots, (and deeper as the plantation gets older) will insure fine fruit. Raspberries are not very nice as to soil and situation; but the twice-bearing sort should have a dry soil and warm birth to forward the crops, that the last may be in time. See that the plants to be set have good brushy roots, and two or three eyes to each root near the stems, for the next year's bearing. The smooth-wooded, or cane rasp, is to be preferred for a principal crop. The large, white, or Antwerp, is also good.

Strawberries may be planted at the edges of borders and quarters, either in single or double rows (rather the latter) for the convenience of gathering, and for ornament; but the common and best way is, in four-feet beds, with eighteen-inch or two-feet alleys, on which beds may be five rows of the wood and alpine, four of the scarlet and pine-apple, three of the Carolina, and two of the Chili; setting the plants at the same distance in the rows, as the rows are from one another in what is called the quincunx order, that is, like the five of cards. In a good, cool, loamy soil, which suits them best, a little more distance may be allowed the first four sorts; and in a quite dry light soil, somewhat less, that they may shade one another the better from drought.

The best situation for strawberries is an open and sunny one, as thus they bear more, and finer-flavoured fruit. Some of the scarlets should be planted under warm walls to come early. The woods bear shade as natural to them, and the alpines do tolerably well in it. As lengthening the season of fruit is a desirable circumstance, for these three sorts (at least) the situation should be various.

The most proper time for planting the strawberry is the first moist weather in September, (or even earlier) that they may be established in the ground before winter, and they will bear the better the first year. Frost is apt to throw up late-planted ones, and injures, if not destroys them. Those planted in spring often suffer from drought, and bear very little the first year, except the alpines. Choose forward runners for planting, and let them be from beds in full bearing, that is, of two or three years old; for plants from old beds are not so fruitful. Take care also they come from beds producing fruit good in its kind, and true as to sort: much depends on this. Press the mould to the roots, give them a watering, and again once or twice, if the weather proves dry. Some gardeners let them run over the beds, which in a dry light soil may be proper; but in this case, a greater distance should be allowed them at planting.

If the alpine sort is planted on a warm border, 18 inches asunder, and suffered to spread, tho first runners will fruit the same year, and sometimes this prolific strawberry bears till November.

Fresh plantations of strawberries should be made every fourth year, though in a good soil and with good management they will continue longer: so that where they are suffered to run, the plants being frequently renewed, and old ones removed, beds have borne tolerably for ten years. Some gardeners insist that this spreading mode is the best way of cultivating the strawberry. In a dry season, such full-covered beds have the advantage, but in a wet one the fruit is apt to rot, though still in such a season it is cleaner than from plants growing in an open way; but this carries the appearance of neglected culture. The method of keeping them in detached plants produces the largest and best-ripened fruit, and on the whole is preferable; for which practice there cannot be a stronger argument, than that those follow it who cultivate the strawberry for sale.

The watering of strawberries should not be neglected, doing it almost daily when in flower, and setting their fruit, if the weather proves dry, particularly to those under a warm wall; but this is not to be continued when the fruit is nearly ripe, which would spoil the flavour, and dispose them to decay.

Flowering shrubs may be dispersed about, and herbaceous perennial flowers; but plant them not too near the edge, lest they hang over the walks. The bulbous sorts may, however, be within six inches, especially crocuses and snowdrops

Asparagus and artichokes should be thought of, but they take up much room, and in small gardens may therefore be left out. It will be of little use to have less than 50 or 60 feet of asparagus beds, as there would be so few heads to cut at a time; and artichokes must be planted wide, or they will not grow large and fleshy, in which their merit consists.

Let not pot-herbs be forgotten, but provide a general herbary in that part of the garden which is warmest, and best-shaded, for these are tender plants.

Having spoken of stationary things, the routine of the seasons must dictate the rest; and the inclinations of the palate will refresh the memory to take care of providing the most necessary and agreeable esculents for dressing, and raw salads.

Perennial flowers have been mentioned; but let fancy direct as many annuals and biennials to be cultivated, as room can conveniently be found for, that the garden may be, as much as possible, ornamented.

In furnishing a garden with shrubs and flowers, respect should be had to their usual height, their bulk, colour, and season, that the mixture may be properly varied, harmonious to the eye, and come in regular succession. The latter part of the year is seldom provided for so well as it might be; late flowers should be set in warm situations, as their proper place. In the most dreary months, by judicious planting, evergreens in their neat and cheerful "winter liveries," may be viewed from our windows, and serve instead of flowers.

Those who garden upon a large scale, should take care to have every thing proper and convenient liberally provided. Let there be a well-situated place for hot-beds, with some building as a tool-house, and (if dry) for keeping bulbs, seeds, and herbs. Those also who garden even upon a small scale will do well to have every needful implement. It is the way to save time and labour, and have work done well.

If water can be introduced, and kept clean with verdant banks around it, it would be found very useful where a garden is large; but let it be as near the centre as possible, as the most convenient situation. It should be fed from a pond in preference to a spring.

Mixed gardening, as comprehending the useful with the sweet, the profitable with the pleasant, has been the subject hitherto; but if the flower garden and the kitchen garden are to be distinct, the case is altered; not so much indeed but that still the kitchen garden should be adorned with a sprinkling of the more ordinary decorations, to skirt the quarters, chiefly those of the most powerful sweet scents, as roses, sweet-briars, and honeysuckles, wall-flowers, stocks, pinks, minionet, &c. in order to counteract the coarser effluvia of vegetables, or of dead leaves, which, however, should not be suffered to annoy.

The flower garden, properly so called, should be rather small than large; and if a separate portion of ground is appropriated for this, only the choicest flowers should be introduced, and no trouble spared to cultivate them in the best manner. The beds of this garden should be narrow, and consequently the walks numerous; and not more than one-half or two-thirds the width of the beds, except one principal walk, all round, which may be a little wider. The gravel, or whatever the walks are made of, should lie about four inches below the edge. The beds for tulips, hyacinths, anemonies, ranunculuses, &c. may be three and a half or four feet wide, and those for single flowers the same, or only two and a half feet wide in the borders, which was the most usual breadth in the old flower gardens. Let the beds lie rather rounded in the middle, but the walks flat.

Figured parterres have got out of fashion, as a taste for open and extensive gardening has prevailed; but when the beds are not too fanciful, but regular in their shapes, and chiefly at right angles, after the Chinese manner, an assemblage of all sorts of flowers, in a fancy spot of about 60 feet square, is a delightful home source of pleasure, worthy of pursuit. There should be neat edgings of box to these beds, or rather of neat inch-boards, painted lead colour, to keep up the mould. Be sure to keep the box from the very first, as soon as rooted, and always after, as low as possible: clip it twice a year, April and July.

Landscape or *picturesque gardening*, is so much the work of fancy, and so much depends upon the situation, or what the celebrated Mr. Brown used to call the capability of the place, that no precise rules can be laid down concerning it. All, therefore, that can be expected, is a few loose hints, on which the man of taste may improve according to circumstances.

Those, however, who would do much in landscape gardening, should not be forward to trust their own taste altogether. In this business there is no making experiments, but all should be executed, as much as possible, upon certainty. There is a variety of works and decorations in extensive gardening, which injudiciously introduced, might create a wasteful expence. This is an error that ought to be avoided, and most probably would be by those who have been in the habit of studying nature, and the powers of art as her submissive handmaid.

The pleasure we seek in laying out gardens, is now justly founded upon the principles of concealed art, which appears like nature; but still, whether ingenious contrivances, and decorations, (altogether artificial,) should be so entirely laid aside as they are, may deserve to be considered. Gardens were formerly loaded with statues, and great improprieties were committed in placing them, as Neptune in a grove, and Vulcan at a fountain, large figures in small gardens, and small in large, &c. but perhaps the works of the statuary might be still be introduced if well executed, and in proper places. A terrace as a boundary, is now seldom formed; but in some situations, such an eminence might in several respects be agreeable.

If trees are planted injudiciously, the error is a trifle; but if cut down so, the consequence is serious, and has often been sorely lamented; extirpation should therefore be well thought of before it is executed; especially trees about houses, for many dwellings have been thus too hastily exposed, and deprived of comfortable shelter and shade. And why should a taste have prevailed for so sudden a transition, as no sooner out of the house than to arrive in the open country; or why should an extensive garden be thrown as much as possible into a single view, when meeting with new objects in our walks is so agreeable?

Hilly spots that are in view of the house should be planted with firs, as fine-looking trees, and very hardy. Beech does well on high ground, especially if chalky. In low ground, not to mention alders, and that tribe, the birch, and even the oak, should not be forgotten, where the wet does not long stand.

About the house some shady walks ought always to be provided, by thick planting, if not of trees, yet of flowering shrubs, and evergreens, of which the laurel will be found the most useful. If there is good room, single trees of the fir kind, at due distances, are admirable ornaments about a house, and clumps of shrubs all of the same kind have a good effect.

Those who have much space of ground to decorate, do well to plant trees and shrubs of every kind, as enlarging the sources of amusement, and affording opportunities for observation; but if the allotment of ground for this purpose is contracted, then, of course, those only should be planted, which by their neat foliage, natural symmetry, and gay flowers, may be truly esteemed ornamental. They should be such as strike the eye of persons in general, though they have nothing of singularity to engage the attention of the curious in plants. It too often happens, that good old sorts of trees, shrubs, and flowers, are excluded for new ones; but if the latter are not more elegant, and generally pleasing, the practice is surely not a wise one: in ornamental gardening, great care should be taken, in the choice of what is really handsome, that nothing dull or rambling be introduced.

The walks should always be wide, some inclining to serpentine, and contrived as much as possible upon a level, as walking up and down hills can hardly be called pleasure. That they may be extensive, they should skirt the grounds, and seldom go across them. In small pleasure-grounds the edges of the walks should be regularly planted with flowers, and long ones occasionally so, or with the most dwarf shrubs; and neat sheltered compartments of flowers, (every now and then to be met with) have a pretty effect. If the walks are extended to distant plantations of forest-trees, every opportunity should be taken, to introduce something of the herbaceous flowery kind, which will prove the more pleasing, as found in unexpected situations. The outer walk of pleasure grounds and plantations, should every now and then break into open views of the country, and to parts of the internal space, made pleasing, if not striking, by some work of art, or decoration of nature.

Water should only be introduced where ir will run itself clear, or may be easily kept so, as also in full sight; and some fall of it should be contrived, (if possible) for the sake of giving it motion and sound, because a lively scene of this element is always much more pleasant than a dead one. Every spring of water should be made the most of, and hough fountains, &c. are out of fashion, something of this kind is agreeable enough. Near some pieces of water, as a cool retreat, it is desirable that there should be something of the summer-house kind; and why not the simple rustic arbour, embowered with the woodbine, the sweetbriar, the jessamine, and the rose? Pole arbours are tied well together with burk or ozier twigs.

Before the design of a rural and extensive

garden is put in execution, it ought to be considered, or anticipated, what it will be in twenty or thirty years time; for it often happens, that a design which looks handsome when first planted, and in good proportion, becomes so small and ridiculous in process of time, that there is a necessity either to alter it, or destroy it entirely, and so plant it anew. To proportion the breadth of walks, the size of carpets, casting and levelling of grounds, parterres, &c.; the disposal of fountains, statues, vases, dials, and other decorations of magnificence to most advantage, requires a particular address, says Mr. Evelyn, or to speak more emphatically, a prophetic eye; and though the taste is not what it was in Mr. Evelyn's time, yet, perhaps, the only difference is that more skill is requisite.

Landscape gardening depends much on the form of the ground, and therefore to shape that is the first object. Some situations may not need it, and perhaps a little alteration may produce a happy effect in others; therefore great alterations should not be attempted without manifest advantages, as either levelling, or raising ground, is a heavier business than is commonly supposed, both as to time and expence.

Too much plane is to be guarded against; and when it abounds, the eye should be relieved by clumps, or some other agreeable object. Hollows are not easily filled; and eminences mostly are advantageous, in the formation of picturesque scenes, in which the general principle of ornamental gardening consists. This idea has been pressed so far, that it is contended, a gardener should be a studier of landscape paintings. But without an immediate view to pictures, no doubt, grounds may be laid out in a way sufficiently picturesque. That view may be very agreeable in nature, which would not be so in a picture, and the contrary.

Picturesque gardening is effected by a number of means, which a true rural genius, and the study of examples, only can produce. These examples may be pictures, but the better instructors will be scenes in nature; and the proper grouping of trees, according to their mode of growth, shades of green, and appearance in autumn, will effect a great deal.

To plant picturesquely, a knowledge of the characteristic differences of trees and shrubs, is evidently a principal qualification. Some trees spread their branches wide, others grow spiral, and some conical; some have a close foliage, others an open one; and some form regular, others irregular heads, the branches and leaves of which may grow erect, level, or pendant.

The mode of growth in trees, as quick or slow, the time of leafing, and shedding leaf, with the colour of the bark, are all circumstances of consideration in order to produce striking contrasts, and happy assemblages, in the way of ornamental gardening.

To range the shrubs and small trees, so that they mutually set off the beauties, and conceal the blemishes, of each other; to aim at no effects which depend on a nicety for their success, and which the soil, the exposure, or the season of the day, may destroy; to attend more to the groupes than to the individuals; and to consider the whole as a plantation, not as a collection of plants; are the best general rules which can be given concerning them.

In considering the subjects of gardening, ground and wood first present themselves; and water next; which, though not absolutely necessary to a beautiful composition, yet occurs so often, and is so capital a feature, that it is always regretted when wanting; and no large place can be supposed, a little spot can hardly be imagined, in which it may not be agreeable. It accommodates itself to every situation, is the most interesting object in a landscape, and the happiest circumstance in a retired recess; captivates the eye at a distance, invites approach, and is delightful when near: it refreshes an open exposure, it animates a shade, cheers the dreariness of a waste, and enriches the most crowded view. In form, in style, and in extent, it may be made equal to the greatest compositions, or adapted to the least: it may spread in a calm expanse to soothe the tranquillity of a spaceful scene; or hurrying along a devious course, add splendour to a gay, and extravagance to a romantic situation. So various are the characters which water can assume, that there is scarcely an idea in which it may not concur, or an impression which it cannot enforce.

On the works of art in gardening, the following passage is pertinent: "Art was carried to excess, when ground, wood, and water, were reduced to mathematical figure, and similarity and order were preferred to freedom and variety. These mischiefs, however, were occasioned, not by the use, but the perversion of art; it excluded, instead of improving upon nature, and thereby destroyed the very end it was called in to promote. Architecture requires symmetry, the objects of nature freedom; and the properties of the one, cannot with justice be transferred to the other. But if by the term art no more is meant than merely design, the dispute is at an end; choice, arrangement, composition, improvement, and preservation, are so many symptoms of art, which may occasionally appear in several parts of a plantation, but ought to be displayed without reserve near the house: nothing there should seem neglected; it is a scene of the most cultivated nature, it ought to be enriched, it ought to be adorned; and design may be avowed in the plan, and even in the execution. Regularity is not excluded: a capital structure may extend its influence beyond its walls; but this power should be exercised only over its immediate appendages. Works of sculpture are not, like buildings, objects familiar in scenes of cultivated nature; but vases, statues, and termini, are usual appendages to a considerable edifice: as such, they may attend the mansion, and trespass a little upon the garden, provided they are not carried so far into it as to lose their connection with the structure."

The cultivation of a garden.—The first object with a view to produce should be, to keep the ground in such a state as will enable it to produce good crops. Good vegetables cannot be had without good manure. Yet raw unwrought dung is not good for a garden. The most economical plan therefore, that can be pursued, is for the first year to make good hot-beds of your dung, and spread it out upon the quarters, and dig it in in autumn and winter. You by this means have a double produce, and the dung is the better.

Dung, however, used in great quantities, and lying in lumps, breeds worms, grubs, and other insects, and causes plants to grow too rampant and rank-flavoured. Carrots it cankers, and it disagrees with many things. On these accounts some persons have been induced to dress their gardens only with rich fresh earth; which, if they do not overcrop, will do very well, being accompanied with good tillage; which alone is of much use, and is essential to due cultivation. The method just recommended, of letting dung lie in the state of a hotbed for a time, is good, as it abates the rankness of it.

If the ground is in proper heart, every spot may be contrived to be constantly and successfully cropped. The common gardeners about London, who give high rents for their land, contrive (manuring well) a succession of crops, one under another, very dexterously; and this sort of conduct should be imitated by private persons. Thus a little spot, in skilful and industrious hands, will be much more productive than a much greater under contrary management: but when hard worked, the soil will not do without a good deal of manure.

In the occupation of ground, the change of crops will be proper, as each sort of plant draws a somewhat different nourishment: so that after a full crop of one thing, one of another kind may often be immediately sown; but it should be contrived that a wide crop may follow a close one, and contrariwise.

Close crops, as onions, leeks, carrots, &c. are conveniently and neatly cultivated in beds of from four to five feet width, with alleys of from a foot to eighteen inches between them.

The seasons proper for furnishing the ground with every particular vegetable, should be well attended to, that each may be obtained as early as its nature will permit; and of the seeds and plants we use, care must be taken to procure the best of the kind, lest after all the trouble of cultivation, disappointment as to quality should ensue.

Seeds and plants should be adapted as much as possible to the soil and situation which best suits them; for in the same garden some difference will be found, not only as to sun and shelter, but the earth; as some will be richer, some poorer, some deeper, some shallower, and some, perhaps, heavier, some lighter, in due attention to which, advantage is to be reaped.

The thinning of seedling crops should be done in time, before the young plants have drawn one another up too much. All plants grow stronger, and ripen better, when the air circulates freely round them, and the sun is not prevented from an immediate influence; an attention to which should be paid from the first appearance of plants breaking ground.

In the pricking and planting out of crops, be sure to do it as early as may be; let every thing be regular, (not sparing to use the line) allowing always room enough for this work; and being thus treated, vegetables will come forwarder, larger, and of a superior flavour. These advantages are seen

in all things, but in lettuces particularly, which often have not half the room allowed them they should have. Over-cropping robs the ground of strength to no purpose, except increasing the dunghill; it makes it also inconvenient to weed, rake, and clean up, which in a private garden, at least, it is proper frequently to do.

Shading of new-planted things, particularly flowers, is of much benefit, and that in proportion as the season is sunny, as neglecting this business has frequently proved: as a little water in a cloudy time does plants much good, so when shaded.

Strawberries and cauliflowers are generally watered in a dry season; that is, the strawberries when in bloom, in order to set the fruit, and the caulitlowers when they shew fruit, in order to swell the head. In a light soil, this ought particularly to be done. In very dry weather, asparagus seedlings, early turnips, carrots, radishes, and small salads, will need watering. Slips, cuttings, and layers of any kind, will need water. Pots of flowers must have it frequently.

When watering is undertaken, let it be a complete business; *i. e.* to the bottom and extent of the roots, as much as may be. The wetting only the surface of the ground is of little use, and of some certain harm, as it binds and cracks the earth, and so excludes the benefit of showers, dews, air and sun, from entering the soil, and benefiting the roots as they otherwise would do. Wetting the surface of the ground, however, in a summer's evening, makes a cool atmosphere; a dew is formed, which pervades the leaves, and helps to fill their exhausted vessels.

Watering the roots of wall-trees, (if dry weather) when the fruit is setting, is by some thought necessary: The best way to do this effectually, is to make a few holes at the some distance from the tree with a smooth sharp-pointed stake, the better to let the water down; but this may wound the roots, and should only be practised in a light soil, and very dry season. To young trees only it can however be of use, for the roots of old ones run far and wide; and it is the small fibres of these distant roots, on which the tree chiefly depends for food. Vines should have no water till they are off blossom, (July) and the fruit as big as large pins' heads; and then if the season is very hot and dry, watering the roots twice a week will help the fruit to swell.

As watering is apt to make ground hide-bound and unsightly, let the surface be occasionally stirred and raked, which will make future waterings enter the ground the better; when the ground is hard on the top, the water runs away from its proper place, and half the labour is lost. Many things are impatient of being kept wet about the shanks, and therefore watering should be generally at a little distance.

The quality of water used for refreshing plants is a material thing, and is very various in its nature, according to the peculiar earths and mineral substances that it passes through. Rain water is by far the best, as appears by the verdure and vivacity it gives.

Pond water is next in fitness, and river water follows. Well water is of least account, though local circumstances occasion its use the most. So that in forming a judgment concerning watering, it is not simply to be considered, whether plants should be watered; but whether with well-water, and that too from a pump. Pump-water, if used directly, is so cold in summer, that it is found prejudicial to plants: and great cold so contracts their vessels, that they perform their proper offices with difficulty, and become diseased.

The management of a garden, as somewhat distinct from the cultivation of it, is an object of consequence; that is, to keep it in such order, that it may not fail in those general impressions of pleasure it is capable of affording, when things are shewn in their best manner. A garden may be cultivated so as to be profitable; and yet not conducted so as to be agreeable to walk in, which in a private garden is a circumstance surely to be lamented. The proper appearance of a well managed one is expressed by the word neat. Let all be done that can be in order to it.

To be neat, weeding must be industriously followed up, and all litter that is made in working, quickly carried off. The ground also should be frequently stirred and raked between crops, and about the borders, to give all a fresh appearance. There is a pleasantness to the eye in new-broken earth: and when there are no flowers left in the borders, this gives an air of culture, and is always agreeable. The observation is particularly meant to apply in autumn, that the garden may not become dreary too soon, and so bring on winter before its time. An asparagus-fork is expeditious and useful in this case; but it must be slightly used, lest it disturb the roots of plants too much. Vegetables should not be suffered to rock themselves by wind, so as to form holes round their stems, but be well earthed up or otherwise supported.

Trees and shrubs should be constantly freed from suckers and dangling shoots, and wall trees ought to be regularly kept in order. Grass plats and walks should have their edges occasionally cut, and be mowed as often as there is the least hold for the scythe, for they lose much of their beauty, when the grass gets long; leaves should not be suffered to remain on them, as it stains the grass; and worm-casts should be cleared away. Edgings of all sorts should be kept in good order, as having a singularly neat effect in the appearance of a garden. The dead edgings will sometimes, and the live edgings often, want putting to rights; either cutting, clipping, or making up complete. Where there are no edgings, or but weak ones, let the earth bordering on the walks be kept firm, and now and then worked up by a line in moist weather, beating it smooth with the spade.

Some fruits may need support, by tying their weak branches when they get heavy, to stakes, &c. Rows of raspberries and beans are kept neatly up in their lines, by putting in here and there a stake, and using packthread lengthwise; and thus will they bear better, and be more conveniently gathered. Strawberries of fine heavy sorts, will be preserved from getting dirty and rotten, by tying their stems to little sticks; by this practice the fruit also gets better ripened, and of a finer flavour. Some persons lay tiles, or moss round the plants, when the fruit is half-grown; but this is not, generally, so well, only it has the advantage in keeping the ground cooler in a hot season. The first and finest scarlets best deserve this trouble.

Flowers should be frequently tied up, and dead and dangling parts trimmed off. Some of them cannot do without support, and many sorts are made more secure and beautiful by proper ties. If this business is neglected, a heavy rain or strong wind may come, and lay all prostrate, especially about the equinoctial seasons; but weakness or their own weight, will often bring flowers down.

The sticks used for flowers, should be of smooth wood, as hazel or sallow, or of neat painted slips of deal, with or without an ornamental head; white is the best colour, on account of its contrast with the leaves.

Decaying flowers should be timely trimmed or removed, and perennials should be regularly freed from the parts running to seed, (except so much as may be wanted) as the production of seeds weakens the root much; sometimes even causing death, and thus many curious perennials have been lost, especially the first year of planting them. To preserve any particular sort therefore, let the stems be cut down as soon as the flowers appear to be going off, or to secure the root in strength, let them not flower at all the first year.

Of Propagation.—Plants are propagated by seeds, suckers, slips, off-sets, divisions, cuttings, layers, and grafts.

By seed is the most general method of propagation, and plants raised any other way are seldom so fine. Those plants from seed which have never been removed, are commonly handsomer, and come forwarder, than those that have been transplanted, provided they were sown in a proper soil and situation.

Commonly speaking, new seed is to be preferred to old, as growing the more luxuriantly, and coming up the surer and quicker. This circumstance induces some private persons to save their own seed that they may not be deceived in buying old for new seed; a trick of trade, it is to be hoped, not practised by every seedsman. Yet a little mixture of old seed is sometimes proper, because the new is perhaps cut off, and the old saved, by being a day or two later in coming up.

If old seed is knowingly sown, some allowance in point of time must be made. Peas and beans of two years old, are by some preferred to new, as not running so much to straw. The same may be said of cucumbers and melons.

As to the age of seeds, at which they may be sown and germinate, it is uncertain, and depends very much how they are preserved. Seeds kept from the air and moisture by being buried deep in the ground will continue a great many years without corruption. Peas and beans will germinate very well at seven years of age; but the seeds of lettuces, onions, kidney-beans, and some others, are not to be depended upon after a year or two; and though generally speakiug the smaller seeds are of the least duration, yet their maintenance of vegetative power depends much upon the texture of the seed, with respect to its coat, and the oil it contains, &c.

The saving of seed by private gardeners, is hardly to be recommended. Things running to seed give a garden a rude appearance, often occupying ground that is wanted, and might be used to better purpose; and the case often is, that seeding plants (in private gardens) are neglected in some measure, or destroyed by birds, and come to little at last. Perhaps they are not saved from proper plants. It is a particular business to raise seeds for sale, and, generally, they are best had from those whose province it is to deal in them.

Seeds should be saved from fine forward plants, secured from rocking about when they get tall; guard them against birds, gather them regularly as they ripen, lest they shed and are lost, and keep them dry. Flowers it may be proper to save the seed of, and it is little trouble. It should be a rule for flower-seeds in general to be fresh from year to year; though if kept dry, and from much air, many sorts will grow that are older: curious flower-seeds are kept well in phials: others may be in small drawers, and some hung up, or kept on shelves in their pods.

Seeds may be forwarded for sowing by various ways of procuring a germination before they are put into the ground. In summer it has been usual to steep both broad and kidney beans in soft water, about twenty-four hours, to forward their growth, and to ascertain their vitality. If the ground is very dry, when these seeds are committed to it, either steeped or not, it is a good way to make drills or trenches to plant them in, watering them well first, and then pressing the seed in a little. Any sort of the broad beans, or even peas, may be forwarded, when ground is not for the present ready, by laying them in damp mould, in a garden-pot; or otherwise, a layer of earth, and a layer of seeds, &c. and they may be put into drills or trenches, with care, when the radicle has got some length, the mould being light, and the work finished by a gentle watering.

The smaller seeds, as carrots, &c. may be prepared for sowing, by simply mixing them in a little moist sand, or fine earth, taking care that they do not lie longer than the usual time of their beginning to sprout; but this practice need only be adopted for seeds that are long in coming up, and then there is some advantage in havingthem to sow in a state ready to strike immediately on fresh-dug earth.

The season for committing seeds to the ground, should be as early as the nature of the plant to be cultivated will bear; for the forward productions which come without forcing, are the best as to size, flavour, and fruitfulness, if they meet with no material check from weather. It is the proper ambition of gardeners also, to have some of the first of each kind of vegetables and fruits, and thus to vie with others.

Let this direction for early sowing be understood, not only of spring, but autumn crops; that the plants designed for winter use, or to stand for spring, may be strong, and well established in the ground: though for those designed for spring, it is advisable to have two or three different sowings; for lettuces, as an instance, that are forward, will sometimes fail when backward plants shall do well.

To be sure of a crop, and in some things a succession of crops, various sowings should be made through the year, at all times that are not too unnatural as to season; for it is an object in gardening, not only to have early and late productions, but never to be without what may be produced. Every sowing that is made, the early ones in particular, should be noticed in time, whether it is likely to succeed, that the work may be repeated. But a little caution is necessary, that this business be not overdone; for though there may seem to be a sufficient distance of time in sowing for succession crops, yet they tread sometimes upon the heels of one another so fast as to occasion a superfluity. This is often the case in peas and beans, in the height of summer, and especially if a hot season: this caution is the more necessary, where there is no ground to spare, or but few hands to cultivate it; labour with discretion.

Sowings should be generally performed on fresh dug or stirred ground. The digging should therefore be done as near the time designed to sow as can be. If the ground turns up raw, or wet, as early in the spring it is apt to do, a little time must be allowed it to dry, and so also if rain falls first. In this case, seed should be sown as soon as ever the ground may be trampled on not to hang to the feet; for when the soil is too wet, it binds and does harm, especially in heavy ground. It is to be observed, however, that sowing in drills or on beds that are not to be trampled, the moisture of the ground is rather an advantage, provided in the last case, that the ground will admit a rake, and the soil is not too wet to drop somewhat loosely about the seeds.

The proper depth at which seeds should be sown is to be carefully observed; if too deep, they will either rot, or not thrive well; and if too shallow, they are liable to be injuriously affected by frost, wind, drought, or birds; but of the two rather too shallow, than too deep, is best, and this we are taught by nature, whose sowings are mostly superficial.

The smaller the seed the finer should the soil be, and the less also the covering; so that while some, as the seed of celery, is to be but barely covered, others, as peas and beans, may have a depth of two, three, or four inches. But some regard is to be had to the season and soil; in a warm season, and light soil, sow deeper, and the contrary shallower.

The quantity of seed sown is a thing to be attended to with some exactness. Small seeds go a great way, and require a careful hand to distribute them; for though sowing a little too much is a trifle as to the value of seeds, yet to have them come up crowding thick is an evil. To sow evenly as to quantity, is an object of practice worthy of care, as it secures a better crop, and more easily managed in the thinning. If the seed is suspected, sow thicker; poor land will require more seed than rich.

It is not generally advisable to sow several sorts of seed on the same spot, as some persons are accustomed to do, The gardeners about London follow the practice; as profit is their great object, and not neatness or propriety. On the same piece they sow radishes, lettuces, and carrots; the radishes are drawn young for the table, the lettuces to plant out, and a sufficient crop of carrots is left, for carrots should not be very near to grow large: this is as reasonable a combination as any that is made; but still, if not short of ground, each kind separate will be found best. In defence of this mode of culture, it is said, if one crop fails, the others may do, and there is no loss of ground or time; and if all succeed they do very well. Some little things of this sort, indeed, may well be done; as a piece of ground new-planted with horse-radish may be top-cropped with radishes or spinach, &c. A thin crop of onions upon new asparagus-beds, may also take place, drawing them while young from about the plants.

All seeds come up best when moderately pressed with the earth; for if they lie too lightly in contact with it, cold and drought more easily affect them; and when once seeds begin to germinate, they are impatient of both. To trample seeds in is on the whole better than any other pressure. This done, lay all immediately and neatly level with a wide rake, drawing off stones, &c. but do it lightly, to avoid driving in the teeth of the rake, which would remove the seed, and make it come up irregularly.

Propagation by suckers is a mode of culture rather peculiar to trees and shrubs. The things to be observed in this business are, to take them up with some care from the mother plant, so as not to injure its root, nor the sucker's own root, by pulling it up without properly loosening it first. The earth should be moved aside by a trowel, and then the sucker cut off by a knife, and not with a spade, as is common. Of those hardy things of which there is plenty, this rough way does not signify much as to the sucker, but it may injure the root too much that it comes from. Wherever a root appears barked, the part below should be cut off. If it is desired to succeed well, in propagating by suckers, consider that all young roots are tender: let them be trimmed to form, and planted immediately; or at least let them be covered with earth or laid by the heels, as it is called. Suckers with poor roots, must have their heads reduced the more.

Propagation by slips is of two sorts, either from the root, or stem; and several sorts of flowers and herbs are increased this way. When from the roots, if the whole is not taken up, move the earth carefully aside, and slip off by a pressure of the thumb and finger, and be cautious of hurting the fibres of the slips, planting with fine and good mould about them. Take off slips from the stem carefully by the push of the thumb, and not too many from the same plant, as it is apt to injure the place by tearing off some of the wood. Slips from the stem are to be considered as cuttings, and treated accordingly. They take more certainly, and make better roots, than cuttings.

Offset is a term sometimes applied to slips from fibrous roots; but more properly so from bulbous roots, which put forth many offsets. These are slipped away at the time they are taken up for removal or replanting, and commonly take two or three years before they bear flowers: dispose of them therefore in a nursery, where they may remain undisturbed till they come to a flowering state. Keep

them however clean from weeds, and stir the ground a little.

Division of the roots is a way of propagating many sorts of plants. To this end, of course, they must be taken up, and then either carefully pulled, or cut asunder with a sharp instrument, as the case may require. It is not safe, however, to divide such roots into very small pieces, especially if cut, as then they are apt to die; but leave them of a size sufficient not barely to secure life, but to form immediately a handsome head. The general season for thus splitting fibrous-rooted plants is October, but it may be done early in the spring, as February.

Cuttings of a variety of woody plants will grow, and many trees and shrubs are propagated this way; but their sap must be of a watery nature, as those plants that are gummy will not strike (or rarely), though ever so much care is bestowed, or time allowed them. The texture of the wood of cuttings must be somewhat soft, as hard-wooded ones will not grow. Cuttings should be rather short than long, and kept steady in the ground. If they are planted where there is any likelihood of their being disturbed, they may be tied to a stick well fastened in the earth.

The season for setting slips and cuttings is for some things summer, as wall-flowers and myrtles; and for most from October to March; but, in general, the sooner the better. It has however been said that spring is the best time for all, and that the sap should be in motion first. This is at least true of some things: as cuttings of the vitex, or chaste-tree (though hardy), are found to do best in spring; and all cuttings from plants of a delicate nature do so.

Cuttings should be of well ripened wood, and have the earth pressed to them the whole length they are in the ground; *i. e.* from four to six inches. Cut them with a sharp knife slopewise, and plant in a good soil, and in a situation where they have only the morning sun; and keep them cool (not wet) by occasional watering in dry weather.

Laying of branches is a mode of propagation that may be adopted for almost all forest-trees, and several sorts of fruit-trees and shrubs; *i. e.* all that will grow from cuttings, and many that will not. Layers are less rampant, and more fruitful than suckers; and for those who are curious, and find a seminal variety of any tree or shrub that is remarkably different from the original, the only way to have it preserved genuine is to convert it into a stool (by cutting down), and raising plants by layers. They are made of the lower branches of the plant, and must be young and pliable, to bend down without breaking to the depth of four, five, or six inches in the ground, as the soil is light or heavy, at which they must be held securely by good pegs; and if they cannot be brought down sufficiently deep, some earth may be raised up to them.

Let the ground about layers be kept cool by occasional waterings, and laying some moss, turf, litter, or rather small pebbles about them, which will not harbour insects. The part out of ground may be supported erectly by a tie to a stick. It is a good way to slit, with a sharp knife, the part at the peg, as in carnation layers, a little more than an inch; and some prick a few holes about the part, at a joint, with a blunt awl, to help the layer to strike root. For the harder woods, some gardeners make several slits, or chips, in the part layered in the earth, and bind the layer rather tight, just above it, with pliant wire; and soft-wooded layers are sometimes twisted to crack the bark, in order to help the part to strike quickly. Generally layers should be shortened to six or eight inches above the ground; or do it to two eyes, be it more or less above ground.

Where there are no branches low enough to be brought into the ground, and it is not thought good to head down for the production of low shoots or suckers, plants may be layered by fixing a broken pot, or a box, with a slit in the side, to the height necessary to lay in a branch. A branch also, if long enough, may be thrust through the hole of a garden-pot upwards, then filled with earth, and supported by some contrivance, and shaded by some means, and in both cases water frequently. Take care not to injure the buds in drawing through the hole of the pot. By this contrivance rooted plants being procured in pots, may be turned out with the earth about their roots undisturbed. A branch of a vine thus layered in November, may be next year cut off, when the fruit is ripe, brought in the pot to table, and afterwards planted out. For propagation of fruit-trees by grafting, see that article. See also GREENHOUSE, HOT-BEDS, NURSERY, ORCHARD, PLANTING, PRUNING, VEGETABLES, &c.

GARNET, granatus, in natural history, a very beautiful gem of a red colour, with an admixture of blueish.

When pure and free from blemishes, it is little inferior, in appearance, to the oriental ruby, though only of a middle degree of hardness between the sapphire and common crystal. It is found of various sizes, from that of a pin's head to an inch in diameter.

Among our lapidaries and jewellers, genuine garnets are known by different names, according to their different degrees of colour. 1. The garnet, simply so called, is the finest and most valuable kind, being of a very deep blood-red, with a faint admixture of blue. 2. The rock-ruby, a name very improperly given to the garnet, when it is of a very strong but not deep red, and has a fairer cast of the blue; this is a very beautiful gem. 3. The sorane or serain garnet, that of a yet brighter red, approaching to the colour of native cinnabar, with a faint blue tinge. 4. The almandine, a garnet only a little paler than that called the rock-ruby.

Garnets are very properly distinguished into the oriental and occidental kinds, as being found in Europe as well as the East Indies. The oriental ones are principally brought from Calicut, Cananor, and Cambay; and the European are common in Italy, Hungary, and Bohemia.

Some authors have supposed the deeper-coloured garnet to be the same with the carbuncle of the antients, from which it really differs; since, on receiving the sun's beams, it never gives so true a fire-colour as the carbuncle.

This stone is found in great plenty in many mountains; it is usually crystallized. The primitive form of its crystals is dodecahedron, whose sides are rhombs with angles of 78° 31′ and 120° 28′. The inclination of the rhombs to each other is 120°. This dodecahedron may be considered as a four-sided prism, terminated by four-sided pyramids. It is divisible into four parallelopipeds, whose sides are rhombs; and each of these may be divided into four tetrahedrons, whose sides are isosceles triangles, equal and similar to either of the halves into which the rhomboidal faces of the dodecahedron are divided by their shorter diagonal. The integrant molecules of garnet are similar tetrahedrons.

The texture of garnet, as Bergman first shewed, is foliated. Its fracture commonly conchoidal: causes single refraction: specific gravity 3.75 to 4.188. Colour usually red, often green; brittle: often attracted by the magnet: fusible per se by the blowpipe into a black glass.

Variety 1. Noble garnet. Specific gravity 4 to 4.188: colour deep red inclining to violet: almost always in crystals.

Variety 2. Common garnet. Found in mass and disseminated, sometimes in crystals: fracture uneven, inclining to the conchoidal: specific gravity 3.75 to 4: colour various; shades of green and brown; sometimes hyacinth red and brown red; rarely orange yellow.

A specimen of oriental garnet, analysed by Klaproth, contained

35.75 silica
27.25 alumina
36.00 oxide of iron
0.25 oxide of manganese.

99.25

A specimen of red garnet analysed by Vauquelin contained

52.0 silica
20.0 alumina
17.0 oxide of iron
7.7 lime.

96.7

And a specimen of black garnet,

43 silica
16 alumina
20 lime
16 oxide of iron
4 water and volat. matter

99.

Pyrop is another species of the garnet. This mineral, which is found in Bohemia, and was formerly distinguished by the name of Bohemian garnet, has been lately separated from the garnet by Werner, and made a distinct species. It is never found crystallized, but only in round or angular fragments, usually small. Colour deep red, which passes to orange when the mineral is exposed to the sun. Very hard. Specific gravity 3.718 to 3.941. Fracture conchoidal, and very brilliant. According to the analysis of Klaproth, it is composed of

40.00 silica
28.50 alumina
10.00 magnesia
3.50 lime
16.50 oxide of iron
0.12 oxide of manganese.

98.75

GARNET, in a ship, is a tackle having a pendant coming down from the mainmast, with a block well seized to the main-stay, just over the hatchway, to which a guy is fixed to keep it steady; and at the other end

is a long tackle-block, in which the fall is reeved, that so by it any goods or casks may be hauled and hoisted into or out of the ship. When this garnet is not used, it is fastened along the stay.

GARNISH, in law-books, signifies to warn; in which sense, to garnish the heir, is mentioned in stat. 27 Eliz. c. 3.

GARNISHEE, is used for the third person or party in whose hands money is attached within the liberties of the city of London, in the sheriff's court there; and he is so called, because he has had garnishment or warning not to pay the money, but to appear and answer to the plaintiff creditor's suit.

GARNISHMENT, is a warning given to a person for his appearance, for the better furnishing of the cause and court; as where a person is sued for detaining charters or other writings delivered him by the plaintiff, and another person, upon some certain conditions; and therefore he prays that the other person may be warned to plead with the plaintiff, whether the conditions are or are not performed, which is the praying of garnishment; and interpreted to be either a warning of that other, or a furnishing the court with parties sufficient to determine the cause.

GARRISON, in the art of war, a body of forces disposed in a fortress, to defend it against the enemy, or to keep the inhabitants in subjection, or even to be subsisted during the winter season: hence, garrison and winter quarters are sometimes used indifferently, for the same thing, and sometimes they denote different things. In the latter case, a garrison is a place wherein forces are maintained to secure it; and where they keep regular guard, as a frontier town, a citadel, castle, tower, &c. The garrison should always be stronger than the townsmen. Garrison or winter-quarters signify a place where a number of forces are laid up in the winter season, without keeping the regular guard.

GARRISON GUNS, such as are mounted and used in a garrison, consisting of the following weights, viz. the 42, 32, 24, 18, 12, 9, and 6 pounders; being made either of brass or iron.

TABLE

Of the Weight and Dimensions of Garrison Guns.

Brass Garrison Guns.			Iron Garrison Guns.		
Shot	Length	Weight.	Shot	Length	Weight.
lb.	ft. in.	Cw. qr. lb	lb.	ft. in.	Cw. qr. lb.
42	10 0	64 0 0	32	9 8	56 0 0
32	9 2	49 2 18	24	9 8	48 0 0
24	8 4	37 0 0	18	9 0	36 0 0
18	7 6	27 3 0	12	7 8	24 0 0
12	6 7	18 2 0	9	7 0	18 0 0
9	6 0	13 3 0	6	6 1	12 0 0
6	5 3	9 1 0	4	5 4	8 0 0

GARTER, *order of the*, a military order of knighthood, the most noble and antient of any lay-order in the world, instituted by king Edward III. This order consists of twenty-six knights-companions, generally princes and peers, whereof the king of England is the sovereign or chief. They are a college or corporation, having a great and little seal. Their officers are a prelate, chancellor, register, king at arms, and usher of the black rod. They have also a dean with twelve canons and petty canons, vergers, and twenty-six pensioners, or poor knights. The prelate is the head. This office is vested in the bishop of Winchester, and has ever been so. Next to the prelate is the chancellor, which office is vested in the bishop of Salisbury, who keeps the seals, &c. The next is the register, who by his oath is to enter upon the registry, the scrutinies, elections, penalties, and other acts of the order, with all fidelity. The fourth officer is garter, and king at arms, being two distinct offices united in one person. Garter carries the rod and sceptre at the feast of St. George, the protector of this order, when the sovereign is present. He notifies the elections of new knights, attends the solemnity of their installations, carries the garter to the foreign princes, &c. He is the principal officer within the college of arms, and chief of the heralds.

All these officers, except the prelate, have fees and pensions. The college of the order is seated in the castle of Windsor, with the chapel of St. George, and the chapter-house, erected by the founder for that purpose. The habit and ensign of the order are a garter, mantle, cap, george, and collar. The first four were assigned the knights-companions by the founder; and the george and collar by Henry VIII. The garter challenges pre-eminence over all the other parts of the dress, for from it the noble order is denominated; and it is the first part of the habit presented to foreign princes, and absent knights, who, and all other knights elect, are therewith first adorned; and it is of so great honour and grandeur, that by the bare investitute with this noble ensign, the knights are esteemed companions of the greatest military order in the world. It is worn on the left leg between the knee and calf, and is enamelled with this motto, *honi soit qui mal y pense, i. e.* "shame to him that evil thinks hereof." The meaning of which is, that king Edward who laid claim to the kingdom of France, retorted shame and defiance upon him that should dare to think amiss of the just enterprize he had undertaken, for recovering his lawful right to that crown, and that the bravery of those knights whom he had elected into this order, was such as would enable him to maintain the quarrel against those that thought ill of it.

The mantle is the chief of those vestments made use of upon all solemn occasions. The colour of the mantle is by the statutes appointed to be blue. The length of the train of the mantle only distinguishes the sovereign from the knights-companions. To the collar of the mantle is fixed a pair of long strings, antiently woven with blue silk only, but now twisted round, and made of Venice gold and silk, of the colour of the robe, with knobs, or buttons, and tassels at the end. The left shoulder of the mantle has from the institution been adorned with a large garter, with the device *honi soit*, &c. within this is the cross of the order, which was ordained to be worn at all times by king Charles I. At length the star was introduced, being a sort of cross irradiated with beams of silver.

The collar is appointed to be composed of pieces of gold in fashion of garters, the ground enamelled blue, and the motto gold. The manner of electing a knight-companion into this most noble order, and the ceremonies of investiture, are as follow. When the sovereign designs to elect a companion of the garter, the chancellor belonging to this order draws up the letters, which passing both under the sovereign's sign manual and signet of the order, are sent to the person by garter principal king at arms, and are in this manner, or to the same effect: "We with the companions of our most noble order of the garter, assembled in chapter, holden this present day at our castle at Windsor, considering the virtuous fidelity you have shewn, and the honorable exploits you have done in our service, by vindicating and maintaining our right, &c. have elected and chosen you one of the companions of our order. Therefore we require you to make your speedy repair unto us, to receive the ensigns thereof, and be ready for your installation upon the — day of this present month, &c."

The garter, which is of blue velvet bordered with fine gold wire, having commonly the letters of the motto of the same, is, at the time of election, buckled upon the left leg, by two of the senior companions, who receive it from the sovereign, to whom it was presented upon a velvet cushion by garter king at arms, with the usual reverence, whilst the chancellor reads the following admonition, enjoined by the statutes: "To the honour of God omnipotent, and in memorial of the blessed martyr St. George, tie about thy leg, for thy renown, this noble garter; wear it as the symbol of the most illustrious order, never to be forgotten or laid aside; that thereby thou mayest be admonished to be courageous, and having undertaken a just war in which thou shalt be engaged, thou mayest stand firm, valiantly fight, and successively conquer."

The princely garter being thus buckled on, and the words of its signification pronounced, the knight elect is brought before the sovereign, who puts about his neck, kneeling, a sky-coloured ribbon, to which is appendant, wrought in gold within the garter, the image of St. George on horseback, with his sword drawn, encountering with the dragon. In the mean time, the chancellor reads the following admonition: "Wear this ribbon about thy neck, adorned with the image of the blessed martyr and soldier of Christ, St. George, by whose imitation provoked, thou mayest so overpass both prosperous and adverse adventures, that having stoutly vanquished thy enemies both of body and soul, thou mayest **not** only receive the praise of this transient combat, but be crowned with the palm of eternal victory."

Then the knight elected kisses the sovereign's hand, thanks his majesty for the great honour done him, rises up, and salutes all the companions severally, who return their congratulations.

Since the institution of this order, there have been eight emperors, and twenty-eight kings, besides numerous sovereign princes, enrolled as companions. Its origin is somewhat differently related: the common account is, that it was erected in ho-

nour of a garter of the countess of Salisbury, which she dropped dancing with king Edward, and which that prince picked up; but our best antiquaries think it was instituted on account of the victory over the French at Cressy, where the king ordered his garter to be displayed as a signal of the battle.

GAS, among chemists, a term made use of to denote all the aerial and permanently elastic fluids, except the atmospheric air. See AIR, p. 28-35.

GASTEROSTEUS, STICKLEBACK, in ichthyology, a fish of the order thoracici. The generic character is, body somewhat lengthened: dorsal spines distinct: ventral fins spiny: abdomen carinated or shielded on the sides, and bony beneath. There are eleven species: the following are the principal:

1. Gasterosteus aculeatus, common stickleback. This minute fish is an almost universal inhabitant of ponds, rivers, and marshes, occurring sometimes even in salt or brackish waters. When in its full perfection of colour it is highly beautiful; the gills and abdomen being of a bright red, the back a fine olive-green, and the sides silvery. It is chiefly in the early part of summer that it appears thus decorated; the colours in a great degree fading as the season advances. The general length of this species is about two inches, but it sometimes arrives to the length of three: the ventral fins consist merely of a very strong and serrated spine on each side, accompanied by a single short ray.

The stickleback or banstickle is a fish of an extremely active and vigorous nature, swimming rapidly, and preying on the smaller kind of water-insects and worms, as well as on the spawn of other fishes, and is from this circumstance considered as highly prejudicial to fish-ponds. In the Philosophical Transactions we find some observations relative to the natural history of this fish by Mr. Henry Baker, who informs us that it will spring occasionally to the perpendicular height of not less than a foot out of the water, and to a much greater space in an oblique direction, when wishing to get over stones or other obstacles. "It is scarcely to be conceived," says this writer, "what damage these little fish do, and how greatly detrimental they are to the increase of all the fish in general among which they live; for it is with the utmost industry, sagacity, and greediness, that they seek out and destroy all the young fry that come in their way, which are pursued with the utmost eagerness, and swallowed down without distinction, provided they are not too large: and in proof of this I must assert that a banstickle which I kept for some time did on the 4th of May devour in five hours time seventy-four young dace, which were about a quarter of an inch long, and of the thickness of a horsehair: two days after, it swallowed sixty-two, and would, I am persuaded, have eaten as many every day, could I have procured them for it."

The stickleback is sometimes observed to swarm in prodigious multitudes in some particular parts of Europe. We are told by Mr. Pennant that at Spalding in Lincolnshire, there are, once in seven years, amazing shoals, which appear in the Welland, and come up the river in the form of a vast column: they are supposed to be the multitudes that have been washed out of the fens by the floods of several years, and collected in some deep hole, till, overcharged with numbers, they are periodically obliged to attempt a change of place; the quantity is so great that a man employed to take them has got for a considerable time four shillings a day by selling them at the rate of a halfpenny per bushel.

2. Gasterosteus spinachia, fifteen-spined stickleback, is much larger than the preceding species, and of a much more slender form; general length from five to six or seven inches; head of a produced and somewhat tubular shape; hinder parts very slender towards the tail; lateral line broad, and composed of a series of small dusky laminæ or scuta; dorsal spines concealed at pleasure in a longitudinal channel; ventral fins each composed of two spines; the first long, the next short; native of the European seas, frequenting shallow places, and preying on marine insects, and the spawn of other fishes; sometimes seen in vast numbers about the coasts of Holland, &c. and occasionally used, like the common stickleback, for the purpose of manuring land, as well as for the preparation of oil for lamps, &c.

GASTRIC JUICE, among physicians, a thin, pellucid, spumous, and saltish liquor, which continually distils from the glands of the stomach, for the dilution of the food. See DIGESTION.

GASTROBRANCHUS, in ichthyology, a genus of fishes of the order chondropterigius: the generic character is, body eel-shaped; mouth beneath, with numerous pectinate teeth; spiracles two, beneath the abdomen. 1. Gastrobranchus cæcus, blind gastrobranchus. The fish which constitutes this genus has long since been described by Linnæus and others under the title of myxine glutinosa, and considered as belonging to the tribe of vermes, in which situation it ranks in the latest editions of the Systema Naturæ. Dr. Bloch, however, from accurate examination both of its external and internal structure, has very justly considered it as a legitimate cartilaginous fish. The usual length of the European specimens is from four to six inches, but in the Indian ocean it appears to arrive at a far superior size, nearly equalling in this respect the common eel. In its general appearance it bears a near resemblance to the lampreys, with which by Kalm, its first describer, it has been associated. It is remarkable for the total want of eyes, not the least vestige of any such organs being discoverable by the most attentive examination: the mouth, which is situated beneath, as in the lampreys, is of an oblong form; on each side are two beards or cirri, and on the upper part four; in front of the top of the head is a small spout-hole, furnished with a valve, by which it can at pleasure be closed; the teeth, which are situated very deep in the mouth, and are of an orange-colour, as in the lamprey, are disposed on each side into a double row, in form of a pectinated bone; each upper row consisting of nine and each lower row of eight teeth; and in the middle of the roof of the mouth is a single, sharp-pointed, and curved tooth; no nostrils are discoverable; the body is destitute of scales, lateral line, and every kind of fin, except that which forms the tail; this fin is shallow, and commencing at the lower part of the back, runs round the extremity of the body, and is continued beneath as far as the vent; the extremity of the body, where it is surrounded by the caudal fin, is taper or pointed; beneath the body, from head to tail, runs a double row of pretty conspicuous, equidistant pores, through which on pressure, exsudes a viscid fluid, and at somewhat more than a third of the animal from the head, are situated beneath the body, the two spiracula, which consist of a pair of oval apertures.

The manners of this fish are represented as highly singular; it is said to enter into the bodies of such fishes as it happens to find on the fishermen's hooks, and which consequently have not the power of escaping its attack, and by gnawing its way through the skin to devour all the internal parts, leaving only the bones and the skin remaining. Another particularity in this animal consists in its uncommonly glutinous nature; if put into a large vessel of sea-water, it is said in a very short space to render the whole so glutinous as easily to be drawn out into the form of threads; when taken out of water the gastrobranchus is said to be incapable of living more than three or four hours. It is an inhabitant of the northern seas, and appears also to occur in those of the southern hemisphere, where, as before mentioned, it arrives at a much larger size than in the northern regions.

2. Dombeyan gastrobranchus. Size much larger than the European specimens of the gastrobranchus cæcus: head rounded, and broader than the body; on the upper lip four beards; number of those on the lower uncertain, the specimen being described in a dried state; teeth pointed, compressed, triangular, and disposed in two circular ranges, the exterior of which is composed of twenty-two, and the interior of fourteen teeth; a single tooth longer than the rest, and of a curved form in the roof of the mouth, as in the European species; eyes and nostrils imperceptible; colour uncertain; tail rounded at the extremity, and terminated by a very shallow fin united with the anal. Native of the South American seas; observed by Mons. Dombey, and described by Cepede from the dried skin in the Paris museum.

GASTROGRAPHY, in surgery, the operation of sowing up wounds of the abdomen. See SURGERY.

GATE, in a military sense, is made of strong planks, with iron bars, to oppose an enemy. They are generally made in the middle of the curtin, from whence they are seen, and defended by the two flanks of the bastions. They should be covered with a good ravelin, that they may not be seen or enfiladed by the enemy. These gates, belonging to a fortified place, are passages through the rampart, which may be shut and opened by means of doors and a portcullis. They are either private or public.

Private gates are those passages by which the troops can go out of the town unseen by the enemy, when they pass to and from the relief of the duty in the outworks, or on any other occasion which is to be concealed from the besiegers.

Public gates are those passages through the middle of such curtins, to which the great roads of public ways lead. The dimensions of these are usually about 13 or 14 feet high,

and 9 or 10 feet wide, continued through the rampart, with proper recesses for foot-passengers to stand in, out of the way of wheel-carriages.

GAVELKIND, a custom principally to be found among the men of Kent, and supposed to be one of the effects of the gallant struggles they made to preserve their liberty, though it is sometimes found in other parts of the kingdom. This tenure has various consequences: the principal are, 1. The tenant can alien his estate by feoffment at the age of 15. 2. The estate does not escheat in case of an attainder and execution for felony. 3. In most places he had a power of devising his estate by will, before the statute was made to restrain him. 4. The lands descend to all the sons equally together, according to the antient course of descent in England, and not according to primogeniture.

GAVELET, in law, an antient and special cessavit used in Kent, where the custom of gavelkind continues, by which the tenant, if he withdraws his rent and services due to the lord, forfeits his land and tenements.

The process of the gavelet is thus. The lord is first to seek by the steward of his court, from three weeks to three weeks, to find some distress upon the tenement, till the fourth court; and if at that time he find none, at this fourth court it is awarded, that he take the tenement in his hand in name of a distress, and keep it a year and a day without manuring; within which time, if the tenant pays his arrears, and make reasonable amends for the withholding, he shall have and enjoy his tenement as before: if he come not before the year and day be past, the lord is to go to the next county-court with witnesses of what had passed at his own court, and pronounce there his process, to have further witnesses; and then by the award of his own court, he shall enter and manure the tenement as his own; so that if the tenant desired afterwards to have and hold it as before, he must agree with the lord; according to this old saying, "Has he not since any thing given, or any thing paid, then let him pay five pound for his were, e'er he become healder again." Other copies have the first part with some variation; "Let him nine times pay, and nine times repay."

Gavelet, in London, is a writ used in the hustings, given to lords of rents in the city of London. Here the parties, tenant and demandant, appear by scire facias, to show cause why the one should not have his tenement again on payment of his rent, or the other recover the lands on default thereof.

GAUGE-POINT, of a solid measure, the diameter of a circle, whose area is equal to the solid content of the same measure. Thus the solidity of a wine-gallon being 231 cubic inches, if you conceive a circle to contain so many inches, the diameter of it will be 17.15; and that will be the gauge-point of wine-measure. And of an ale-gallon, containing 282 cubic inches, by the same rule, the gauge-point for ale-measure will be found to be 19.15. After the same manner, may the gauge-point of any foreign measure be obtained; and hence may be drawn this consequence, that when the diameter of a cylinder, in inches, is equal to the gauge-point of any measure, given likewise in inches, every inch in length thereof will contain an integer of the same measure, *e. gr.* in a cylinder whose diameter is 17.15 inches, every inch in height contains one entire gallon in wine-measure; and in another, whose diameter is 18.95 inches, every inch in length contains one ale-gallon.

GAUGER, a king's officer, who is appointed to examine all tuns, pipes, hogsheads, and barrels of wine, beer, ale, oil, honey, &c. and give them a mark of allowance, before they are sold in any place within the extent of his office.

There are divers statutes that mention this officer and his office; as by 27 Ed. III. c. 8 all wines, &c. imported are to be gauged by the king's gaugers, or their deputies, otherwise they shall be forfeited, or their value; and on default of the gauger, that he be not ready to do his office when required, or that he defrauds in doing his office to the damage of the buyer or seller, he shall pay the party grieved his treble damage, lose his office, be punished by imprisonment, and be ransomed at the king's will; and in case less is found in the tun or pipe than ought to be, the value of as much as shall lack, shall be deducted in the payment.

Every gauger shall truly, within the limits of his office, gauge all tuns, butts, pipes, tierces, puncheons, tertians, hogsheads, barrels, and runlets; and mark on the head of every vessel the contents, upon pain of forfeiting to the party to whose use the wine, &c. shall be sold, four times the value of that which the vessel marked shall lack of its content: the same forfeiture shall be recovered by an original writ, &c. and every person selling the wine, &c. in the vessel marked, shall allow of the price, the value of gauge, or default of filling, upon pain of forfeiture to the buyer, of double the value, to be recovered with costs as before. No brewer shall put to sale any beer or ale in vessels brought from beyond the sea, within the city of London, or suburbs of the same, or within two miles compass without the suburbs, before the same is gauged, and the true content of every such vessel set upon the same, by the gallon appointed for beer and ale, according to the standard, by the master and wardens of the coopers of London.

GAUGING, the art or act of measuring the capacities or contents of all kinds of vessels, and determining the quantities of fluids or other matters contained therein.

To gauge any vessel, or to find the quantity of liquor it can contain,

Find how many solid inches will fill the cavity of the vessel, and divide these by the number of solid inches which make a pint or gallon; the quotient is the content of the vessel in pints or gallons.

TABLE *of Cubic Inches in several Measures.*

282	Cubic inches	= 1 English ale gallon
231	Ditto	= 1 English wine gallon
268.8	Ditto	= 1 English corn gallon
2150.4	Ditto	= 1 English corn or malt bushel.

From these divisors, multipliers may be found thus: Divide 1 by any number in this table, the quotient is a constant multiplier, by which the content of any vessel in cubic inches being multiplied, the product is its content in that measure for which the multiplier was found.

TABLE *of Divisors and Multipliers.*

282	.003546 ale gallons
231	.004329 wine gallons
268.8	.0037202 corn gallons
2150.42	.00046502 malt bushels.

In gauging vessels, the dimensions are always taken in inches and decimals of an inch.

Ex. 1. Suppose a vessel in form of a parallelopiped, the length of its base 27 inches, breadth 16½ inches, and the depth of the vessel 32¼ inches; required the content in English ale gallons?

$27 \times 16.5 \times 32.25 = 14367.375$ cubic inches.

If you divide 14367.375 by 282, or multiply them by .003546, the result will be the content of the vessel in English ale gallons, viz. 50.946.

In the same manner, the content of any vessel may be found; but those who practise gauging proceed thus:

In any vessel equally wide from top to bottom, they compute the area of its base in square inches; and, by dividing or multiplying these by the numbers in the tables, get what they call the area in gallons, (that is, the number of gallons which the vessel contains when the liquid is only one inch deep), which multiplied by the depth of the liquid, gives the quantity contained in the vessel.

Ex. 2. Suppose a trough, or cistern, in form of a right-angled parallelopiped, its base 27 inches long, and 16½ inches wide, and the height of the vessel 32½ inches, but the depth of liquor only 20 inches; required its content in English ale gallons? *Ans.* 31.594.

$27 \times 16.5 \times .003546 = 1.579743$, the area of the base in gallons, which multiplied by 20, produces 31.594 ale gallons.

Ex. 3. Suppose a cylindric vessel hath the diameter of its base 20 inches, and its height 30 inches; required the content in wine gallons? *Ans.* 40.8.

$20 \times 20 \times .7854 \times 30 \times .004329 = 40.8$.

Suppose a tub having circular bases, the diameter of the mouth is 60 inches, and the diameter of the bottom is 36 inches, and the perpendicular depth from top to bottom is 30 inches; required its content in English ale gallons?

This vessel is to be considered as the frustum of a cone; and, on this supposition its content will be 55417.8 cubic inches; which, by reduction, is 196.5 English ale gallons.

The calculation is tedious by common arithmetic, but may be easily performed by logarithms; thus, To twice the logarithm of the diameter of one base add the logarithm of .7854, the sum is the logarithm of the area of that base. Do the same for the area of the other base, and find the numbers answering to each. Then add the logarithms of the areas of the two bases, and take half of the sum, and find the number answering thereto. Add the areas of the two bases, and the last-found number, and multiply the sum by one-third part of the depth, the product is the content in cubic inches.

Operation for the last Example.

	Log.		Log.
Diameter 60	1.7781513	Diameter 36	1.5563025
	1.7781513		1.5563025
.7854	9.8950909	.7854	9.8950909
2827.44	3.4513935	1017.8784 =	3.0076959
1017.8784		2827.44	3.4513935
1696.464			
5541.7824			2)6.4590894
Mult. by 10		1696.464 =	3.2295447
55417.824 Ans.			

The content of any vessel of this form may be found with less trouble by this rule:

To the product of the diameters of the two bases, add one-third part of the square of their difference; the sum is the square of a mean diameter; which being multiplied by .7854, and the product by the depth of the vessel, gives the content in cubic inches.

Exam. Let the diameter of the greater base be 60, and of the lesser base 57.6, and the perpen-

dicular height of the tub 29.976 inches; required its content? *Ans.* 81410.3 cubic inches.

To Gauge a CASK.—Casks are distinguished into the following four varieties:

1. Such as resemble the middle frustum of a spheroid.

2. Such as resemble the middle frustum of a parabolic spindle.

3. Such as being cut through in the middle, the two parts are parabolic conoids.

4. Such as being cut through in the middle, the parts are the lower frustums of two equal cones.

Measure the head and bung diameters, and the length of the cask in inches; and then,

1. If the staves are very much curved, the cask is supposed to be the middle zone, or frustum of a spheroid; and its content may be found by this rule:

To twice the square of the bung diameter, add the square of the head diameter; multiply the sum by the length of the cask, and divide the product by 3.8197, the quotient is the content in cubic inches.

Exam. Suppose there is a spheroidal cask, its bung diameter = 31.5 inches, head diameter = 24.5 inches, and the length of cask = 42 inches; required its content in English ale gallons?

Ans. 100.78.

2. If the staves of a cask are less curved than was supposed in the last article, the cask is taken for the middle frustum, or zone, of a parabolic spindle; and its content is computed by this rule:

To twice the square of the bung diameter, add the square of the head diameter, and from the sum subtract four-tenths of the square of the difference of the diameters; divide the remainder by 3.8197, and multiply the quotient by the length of the cask; the product is its content in cubic inches.

Exam. Let the bung diameter = 34 inches, the head diameter = 30, and the length of the cask = 40 inches; what is its content in English ale gallons? *Ans.* 119.039.

3. When the staves of a cask are very little curved, the cask is supposed to consist of the two lower frustums of two equal parabolic conoids, their greatest bases joined together in the middle of the cask; the content of such a vessel may be found by this rule:

To the square of the bung diameter, add the square of the head diameter; multiply the sum by .3927, and the product by the length of the cask; the last product is the content in cubic inches.

Exam. Let the bung diameter of such a cask = 32 inches, the head diameter = 29, and the length of the cask = 42 inches; required its content in cubic inches and ale gallons?

Ans. 30760.191 cubic inches, or 109.07 ale gallons.

4. If the staves of a cask are straight between the bung and the ends of the cask, the vessel is supposed to consist of the two lower frustums of equal cones; and its content is found by this rule:

To the sum of the squares of the head and bung diameters add their product; multiply the sum by the length of the cask, and divide the product by 3.8197; the quotient is the content in cubic inches.

Exam. Required the content of a cask in ale gallons, its bung diameter being 32 inches, its head diameter 24 inches, and the length 40 inches? *Ans.* 87.93.

By these rules, the content of any cask may be found, it being known to which of the four varieties the cask belongs; but in common practice, a mean diameter, whereby the cask is reduced to a cylinder in either variety, is found thus:

5. Multiply the difference between the bung and head diameters by .7 for the spheroid, by .65 for the spindle, by .6 for the conoids, and by .55 for the cones; add the product to the head diameter; the sum is a mean diameter; or the diameter of the base of a cylinder equal to the cask, their lengths being the same. The mean diameter being squared and multiplied by .7854, and the product by the length of the cask, gives the content in cubic inches, which may be reduced to gallons by the table.

Ex. Suppose the bung diameter is 30 inches, the head diameter 20 inches, and the length of the cask 40 inches; required its content in ale gallons according to each variety?

DIFFERENCE *of* BUNG *and* HEAD DIAMETERS *is* 10 INCHES. *M. D.*

10 × .7 = 7. and 20 + 7. = 27. for the spheroid

10 × .65 = 6.5 and 20 + 6.5 = 26.5 for the spindle

10 × .6 = 6. and 20 + 6. = 26. for the conoids

10 × .55 = 5.5 and 20 + 5.5 = 25.5 for the cones.

For the CONTENT *in* ALE GALLONS.

27. × 27. × .7854 × 40 × .003546 = 81.21 spheroid

26.5 × 26.5 × .7854 × 40 × .003546 = 78.23 spindle

26. × 26. × .7854 × 40 × .003546 = 75.3 conoids

25.5 × 25.5 × .7854 × 40 × .003546 = 72.43 cones.

Mr. Ward, who had much practice in gauging, says, he never gauged a cask that contained so much as the first variety makes it; and therefore, recommends the 2d and 3d varieties as the best general rules for gauging casks.

The following rule is given by Dr. Hutton, which is not only general for all casks that are commonly met with, but easily to be worked, and accurate in its application.

General Rule. Add into one sum,
39 times the square of the bung diameter,
25 times the square of the head diameter, and
26 times the product of those diameters;
multiply the sum by the length of the cask, and the product by the number .00034; then this last product divided by 9 will give the wine gallons, and divided by 11 will give the ale gallons.

Or, $\overline{39B^2 + 25H^2 + 26BH} \times \frac{L}{114}$ is the content in inches; which being divided by 231 for wine gallons, or by 282 for ale gallons, will be the content.

For Ex. If the length of a cask be 40 inches, the bung diameter 32, and the head diameter 24,

Here	$32^2 \times 39$	= 39936
and	$24^2 \times 25$	= 14400
and	$32 \times 24 \times 26$	= 19968
	the sum	74804
	multiplied by	40
	and divid. by 114	2972160
	gives	26071 cubic inches;

this divided by 231 gives 112 wine gallons,
or divided by 282 gives 92 ale gallons.

But gauging, as now practised, is chiefly done by means of instruments called gauging rods or rulers, which do the business at once, and answer the question without so much calculation, which is no inconsiderable addition both to the ease and dispatch of the work, though it is not so much to be depended on.

The method of gauging which is mostly used, is by the four-feet gauging-rod and Everard's sliding-rule; the description and uses of both are as follows:

The four-feet gauging-rod (Plate Miscel. fig. 101) is usually made of box, and consists of four rules, each a foot long, and about three-eighths of an inch square, joined together by three brass joints; by which means the rod is rendered four feet long when the four rules are opened, and but one foot when all are folded together. On the first face of this rod, marked 4, are placed two diagonal lines, one for beer and the other for wine; by means of which the content of any common vessel in beer or wine gallons, may be readily found, by putting the brased end of the gauging-rod into the bung-hole of the cask, with the diagonal lines upwards, and thrusting this brased end to the meeting of the head and staves; then with chalk make a mark at the middle of the bung-hole of the vessel, and also on the diagonal lines of the rod, right against or over one another, when the brased end is thrust home to the head and staves; then turn the gauging-rod to the other end of the vessel, and thrust the brased end home to the end as before. Lastly, see if the mark made on the gauging-rod, come even with the mark made on the bung-hole, when the rod was thrust to the other end, which if it be, the mark made on the diagonal lines will, on the same lines, shew the whole content of the cask in beer or wine gallons. If the mark made on the bung-hole be not right against that made on the rod, when you put it the other way, then right against the mark made on the bung-hole, make another on the diagonal lines; and the division on the diagonal line, between the two chalks, will shew the whole content of the vessel in beer or wine gallons.

Thus, if the diagonal line of a vessel be 28 4-10 inches, its content in beer-gallons will be nearly 51, and in wine-gallons 62.

If a vessel be open as a half-barrel, tun, or copper, and the measure from the middle on one side to the head and staves be 38 inches, the diagonal line gives 122 beer-gallons; half of which, viz. 61, is the content of the half-tub.

If you have a large vessel, as a tun or copper, and the diagonal line taken by a long rule be 70 inches, then every inch at the beginning-end of the diagonal line call 10 inches; thus 10 inches become 100 inches, and every tenth of a gallon call 100 gallons, and every whole gallon call 1000 gallons.

Example. At 44.8 inches on the diagonal beer-line is 200 gallons; so that 4 inches 48 parts, now called 44 inches eight-tenths, is just two-tenths of a gallon, now called 200 gallons; so also, if the diagonal line be 76 inches and seven-tenths, a close cask of such diagonal will hold 1000 beer-gallons; but an open cask but half so much, viz. 500 beer-gallons.

On the second face, 5, are a line of inches and the gauge-line, which is a line expressing the areas of circles (whose diameters are the correspondent inches) in ale-gallons; at the beginning is written ale-area. Thus, to find the content of any cylindrical vessel in ale-gallons, seek the diameter of the vessel in inches, and just against it, on the gauge-line, is the quantity of ale-gallons contained

at one inch deep; this multiplied by the length of the cylinder, will give its contents in ale-gallons.

On the third face, 6, are three scales of lines; the first, at the end of which is written hogshead, is for finding how many gallons there are in a hogshead, when it is not full, lying with its axis parallel to the horizon. The second line, at the end of which is written B.L. is for the same purpose. The third is to find how much liquor is wanting to fill up a butt, when it is standing; at the end of it is wrote B.S. signifying, butt standing.

Half-way the fourth face of the gauging-rod, 7, there are three scales of lines, to find the wants in a firkin, kilderkin, and barrel, lying with their areas parallel to the horizon. They are distinguished by the letters F. K. B. signifying a firkin, kilderkin, and barrel.

Use of the gauge-line.—To find the content of any cylindrical vessel in ale-gallons, seek the diameter of the vessel in inches, and just against it on the gauge-line is the quantity of ale-gallons contained in one inch deep; this multiplied by the length of the cylinder will give its content in ale-gallons. For example, suppose the length of the vessel 32.06, and the diameter of its base 25 inches, to find what is the content in ale-gallons? Right against 25 inches on the gauge-line is one gallon and .745 of a gallon: which multiplied by 32.06, the length, gives 55.9447 gallons for the content of the vessel. The bung diameter of a hogshead being 25 inches, the head diameter 22 inches, and the length 32.06 inches, to find the quantity of ale-gallons contained in it? Seek 25, the bung diameter, on the line of inches, and right against it on the gauge-line you will find 1.745: take one-third of it, which is .580, and set it down twice; seek 22 inches in the head diameter, and against it you will find on the gauge-line 1.356; one-third of which added to twice .580 gives 1.6096; which multiplied by the length 32.06, the product will be 51.6, the content in ale-gallons.

Everard's sliding-rule is principally used in gauging, being ordinarily made of box, a foot long, an inch broad, and 1-6-10th inch thick, with two small scales to slide in it, which may be drawn out, one towards the right hand, and the other towards the left, till the whole be 3 feet long.

To gauge malt.—1. If the malt lies on the floor in a rectangular form, multiply the length by the breadth, and the product by the depth, all taken in inches; the product is the number of cubic inches in the quantity; which being divided by 2150.42, the quotient is the number of bushels.

The same rule serves for finding the quantity of malt contained in any vessel in form of a parallelopipedon.

Examp. Suppose a quantity of malt on the floor, 288 inches long, 144 inches broad, and 9½ inches deep; required the number of bushels?

Ans. 183.21.

2. When malt is in a cistern, or any vessel, the content of the vessel is to be found in cubic inches, by some of the former rules, and then divided by 2150.42, the quotient is the number of bushels.

3. To find the solidity of any irregular solid.

Put the irregular body into any vessel, and fill it with water; take out the body, and the water will fall lower, and leave a part of the vessel empty, equal to the solidity of the body to be measured; then measure so much water by a vessel of a known capacity as shall fill up the empty space; and the number of cubic inches in that space, and consequently in the irregular body, will be known.

GAULTHERIA, a genus of the class and order decandria monogynia. The cal. outer, 2-leaved, inner 5-cleft; cor. ovate; nect. with 10 dagger-points; caps. 5-celled, covered with the inner calyx, now become a berry. There is one species, a small but beautiful shrub of Canada.

GAURA, a genus of the class and order octandria monogynia. The calyx is four-cleft, tubulous; corolla four-petalled, rising towards the upper side; nect. inferior, one-seeded, four-cornered. There is one species, a biennial plant of North America.

GAURS, an antient sect of the magicians in Persia. They have a suburb at Ispahan, which is called Gaurabad, or the town of the gaurs, where they are employed only in the meanest and vilest drudgery; but they chiefly abound in Kerman, the barrenest province in all Persia, where the Mahometans suffer them to live with some freedom, and in the full exercise of their religion. Some years ago many of them fled into India, where their posterity remain. They are a poor harmless sort of people, zealous in their superstition, rigorous in their morals, and exact in their dealings; they profess the worship of one God alone, the belief of a resurrection and a future judgment, and utterly detest all idolatry, though the Mahometans believe them to be the most guilty of it. It is true, they perform their worship before fire, for which they have an extraordinary veneration, as believing it to be the most perfect emblem of the Deity. They have the same veneration for Zoroaster that the Jews have for Moses, esteeming him a prophet sent from God.

GAWSE, or GAWZE, in commerce, a very slight, thin, open kind of stuff, made of silk, and sometimes of thread; there are also figured gawzes, and some with gold or silver flowers on a silk ground.

GAZELLE, in zoology. See ANTELOPE, and CAPRA.

GAZONS, in fortification, pieces of fresh earth, covered with grass, and cut in form of a wedge, about a foot long and half a foot thick, to line the outsides of works made of earth, as ramparts, parapets, &c. See FORTIFICATION.

GEARS, or CHAINS, in country-affairs, the trappings and other harness belonging to draught horses or oxen.

GELATINE, in chemistry. If a piece of the fresh skin of an animal, after the hair and every impurity are carefully separated, is washed repeatedly in cold water till the liquid ceases to be coloured, or to subtract any thing; if the skin, thus purified, is put into a quantity of pure water, and boiled for some time, part of it will be dissolved. Let the decoction be slowly evaporated till it is reduced to a small quantity, and then put aside to cool. When cold, it will be found to have assumed a solid form, and to resemble precisely that tremulous substance well known to every body under the name of jelly. This is the substance called in chemistry gelatine. If the evaporation is still farther continued, by exposing the jelly to dry air, it becomes hard, semitransparent, breaks with a glassy fracture, and is, in short, the substance so much employed in different arts under the name of glue. Gelatine then is precisely the same with glue, only that it must be supposed always free from those impurities with which glue is so often contaminated.

Gelatine is semitransparent and colourless when pure. Its consistency and hardness vary considerably. The best kinds are very hard, brittle, and break with a glassy fracture. Its taste is insipid, and it has no smell. When thrown into water it swells very much, but does not readily dissolve; and when taken out, it is soft and gelatinous, but when allowed to dry, it recovers its former appearance. If it is put in this gelatinous state into warm water, it very soon dissolves, and forms a solution of an opal colour, and the more opaque according to the quantity of gelatine which it contains. Tremulous gelatine dissolves in a very small portion of hot water; but as the solution cools, it gelatinizes afresh. If this solution, as soon as it assumes the tremulous form, is mixed with cold water, and shaken, a complete solution takes place. Dry gelatine undergoes no change when kept, but in the gelatinous state, or when dissolved in water, it very soon putrefies; an acid makes its appearance in the first place (probably the acetic), a fetid odour is exhaled, and afterwards ammonia is formed. When dry gelatine is exposed to heat, it whitens, curls up like horn, then blackens, and gradually consumes to a coal; but tremulous gelatine first melts, assuming a black colour. When distilled, it yields, like most animal substances, a watery liquid impregnated with ammonia, and a fetid empyreumatic oil, leaving a bulky charcoal of difficult incineration. It is by no means a very combustible substance.

Acids dissolve gelatine with facility, even when diluted, especially when assisted by heat; but we are still ignorant of the changes produced upon it by these agents, except by nitric acid. When this acid is digested on it, a small quantity of azotic gas is disengaged, then abundance of nitrous gas; the gelatine is dissolved, except an oily matter which appears on the surface, and converted partly into oxalic and malic acids.

Muriatic acid dissolves glue with great ease. The solution is of a brown colour, and still continues strongly acid. It gradually lets fall a white powder. This solution precipitates tan in great abundance from water, and may be employed with advantage to detect tan when an alkali conceals it. Sulphuric acid acts much more slowly. The solution is brown, and gradually deepens; sulphurous acid is exhaled during the action of sulphuric acid on glue. Neither sulphuric nor muriatic acid occasions any change in the solution of glue in water. Alkalies also dissolve gelatine with facility, especially when assisted by heat; but the solution does not possess the properties of soap.

None of the earths seem to combine with gelatine; at least they do not precipitate it from its solution in water. The following

table exhibits the effect of different earthy solutions when mixed with a pretty concentrated solution of common glue.

Substances.	Effects.
Lime water -	No change.
Strontian water -	No change.
Barytes water -	Became milky. Precipit. not dissolved by acetic acid.
Muriat of barytes	The same as the last.
Silicated potass -	No change.
Aluminated potass	No change.
Oxalat of ammonia	Became milky.
Phosphat of soda	Became slightly milky.

The milkiness produced by some of these re-agents was not owing to their effect upon the gelatine, but upon the lime and the sulphuric acid which it contained.

The metals in their pure state have no effect upon gelatine; but several of the metallic oxides, when agitated in a solution of gelatine, have the property of depriving the water of the greatest part of that body, with which they form an insoluble compound. Several of the metallic salts likewise precipitate gelatine from water. The following table exhibits the result of mixing various metallic salts with a concentrated solution of gelatine, as far as experiments have gone.

Metallic Solutions.	Effects.
Nitromuriat of gold	A copious yellowish-white precipitate. Soluble by adding water.
Nitrat of silver -	Becomes slightly milky.
Nitrat of mercury -	A very copious curdy precipitate.
Oxymuriat of mercury	A copious white precip.
Sup. oxysulphat of mer.	No change.
Dry oxysulphat of mer.	Crystals become yellow, white flakes appear, and the liquid becomes transparent.
Prussiat of mercury	No change.
Oxynitrat of copper	No change.
Muriat of copper	Becomes milky.
Oxysulphat of copper	No change.
Cuprat of ammonia	No change.
Sulphat of iron -	A few yellow flakes appear.
Oxysulphat of iron	Becomes slightly milky, as when alcohol is added.
Oxynitrat of iron	Assumes a pink colour.
Oxymuriat of iron	Becomes green.
Nitromuriat of tin	No change.
Oxymuriat of tin -	Becomes slowly milky.
Nitrat of lead -	No change.
Acetat of lead -	No change.
Plumbat of potass -	No change.
Plumbat of lime -	No change.
Muriat of zinc -	No change.
Muriat of antimony	A copious flaky precip.
Tartar emetic - -	No change.
Nitrat of bismuth precipitable by water	Becomes milky.
Ditto, not precipitable by water - -	No change.
Muriat of arsenic -	No change.

Gelatine is insoluble in alcohol. When alcohol is mixed with a solution of gelatine, the mixture becomes milky, but becomes again transparent when agitated, unless the solution is concentrated, and the quantity of alcohol considerable. Gelatine is most probably equally insoluble in ether.

When the solution of tan is dropped into gelatine, a copious white precipitate appears, which soon forms an elastic adhesive mass, not unlike vegetable gluten. This precipitate is composed of gelatine and tan; it soon dries in the open air, and forms a brittle resinous-like substance, insoluble in water, capable of resisting the greater number of chemical agents, and not susceptible of putrefaction. It resembles exactly overtanned leather. The precipitate is soluble in the solution of gelatine, as Mr. Davy first observed. Neither is the whole tan thrown down, unless the solutions both of tan and gelatine are somewhat concentrated. Tremulous gelatine, as was first observed by the same chemist, does not precipitate tan; but if we employ a solution of gelatine so strong that it gelatinizes when cold, and heated till it becomes quite liquid, it answers best of all for throwing down tan. It is by this property of forming a white precipitate with tan that gelatine is usually detected in animal fluids. It is not, however, a perfectly decisive test, as there are two other animal substances namely, albumen and mucilage, which are thrown down likewise by tan. Gelatine does not, properly speaking, combine with oils, but it renders them miscible with water, and forms a kind of emulsion.

From the effects of different reagents on gelatine, and from the decomposition which it undergoes when heated, we see that it contains carbon, hydrogen, azote, and oxygen. But what the proportion of these constituents is, cannot be easily ascertained. The phosphat of lime, and the traces of soda, which it always yields, are most likely only held in solution by it.

Gelatine, like all other constituents of animal bodies, is susceptible of numerous shades of variations in its properties, and of course is divisible into an indefinite number of species. Several of these have been long known and manufactured for different purposes; and many curious varieties have been pointed out by Mr. Hatchett, in his admirable dissertations on shell, bone, and zoophytes, published in the Philosophical Transactions for 1797 and 1800. The most important species are the following:

1. *Glue.*—This well-known substance has been long manufactured in most countries, and employed to cement pieces of wood together. It is extracted by water from animal substances, and differs in its qualities according to the substances employed. Bones, muscles, tendons, ligaments, membranes, and skins, all yield it; but the quality is best when skins are employed; and those of old animals yield a much stronger glue than those of young animals. English glue is considered as the best, owing to the care with which it is made. The parings of hides, pelts from furriers, the hoofs and ears of horses, oxen, calves, sheep, &c. are the substances from which it is extracted in Britain, and quantities of these substances are imported for the purpose. They are first digested in lime-water to clean them, then steeped in clean water, laid in a heap till the water runs off, and then boiled in brass caldrons with pure water. The impurities are skimmed off as they rise; and when the whole is dissolved, a little alum or finely-powdered lime is thrown in. The skimming having been continued for some time, the whole is strained through baskets, and allowed to settle. The clear liquid is gently poured back into the kettle, boiled a second time, and skimmed till it is reduced to the proper consistency. It is then poured into large frames, where it concretes on cooling, into a jelly. It is cut by a spade into square cakes, which are again cut by means of a wire into thin slices; these slices are put into a kind of coarse net-work, and dried in the open air. The best glue is extremely hard and brittle; it has a dark-brown colour, and an equal degree of transparency without black spots. When put into cold water, it swells very much, and becomes gelatinous, but does not dissolve. When glue is soluble in cold water, it is a proof that it wants strength.

2. *Size.*—This substance differs from glue in being colourless, and more transparent. It is manufactured in the same way, but with more care; eel-skins, vellum, parchment, some kinds of white leather, and the skins of horses, cats, and rabbits, are the substances from which it is procured. It is commonly inrior to glue in strength. It is employed by paper-makers to give strength to that article, and likewise by linen-manufacturers, gilders, polishers, painters in fresco, &c.

3. *Isinglass.*—This substance agrees with size in being transparent, but it is much finer, and is therefore sometimes employed as an article of food. It is prepared in Russia from the air-bladders and sounds of different kinds of fish which occur in the mouths of large rivers; chiefly different species of accipenser, as the sturio, stellatus, huso, ruthenus, and likewise the siluris glaris. The bladder is taken from the fish, clean washed, the exterior membrane separated, cut lengthwise and formed into rolls, and then dried in the open air. When good, isinglass is of a white colour, semitransparent, and dry. It dissolves in water with more difficulty than glue, probably because it is not formed originally by solution. It differs from common glue in being soluble in alcohol. From the analysis of isinglass, by Mr. Hatchett, we learn that it is almost completely convertible into gelatine by solution and boiling. 500 grains of it left by incineration 1.5 grains of phosphat of soda mixed with a little phosphat of lime.

A coarse kind of isinglass is prepared from sea-wolves, porpoises, sharks, cuttle-fish, whales, and all fish without scales. The head, tail, and fins of these, are boiled in water, and concentrated by evaporation, till it gelatinizes on cooling: it is then cast into flat slabs, and cut into tablets. This species is used for clarifying, stiffening silk, making sticking-plaster, and other purposes.

Gelatine exists in great abundance in animals, forming the constituent part of their solid and fluid parts. Its uses are numerous. In a state of jelly it constitutes one of the most nourishing and palatable species of food.

GELATINOUS, in pharmacy and medicine, any thing approaching to the glutinous consistence of a gelatine, or jelly.

GELD, or GILD, in law, a fine or compensation for an offence. Hence wergeld, in our antient laws, was used for the value of a man slain; and orsgeld, of a beast.

GEM, in natural history, a common name for all precious stones, of which there are two classes, the pellucid and semipellucid. See GEMMA.

GEMINI, the Twins, in astronomy, one of the twelve signs of the zodiac, the third in order, beginning with Aries. This constellation, according to different authors, contains from 24 to 89 stars. It is represented by the figure of two twin-children, looking each other affectionately in the face, and supposed to be Castor and Pollux.

GEMMA, in natural history, a common name for all precious stones; of which there are two classes, the pellucid and semipellucid.

The bodies composing the class of pellucid gems are bright, elegant, and beautiful fossils, naturally and essentially compound, ever found in small detached masses, extremely hard, and of great lustre.

The bodies composing the class of semipellucid gems are stones naturally and essentially compound, not inflammable nor soluble in water, found in detached masses, and composed of crystalline matter debased by earth: however, they are but slightly debased, and are of great beauty and brightness, of a moderate degree of transparency, and are usually found in small masses.

The knowledge of gems depends principally on observing their hardness and colour. For hardness, they are commonly allowed to stand in the following order: the diamond the hardest of all; then the ruby, sapphire, hyacinth, emerald, amethyst, garnet, carneol, chalcedony, onyx, jasper, agate, porphyry, and marble. This difference, however, is not regular and constant, but frequently varies. Good crystals may be allowed to succeed the onyx; but the whole family of metallic glassy fluors seem to be still softer. In point of colour, the diamond is valued for its transparency, the ruby for its purple, the sapphire for its blue, the emerald for its green, the hyacinth for its orange, the amethyst carneol for its carnation, the onyx for its tawny, the jasper, agate, and porphyry, for their vermilion, green, and variegated colours, and the garnet for its transparent blood-red.

All these gems are sometimes found coloured and spotted, and sometimes quite limpid and colourless. In this case the diamond-cutter or polisher knows how to distinguish their different species by their different degrees of hardness upon the mill. For the cutting or polishing of gems, the fine powder of the fragments of those that are next in degree of hardness is always required to grind away the softer; but as none of them are harder than the diamond, this can only be polished by its own powder.

Cronstedt observes of gems in general, that the colour of the ruby and emerald is said to remain in the fire, while that of the topaz flies off. Hence it is usual to burn the topaz, and thence substitute it for the diamond.

With regard to the texture of gems, M. Magellan observes, that all of them are foliated or laminated, and of various degrees of hardness. Whenever the edges of these laminæ are sensible to the eye, they have a fibrous appearance, and reflect various shades of colour, which change successively according to their angular position to the eye. These are called by the French chatorantes; and what is a blemish in their transparency often enhances their value on account of their scarcity. But when the substance of a gem is composed of a broken texture, consisting of various sets of laminæ differently inclined to each other, it emits at the same time various irradiations of different colours, which succeed one another according to their angle of position. This kind of gems has obtained the name of opals, and are valued in proportion to the brilliancy, beauty, and variety of their colours. Their crystallization, no doubt, depends on the same cause which produces that of salt, earths, and metals. The following table shows in general the component parts of gems according to the analysis of Bergman and M. Achard; the letter B prefixed to each denoting Bergman's analysis, and A that of Achard. We must observe, however, that under the description of the different gems our readers will find much more accurate statements.

		alum.	silex.	lime.	iron.
Red oriental ruby, -	B	40	39	9	10
Ditto, - - -	A	37.5	42.5	9	11
Blue oriental sapphire,	B	58	35	5	2
Ditto, - - -	A	58	33	6	3
Yellow topaz from Saxony,	B	46	39	8	6
Green oriental emerald,	B	60	24	8	6
Ditto, - - -	A	60	23	10	7
Yellow-brown oriental hyacinth - - .	B	40	25	20	13
Ditto, - - -	A	42	22	20	16
Tourmalin from Ceylon,	B	39	37	15	9
Ditto from Brasil, -	B	50	34	11	5
Ditto from Tyrol, -	B	42	40	12	6
Garnet from Bohemia, -	A	30	48	11	10

GEMMA, a bud. See BOTANY; and PLANTS, *physiology of*.

GEMONIÆ SCALÆ, in Roman antiquity, a place for executing criminals. It was situated on the Aventine mount, or tenth region of the city, and was, according to some, a place raised on several steps, whence they precipitated the criminals. But others will have it to have been a kind of dungeon, to which they descended by steps.

GEMS, *factitious*, or *counterfeit*. See GLASS.

GEMS, *imitation of antique*. There has been at different times a method practised by particular persons, of taking the impressions and figures of antique gems, with their engravings, in glass of the colour of the original gem. This has always been esteemed a very valuable method, and greatly preferable to the more ordinary ones of doing it on sealing-wax or brimstone: but, to the misfortune of the world, this art, being a secret only in the hands of some particular persons who got their bread by it, died with them, and every new artist was obliged to re-invent the method; till at length Mr. Homberg, having found it in great perfection, gave the whole process to the world, to be no more forgotten or lost; and since that time it has been very commonly practised in France, and sometimes in other places.

Mr. Homberg was favoured in his attempts with all the engraved gems of the king's cabinet, and took such elegant impressions, and made such exact resemblances of the originals, and that in glasses so artfully tinged to the colour of the gems themselves, that the nicest judges were deceived in them, and often mistook them for the true antique stones. These counterfeit gems also serve, as well as the original ones, to make more copies from afterwards; so that there is no end of the numbers that may be made from one; and there is this farther advantage, that the copy may be easily made perfect, though the original should not be so, but should have sustained some damage from a blow or otherwise.

The great care in the operation is, to take the impression of the gem in a very fine earth, and to press down upon this a piece of proper glass, softened or half-melted at the fire, so that the figures of the impression made in the earth may be nicely and perfectly expressed upon the glass. In general, the whole process much resembles that of the common founders. But when it is brought to the trial, there are found a number of difficulties which were not to be foreseen, and which would not at all affect the common works of the founder. For his purpose every earth will serve that is fine enough to receive the impressions, and tough enough not to crack in the drying; these all serve for their use, because the metals which they cast are of a nature incapable of mixing with earth, or receiving it into them, even if both are melted together, so that the metal always easily and perfectly separates itself from the mould; but it is very difficult in these casts of glass. They are composed of a matter which differs in nothing from that of the mould, but that it has been run into this form by the force of fire, and the other has not yet been so run, and will mix itself inseparably with the glass in a large fire: consequently, if there is not great care used, as well in the choice of the glass as the manner of using it, when the whole is finished, there will be found great difficulty in separating the glass from the mould; and often this cannot be done without wholly destroying the impression.

All earths run more or less easily in the fire as they are more or less mixed with saline particles in their natural formation. As all salts make earths run into glass, and as it is necessary to use an earth on this occasion for the making a mould, it being also necessary, to the perfection of the experiment, that this earth should not melt or run, it is our business to search out for this purpose some earth which naturally contains very little salt. Of all the species of earth which Mr. Homberg examined on this occasion, none proved so much divested of salts, or so fit for the purpose, as the common tripela, or tripoli, used to polish glass and stones. Of this earth there are two common kinds; the one reddish, and composed of several flakes or strata; the other yellowish, and of a simple structure. These are both to be had in the shops. The latter kind is from the Levant; the former is found in England, France, and many other places. This tripela must be chosen soft and smooth to the touch, and not mixed with sandy or other extraneous matter. The yellowish kind is the best of the two, and is commonly called Venetian tripoli. This receives the impression very beautifully, and never mixes with the glass in the operation, which the red kind sometimes does. Mr. Homberg usually employed both kinds at once in the following manner: 1st, powder a quantity of the red tripela in an iron mor-

tar, and sifting it through a fine sieve, set it by for use; then scrape with a knife a quantity of the yellow tripela into a sort of powder, and afterwards rub it till very fine in a glass mortar with a glass pestle. The finer this powder is, the finer will be the impression, and the more accurately perfect the cast. The artificer might naturally suppose, that the best method to obtain a perfectly fine powder of this earth, would be by washing it in water; but he must be cautioned against this. There is naturally in this yellowish tripela a sort of unctuosity, which, when it is formed into a mould, keeps its granules together, and gives the whole an uniform glossy surface; now washing the powder takes away this unctuosity; and though it renders it much finer, it makes it leave a granulated surface, not this smooth one, in the mould; and this must render the surface of the cast less smooth.

When the two tripelas are thus separately powdered, the red kind must be mixed with so much water as will bring it to the consistence of paste, so that it may be moulded like a lump of dough between the fingers: this paste must be put into a small crucible of a flat shape, and about half an inch or little more in depth, and of such a breadth at the surface as is a little more than that of the stone whose impression is to be taken. The crucible is to be nicely filled with this paste lightly pressed down into it, and the surface of the paste must be strewed over with the fine powder of the yellow tripela not wetted. When this is done, the stone of which the impression is to be taken must be laid upon the surface, and pressed evenly down into the paste with a finger and thumb, so as to make it give a strong and perfect impression; the tripela is then to be pressed nicely even to its sides with the fingers, or with an ivory knife. The stone must be thus left a few moments, for the humidity of the paste to moisten the dry powder of the yellow tripela which is strewed over it; then the stone is to be carefully raised by the point of a needle fixed in a handle of wood, and the crucible being then turned bottom upwards, the stone will fall out, and the impression will remain very beautifully on the tripela. If the sides of the cavity have been injured in the falling out of the stone, they may be repaired, and the crucible must then be set, for the paste to dry, in a place where it will not be incommoded by the dust.

The red tripela, being the more common and the cheaper kind, is here made to fill the crucible only to save the other, which alone is the substance fit for taking the impression. When the stone is taken out, it must be examined, to see whether any thing is lodged in any part of the engraving, because, if there is any of the tripela remaining, there will of course be so much wanting in the impression. When the crucible and paste are dry, a piece of glass must be chosen of a proper colour, and cut to a size proper for the figure; this must be laid over the mould, but in such a manner that it shall not touch the figures, otherwise it would spoil them. The crucible is then to be brought near the furnace by degrees, and gradually heated till it cannot be touched without burning the fingers; then it is to be placed in the furnace under a muffle surrounded with charcoal. Several of these small crucibles may be placed under one muffle; and when they are properly disposed, the aperture of the muffle should have a large piece of burning charcoal put to it, and then the operator is to watch the process, and see when the glass begins to look bright: this is the signal of its being fit to receive the impression. The crucible is then to be taken out of the fire, and the hot glass must be pressed down upon the mould with an iron instrument, to make it receive the regular impression; as soon as this is done, the crucible is to be set by the side of the furnace out of the way of the wind, that it may cool gradually without breaking. When it is cold, the glass is to be taken out, and its edges should be grated round with pincers, in order to prevent its flying afterwards, which is an accident that sometimes happens when this caution has been omitted, especially when the glass is naturally tender. The different coloured glasses are of different degrees of hardness, according to their composition; but the hardest to melt are always the best for this purpose, and this is known by a few trials.

If it is desired to copy a stone in relief which is naturally in creux, or to take one in creux which is naturally in relief, there needs no more than to take an impression, first in wax or sulphur, and to mould that upon the paste of tripela instead of the stone itself; then proceeding in the manner before directed, the process will have the desired effect.

A still more simple and easy method is by taking the casts in gypsum, or plaister of Paris, as it is commonly called. For this purpose the gypsum must be finely pulverized, and then mixed with clear water to the consistence of thick cream. This is poured upon the face of the gem or seal of which the impression is wanted, and which must be previously moistened with oil to facilitate the separation of the cast; and in order to confine the liquid plaister it is only necessary to pin a slip of oiled paper round the sides of the seal by way of a cap or rim. When the plaister is dry, it is to be taken off, and set before the mouth of the furnace, in order to free it entirely from moisture, when it is fit to be used as a matrix in the same way as that formed with the tripoli earths. Only no crucible or other receptacle is at all necessary, the casts being formed like so many small cakes half an inch thick, and then put into the furnace with the bits of glass upon them. The glass, after coming to a proper heat, is pressed down upon the mould with an iron spatula to receive the desired impression, the pressure required being more or less, according to the size of the stone. This method has been long practised very successfully, and with no small emolument, by that ingenious seal-engraver, Mr. Deuchar of Edinburgh. The only respect in which it is inferior to the other more operose and expensive methods, consists in the chance of air-bubbles arising in pouring on the plaister; which chance, however, is less in proportion to the fineness of the gypsum employed. When air-bubbles do occur, the casts may be laid aside, as it is so easy to replace them.

Of all the artists and ingenious men who have taken impressions of engraved gems in sulphur and in paste, no one seems to have carried that art to such perfection as Mr. James Tassie, a native of Glasgow, but who latterly resided in London.

Mr. Tassie, profiting by the former publications of this sort, and by expence, industry, and access to many cabinets in England and other kingdoms to which former artists had not obtained admission, increased his collection of impressions of ancient and modern gems to the number of above 15,000 articles. It is the greatest collection of this kind that ever existed, and serves for all the purposes of artists, antiquaries, scholars, men of taste, and even philosophers. The great demand for his pastes was perhaps owing in the beginning to the London jewellers, who introduced them into fashion by setting them in rings, seals, bracelets, necklaces, and other trinkets.

The reputation of this collection having reached the empress of Russia, she was pleased to order a complete set; which, being accordingly executed in the best and most durable manner, were arranged in elegant cabinets, and are now placed in the noble apartments of her imperial majesty's superb palace at Czarsko Zelo.

Mr. Tassie, in executing this commission, availed himself of all the advantages which the improved state of chemistry, the various ornamental arts, and the knowledge of the age, seemed to afford. The impressions were taken in a beautiful white enamel composition, which is not subject to shrink or form air-bladders, which emits fire when struck with steel, and takes a fine polish, and which shows every stroke and touch of the artist in higher perfection than any other substance. When the colours, mixed colours, and nature of the respective originals, could be ascertained, they were imitated as completely as art can imitate them; insomuch that many of the paste intaglios and cameoes in this collection are such faithful imitations, that artists themselves have owned they could hardly be distinguished from the originals. And when the colour and nature of the gems could not be authenticated, the pastes were executed in agreeable, and chiefly transparent, colours; constant attention being bestowed to preserve the outlines, extremities, attributes, and inscriptions.

GENDARMERIE, *Fr.* The gendarmerie was a select body of cavalry that took precedence of every regiment of horse in the French service, and ranked immediately after the king's household. The reputation of the gendarmerie was so great, and its services so well estimated by the king of France, that when the emperor Charles V. in 1552, sent a formal embassy to the court of Versailles to request a loan of money, and the assistance of the gendarmerie to enable him to repulse the Turks; Francis I. returned the following answer: "With respect to the first object of your mission, (addressing himself to the ambassador) I am not a banker; and with regard to the other, as my gendarmerie is the arm which supports my sceptre, I never expose it to danger, without myself sharing its fatigue and glory."

The uniform of the gendarmerie, as well as of the light cavalry, under the old French government, was scarlet, with facings of the same colour. The coat was formerly more or less laced with silver, according to the king's pleasure. A short period before the revolution, it was only laced on the cuff. The waistcoat was of buff leather, and the ban-

douleer of the same, silver-laced; the hat was edged with broad silver lace. The horse-cloths and holster-caps were red, and the arms of the captain embroidered on the corners of the saddle-cloths, and on the front of the holsters.

In 1762, a considerable body of men was raised by order of Louis XV. The soldiers who composed it were called gensdarmes. And in 1792 the number was considerably augmented, consisting of horse and foot, and being indiscriminately called gensdarmes; but their clothing was altered to deep blue. Their pay was greater than what the rest of the army enjoyed; and when others were paid in paper currency, they received their subsistence in hard cash (en argent sonant). They possessed these privileges on account of the proofs they were obliged to bring of superior claims to military honour, before they could be enlisted as gensdarmes. It was necessary, in fact, that every individual amongst them should produce a certificate of six or eight years service.

GENDARMES (gens d'armes) de la garde, a select body of men so called during the old government of France, and still preserved in that country; but their services are applied to different purposes. They consisted originally of a single company which was formed by Henry IV. when he ascended the throne. He distinguished them from his other troops by styling them hommes d'armes de ses ordonnances, men at arms under his own immediate orders. They consisted of men best qualified for every species of military duty, and were to constitute a royal squadron, at whose head the king himself personally engaged the enemy, as necessity might require. He gave this squadron to his son, the dauphin, who was afterwards king of France, under the name and title of Louis XIII.

GENDER, among grammarians, a division of nouns, or names, to distinguish the two sexes.

GENEALOGICA ARBOR, or tree of consanguinity, signifies a genealogy or lineage drawn out under the figure of a tree, with its root, stock, branches, &c. The genealogical degrees are usually represented in circles, ranged over, under, and aside each other. This the Greeks called stemmata, a word signifying crown, or garland.

GENEALOGY, an enumeration of a series of ancestors, or a summary account of the relations and alliances of a person or family, both in the direct and collateral line.

GENEPPA. See GARDENEA.

GENERAL, in a military sense, is an officer in chief, to whom the prince or senate of a country have judged proper to intrust the command of their troops. He holds this important trust under various titles: as captain-general, in England and Spain; feldt mareschal in Germany, or mareschal in France.

In the British service the king is constitutionally, and in his own proper right, captain-general. He has ten aide-de-camps; every one of whom enjoys the brevet rank of full colonel in the army. Next to his majesty is the commander in chief, whom he sometimes honours with the title of captain-general. During the expedition to Holland, his royal highness the duke of York was entrusted with this important charge.

The natural qualities of a general are a martial genius, a solid judgment, a healthy robust constitution, intrepidity and presence of mind on critical occasions, indefatigability in business, goodness of heart, liberality, a reasonable age; if too young, he may want experience and prudence; if too old, he may not have vivacity enough. His conduct must be uniform, his temper affable, but inflexible in maintaining the police and discipline of an army.

The acquired qualities of a general should be secrecy, justice, sobriety, temperance, knowledge of the art of war from theory and practice, the art of commanding and speaking with precision and exactness, great attention to preserve the lives and supply the wants of the soldiers; and a constant study of the characters of the officers of his army, that he may employ them according to their talents. His conduct appears in establishing his magazines in the most convenient places; in examining the country, that he may not engage his troops too far, while he is ignorant of the means of bringing them off; in subsisting them, and in knowing how to take the most advantageous posts, either for fighting, retreating, or shunning a battle. His experience inspires his army with confidence, and an assurance of victory; and his quality, by creating respect, augments his authority. By his liberality he gets intelligence of the strength and designs of the enemy, and by this means is enabled to take the most successful measures. He ought to be fond of glory, to have an aversion to flattery, to render himself beloved, and to keep a strict discipline and regular subordination.

The office of a general is to regulate the march and encampment of the army; in the day of battle to chuse out the most advantageous ground; to make the disposition of the army; to post the artillery, and where there is occasion, to send his orders by his aide-de-camps. At a siege he is to cause the place to be invested, to regulate the approaches and attacks, to visit the works, and to send out detachments to secure the convoy and foraging parties.

GENERAL TERMS, among logicians, those which are made the signs of general ideas.

GENERAL *of horse*, and GENERAL *of foot*, are posts next under the general of the army, and these have upon all occasions an absolute authority over all the horse and foot in the army.

GENERAL *of the artillery*, or *Master* GENERAL *of the ordnance*. See ORDNANCE.

GENERAL is also used for a particular march, or beat of drum, being the first which gives notice, commonly in the morning early, for the infantry to be in readiness to march.

GENERAL is also used for the chief of an order of monks; or of all the houses and congregations, established under the same rule. Thus we say, the general of the Franciscans, Cistercians, &c.

GENERALISSIMO, a supreme and absolute commander in the field. This word is generally used in most foreign languages. It was first invented by the absolute authority of cardinal Richelieu, when he went to command the French army in Italy.

GENERATING LINE OR FIGURE, in geometry, is that which by its motion produces any other plane or solid figure. Thus a right line moved any way parallel to itself, generates a parallelogram; round a point in the same plane, with one end fastened in that point, it generates a circle. One entire revolution of a circle, in the same plane, generates the cycloid; and the revolution of a semicircle round its diameter, generates a sphere.

GENERATION. See COMPARATIVE ANATOMY, and PHYSIOLOGY.

GENESIS, among mathematicians, signifies the formation or production of some figure or quantity.

GENEVA, or GIN, among distillers, an ordinary malt-spirit distilled a second time, with the addition of some juniper-berries. See DISTILLATION.

GENIOSTOMA, a genus of the monogynia order, in the pentandria class of plants. The calyx is a turbinated quinquefid perianthium; the corolla monopetalous and tubular; the stamina five short filaments; the antheræ oblong; the seeds very numerous and subangulated, placed on a filiform receptacle. There is one species, a native of the South Seas.

GENISTA, BROOM, OR DYER'S-WEED, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is bilabiate; the upper lip bidented, the under one tridentate; the vexillum is oblong and reflexed, or turned back from the pistil and stamina. There are 17 species, of which the most remarkable are the cytiso-genista, or common broom, and the tinctoria, or dyer's-weed. The first is too well known to need description. Its young flowers are sometimes preserved as pickles; and the plant, when burnt, affords a tolerably pure alkaline salt. Dr. Mead relates the case of a dropsical patient that was cured by taking half a pint of a decoction of green broom-tops, with a spoonful of whole white mustard-seed, every morning and evening. The patient had been tapped three times, and tried the usual remedies before. The seeds, or an infusion of them drunk freely, have been known to produce similar happy effects; but these are to be expected in very few instances. Cows, horses, and sheep, refuse the plant. 2. The tinctoria is also a native of Britain. It rises with shrubby stalks three feet high, with spear-shaped leaves placed alternate, and terminated by several spikes of yellow flowers, succeeded by pods. The branches of the plant are used by dyers for giving a yellow colour; whence it is called dyer's-broom, green-wood, wood waxen, or dyer's-weed. A dram and half of the powdered seeds operates as a mild purgative. A decoction of the plant is diuretic, and, like the former, has proved serviceable in dropsical cases. Horses, cows, goats, and sheep, eat it.

GENITIVE, in grammar, the second case of the declension of nouns.

GENTIANA, GENTIAN, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 20th order, rotaceæ. The corolla is monopetalous, the capsule bivalved and unilocular; there are two longitudinal recep-

tacles. There are 53 species. The most remarkable are the following:

1. The lutea, or common gentian of the shops. This is a native of the mountainous parts of Germany, whence the roots, the only part used in medicine, are brought to this country. They have a yellowish-brown colour, and a very bitter taste. The lower leaves are of an oblong oval shape, a little pointed at the end, stiff, of a yellowish green, and have five large veins on the back of each. The stalk rises four or five feet high, with leaves growing by pairs at each joint, almost embracing the stalk at their base. They are of the same form with the lower, but diminish gradually in their size to the top. The flowers come out in whorls at the joints on the upper part of the stalks, standing on short footstalks, whose origin is in the wings of the leaves. They are of a pale-yellow colour. The roots of this plant are very frequently used in medicine as stomachic bitters. In taste they are less exceptionable than most of the substances of this class. Infusions of gentian-root flavoured with orange-peel are sufficiently grateful. Some years ago a poisonous root was discovered among the gentian brought to London, the use of which occasioned violent disorders, and in some cases death. This root is easily distinguished from the gentian, by its being internally of a white colour, and void of bitterness.

2. The centaureum, or lesser centaury of the shops, is a native of many parts of Britain. It grows on dry pastures, and its height is commonly proportioned to the goodness of the soil, as in rich soils it will grow to the height of a foot, but in poor ones not above three or four inches. It is an annual plant, with upright branching stalks, and small leaves, placed by pairs. The flowers grow in form of an umbel at the top of the stalk, and are of a bright purple colour. They come out in July, and the seed ripens in autumn. The plant cannot be cultivated in gardens. The tops are an useful aperient bitter, in which view they have been often used in the practice of medicine.

3. The acaulis, a beautiful little plant for the flower garden, conspicuous for its fine changeable azure blue flowers. It is a native of the Alps.

GENTILE, *gentilis*, in the Roman law and history, a name which sometimes expresses what the Romans otherwise called barbarians, whether they were allies of Rome or not: but this word was used in a more particular sense for all strangers and foreigners not subject to the Roman empire, in contradistinction to provincialis, or an inhabitant of a province of the empire.

GENTLEMAN, according to sir Edward Coke, is one who bears coat-armour, the grant of which adds gentility to a man's family. 2 Inst. 667.

GENUS, among metaphysicians and logicians, denotes a number of beings, which agree in certain general properties, common to them all, so that a genus is nothing but an abstract idea, expressed by some general name or term.

GENUS, in natural history, a subdivision of any class or order of natural beings, whether of the animal, vegetable, or mineral kingdoms, all agreeing in certain common characters.

GENUS, in music, by the antients called genus melodiæ, is a certain manner of dividing and subdividing the principles of melody, that is, the consonant and dissonant intervals, into their concinnous parts.

GEOCENTRIC, in astronomy, is applied to a planet or its orbit to denote it concentric with the earth, or as having the earth for its centre, or the same centre with the earth.

GEOCENTRIC *latitude of a planet*, is its distance from the ecliptic as it is seen from the earth, which even though the planet be in the same point of her orbit, is not constantly the same, but alters according to the position of the earth in respect to the planet.

GEOCENTRIC *place of a planet*, the place in which it appears to us from the earth, supposing the eye there fixed: or it is a point in the ecliptic to which a planet seen from the earth is referred.

GEOFFROYA, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is quinquefid, the fruit an oval plum, the kernel compressed. There are two species; the intermis, or cabbage-bark tree, is a native of Brasil and Jamaica. The wood of this tree is used in building; but it is chiefly valued for its bark, which is administered as an anthelmintic medicine. From this medical property it is also called the worm-bark tree. This bark is of a grey colour externally, but black and furrowed on the inside. It has a mucilaginous and sweetish taste, and a disagreeable smell. It is given in cases of worms, in form of powder, decoction, syrup, and extract. The decoction is preferred, and is made by slowly boiling an ounce of the fresh-dried bark in a quart of water, till it assumes the colour of Madeira wine. This, sweetened, is the syrup; evaporated, it forms an extract. It commonly produces some sickness and purging; sometimes violent effects, as vomiting, delirium, and fever. These last are said to be owing to an over-dose, or to drinking cold water, and are relieved by the use of warm water, castor oil, or a vegetable acid. It should always be begun in small doses. But when properly and cautiously administered, it is said to operate as a very powerful anthelmintic, particularly for the expulsion of the lumbrici, which are a very common cause of disease in the West Indies.

GEOGRAPHY is a word derived from the Greek language, and implies a description of the earth. It is sometimes contrasted with hydrography, which signifies a description of the water, that is, of seas, lakes, rivers, &c. including marine charts. Antiently both were considered in connection with astronomy, as parts of cosmography, which attempted to delineate the universe. Geography is more justly contrasted with chorography, which illustrates a country or province; and still more with topography, which describes a particular place, or smaller district.

What is called general geography embraces a wide view of the subject; regarding the earth astronomically as a planet, the grand divisions of land and water, the winds, tides, meteorology, and may extend to what is called mechanical geography, including directions for the construction of globes, maps, and charts.

Among other divisions of this science may be named sacred geography, solely employed in the illustration of the scriptures; ecclesiastical geography, which describes the government of the church as divided into patriarchates, archbishopricks, bishopricks, archdeanries, &c. with their respective boundaries, which frequently vary much from those of the secular provinces; and physical geography, or geology which investigates the interior of the earth, so far only as real discoveries can be made. See GEOLOGY.

Geography, popularly considered, is occupied in the description of the various regions of this globe, chiefly as being divided among various nations, and improved by human art and industry.

GEOGRAPHY, *history of*, The study of geography being of so much practical importance in life, must have commenced in the early ages of the world. It was regarded as a science by the Babylonians and Egyptians, from whom it passed to the Greeks, and from these to the Romans, the Arabians, and the western nations of Europe Thales of Miletus, in the 6th century before Christ, first made observations on the apparent progress of the sun from tropic to tropic; and is said to have written two treatises, the one on the tropic, and the other on the equinox, whence he was led to the discovery of the four seasons, which are determined by the equinoxes and solstices. We are assured this knowledge was obtained by means of the gnomon. Thales, it is also said, constructed a globe, and represented the land and sea upon a table of brass.

Meton and Euctemon observed the summer solstice at Athens, on the 27th of June, 432 years before Christ, by watching narrowly the shadow of the gnomon, with the design of fixing the beginning of their cycle of 19 years.

Timocharis and Aristillus, who began their observations about 295 B. C., first attempted to fix the latitudes and longitudes of the fixed stars, by considering their distances from the equator, &c. One of their observations gave rise to the discovery of the precession of the equinoxes, which was first remarked by Hipparchus about 150 years after; who also made use of their method for delineating the parallels of latitude and the meridians, on the surface of the earth; thus laying the foundation of this science as it now appears. See EQUINOXES, *precession of*.

The latitudes and longitudes, thus introduced by Hipparchus, were not however much attended to till Ptolemy's time. Strabo, Vitruvius, and Pliny, have all of them entered into a minute geographical description of the situation of places, according to the length of the shadows of the gnomon, without noticing the longitudes and latitudes.

Maps at first were little more than rude outlines, and topographical sketches of different countries. The earliest on record were those of Sesostris, mentioned by Eustathius, who says, that "this Egyptian king, having traversed great part of the earth, recorded his march in maps, and gave copies of them not only to the Egyptians, but to the Scythians, to their great astonishment." Some have imagined, with much probability, that the Jews made a map of the Holy Land when they gave the different portions to the nine tribes at Shiloh; for Joshua tells us

that they were sent to walk through the land, and that they described it in seven parts in a book; and Josephus relates that when Joshua sent out people from the different tribes to measure the land, he gave them as companions persons well skilled in geometry, who could not be mistaken in the truth.

The first Grecian map on record was that of Anaximander, mentioned by Strabo, supposed to be that referred to by Hipparchus under the designation of the antient map. Herodotus minutely describes a map made by Aristagoras, tyrant of Miletus, which will serve to give some idea of the maps of those times. He relates, that Aristagoras shewed it to Cleomenes, king of Sparta, to induce him to attack the king of Persia at Susa, in order to restore the Ionians to their antient liberty. It was traced upon brass or copper, and seems to have been a mere itinerary, containing the route through the intermediate countries which were to be traversed in that march, with the rivers Halys, the Euphrates, and Tigris, which Herodotus mentions as necessary to be crossed in that expedition. It contained one straight line called the royal road, or highway, which took in all the stations or places of encampment from Sardis to Susa; being 111 in the whole journey, and containing 13,500 stadia, or 1687½ Roman miles of 5000 feet each.

Eratosthenes first attempted to reduce geography to a regular system, and introduced a regular parallel of latitude, which began at the straits of Gibraltar, passed eastwards through the isle of Rhodes, and so on to the mountains of India, noting all the intermediate places through which it passed. In drawing this line, he was not regulated by the same latitude, but by observing where the longest day was 14 hours and a half, which Hipparchus afterwards determined was the latitude of 36 degrees.

This first parallel through Rhodes was ever after considered with a degree of preference, in constructing all the antient maps; and the longitude of the then known world was often attempted to be measured in stadia and miles, according to the extent of that line, by many succeeding geographers.

Eratosthenes soon after attempted not only to draw other parallels of latitude, but also to trace a meridian at right angles to these, passing through Rhodes and Alexandria down to Syene and Meroe; and at length he undertook the arduous task of determining the circumference of the globe, by an actual measurement of a segment of one of its great circles. To find the magnitude of the earth is indeed a problem which has engaged the attention of astronomers and geographers ever since the spherical figure of it was known. It seems Anaximander was the first among the Greeks who wrote upon this subject. Archytas of Tarentum, a Pythagorean, famous for his skill in mathematics and mechanics, also made some attempts in this way; and Dr. Long conjectures that these are the authors of the most antient opinion that the circumference of the earth is 400,000 stadia; and Archimedes makes mention of the antients who estimated the circumference of the earth at only 30,000 stadia.

As to the methods of measuring the circumference of the earth, it would seem, from what Aristotle says in his treatise De Cœlo, that they were much the same as those used by the moderns, deficient only in the accuracy of the instruments. That philosopher there says, that different stars pass through our zenith, according as our situation is more or less northerly; and that in the southern parts of the earth stars come above our horizon, which are no longer visible if we go northward. Hence it appears that there are two ways of measuring the circumference of the earth; one by observing stars which pass through the zenith of one place, and do not pass through that of another; the other, by observing some stars which come above the horizon of one place, and are observed at the same time to be in the horizon of another. The former of these methods, which is the best, was followed by Eratosthenes at Alexandria in Egypt, 250 years before Christ. He knew that at the summer solstice, the sun was vertical to the inhabitants of Syene, a town on the confines of Ethiopia, under the tropic of Cancer, where they had a well made to observe it, at the bottom of which the rays of the sun fell perpendicularly the day of the summer solstice: he observed by the shadow of a wire set perpendicularly in an hemispherical bason, how far the sun was on that day at noon distant from the zenith of Alexandria; when he found that distance was equal to the 50th part of a great circle in the heavens. Then supposing Syene and Alexandria under the same meridian, he inferred that the distance between them was the 50th part of a great circle upon the earth; and this distance being by measure 5000 stadia, he concluded that the whole circumference of the earth was 250,000 stadia. But as this number divided by 360 would give 694⅘ stadia to a degree, either Eratosthenes himself, or some of his followers, assigned the round number 700 stadia to a degree, which multiplied by 360, makes the circumference of the earth 252,000 stadia; whence both these measures are given by different authors as that of Eratosthenes.

In the time of Pompey the Great, Posidonius determined the measure of the circumference of the earth by the 2d method above hinted by Aristotle, viz. the horizontal observations. Knowing that the star called Canopus was but just visible in the horizon of Rhodes, and at Alexandria finding its meridian height was the 48th part of a great circle in the heavens, or 7½ deg., answering to the like quantity of a circle on the earth; then supposing these two places under the same meridian, and the distance between them 5000 stadia, the circumference of the earth will be 240,000 stadia; which is the first measure of Posidonius. But according to Strabo, Posidonius made the measure of the earth to be 180,000 stadia, at the rate of 500 stadia to a degree. The reason of this difference is thought to be, that Eratosthenes measured the distance between Rhodes and Alexandria, and found it only 3750 stadia; taking this for a 48th part of the earth's circumference, which is the measure of Posidonius, the whole circumference will be 180,000 stadia. This measure was received by Marinus of Tyre, and is usually ascribed to Ptolemy. But this measurement is subject to great uncertainty, both on account of the great refraction of the stars near the horizon, the difficulty of measuring the distance at sea between Rhodes and Alexandria, and by supposing those places under the same meridian, when they are really very different.

Several geographers afterwards made use of the different heights of the pole in distant places under the same meridian, to find the dimensions of the earth. About the year 800 the khalif Almemun had the distance measured between two places that were two degrees asunder, and under the same meridian, in the plains of Sinjar in the Red Sea; and the result was, that the degree at one time was found equal to 56 miles, and at another 56⅓ or 56⅔ miles.

The next attempt to find out the circumference of the earth was in 1525, by Fernelius, a learned philosopher of France. For this purpose he took the height of the pole at Paris, going thence directly northwards, till he came to the place where the height of the pole was one degree more than at that city. The length of the way was measured by the number of revolutions made by one of the wheels of his carriage; and after proper allowances for the declivities and turnings of the road, he concluded that 68 Italian miles were equal to a degree of the earth.

According to these methods many other measurements of the earth's circumference have since that time been made, with much greater accuracy: a particular account of which is given under the article DEGREE.

Though the maps of Eratosthenes were the best of his time, they were yet very imperfect and inaccurate. They contained little more than the states of Greece, and the dominions of the successors of Alexander, digested according to the surveys above-mentioned. He had indeed seen, and has quoted, the voyages of Pythias into the great Atlantic ocean, which gave him some faint ideas of the western parts of Europe; but so imperfect, that they could not be realized into the outlines of a chart. Strabo says he was very ignorant of Gaul, Spain, Germany, and Britain; and he was equally ignorant of Italy, the coast of the Adriatic, Pontus, and all the countries towards the north.

Such was the state of geography, and the nature of the maps, before the time of Hipparchus. He made a closer connection between geography and astronomy, by determining the latitudes and longitudes from celestial observations.

War has usually been the occasion of making or improving the maps of countries; and accordingly geography made great advances from the progress of the Roman arms. In all the provinces occupied by that people, camps were every where constructed at proper intervals, and good roads made for communication between them; and thus civilization and surveying were carried on according to system through the whole extent of that large empire. Every new war produced a new survey and itinerary of the countries where the scenes of action passed; so that the materials of geography were accumulated by every additional conquest. Polybius says, that at the beginning of the second Punic war, when Hannibal was preparing his expedition against Rome, the countries through which he was to pass were carefully measured by the Romans. And Julius Cæsar caused a general survey of the Roman empire to be made, by a decree of the senate. Three surveyors had this task assigned them, which they completed in 25 years. The Roman itineraries

that are still extant, also shew what care and pains they had been at in making surveys in all the different provinces of their empire, and Pliny has filled the 3d, 4th, and 5th books of his Natural History with the geographical distances that were thus measured. Other maps are also still preserved, known by the name of the Pentigerian Tables, published by Welser and Bertius, which give a good specimen of what Vegetius calls the itinera picta, for the better direction of their armies in their march.

The Roman empire had been enlarged to its greatest extent, and all its provinces well known and surveyed, when Ptolemy, about 150 years after Christ, composed his system of geography. The chief materials he employed in composing this work, were the proportions of the gnomon to its shadow, taken by different astronomers at the times of the equinoxes and solstices; calculations founded on the length of the longest days; the measured or computed distances of the principal roads contained in their surveys and itineraries; and the various reports of travellers and navigators. All these were compared together, and digested into one uniform body or system; and afterwards were translated by him into a new mathematical language, expressing the different degrees of latitude and longitude, after the invention of Hipparchus, which had been neglected for 250 years.

Ptolemy's system of geography, notwithstanding it was still very imperfect, continued in vogue till the last three or four centuries, within which time the great improvements in astronomy, the many discoveries of new countries by voyagers, and the progress of war and arms, have contributed to bring it to a very considerable degree of perfection.

Principles of geography.

The fundamental principles of geography are, the spherical figure of the earth, its rotation on its axis, its revolution round the sun, and the position of the axis or line round which it revolves with regard to the celestial luminaries. That the earth and sea taken together constitute one vast sphere is demonstrable by the following arguments: 1. To people at sea the land disappears, though near enough to be visible was it not for the intervening convexity of the water. 2. The higher the eye is placed, the more extensive is the prospect; whence it is common for sailors to climb up to the tops of the masts to discover land or ships at a distance. But this would give them no advantage, was it not for the convexity of the earth; for upon an infinitely extended plane objects would be visible at the same distance whether the eye was high or low, nor would any of them vanish till the angle under which they appeared became too small to be perceived. 3. To people on shore, the mast of a ship at sea appears before the hull; but was the earth an infinite plane, not the highest objects, but the largest, would be longest visible; and the mast of a ship would disappear, by the smallness of its angle, long before the hull did so. 4. The convexity of any piece of still water of a mile or two in extent may be perceived by the eye. A little boat, for instance, may be perceived by a man who is any height above the water; but if he stoops down or lays his eye near the surface, he will find that the fluid appears to rise and intercept the view of the boat entirely. 5. The earth has been often sailed round, as by Magellan, Drake, Dampier, Anson, Cook, and many other navigators, which demonstrates that the surface of the ocean is spherical; and that the land is very little different may easily be proved from the small elevation of any part of it above the surface of the water. The mouths of rivers which run 1000 miles are not more than one mile below their sources, and the highest mountains are not quite four miles of perpendicular height; so that, though some parts of the land are elevated into hills, and others depressed into valleys, the whole may still be accounted spherical. 6. An undeniable, and indeed ocular, demonstration of the spherical figure of the earth is taken from the round figure of its shadow which falls upon the moon in time of eclipses. As various sides of the earth are turned towards the sun during the time of different phenomena of this kind, and the shadow in all cases appears circular, it is impossible to suppose the figure of the earth to be any other than spherical. The inequalities of its surface have no effect upon the earth's shadow on the moon; for as the diameter of the terraqueous globe is very little less than 8000 miles, and the height of the highest mountains on earth not quite four, we cannot account the latter any more than the 2000th part of the former, so that the mountains bear no more proportion to the bulk of the earth, than grains of dust bear to that of a common globe.

A great many of the terrestrial phenomena depend upon the globular figure of the earth, and the position of its axis with regard to the sun, particularly the rising and setting of the celestial luminaries, the length of the days and nights, &c.

Though the sun rises and sets all over the world, the circumstances of his doing so are very different in different countries. The most remarkable of these circumstances is the duration of the light, not only of the sun himself, but of the twilight before he rises and after he sets. In the equatorial regions, for instance, darkness comes on very soon after sunset; because the convexity of the earth comes quickly in between the eye of the observer and the luminary, the motion of the earth being much more rapid there than any where else. In our climate the twilight always continues two hours, or thereabouts, and during the summer season it continues in a considerable degree during the whole night. In countries farther to the northward or southward, the twilight becomes brighter and brighter as we approach the poles, until at last the sun does not appear to touch the horizon, but goes in a circle at some distance above it for many days successively. In like manner, during the winter, the same luminary sinks lower and lower, until at last he does not appear at all; and there is only a dim twinkling of twilight for an hour or two in the middle of the day. By reason of the refraction of the atmosphere, however, the time of darkness, even in the most inhospitable climates, is always less than that of light; and so remarkable is the effect of this property, that in the year 1682, when some Dutch navigators wintered in Nova Zembla, the sun was visible to them 16 days before he could have been seen above the horizon, had there been no atmosphere. The reason of all this is, that in the northern and southern regions only a small part of the convexity of the globe is interposed betwixt us and the sun for many days, and in the high latitudes none at all. In the warmer climates the sun has often a beautiful appearance at rising and setting, from the refraction of his light through the vapours which are copiously raised in those parts. In the colder regions, halos, parhelia, aurora borealis, and other meteors, are frequent; the two former owing to the great quantity of vapour continually flying from the warm regions of the equator to the colder ones of the poles. In the high northern latitudes, thunder and lightning are unknown, or but seldom heard of; but the more terrible phenomena of earthquakes, volcanoes, &c. are by no means unfrequent. These, however, seem only to affect islands and the maritime parts of the continent.

Notwithstanding the seeming inequality in the distribution of light and darkness, however, it is certain, that throughout the whole world there is nearly an equal proportion of light diffused on every part, abstracting from what is absorbed by clouds, vapours, and the atmosphere itself. The equatorial regions have indeed the most intense light during the day, but the nights are long and dark; while, on the other hand, in the northerly and southerly parts, though the sun shines less powerfully, yet the length of time that he appears above the horizon, with the greater duration of the twilight, compensates for the seeming deficiency.

Was the earth a perfect plane, the sun would appear to be vertical in every part of it; for, in comparison with the immense magnitude of that luminary, the diameter of this globe itself is but very small; and as the sun, was he near to us, would do much more than cover the whole earth, so, though he was removed to any distance, the whole diameter of the latter would make no difference in the apparent angle of altitude. By means of the globular figure of the earth also, along with the great disparity between the diameters of the two bodies, some advantage is given to the day over the night; for thus the sun, being immensely the larger of the two, shines upon more than one-half of the earth; whence the unenlightened part has a shorter way to go before it again receives the benefit of his rays. This difference is greater in the inferior planets Venus and Mercury than in the earth.

To the globular figure of the earth likewise is owing the long moonlight which the inhabitants of the polar regions enjoy. The same thing likewise occasions the appearance and disappearance of certain stars at some seasons of the year in some countries; for, was the earth flat, they would all be visible in every part of the world at the same time. Hence most probably has arisen the opinion of the influence of certain stars upon the weather and other sublunary matters. In short, on the globular figure of the earth depends the whole present appearance of nature around us; and was the shape of the planet we inhabit to be altered to any other, besides the real differences which would of consequence take place, the apparent ones would be so great, that we cannot form any idea of the face which nature would then present to us. See ASTRONOMY.

In geography the circles which the sun apparently describes in the heavens are supposed to be extended as far as the earth, and

marked on its surface; and in like manner we may imagine as many circles as we please to be described on the earth, and their planes to be extended to the celestial sphere, till they mark concentric ones on the heavens. The most remarkable of those supposed by geographers to be described in this manner are the following.

1. *The horizon.* This is properly a double circle, one of the horizons being called the sensible, and the other the rational. The former comprehends only that space which we can see around us upon any part of the earth, and which is very different according to the difference of our situation. The other, called the rational, is a circle parallel to the former, and passing through the centre of the earth, supposed to be continued as far as the celestial sphere itself. To the eyes of spectators there is always a vast difference between the sensible and rational horizons; but from the immense disparity betwixt the size of the earth and celestial sphere, planes of both circles may be considered as coincident. Hence in geography, when the horizon, or plane of the horizon, is spoken of, the rational is always understood when nothing is said to the contrary. In consequence of the round figure of the earth, every part has a different horizon. The poles of the horizon, that is, the points directly above the head, and opposite to the feet of the observer, are called the zenith and nadir.

2. A great circle described upon the sphere of the heaven, and passing through the two vertical points, is called a vertical circle, or an azimuth; and of these we may suppose as many as we please all round the horizon. In geography every circle obtains the epithet of great whose plane passes through the centre of the earth; in other cases they are called lesser circles. The altitudes of the heavenly bodies are measured by an arch of the azimuth or vertical circle intercepted between the horizon and the body itself. The most accurate method of taking them, with regard to the sun and moon, is for two persons to make their observations at the same time; one of them to observe the altitude of the upper limb, the other of the lower limb of the luminary; the mean betwixt these two giving the true height of the centre. The same thing may also be done accurately by one observer, having the apparent diameter of the luminary given. For, having found the height of the upper edge of the limb by the quadrant, take from it half his diameter, the remainder is the height of his centre; or having found the altitude of his lower edge, add to it half the diameter, and the sum is the height of the centre as before. When the observations are made with a large instrument, it will be convenient to use a sextant, or sixth part of a circle, rather than a quadrant, as being less unwieldy.

3. Almucantars are circles supposed to be drawn upon the sphere parallel to the horizon, and grow less and less as they approach the vertical points, where they entirely vanish. The apparent distances betwixt any two celestial bodies are measured by supposing arches of great circles drawn through them, and then finding how many degrees, minutes, &c. of these circles are intercepted between them.

4. Sometimes the visible horizon is considered only with regard to the objects which are upon the earth itself, in which case we may define it to be a lesser circle on the surface of the earth, comprehending all such objects as are at once visible to us; and the higher the eye, the more is the visible horizon extended. It is most accurately observed, however, on the sea, on account of the absence of those inequalities which at land render the circle irregular; and for this reason it is called sometimes the horizon of the sea, and may be observed by looking through the sights of a quadrant at the most distant part of the sea then visible.

5. The equator is a great circle upon the earth, every part of which is equally distant from the poles or extremities of the imaginary line on which the earth revolves. In the sea-language it is usually called the line, and when people sail over it they are said to cross the line.

6. The meridian of any place is a great circle on the earth drawn through that place and both poles of the earth. It cuts the horizon at right angles, marking upon it the true north and south point; dividing also the globe into two hemispheres, called the eastern and western from their relative situation to that place and to one another. The poles divide the meridians into two semicircles, one of which is drawn through the place to which the meridian belongs, the other through that point of the earth which is opposite to the place. By the meridian of a place, geographers and astronomers often mean that semicircle which passes through the place, and which may therefore be called the geographical meridian. All places lying under this semicircle are said to have the same meridian; the semicircle opposite to this is called the opposite meridian. The meridians are thus immoveably fixed to the earth as much as the places themselves on its surface, and are carried along with it in its diurnal rotation. When the geographical meridian of any place is, by the rotation of the earth, brought to point at the sun, it is noon or mid-day at that place; in which case, was the plane of the circle extended, it would pass through the middle of the luminary's disk. Supposing the plane of the meridians to be extended to the sphere of the fixed stars, in that case, when by the rotation of the earth the meridian comes to any point in the heavens, then, from the apparent motion of the heavens, that point is said to come to the meridian. The rotation of the earth is from west to east; whence the celestial bodies appear to move the contrary way. East and west, however, are terms merely relative, since a place may be west from one part of the earth, and east from another; but the true east and west points from any place are those where its horizon cuts the equator.

7. All places lying under the same meridian are said to have the same longitude, and those which lie under different meridians to have different longitudes; the difference of longitude being reckoned eastward or westward on the equator. Thus, if the meridian of any place cuts the equator in a point 15 degrees distant from one another, we say there is a difference of 15° longitude betwixt these two places. Geographers usually fix upon the meridian of some remarkable place for the first meridian, and reckon the longitude of all others by the distance of their meridians from that which they have determined upon as the first; measuring sometimes eastward on the equator all round the globe, or sometimes only one-half east and the other west; according to which last measurement no place can have more than 180° longitude either east or west. By the antient Greek geographers the first meridian was placed in Hera or Junonia, one of the Fortunate islands, as they were then called, which is supposed to be the present island of Teneriffe, one of the Canaries. These islands, being the most westerly part of the earth then known, were on that account made the seat of the first meridian, the longitude of all other places being counted eastward from them. Among modern geographers indeed, it is now become customary for each to make the first meridian pass through the capital of his own country; a practice, however, which is certainly improper, as it is thus impossible for the geographers of one nation to understand the maps of another without a troublesome calculation, which answers no purpose. By the British geographers the royal observatory at Greenwich is accounted the place of the first meridian.

8. If we suppose 12 great circles, one of which is the meridian to a given place, to intersect each other at the poles of the earth, and divide the equator into 24 equal parts, these are the hour-circles of that place. These are by the poles divided into 24 semicircles, corresponding to the 24 hours of the day and night. The distance betwixt each two of these semicircles is 15°, being the 24th part of 360; and by the rotation of the earth each succeeding semicircle points at the sun one hour after the preceding: so that in 24 hours all the semicircles point successively at the sun. Hence it appears, that such as have their meridian 15° east from any other have likewise noon one hour sooner, and the contrary; and in like manner every other hour of the natural day is an hour sooner at the one place than at the other. Hence, from any instantaneous appearance in the heavens observed at two distant places, the difference of longitude may be found, if the hour of the day is known at each place. Thus the beginning of an eclipse of the moon, when the luminary first touches the shadow of the earth, is an instantaneous appearance, as also the end of an eclipse of this kind, when the moon leaves the shadow of the earth visible to all the inhabitants on that side of the globe. If therefore we find, that at any place an eclipse of the moon begins an hour sooner than at another, we conclude that there is a difference of 15° of longitude between the two places. Hence also was a man to travel or sail round the earth from west to east, he would reckon one day more to have passed than they do who stay at the place whence he set out; so that their Monday would be his Tuesday, &c. On the other hand, if he sails westward, he will reckon a day less, or be one day in the week later, than those he leaves behind.

9. The equator divides the earth into two hemispheres, called the northern and southern; all places lying under the equator are said to have no latitude; and all others to have north or south latitude according to their situation with respect to the equator. The latitude itself is the distance from the equator measured upon the meridian, in degrees, minutes, and seconds. The comple-

ment of latitude is the difference between the latitude itself and 90°, or as much as the place itself is distant from the pole; and this complement is always equal to the elevation of the equator above the horizon of the place. The elevation of the pole of any place is equal to the latitude itself.

An inhabitant of the earth who lived (if it was possible) at either of the poles would have always one of the celestial poles in his zenith, and the other in his nadir, the equator coinciding with the horizon. Hence all the celestial parallels are also parallel to the horizon; whence the person is said to live in a parallel sphere, or to have a parallel horizon.

Those who live under the equator have both poles in the horizon, all the celestial parallels cutting the horizon at right angles; whence they are said to live in a right sphere, or to have a right horizon.

Lastly, those who live between either of the poles and the equator, are said to live in an oblique sphere, or to have an oblique horizon, because the celestial equator cuts their horizon obliquely, and all the parallels in the celestial sphere have their planes oblique to that of the horizon. In this sphere some of the parallels intersect the horizon at oblique angles, some are entirely above it, and some entirely below it; all of them, however, so situated, that they would obliquely intersect the plane of the horizon extended.

The largest parallel which appears entire above the horizon of any place in north latitude is called by the antient astronomers the arctic circle of that place; within this circle, that is, between it and the arctic pole, are comprehended all the stars which never set in that place, but are carried perpetually round the horizon in circles parallel to the equator. The largest parallel which is hid entirely below the horizon of any place in north latitude was called the antarctic circle of that place by the antients. This circle comprehends all the stars which never rise in that place, but are carried perpetually round below the horizon in circles parallel to the equator. In a parallel sphere, however, the equator may be considered as both arctic and antarctic circle; for, being coincident with the horizon, all the parallels on one side are entirely above it, and those on the other entirely below it. In an oblique sphere, the nearer any place is to either of the poles, the larger are the arctic and antarctic circles, as being nearer to the celestial equator, which is a great circle. In a right sphere, the arctic and antarctic circles have no place, because no parallel appears either entirely above or below it. By the arctic and antarctic circles, however, modern geographers in general understand two fixed circles at the distance of 23½ degrees from the pole. These are supposed to be described by the poles of the ecliptic, and mark out the space all round the globe where the sun appears to touch the horizon at midnight in the summer time, and to be entirely sunk below it in the winter. These are also called the polar circles.

According to the different positions of the globe with regard to the sun, the celestial bodies will exhibit different phenomena to the inhabitants. Thus, in a parallel sphere, they will appear to move in circles round the horizon; in a right sphere they would appear to rise and set as at present, but always in circles, cutting the horizon at right angles; but in an oblique sphere the angle varies according to the degree of obliquity, and the position of the axis of the sphere with regard to the sun. Hence we easily perceive the reason of the sun's continual change of place in the heavens; but though it is certain that this change takes place every moment, the vast distance of the luminary renders it imperceptible for some time, unless to very nice astronomical observers. Hence we may generally suppose the place of the sun to be the same for a day or two together, though in a considerable number of days it becomes exceedingly obvious to every body. When he appears in the celestial equator, his motion appears for some time to be in the plane of that circle, though it is certain that his place there is only for a single moment; and in like manner, when he comes to any other point of the heavens, his apparent diurnal motion is in a parallel drawn throughout. Twice a year he is in the equator, and then the days and nights are nearly equal all over the earth. This happens in the months of March and September; after which the sun proceeding either northward or south, according to the season of the year and the position of the observer, the days become longer or shorter than the nights, and summer or winter comes on, as is fully explained under the article ASTRONOMY. The secession of the sun from the equator either northward or southward is called his declination, and is either north or south according to the season of the year; and when this declination is at its greatest height, he is then said to be in the tropic, because he begins to turn back (the word tropic being derived from the Greek τρεπω, verto). The space between the two tropics, called the torrid zone, extends for no less than 47 degrees of latitude all round the globe; and throughout the whole of that space the sun is vertical to some of the inhabitants twice a year, but to those who live directly under the tropics only once. Throughout the whole torrid zone also there is little difference between the length of the days and nights. The antient geographers found themselves considerably embarrassed in their attempts to fix the northern tropic; for though they took a very proper method, namely, to observe the most northerly place where objects had no shadow on a certain day, yet they found that on the same day no shadow was cast for a space of no less than 300 stadia. The reason of this was, the apparent diameter of the sun, which, being about half a degree, seemed to extend himself over as much of the surface of the earth, and to be vertical every where within that space.

When the sun is in or near the equator, he seems to change his place in the heavens most rapidly; so that about the equinoxes one may very easily perceive the difference in a day or two; but as he approaches the tropics, this apparent change becomes gradually slower, so that for a number of days he scarcely seems to move at all. The reason of this may easily be understood from any map on which the ecliptic is delineated; for by drawing lines through every degree of it parallel to the equator, we shall perceive them gradually approach nearer and nearer each other, until at last, when we approach the point of contact betwixt the ecliptic and tropic, they can for several degrees scarcely be distinguished at all.

From an observation of the diversity in the length of the days and nights, the rising and setting of the sun, with the other phenomena already mentioned, the antient geographers divided the surface of the earth into certain districts, which they called climates; and instead of the method of describing the situation of places by their latitude and longitude as we do now, they contented themselves with mentioning the climate in which they were situated.

This method of dividing the surface of the earth into climates, though now very much disused, has been adopted by several modern geographers. Some of these begin their climates at the equator, reckoning them by the increase of half an hour in the length of the day northward. Thus they go on till they come to the polar circles, where the longest day is 24 hours: betwixt these and the poles they count the climates by the increase of a natural day in the length of time that the sun continues above the horizon, until they come to one where the longest day is 15 of ours, or half a month; and from this to the pole they count by the increase of half-months or whole months, the climates ending at the poles where the days are six months long. The climates betwixt the equator and the polar circles are called hour-climates, and those between the polar circles and the poles are called month-climates. In common language, however, we take the word climate in a very different sense; so that when two countries are said to be in different climates, we understand only that the temperature of the air, seasons, &c. are different.

From the difference in the length and positions of the shadows of terrestrial substances, antient geographers have given different terms to the inhabitants of certain places of the earth; the reason of which will be easily understood from the following considerations: 1. Since the sun in his apparent annual revolution never removes farther from the equator than 23½ degrees, it follows, that none of those who live without that space, or beyond the tropics, can have the luminary vertical to them at any season of the year. 2. All who live between the tropics have the sun vertical twice a year, though not all at the same time. Thus, to those who live directly under the equator, he is directly vertical in March and September at the time of the equinox. If a place is in 10° north latitude, the sun is vertical when he has 10° north declination, and so of every other place. 3. All who live between the tropics have the sun at noon sometimes north and sometimes south of them. Thus those who live in a place situated in 20° north latitude have the sun at noon to the northward when he has more than 20 degrees north declination, and to the southward when he has less. 4. Such of the inhabitants of the earth as live without the tropics, if in the northern hemisphere, have the sun at noon to the southward of them, but to the northward if in the southern hemisphere.—1. Hence when the sun is in the zenith of any place, the shadow of a man or any upright object falls directly upon the place where they stand, and consequently is invisible; whence the inhabitants of such places were called Aseii, or without shadows. 2. Those who live between the tropics, and have the sun sometimes to the north and sometimes to the south of them, have of con-

sequence their shadows projecting north at some seasons of the year, and south at others, whence they were called Amphiscii, or having two kinds of shadows. 3. Those who live without the tropics have their noon-shadows always the same way, and are therefore called Heteroscii, that is, having only one kind of shadow. If they are in north latitude, the shadows are always turned towards the north, and if in the southern hemisphere, towards the south. 4. When a place is so far distant from the equator that the days are 24 hours long, or longer, the inhabitants were called Periscii, because their shadows turn round them.

Names have likewise been imposed upon the inhabitants of different parts of the earth from the parallels of latitude under which they live, and their situation with regard to one another. 1. Those who lived at distant places, but under the same parallel, were called Periæci, that is, living in the same circle. Some writers, however, by the name of Periæci distinguish those who live under opposite points of the same parallel, where the noon of one is the midnight of the other. 2. When two places lie under parallels equally distant from the equator, but in opposite hemispheres, the inhabitants were called Antæci. These have a similar increase of days and nights, and similar seasons, but in opposite months of the year. According to some, the Antæci were such as lived under the same geographical meridian, and had day and night at the same time. 3. If two places are in parallels equally distant from the equator, and in opposite meridians, the inhabitants were called Antipodes, that is, having their feet opposite to one another. When two persons are Antipodes, the zenith of the one is the nadir of the other. They have a like elevation of the pole, but it is of different poles; they have also days and nights alike, and similar seasons of the year, but they have opposite hours of the day and night, as well as seasons of the year. Thus, when it is midday with us, it is midnight with our Antipodes; when it is summer with us, it is winter with them, &c.

From the various appearances of the sun, and the effects of his light and heat upon different parts of the earth, the division of it into zones has arisen. These are five in number. 1. The torrid zone, lying between the two tropics for the space of 47° of latitude. This is divided into two equal parts by the equator. 2. The two temperate zones lie between the polar circles and the tropics, containing a space of 43° of latitude. And, 3. The two frigid zones lie between the polar circles and the poles. In these last the longest day is never below 24 hours; in the temperate zones it is never quite so much, and in the torrid zone it is never above 14. The zones are named from the degree of heat they were supposed to be subjected to. The torrid zone was supposed by the antients to be uninhabitable, on account of its heat; but this is now found to be a mistake, and many parts of the temperate zones are more intolerable in this respect than the torrid zone itself. Towards the polar circles also these zones are intolerably cold during the winter season. Only a small part of the northern frigid zone, and none of the southern, is inhabited. Some geographers reckoned six zones, dividing the torrid zone into two by the equator.

Besides these there are other technical terms belonging to geography which it is necessary to explain; some of these have relation to the earth, and others to the water.

A *continent* is a large portion of the earth, which comprehends several countries that are not separated by any sea; such are Europe, Asia, Africa, and America. An *island* is a part of the earth which is entirely surrounded by water; as Great Britain. A *peninsula* is a tract of land almost surrounded with water, and is joined to a continent only by a narrow slip or neck; such is the Morea in Greece. An *isthmus*, or neck of land, is that part by which a peninsula is joined to a continent, or two continents together; as the isthmus of Suez, which joins Africa to Asia. A *promontory*, or cape, is a high part of land which stretches into the sea; thus the Cape of Good Hope is a promontory. An *ocean* is a vast collection of waters surrounding a considerable part of the continent; as the Atlantic. A *sea* is a smaller collection of waters; as the Black Sea. A *gulf* is a part of the sea which is nearly surrounded with land; as the gulf of Venice. A *bay* has a wider entrance than a gulf; as the Bay of Biscay. A *strait* is a narrow passage that joins two seas; as the Strait of Gibraltar, which joins the Mediterranean to the Atlantic. A *lake* is a large collection of water entirely surrounded by land, having no visible communication with the sea; as the Caspian Lake in Asia. A *river* is a stream of water that has its source from a spring, which keeps constantly running till it falls into some other river, or into the sea.

In a popular point of view, geography admits of three divisions: 1. The antient or classical, which describes the state of the earth, not extending farther than the 500th year of the Christian æra. 2. That of the middle ages, which reaches to the 15th century, when the discoveries of the Portuguese began to lay broader foundations for this science. 3. Modern geography, the chief object of which is to present the most recent and authentic information concerning the nations and states which divide and diversify the earth. In some instances natural barriers have divided, and continue to divide, nations; but in general the boundaries are arbitrary, so that the natural geography of a country may be regarded as a sequel to the science, which is chiefly occupied in describing the diversities of nations, and the conditions of the various races of mankind.

The antients considered the globe under the three grand divisions of Asia, Europe, and Africa. Here the distinctions were arbitrary, as they often included Egypt under Asia, and they had not discovered the limits of Europe towards the N. E. Modern discoveries have added a fourth division, that of America, which exceeding even Asia in size, might have been admitted under two grand and distinct denominations, limited by the isthmus of Darien. Till within these last 30 years it was supposed that a vast continent existed in the south of the globe; but the second navigation of captain Cook dispelled the idea, and demonstrated, that if any continent existed there, it must be in the uninhabitable ice of the south pole. The vast extent of New Holland rewarded the views of enterprize; this, which seems too large to be ranked among islands, and too small for a continent, eludes the petty distinctions of man: and while geographers hesitate whether to ascribe it to Asia, or to denominate it a fifth specific division of the earth, it is not improbable that the popular division of four quarters will still predominate over all speculative discussions.

Of the grand divisions of the earth, Asia has ever been esteemed the most populous; and is supposed to contain five hundred millions of souls, if China, as has been averred by the latest writers, comprizes three hundred and thirty millions. The population of Africa may be estimated at thirty millions, of America at twenty millions, and one hundred and fifty millions may perhaps be assigned to Europe.

Modern discoveries have evinced that more than two-thirds of the globe is covered with water, which is contained in hollow spaces, or concavities, more or less large. But the chief convexities or protuberances of the globe consist of elevated uplands, sometimes crowned by mountains, sometimes rather level, as the extensive protuberance of Asia. In either case, long chains of mountains commonly proceed from those chief convexities in various directions, and the principal rivers usually spring from the most elevated grounds.

The grandest concavity of this globe is filled by the Pacific Ocean; occupying nearly half its surface from the eastern shores of New Holland, to the western coast of America, and diversified with several groups of islands, which seem in a manner the summits of vast mountains emerging from the waves. This ocean receives but few rivers, the chief being the Amur from Tartary, the Hoan Ho and Kian Ku from China, while the principal rivers of America run towards the east.

Next to this in magnitude is the Atlantic, between the Old and New Continents; and the third is the Indian Ocean. The seas between the arctic and antarctic circles and the poles, have been sometimes styled the Arctic and Antarctic Oceans; but the latter is only a continuation of the Pacific, Atlantic, and Indian Oceans; while the Arctic Sea is partly embraced by continents, and receives many important rivers. Besides these, there are other seas more minute, as the Mediterranean, the Baltic, and others still smaller, till we come by due gradation to inland lakes of fresh water.

The courses of rivers are sometimes marked by oblong concavities, which generally at first intersect the higher grounds, till the declivity becomes more gentle on their approach towards their inferior receptacles. But even large rivers are found sometimes to spring from lowland marshes, and wind through vast plains, unaccompanied by any concavity, except that of their immediate course; while on the other hand, extensive vales, and low hollow spaces, frequently occur destitute of any stream. Rivers will also sometimes force a passage where nature has erected mountains and rocks against it, and where the concavity would appear to be in another direction, which the river might have gained with more ease. In like manner, though the chief mountains of Europe extend in a south-easterly and north-westerly direction, yet there are so many exceptions, and such numerous and important variations in

ther parts of the globe, as to render any attempt at a general theory vain.

From the vast expanse of oceanic waters, arises in the antient hemisphere, that wide continent, which contains Asia, Europe, and Africa; and in the modern hemisphere the continent of America, which forms a kind of separate island, divided by a strait of the sea from the antient continent. In the latter many discoveries of great importance to geography, are of very modern date, and it is not above 60 years since we obtained an imperfect idea of the extent of Siberia and the Russian empire, nor above 25 since ample, real, and accurate knowledge of these wide regions began to be diffused. So that, in truth, America may be said to have been discovered before Asia; and of Africa our knowledge continues imperfect, while the latest observations, instead of diminishing, rather increase our idea of its extent.

But the grandest division of the antient continent is Asia, the parent of nations, and of civilization: on the north-east and south, surrounded by the ocean; but on the west, divided by an ideal line from Africa; and from Europe by boundaries not very strongly impressed by the hand of nature. The Russian and the Turkish empires, extending over large portions of both continents, intimately connect Asia with Europe. But for the sake of clearness and precision, geographers retain the strict division of the antient continent into three parts, which, if not strictly natural, is ethical, as the manners of the Asiatic subjects of Russia, and even of Turkey, differ considerably from those of the European inhabitants of those empires.

A description of the four quarters of the globe, and of the several kingdoms and states into which they are divided, belongs rather to a work devoted exclusively to geography, than to a dictionary of arts and sciences: we shall therefore forbear entering more into detail in this article.

GEOLOGY, a science which treats of the decomposition and changes to which the stony part of our globe has been subjected.

If it was permitted to man to follow, during several ages, the various changes which are produced on the surface of our globe by the numerous agents that alter it, we should at this time have been in possession of the most valuable information respecting these great phenomena: but thrown as we are, almost by accident, upon a small point of this vast theatre of observation, we fix our attention for a moment upon operations which have been the work of nature for ages; and we are unable either to perceive or to foretel the results, because several ages are scarcely sufficient to render the effects or changes perceptible.

It must be allowed that those men who, by the mere efforts of their imagination, have endeavoured to form ideas respecting the construction, and the great phenomena, of this globe, have numerous titles to our indulgence. In their proceedings we behold the efforts of genius, tormented with the desire of acquiring knowledge, and irritated at the prospect of the scanty means which nature has put in its power; and when these naturalists, such as M. de Buffon, have possessed the power of embellishing their hypotheses with every ornament which imagination and eloquence can furnish, either as instruments of illusion or entertainment, we ought to consider ourselves indebted to them.

For our part, we shall confine ourselves to a few ideas respecting the successive decompositions of our planet, and shall endeavour to avoid every departure from observation and matter of fact.

The slightest observation shews us that living beings are kept up and perpetuated only by successive decompositions and combinations. A slight view of the mineral kingdom exhibits the same changes; and our globe, in all its productions, presents continual modifications, and a circle of activity, which might appear incompatible with the apparent inertia of earthy products.

In order to arrange our ideas with greater regularity, we may consider this globe in two different states. We shall first examine the primitive rock which forms the nodule or central part. This appears to contain no germ of life; includes no remains or part of any living being; and from every circumstance appears to have been of primitive formation, anterior to the creation of animated or vegetating bodies. We shall pursue the various changes which are daily produced by the destructive action of such agents as alter or modify this substance.

We shall then proceed to examine what stones have been successively placed upon this, and what are the decompositions to which these secondary rocks have been subjected.

1. The observations of naturalists all unite to prove that the primitive part of the globe consists of the stone known by the name of granite. The profound excavations which the art of man, or currents of water, have made in the surface of our planet, have all uncovered this rock, and have been incapable of penetrating lower: we may therefore consider this substance as the nucleus of the globe; and upon this substance it is that all matters of posterior formation rest.

Granite exhibits many varieties in its form, composition, and disposition: but it in general consists of an assemblage of certain siliceous stones, such as quartz, schorl, feldtspar, mica, &c.; and the more or less considerable magnitude of these elements of granite, has caused it to be divided into coarse-grained granite, and fine-grained granite.

It is thought that these rocks owe their arrangement to water; and if we may be permitted to recur, by an effort of the imagination, to that epocha in which, according to sacred and profane historians, the water and earth were confounded, and the confused mixture of all principles formed a chaos, we shall see that the laws of gravity inherent in matter must have carried it down, and necessarily produced the arrangement which observation at present exhibits to us. The water, as the least heavy, must have purified itself, and arisen to the surface by a filtration through the other materials: while the earthy principles must have precipitated, and formed a mud, in which all the elements of stones were confounded. In this very natural order of things, the general law of affinities, which continually tends to bring together all analogous parts, must have exerted itself with its whole activity upon the principles of this almost fluid paste; and the result have been a number of bodies of a more definite kind, in crystals more or less regular; and from this muddy substance, in which the principles of the stones were confounded that compose the granite, a rock must have been produced, containing the elementary stones all in possession of their distinct forms and characters. In this manner it is that we observe salts of very different kinds develope themselves in waters which hold them in solution; and in this manner it still happens that crystals of spar and gypsum are formed in clays which contain their component parts.

It may easily be conceived that the laws of gravitation must have influenced the arrangement and disposition of the products. The most gross and heavy bodies must have fallen, and the lightest and most attenuated substances must have arranged themselves on the surface of the foregoing; and this it is which constitutes the primitive schisti, the gneis, the rocks of mica, &c. which commonly repose upon masses of coarse-grained granite.

The disposition of the fine-grained granite in strata or beds, appears to depend on this position, and the fineness or tenuity of its parts. Being placed in immediate contact with water, this fluid must naturally have influenced the arrangement which it presents to us; and the elements of this rock being subjected to the effect of waves, and the action of currents, must have formed strata.

The rocks of granite being once established as the nucleus of our globe, we may, from the analysis of its constituent principles, and by attending to the action of the various agents capable of altering it, follow the changes to which it has been subjected, step by step.

Water is the principal agent whose effects we shall examine.

This fluid, collected in the cavity of the ocean, is carried by the atmosphere to the tops of the most elevated mountains, where it is precipitated in rain, and forms torrents, which return with various degrees of rapidity into the common reservoir.

This uninterrupted motion and fall must gradually attenuate and wear away the hardest rocks, and carry their detached parts to distances more or less considerable. The action of the air, and the varying temperature of the atmosphere, facilitate the attenuation and the destruction of these rocks. Heat acts upon their surface, and renders it more accessible and more penetrable to the water which succeeds; cold divides them, by freezing the water which has entered into their texture; the air itself affords the acid principle, which attacks the limestone, and causes it to effloresce; the oxygen unites to the iron, and calcines it: insomuch that this concurrence of causes favours the disunion of principles; and consequently the action of water, which clears the surface, carries away the products of decomposition, and makes preparation for a succeeding process of the same nature.

The first effects of the rain is therefore to depress the mountains. But the stones which compose them must resist in proportion to their hardness; and we ought not to be surprised when we observe peaks which have braved the destructive action of time, and still remain to attest the primitive level of the mountains which have disappeared. The primitive rocks, alike inaccessible to the injury of ages as to the animated

beings which cover less elevated mountains with their remains, may be considered as the source or origin of rivers and streams. The water which falls on their summits, flows down in torrents by their lateral surfaces. In its course it wears away the soil upon which it incessantly acts. It hollows out a bed, of a depth proportioned to the rapidity of its course, the quantity of its waters, and the hardness of the rock over which it flows; at the same time that it carries along with it portions and fragments of such stones as it loosens in its course.

These stones, rolled along by the water, must strike together, and break off their projecting angles: a process that must quickly have afforded those rounded flints which form the beds of rivers. These pebbles are found to diminish in size, in proportion to the distance from the mountain which affords them; and it is to this cause that Mr. Dorthes has referred the disproportionate magnitude of the pebbles which form our antient worn stones, when compared with those of modern date; for the sea extending itself formerly much more inland, in the direction of the Rhone, the stones which it received from the rivers, and threw back again upon the shores, had not run through so long a space in their beds as those which they at present pass over. Thus it is that the remains of the Alps, carried along by the Rhone, have successively covered the vast interval comprised between the monntains of Dauphiny and Vivarais; and are carried into seas, which deposit them in small pebbles on the shore.

The pulverulent remains of mountains, or the powder which results from the rounding of these flints, are carried along with greater facility than the flints themselves: they float for a long time in the water, whose transparency they impair; and when these same waters are less agitated, and their course becomes slackened, they are deposited in a fine and light paste, forming beds more or less thick, and of the same nature as that of the rocks to which they owe their origin. These strata gradually become drier by the agglutination of their principles; they become consistent, acquire hardness, and form siliceous clays, silex, petrosilex, and all the numerous class of pebbles which are found dispersed in strata, or in banks, in the antient beds of rivers.

The mud is much more frequently deposited in the interstices left between the rounded flints themselves, which intervals it fills, and there forms a true cement that becomes hard, and constitutes the compound stones known by the name of pudding-stones and grit-stones; for these two kinds of stones do not appear to differ but in the coarseness of the grain which forms them, and the cement which connects them together

We sometimes observe the granite spontaneously decomposed. The texture of the stones which form it has been destroyed; the principles or compouent parts are disunited and separated, and they are gradually carried away by the waters.

Water filtrating through mountains of primitive rock, frequently carries along with it very minutely divided particles of quartz; and proceeds to form, by deposition, stalactites, agates, rock crystal, &c.

These quartzose stalactites, differently coloured, are of a formation considerably analogous to that of calcareous alabasters; and we perceive no other difference between them than that of their constituent parts.

II. Thus far we have exhibited, in a few words, the principal changes, and various modifications, to which the primitive rocks have been subjected. We have not yet observed either germination or life; and the metals, sulphur, and bitumens, have not hitherto presented themselves to our observation. Their formation appears to be posterior to the existence of this primitive globe; and the alterations and decompositions which now remain to be inquired into, appear to be produced by the class of living, or organized beings.

On the one hand, we behold the numerous class of shell animals, which cause the stony mass of our globe to increase by their remains. The spoils of these creatures, long agitated and driven about by the waves, and more or less altered by collision, form those strata and banks of limestone, in which we very often perceive impressions of those shells to which they owe their origin.

On the other hand, we observe a numerous quantity of vegetables that grow and perish in the sea; and these plants likewise, deposited and heaped together by the currents, form strata, which are decomposed, lose their organization, and leave all the principles of the vegetable confounded with the earthy principle. It is to this source that the origin of pit-coal, and secondary schistus, is usually attributed; and this theory is established on the existence of the texture of decomposed vegetables very usually seen in schisti and coal, and likewise on the presence of shells and fish in most of these products.

It appears that the formation of pyrites ought in part to be attributed to the decomposition of vegetables: it exists in greater or less abundance in all schisti and coal. A wooden shovel has been found buried in the depositions of the river De Ceze, converted into jet and pyrites. The decomposition of animal substances may be added to this cause; and it appears to be a confirmation of these ideas, that we find many shells passed to the state of pyrites.

Not only the marine vegetables form considerable strata by their decomposition; but the remains of those which grow on the surface of the globe ought to be considered among the causes or agents which concur in producing changes upon that surface.

We shall separately consider how much is owing to each of these causes; and shall follow the effects of each, as if that cause alone was employed in modifying and altering our planet.

1. The secondary calcareous mountains are constantly placed upon the surface of the primitive mountains; and though a few solitary observations present a contrary order, we ought to consider this inversion and derangement as produced by shocks which have changed the primitive disposition. It must be observed also, that the disorder is sometimes merely apparent; and that some naturalists of little information have described calcareous mountains as inclining beneath the granite, because this last pierces through the envelope, rises to a greater height, and leaves at its feet, almost beneath it, the calcareous remains deposited at its base.

Sometimes even the limestone fills to a very great depth the crevices or clefts formed in the granite. The writer of this article has seen in Gevaudan, towards Florac, a profound cavity in the granite filled with calcareous stone. This vein is known to possess a depth of more than 150 fathoms, with a diameter of about two or three.

It likewise happens frequently enough that such waters as are loaded with the remains of the primitive granite, heap them together, and form secondary granites, which may exist above the calcareous stone.

These calcareous mountains are decomposed by the combined action of air and water; and the product of their decomposition sometimes forms chalk or marle.

The lightness of this earth renders it easy to be transported by water; and this fluid, which does not possess the property of holding it in solution, soon deposits it in the form of gurhs, alabasters, stalactites, &c. Spars owe their formation to no other cause. Their crystallization is posterior to the origin of calcareous mountains.

Waters wear down and carry away calcareous mountains with greater ease than the primitive mountains: their remains being very light, are rolled along, and more or less worn. The fragments of these rocks are sometimes connected by a gluten or cement of the same nature; from which process calcareous grit and breccias arise. These calcareous remains formerly deposited themselves upon the quartzose sand; and the union of primitive matter, and secondary products, gives rise to a rock of a mixed nature.

2. The mountains of secondary schistus frequently exhibit to us a pure mixture of earthy principles, without the smallest vestige of bitumen. These rocks afford, by analysis, silex, alumina, magnesia, lime in the state of carbonate, and iron; principles which are more or less united, and consequently accessible in various degrees to the action of such agents as destroy the rocks hitherto treated of.

The same principles, when disunited, and carried away by waters, give rise to a great part of the stones which are comprised in the magnesian class. The same elements, worn down by the waters, and deposited under circumstances proper to facilitate crystallization, form the schorls, tourmaline, garnets, &c.

We do not pretend by this to exclude and absolutely reject the system of such naturalists as attribute the formation of magnesian stones to the decomposition of the primitive rocks. But we think that this formation cannot be objected to for several of them, more especially such as contain magnesia in the greatest abundance.

It frequently happens that the secondary schisti are interspersed with pyrites; and, in this case, the simple contact of air and water facilitates their decomposition. Sulphuric acid is thus formed, which combines with the various constituent principles of the stone; whence result the sulphates of iron, of magnesia, of alumina, and of lime, which effloresce at the surface, and remain confounded together. Schisti of this nature are wrought in most places where alum-works have been established; and the most laborious part of this undertaking consists in separating the sulphates of iron, of lime, and of magnesia from each other, which are mixed together. Sometimes the magnesia is so abundant that

its sulphate predominates. The sulphate of lime, being very sparingly soluble in water, is carried away by that liquid, and deposited to form gypsum; while the other more soluble salts, remaining suspended, form vitriolic mineral waters.

The pyritous schisti are frequently impregnated with bitumen, and the proportions constitute the various qualities of pit-coal.

It appears that we may lay it down as an incontestable principle, that the pyrites is abundant in proportion as the bituminous principle is more scarce. Hence it arises, that coals of a bad quality are the most sulphureous, and destroy metallic vessels, by converting them into pyrites. The foci of volcanos appear to be formed by a schistus of this nature; and in the analyses of the stony matters which are ejected, we find the same principles as those which constitute this schistus. We ought not therefore to be much surprised at finding schorls among volcanic products; and still less at observing that subterranean fires throw sulphuric salts, sulphur, and other analogous products, out of the entrails of the earth.

3. The remains of terrestrial vegetables exhibit a mixture of primitive earths more or less coloured by iron: we may therefore consider these as a matrix in which the seeds of all stony combinations are dispersed. The earthy principles assort themselves according to the laws of their affinities; and form crystals of spar, of plaister, and even the rock crystals, according to all appearance: for we find ochreous earths in which these crystals are abundantly dispersed; we see them formed almost under our eyes. We have frequently observed indurated ochres full of these crystals terminating in two pyramids.

The ochreous earths appear to deserve the greatest attention of naturalists. They constitute one of the most fertile means of action which nature employs; and it is even in earths nearly similar to these that she elaborates the diamond, in the kingdoms of Golconda and Visapour.

The spoils of animals, which live on the surface of the globe, are entitled to some consideration among the number of causes which we assign to explain the various changes our planet is subjected to. We find bones in a state of considerable preservation in certain places; we can even frequently enough distinguish the species of the animals to which they have belonged. From indications of this sort it is that some writers have endeavoured to explain the disappearance of certain species; and to draw conclusions thence, either that our planet is perceptibly cooled, or that a sensible change has taken place in the position of the axis of the earth. The phosphoric salts and phosphorus which have been found, in our time, in combination with lead, iron, &c. prove that, in proportion as the principles are disengaged by animal decomposition, they combine with other bodies, and form the nitric acid, the alkalis, and in general all the numerous kinds of nitrous salts. See MINERALOGY.

GEOMETRICAL *lines*, as observed by Newton, are distinguished into classes, orders, or genera, according to the number of the dimensions of the equation that expresses the relation between the ordinates and abscisses; or, which comes to the same thing, according to the number of points in which they may be cut by a right line.

Thus, a line of the first order, is a right line, since it can be only once cut by another right line, and is expressed by the simple equation $y + ax + b = 0$; those of the 2d, or quadratic order, will be the circle, and the conic sections, since all of these may be cut in two points by a right line, and expressed by the equation $y^2 + \overline{ax + b}.y + cx^2 + dx + e = 0$: those of the 3d or cubic order, will be such as may be cut in three points by a right line, whose most general equation is $y^3 + \overline{ax + b}.y^2 + \overline{cx^2 + dx + e}.y + fx^3 + gx^2 + bx + i = 0$; as the cubical parabola, the cissoid, &c. And a line of an infinite order, is that which a right line may cut in infinite points; as the spiral, the cycloid, the quadratrix, and every line that is generated by the infinite revolutions of a radius, or circle, or wheel, &c.

In each of those equations, x is the abscis, y its corresponding ordinate, making any given angle with it; and a, b, c, &c. are given or constant quantities, affected with their signs + and −, of which one or more may vanish, be wanting or equal to nothing, provided that by such defect the line or equation does not become one of an inferior order.

It is be observed that a curve of any kind is denominated by a number next less than the line of the same kind: thus, a curve of the first order (because the right line cannot be reckoned among curves), is the same with a line of the second order; and a curve of the second kind, the same with a line of the third order, &c.

It is to be observed also, that it is not so much the equation, as the construction or description, that makes any curve, geometrical, or not. Thus, the circle is a geometrical line, not because it may be expressed by an equation, but because its description is a postulate; and it is not the simplicity of the equation, but the easiness of the description, that is to determine the choice of the lines for the construction of a problem. The equation that expresses a parabola, is more simple than that which expresses a circle; and yet the circle, by reason of its more simple construction, is admitted before it. Again, the circle and the conic sections, with respect to the dimensions of the equations, are of the same order; and yet the circle is not numbered with them in the construction of problems, but by reason of its simple description is depressed to a lower order, viz. that of a right line; so that it is not improper to express that by a circle, which may be expressed by a right line; but it is a fault to construct that by the conic sections, which may be constructed by a circle.

GEOMETRICAL *solution* of a problem, is when the problem is directly resolved according to the strict rules and principles of geometry, and by lines that are truly geometrical. This expression is used in contradistinction to an arithmetical, or a mechanical, or instrumental solution; the problem being resolved only by a ruler and compasses.

The same term is likewise used in opposition to all indirect and inadequate kinds of solutions, as by approximation, infinite series, &c. So, we have no geometrical way of finding the quadrature of the circle, the duplicature of the cube, or two mean proportionals; though there are mechanical ways, and others by infinite series, &c.

Pappus informs us, that the antients endeavoured in vain to trisect an angle and to find out two mean proportionals, by means of the right line and circle. Afterwards they began to consider the properties of several other lines; as the conchoid, the cissoid, and the conic sections; and by some of these they endeavoured to resolve some of those problems. At length, having more thoroughly examined the matter, and the conic sections being received into geometry, they distinguished geometrical problems and solutions into three kinds; viz.

1. Plane ones, which deriving their origin from lines on a plane, may be properly resolved by a right line and a circle.

2. Solid ones, which are resolved by lines deriving their original from the consideration of a solid; that is, of a cone.

3. Linear ones, to the solution of which are required lines more compounded.

According to this distinction, we are not to resolve solid problems by other lines than the conic sections, especially if no other lines beside the right line, circle, and the conic sections, must be received into geometry.

But the moderns, advancing much farther, have received into geometry all lines that can be expressed by equations; and have distinguished, according to the dimensions of the equations, those lines into classes or orders; and have laid it down as a law, not to construct a problem by a line of a higher order, that may be constructed by one of a lower.

GEOMETRICAL progression, or proportion. See ALGEBRA.

GEOMETRY, the science and doctrine of local extension, as of lines, surfaces, and solids, with that of ratios, &c.

The name geometry literally signifies measuring of the earth, as it was the necessity of measuring the land that first gave occasion to contemplate the principles and rules of this art, which has since been extended to numberless other speculations; insomuch that, together with arithmetic, geometry forms now the chief foundation of all the mathematics.

Herodotus and Proclus ascribe the invention of geometry to the Egyptians, and assert that the annual inundations of the Nile gave occasion to it; for those waters bearing away the bounds and landmarks of estates and farms, covering the face of the ground uniformly with mud, the people, say they, were obliged every year to distinguish and lay out their lands by the consideration of their figure and quantity; and thus by experience and habit they formed a method or art, which was the origin of geometry. A farther contemplation of the draughts of figures of fields, thus laid down and plotted in proportion, might naturally lead them to the discovery of some of their excellent and wonderful properties; which speculation continually improving, the art continually gained ground, and made advances more and more towards perfection.

Geometry is distinguished into theoretical or speculative, and practical.

Theoretical or speculative geometry, treats of the various properties and relations in magnitudes, demonstrating the theorems, &c. And

Practical geometry, is that which applies those speculations and theorems to particular uses in the solution of problems, and in the measurements in the ordinary concerns of life.

Speculative geometry again may be divided into elementary and sublime.

Elementary or common geometry, is that which is employed in the consideration of right lines and plane surfaces, with the solids generated from them. And the

Higher or sublime geometry, is that which is employed in the consideration of curve lines, conic sections, and the bodies formed of them. This part has been chiefly cultivated by the moderns, by help of the improved state of algebra, and the modern analysis or fluxions.

We shall now proceed to give the principles of practical geometry, beginning with

Definitions or explanation of terms.—1. A mathematical point has neither length, breadth, nor thickness. From this definition it may be easily understood that a mathematical point cannot be seen nor felt; it can only be imagined. What is commonly called a point, as a small dot made with a pencil or pen, or the point of a needle, is not in reality a mathematical point; for however small such a dot may be, yet if it be examined with a magnifying glass, it will be found to be an irregular spot, of a very sensible length and breadth; and our not being able to measure its dimensions with the naked eye, arises only from its smallness. The same reasoning may be applied to every thing that is usually called a point; even the point of the finest needle appears like that of a poker when examined with the microscope.

2. A line is length without breadth or thickness. What was said above of a point, is also applicable to the definition of a line. What is drawn upon paper with a pencil or pen, is not in fact a line, but the representation of a line. For however fine you may make these representations, they will still have some breadth. But by the definition, a line has no breadth whatever, yet it is impossible to draw any thing so fine as to have no breadth. A line therefore can only be imagined. The ends of a line are points.

3. Parallel lines are such as always keep at the same distance from each other, and which, if prolonged ever so far, would never meet. See Plate Geometry, fig. 1.

4. A right line is what is commonly called a straight line, or one that tends every where the same way.

5. A curve is a line which continually changes its direction between its extreme points.

6. An angle is the inclination or opening of two lines meeting in a point, fig. 2.

7. The lines AB, and BC, which form the angle, are called the legs or sides; and the point B, where they meet, is called the vertex of the angle, or the angular point. An angle is sometimes expressed by a letter placed at the vertex, as the angle B, fig. 2; but most commonly by three letters, observing to place in the middle the letter at the vertex, and the other two are those at the end of each leg, as the angle ABC.

8. When one line stands upon another, so as not to lean more to one side than to another, both the angles which it makes with the other are called right angles, as the angles ABC and ABD, fig. 3; and all right angles are equal to each other, being all equal to 90°; and the line AB is said to be perpendicular to CD.

Beginners are very apt to confound the terms perpendicular, and plumb or vertical line. A line is vertical when it is at right angles to the plane of the horizon, or level surface of the earth, or to the surface of water, which is always level. The sides of a house are vertical. But a line may be perpendicular to another, whether it stands upright, or inclines to the ground, or even if it lies flat upon it, provided only that it makes the two angles formed by meeting with the other line equal to each other; as for instance, if the angles ABC and ABD be equal, the line AB is perpendicular to CD, whatever may be its position in other respects.

9. When one line BE (fig. 3), stands upon another, CD, so as to incline, the angle EBC, which is greater than a right angle, is called an obtuse angle; and that which is less than a right angle is called an acute angle, as the angle EBD.

10. Two angles which have one leg in common, as the angles ABC and ABE, are called contiguous angles, or adjoining angles; those which are produced by the crossing of two lines, as the angles EBD and CBF, formed by CD and EF, crossing each other, are called opposite or vertical angles.

11. A figure is a bounded space, and is either a surface or a solid.

12. A superficies, or surface, has length and breadth only. The extremities of a superficies are lines.

13. A plane, or plane surface, is that which is every where perfectly flat and even, or which will touch every part of a straight line, in whatever direction it may be laid upon it. The top of a marble slab, for instance, is an example of this, which a straight edge will touch in every point, so that you cannot see light any where between.

14. A curved surface is that which will not coincide with a straight line in any part. Curved surfaces may be either convex or concave.

15. A convex surface is when the surface rises up in the middle; as, for instance, a part of the outside of a globe.

16. A concave surface is when it sinks in the middle, or is hollow, and is the contrary to convex.

A surface may be bounded either by straight lines, curved lines, or both these.

17. Every surface bounded by straight lines only is called a polygon. If the sides are all equal, it is called a regular polygon. If they are unequal, it is called an irregular polygon. Every polygon, whether equal or unequal, has the same number of sides as angles, and they are denominated sometimes according to the number of sides, and sometimes from the number of angles they contain. Thus a figure of three sides is called a triangle, and a figure of four sides a quadrangle.

A pentagon is a polygon of five sides; a hexagon has six sides; a heptagon seven sides; an octagon eight sides; a nonagon nine sides; a decagon ten sides; an undecagon eleven sides; a duodecagon twelve sides. See PENTAGON, &c.

When they have a greater number of sides it is usual to call them polygons of 13 sides, of 14 sides, and so on.

Triangles are of different kinds, according to the lengths of their sides.

18. An equilateral triangle has all its sides equal, as ABC, fig. 4.

19. An isosceles triangle has two equal sides, as DEF, fig. 5.

20. A scalene triangle has all its sides unequal, as GHI, fig. 6.

Triangles are also denominated according to the angles they contain.

21. A right angled triangle is one that has in it a right-angle, as ABC, fig. 7.

22. A triangle cannot have more than one right angle. The side opposite to the right angle B, as AC, is called the hypothenuse, and is always the longest side.

23. An obtuse-angled triangle has one obtuse angle, as fig. 8.

24. An acute-angled triangle has all its angles acute, as fig. 4.

25. An isosceles, or a scalene triangle, may be either right angled, obtuse, or acute.

26. Any side of a triangle is said to subtend the angle opposite to it: thus AB (fig. 7) subtends the angle ACB.

27. If the side of a triangle be drawn out beyond the figure, as AD (fig. 8), the angle A, or CAB, is called an internal angle, and the angle CAD, or that without the figure, an external angle.

28. A quadrangle is also called a quadrilateral figure. They are of various denominations, as their sides are equal or unequal, or as all their angles are right-angles or not.

29. Every four-sided figure whose opposite sides are parallel, is called a parallelogram. Provided that the sides opposite to each other be parallel, it is immaterial whether the angles are right or not. Figs. 9, 10, 11, and 12, are all parallelograms.

30. When the angles of a parallelogram are all right angles, it is called a rectangular parallelogram, or a rectangle, as figs. 11 and 12.

31. A rectangle may have all its sides equal, or only the opposite sides equal. When all its sides are equal, it is called a square, as fig. 12.

32. When the opposite sides are parallel, and all the sides equal to each other, but the angles not right angles, the parallelogram is called a rhombus, as fig. 10.

33. A parallelogram having all its angles oblique, and only its opposite equal, is called a rhomboid, as fig. 9.

34. When a quadrilateral, or four-sided figure, has none of its sides parallel, it is called a trapezium, as fig. 13; consequently every quadrangle, or quadrilateral, which is not a parallelogram, is a trapezium.

35. A trapezoid has only one pair of its sides parallel, as fig. 14.

36. A diagonal is a right line drawn between any two angles that are opposite in a polygon, as IK, fig. 15. In parallelograms the diagonal is sometimes called the diameter, because it passes through the centre of the figure.

37. Complements of a parallelogram. If any point, as E (fig. 15), be taken in the diagonal of a parallelogram, and through that point two lines are drawn parallel to the sides, as AB, CD, it will be divided into four parallelograms, D, D, L, F, G, G. The two divisions, L, F, through which the diameter does not pass, are called the complements.

38. Base of a figure, is the side on which it

is supposed to stand erect, as AD and CD, fig. 16.

39. Altitude of a figure is its perpendicular height from the base to the highest part, as EF, fig. 16.

40. Area of a plane figure, or other surface, means the quantity of space contained within its boundaries, expressed in square feet, yards, or any other superficial measure.

41. Similar figures are such as have the same angles, and whose sides are in the same proportion, as fig. 17.

42. Equal figures are such as have the same area or contents.

43. A circle is a plane figure, bounded by a curve line returning into itself, called its circumference, ABCD (fig. 18), every where equally distant from a point E within the circle, which is called the centre.

44. The radius of a circle is a straight line drawn from the centre to the circumference, as EF (fig. 18). The radius is the opening of the compass when a circle is described; and consequently all the radii of a circle must be equal to each other.

45. A diameter of a circle is a straight line drawn from one side of the circumference to the other through the centre, as CB (fig. 18). Every diameter divides the circle into two equal parts.

46. A segment of a circle is a part of a circle cut off by a straight line drawn across it. This straight line is called the chord. A segment may be either equal to, greater, or less than, a semicircle, which is a segment formed by the diameter of the circle, as CEB, and is equal to half the circle.

47. A tangent is a straight line drawn so as just to touch a circle without cutting it, as GH (fig. 18). The point A, where it touches the circle, is called the point of contact. And a tangent cannot touch a circle in more points than one.

48. A sector of a circle is a space comprehended between two radii and an arc, as IK, fig. 19.

49. The circumference of every circle, whether great or small, is supposed to be divided into 360 equal parts, called degrees; and every degree into 60 parts, called minutes; and every minute into 60 seconds. To measure the inclination of lines to each other, or angles, a circle is described round the angular point as a centre, as IK, fig. 19; and according to the number of degrees, minutes, and seconds, cut off by the sides of the angle, so many degrees, minutes, and seconds, it is said to contain. Degrees are marked by °, minutes by ′, and seconds by ″; thus an angle of 48 degrees, 15 minutes, and 7 seconds, is written in this manner, 48° 15′ 7″.

50. A solid is any body that has length, breadth, and thickness: a book, for instance, is solid, so is a sheet of paper; for though its thickness is very small, yet it has some thickness. The boundaries of a solid are surfaces.

51. Similar solids are such as are bounded by an equal number of similar planes.

52. A prism is a solid, of which the sides are parallelograms, and the two ends or bases are similar polygons, parallel to each other. Prisms are denominated according to the number of angles in the base, triangular prisms, quadrangular, heptangular, and so on, as figs. 20, 21, 22, 23. If the sides are perpendicular to the plane of the base, it is called an upright prism; if they are inclined, it is called an oblique prism.

53. When the base of a prism is a parallelogram, it is called a parallelopipedon, as figs. 22 and 23. Hence a parallelopipedon is a solid terminated by six parallelograms.

54. When all the sides of a parallelopipedon are squares, the solid is called a cube, as fig. 23.

55. A rhomboid is an oblique prism, whose bases are parallelograms (fig. 24).

56. A pyramid (figs. 25 and 26) is a solid bounded by, or contained within, a number of planes, whose base may be any polygon, and whose faces are terminated in one point, B, commonly called the vertex of the pyramid.

57. When the figure of the base is a triangle, it is called a triangular pyramid; when the figure of the base is a quadrilateral, it is called a quadrilateral pyramid, &c.

58. A pyramid is either regular or irregular, according as the base is regular or irregular.

59. A pyramid is also right or upright, or it is oblique. It is right, when a line drawn from the vertex to the centre of the base, is perpendicular to it, as fig. 25; and oblique, when this line inclines, as fig. 26.

60. A cylinder is a solid (figs. 27 and 28), generated or formed by the rotation of a rectangle about one of its sides, supposed to be at rest: this quiescent side is called the axis of the cylinder. Or it may be conceived to be generated by the motion of a circle, in a direction perpendicular to its surface, and always parallel to itself.

61. A cylinder is either right or oblique, as the axis is perpendicular to the base or inclined.

62. Every section of a right cylinder taken at right angles to its axis, is a circle; and every section taken across the cylinder, but oblique to the axis, is an ellipsis.

63. A circle being a polygon of an infinite number of sides, it follows, that the cylinder may be conceived as a prism, having such a polygon for bases.

64. A cone is a solid (figs. 29 and 30), having a circle for its base, and its sides a convex surface, terminating in a point A, called the vertex, or apex of the cone. It may be conceived to be generated by the revolution of a right-angled triangle about its perpendicular.

65. A line drawn from the vertex to the centre of the base is the axis of the cone.

66. When this line is perpendicular to the base, the cone is called an upright, or right cone; but when it is inclined it is called an oblique cone.

67. If it be cut through the axis from the vertex to the base, the section will be a triangle.

68. If a right cone be cut by a plane at right angles to the axis, the section will be a circle.

69. If it be cut oblique to the axis, and quite across from one side to the other, the section will be an ellipsis, as fig. 31. A section of a cylinder made in the same manner is also an ellipsis; and that is easily conceived: but it does not appear so readily to most people, that the oblique section of a cone is an ellipsis: they frequently imagine that it will be wider at one end than the other, or what is called an oval, which is the shape of an egg. But that this is a mistake, any one may convince himself by making a cone, and cutting it across obliquely; it will be then seen that the section, in whatever direction it is taken, is a regular ellipsis; and this is the case, whether the cone be right or oblique, except only in one case in the oblique cone; which is when the section is taken in a particular direction, which is called subcontrary to its base.

70. When the section is made parallel to one of the sides of the cone, as fig. 32, the curve ABC, which bounds the section, is called a parabola.

71. When the section is taken parallel to the axis, as fig. 33, the curve is called an hyperbola.

These curves, which are formed by cutting a cone in different directions, have various properties, which are of great importance in astronomy, gunnery, perspective, and many other sciences.

72. A sphere is a solid, terminated by a convex surface, every point of which is at an equal distance from a point within, called the centre, fig. 34.

73. It may be conceived to be formed by making a semicircle revolve round its diameter. This may be illustrated by the process of forming a ball of clay by the potter's wheel, a semicircular mould being used for the purpose. The diameter of the semicircle round which it revolves, is called the axis of the sphere.

74. The ends of the axis are called poles.

75. Any line passing through the centre of the sphere, and terminated by the circumference, is a diameter of the sphere.

76. Every section of a sphere is a circle; every section taken through the centre of the sphere is called a great circle, as AB, fig. 34; every other is a lesser circle, as CD.

77. Any portion of a sphere cut off by a plane is called a segment; and when the plane passes through the centre, it divides the sphere into two equal parts, each of which is called a hemisphere.

78. A spheroid is a solid (fig. 35), generated by the rotation of a semi-ellipsis about the transverse or conjugate axis; and the centre of the ellipsis is the centre of the spheroid.

79. The line about which the ellipsis revolves is called the axis. If the spheroid be generated about the conjugate axis of the semi-ellipsis, it is called a prolate spheroid.

80. If the spheroid be generated by the semi-ellipsis by revolving about the transverse axis, it is called an oblong spheroid.

81. Every section of a spheroid is an ellipsis, except when it is perpendicular to that axis about which it is generated; in which case it is a circle.

82. All sections of a spheroid parallel to each other, are similar figures.

A frustum of a solid, means a piece cut off from the solid by a plane passed through it, usually parallel to the base of the solid, as the frustum of a cone, a pyramid, &c.

There are a lower and an upper frustum, according as the piece spoken of does or does not contain the base of the solid.

83. Ratio is the proportion which one magnitude bears to another of the same kind,

with respect to quantity, and is usually marked thus, A : B.

Of these the first is called the antecedent, and the second the consequent.

84. The measure or quantity of a ratio is conceived by considering what part of the consequent is the antecedent; consequently it is obtained by dividing the consequent by the antecedent.

85. Three magnitudes or quantities, A, B, C, are said to be proportional, when the ratio of the first to the second is the same as that of the second to the third. Thus 2, 4, 8, are proportional; because 4 is contained in 8 as many times as 2 is in 4.

86. Four quantities, A, B, C, D, are said to be proportional when the ratio of the first A to the second B is the same as the ratio of the third C to the fourth D. It is usually written A : B : : C : D, or, if expressed in numbers, 2 : 4 : : 8 : 16.

87. Of three proportional quantities, the middle one is said to be a mean proportional between the other two; and the last a third proportional to the first and second.

88. Of four proportional quantities, the last is said to be a fourth proportional to the other three, taken in order.

89. Ratio of equality is that which equal numbers bear to each other.

90. Inverse ratio is when the antecedent is made the consequent, and the consequent the antecedent. Thus, if 1 : 2 : : 3 : 6; then inversely, 2 : 1 : : 6 : 3.

91. Alternate proportion is when antecedent is compared with antecedent, and consequent with consequent. Thus, if 2 : 1 : : 6 : 3; then by alternation 2 : 6 : : 1 : 3.

92. Proportion by composition is when the antecedent and consequent, taken as one quantity, are compared either with the consequent or with the antecedent. Thus, if 2 : 1 : : 6 : 3; then by composition 2 + 1 : 1 : : 6 + 3 : 3: and 2 + 1 : 2 : 6 + 3 : 6.

93. Divided proportion is when the difference of the antecedent and consequent is compared either with the consequent or with the antecedent. Thus, if 3 : 1 : : 12 : 4; then, by division, 3 — 1 : 1 : : 12 — 4 : 4, and 3 — 1 : 3 : : 12 — 4 : 12.

94. Continued proportion is when the first is to the second as the second to the third; as the third to the fourth; as the fourth to the fifth; and so on.

95. Compound ratio is formed by the multiplication of several antecedents and the several consequents of ratios together, in the following manner:

If A be to B as 3 to 5, B to C as 5 to 8, and C to D as 8 to 6; then A will be D, as $\frac{3 \times 5 \times 8}{5 \times 8 \times 6} = \frac{120}{240} = \frac{1}{2}$; that is, A : D : : 1 : 2.

96. *Bisect* means to divide any thing into two equal parts.

97. *Trisect* is to divide any thing into three equal parts.

98. *Inscribe*, to draw one figure within another, so that all angles of the inner figure touch either the angles, sides, or planes, of the external figure.

99. *Circumscribe*, to draw a figure round another, so that either the angles, sides, or planes of the circumscribed figure, touch all the angles of the figure within it.

100. Rectangle under any two lines, means a rectangle which has two of its sides equal to one of the lines, and two of them equal to the other. Also the rectangle under AB, CD, means AB × CD.

101. Scales of equal parts. A scale of equal parts is only a straight line, divided into any number of equal parts at pleasure. Each part may represent any measure you please, as an inch, a foot, a yard, &c. One of these is generally subdivided into parts of the next denomination, or into tenths or hundredths. Scales may be constructed in a variety of ways. The most usual manner is to make an inch, or some aliquot part of an inch, to represent a foot; and then they are called inch scales, three-quarter-inch scales, half-inch scales, quarter-inch scales, &c. They are usually drawn upon ivory or boxwood. See INSTRUMENTS.

102. An axion is a manifest truth, not requiring any demonstration.

103. Postulates are things required to be granted true, before we proceed to demonstrate a proposition.

104. A proposition is when something is either proposed to be done, or to be demonstrated, and is either a problem or a theorem.

105. A problem is when something is proposed to be done, as some figure to be drawn,

106. A theorem is when something is proposed to be demonstrated or proved.

107. A lemma is when a premise is demonstrated, in order to render the thing in hand the more easy.

108. A corollary is an inference drawn from the demonstration of some proposition.

109. A scholium is when some remark or observation is made upon something mentioned before.

110. The sign = denotes that the quantities betwixt which it stands are equal.

111. The sign + denotes that the quantity after it, is to be added to that immediately before it.

112. The sign — denotes that the quantity after it is to be taken away, or subtracted from, the quantity preceding it.

GEOMETRICAL PROBLEMS.

Prob. 1. To divide a given line AB into two equal parts.

From the points A and B as centres, and with any opening of the compasses greater than half AB, describe arches, cutting each other in c and d. Draw the line c d; and the point E, where it cuts AB, will be the middle required.

Prob. 2. To raise a perpendicular to a given line AB, from a point given at C.

Case 1. When the given point is near the middle of the line on each side of the point C. Take any two equal distances, C d and C e; from d, and e, with any radius or opening of the compasses greater than C d, or C e, describe two arcs cutting each other in f. Lastly, through the points f, C, draw the line f C, and it will be the perpendicular required.

Case 2. When the point is at, or near, the end of the line. Take any point d, above the line, and with the radius or distance d C, describe the arc e C f, cutting AB in e and C. Through the centre d, and the point e, draw the line e d f, cutting the arc e C f in f. Through the points f, C, draw the line f C, and it will be the perpendicular required.

Prob. 3. From a given point f, to let fall a perpendicular upon a given line AB.

From the point f, with any radius, describe the arc d e, cutting AB in e and d. From the points e d, with the same or any other radius, describe two arcs, cutting each other in g. Through the points f and g, draw the line f g, and f C will be the perpendicular required.

Prob. 4. To make an angle equal to another angle which is given, as a Bb.

From the point B, with any radius, describe the arc a b, cutting the legs Ba, Bb, in the points a and b. Draw the line D e, and from the point D, with the same radius as before, describe the arc e f, cutting D e in e. Take the distance b a, and apply it to the arc e f, from e to f. Lastly, through the points D, f, draw the line D f, and the angle e D f will be equal to the angle b B a, as was required.

Prob. 5. To divide a given angle, ABC, into two equal angles.

From the point B, with any radius, describe the arc AC. From A and C with the same, or any other radius, describe arcs cutting each in d. Draw the line B d, and it will bisect the angle ABC, as was required.

Prob. 6. To lay down an angle of any number of degrees.

There are various methods of doing this. One is by the use of an instrument called a protractor, with a semicircle of brass, having its circumference divided into degrees. Let AB be a given line, and let it be required to draw from the angular point A, a line making with AB any number of degrees, suppose 20. Lay the straight side of the protractor along the line AB, and count 20° from the end B of the semicircle; at C, which is 20° from B, mark; then, removing the protractor, draw the line AC, which makes with AB the angle required. Or, it may be done by a divided line, usually drawn upon scales, called a line of chords. Take 60° from the line of chords in the compasses, and setting one at the angular point B, prob. 4, with that opening as a radius, describe an arch, as a b: then take the number of degrees you intend the angle to be of, and set it from b to a, then is a B b the angle required. See INSTRUMENTS.

Prob. 7. Through a given point C, to draw a line parallel to a given line AB.

Case 1. Take any point d, in AB; upon d and C, with the distance C d, describe two arcs, e C, and d f, cutting the line AB in e and d. Make d f equal to e C; through C and f draw C f, and it will be the line required.

Case 2. When the parallel is to be at a given distance from AB. From any two points, c and d, in the line AB, with a radius equal to the given distance, describe the arcs e and f: draw the line CB to touch those arcs without cutting them, and it will be parallel to AB, as was required.

Prob. 8. To divide a given line AB, into any proposed number of equal parts.

From A, one end of the line, draw A c, making any angle with AB; and from B, the other end, draw B d, making the angle ABd equal to BAc. In each of these lines, Ac, Bd, beginning at A and B, set off as many equal parts of any length as AB is to be divided into. Join the points C 5, 46, 57, and AB will be divided as required.

Prob. 9. To find the centre of a given circle, or of any one already described. Draw any chord, AB, and bisect it with the perpendicular CD. Bisect CD with the diameter

EF, and the intersection O will be the centre required.

Prob. 10. To draw a tangent to a given circle that shall pass through a given point, A.

From the centre O, draw the radius OA. Through the point A, draw DE perpendicular to OA, and it will be the tangent required.

Prob. 11. To draw a tangent to a circle, or any segment of a circle ABC, through a given point B, without making use of the centre of the circle.

Take any two equal divisions upon the circle from the given point B, towards d and e, and draw the chord eB. Upon B, as a centre, with the distance Bd, describe the arc fdg, cutting the chord eB in f. Make dg equal to df; through g draw gB, and it will be the tangent required.

Prob. 12. Given three points, A, B, C, not in a straight line, to describe a circle that shall pass through them.

Bisect the lines AB, BC, by the perpendiculars ad, bd, meeting at d. Upon d, with the distance dA, dB, describe ABC, and it will be the required circle.

Prob. 13. To describe the segment of a circle to any length AB, and height CD.

Bisect AB by the perpendicular Dg, cutting AB in c. From c make cD on the perpendicular equal to CD. Draw AD, and bisect it by a perpendicular ef, cutting Dg in g. Upon g the centre, describe ADB, and it will be the required segment.

Prob. 14. In any given triangle to inscribe a circle.

Bisect any two angles, A and C, with the lines AD and DC. From D the point of intersection, let fall the perpendicular DE; it will be the radius of the circle required.

Prob. 15. In a given square, to describe a regular octagon.

Draw the diagonals AC and BD, intersecting at e. Upon the points A, B, C, D, as centres, with a radius eC, describe the arcs ken, meg, fei, &c. Join fn, mb, ki, lg, and it will be the required octagon.

Prob. 16. In a given circle, to describe any regular polygon.

Divide the circumference into as many parts as there are sides in the polygon to be drawn, and join the points of division.

Prob. 17. Upon a given line AB, to construct an equilateral triangle.

Upon the points A, and B, with a radius equal to AB, describe arches cutting each other at C. Draw AC and BC, and ABC will be the triangle required.

Prob. 18. To make a trapezium equal and similar to a given trapezium ABCD.

Divide the given trapezium ABCD into two triangles by the diagonal DB. Make EF equal to AB; upon EF construct the triangle EFH, whose sides shall be respectively equal to those of the triangle ABD by the last problem. Upon HF, which is equal to DB, construct the triangle HFG, whose sides are respectively equal to DBC; then EFGH will be the trapezium required.

By the help of this problem any plan may be copied; as every figure, however irregular, may be divided into triangles. Upon this the practice of land-surveying and making plans of estates, is founded.

Prob. 19. To make a square equal to two given squares. Make the sides DE and DF of the two given squares A and B, form the sides of a right-angled triangle FDE; draw the hypothenuse FE; on it describe the square EFGH, and it will be the square required.

Prob. 20. Between two given lines, AB and CD, to find a mean proportional.

Draw the right line EG, in which make EF equal to AB, and FG equal to CD. Bisect EG in H, and with HE or HG, as radius, describe the semicircle EIG. From F draw FI perpendicular to EG, cutting the circle in I; and IF will be the mean proportional required.

GEOMETRY, *application of algebra to.* When a geometrical problem is proposed to be resolved by algebra, you are, in the first place, to describe a figure that shall represent, or exhibit, the several parts or conditions thereof, and look upon that figure as the true one; then, having considered attentively the nature of the problem, you are next to prepare the figure for a solution (if need be), by producing and drawing such lines therein as appear most conducive to that end. This done, let the unknown line or lines which you think will be the easiest found (whether required or not), together with the known ones (or as many of them as are requisite), be denoted by proper symbols; then proceed to the operation, by observing the relation that the several parts of the figure have to each other; in order to which a competent knowledge of the elements of geometry is absolutely necessary.

As no general rule can be given for the drawing of lines, and electing the most proper quantities to substitute for, so as to always bring out the most simple conclusions (because different problems require different methods of solution); the best way, therefore, to gain experience in this matter, is to attempt the solution of the same problem several ways, and then apply that which succeeds best to other cases of the same kind when they afterwards occur. We shall, however, subjoin a few general directions, which will be found of use.

1. In preparing the figure, by drawing lines, let them be either parallel or perpendicular to other lines in the figure, or so as to form similar triangles; and, if an angle be given, let the perpendicular be opposite to that angle, and also fall from the end of a given line, if possible.

2. In electing proper quantities to substitute for, let those be chosen (whether required or not) which lie nearest the known, or given parts of the figure, and by help whereof the next adjacent parts may be expressed, without the intervention of surds, by addition and subtraction only. Thus, if the problem were to find the perpendicular of a plane triangle, from the three sides given, it will be much better to substitute for one of the segments of the base than for the perpendicular, though the quantity required; because the whole base being given, the other segment will be given, or expressed, by subtraction only, and so the final equation comes out a single one; from whence the segments being known, the perpendicular is easily found by common arithmetic: whereas, if the perpendicular were to be first sought, both the segments would be surd quantities, and the final equation an unsightly quadratic one.

3. When, in any problem, there are two lines or quantities alike related to other parts of the figure, or problem, the best way is to make use of neither of them, but to substitute for their sum, their rectangle, or the sum of their alternate quotients, or for some line or lines in the figure, to which they have both the same relation.

4. If the area, or the perimeter, of a figure be given, or such parts thereof as have but a remote relation to the parts required, it will sometimes be of use to assume another figure similar to the proposed one, whereof one side is unity, or some other known quantity; from whence the other parts of this figure, by the known proportions of the homologous sides, or parts, may be found, and an equation obtained.

These are the most general observations, which we shall now proceed to illustrate by examples.

PROB. I. *The base (b), and the sum of the hypothenuse and perpendicular (a) of a right-angled triangle* ABC, *being given; to find the perpendicular.* See Fig. 36.

Let the perpendicular BC be denoted by x; then the hypothenuse AC will be expressed by $a - x$; but (by Euc. 47. 1.) $AB^2 + BC^2 = AC^2$; that is, $b^2 + x^2 = a^2 - 2ax + xx$; whence $x = \frac{a^2 - b^2}{2a}$ = the perpendicular required.

PROB. II. *The diagonal, and the perimeter of a rectangle,* ABCD, *being given; to find the sides.* See Fig. 37.

Put the diagonal $BD = a$, half the perimeter $(DA + AB) = b$, and $AB = x$; then will $AD = b - x$; and therefore, $AB^2 + AD^2$ being $= BD^2$, we have $x^2 + b^2 - 2bx + x^2 = b^2$; which, solved, gives $x = \frac{\sqrt{2a^2 - b^2} + b}{2}$.

PROB. III. *The area of a right-angled triangle* ABC, *and the sides of a rectangle* EBDF, *inscribed therein, being given; to determine the sides of the triangle.* See Fig. 38.

Put $DF = a$, $DE = b$, $BC = x$, and the measure of the given area $ABC = d$; then, by similar triangles, we shall have $x - b$ (CF) : a (DF) :: x (BC) : $AB = \frac{ax}{x - b}$. Therefore $\frac{ax}{a - b} \times \frac{x}{2} = d$, and consequently $ax^2 = 2dx - 2bd$, or $x^2 - \frac{2dx}{a} = -\frac{2bd}{a}$; which, solved, gives $x = \frac{d}{a} \pm \sqrt{\frac{dd}{aa} - \frac{2bd}{a}}$; from whence AB and AC will likewise be known.

PROB. IV. *Having the lengths of the three perpendiculars,* PF, PG, PH, *drawn from a certain point* P, *within an equilateral triangle* ABC, *to the three sides thereof; from thence to determine the sides.* See Fig. 39.

Let lines be drawn from P to the three angles of the triangle; and let CD be perpendicular to AB: call PF, a; PG, b; PH, c; and $AD = x$: then will AC $(= AB) = 2x$, and CD $(= \sqrt{AC^2 - AD^2}) = \sqrt{3xx} = x\sqrt{3}$; and consequently the area of the whole triangle ABC $(= CD \times AD) = xx\sqrt{3}$. But this triangle is composed of the three triangles APB, BPC, and APC; whereof the respective areas are ax, bx, and cx. Therefore we have $xx\sqrt{3} = ax + bx$

$+ cx$; and from thence, by division, $x = \frac{a+b+c}{\sqrt{3}}$.

PROB. V. *Having the area of a rectangle* DEFG, *inscribed in a given triangle* ABC; *to determine the sides of the rectangle.* See Fig. 40.

Let CI be perpendicular to AB, cutting DG in H; and let CI $= a$, AB $= b$, DG $= x$, and the given area $= cc$; then it will be, as $b : x :: a : \frac{ax}{b} =$ CH; which, taken from CI, leaves $a - \frac{ax}{b} =$ IH; and this, multiplied by x, gives $ax - \frac{ax^2}{b} = cc =$ the area of the rectangle; whence we have $abx - ax^2 = bcc$, $x^2 - bx = -\frac{bcc}{a}$, $x - \frac{b}{2} = \pm\sqrt{\frac{b^2}{4} - \frac{bcc}{a}}$, and $x = \frac{b}{2} \pm \sqrt{\frac{b^2}{4} - \frac{bcc}{a}}$.

PROB. VI. *Through a given point* P, *within a given circle, so to draw a right line, that the two parts thereof,* PR, PQ, *intercepted by that point and the circumference of the circle, may have a given difference.* See Fig. 41.

Let the diameter APB be drawn; and let AP and BP, the two parts thereof (which are supposed given) be denoted by a and b; making PR $= x$, and PQ $= x + d$ (d being the given difference). Then, by the nature of the circle, PQ $\times$ PR being $=$ PA $\times$ PB, we have $x + d \times x = ab$, or $xx + dx = ab$; whence x is found $= \sqrt{ab + \frac{1}{4}dd} - \frac{1}{2}d$.

PROB. VII. *From a given point* P, *without a given circle, so to draw a right line* PQ, *that the part thereof* RQ, *intercepted by the circle, shall be to the external part* PR, *in a given ratio.* See Fig. 42.

Through the centre O, draw PAB; put PA $= a$, PB $= b$, PR $= x$, and let the given ratio of PR to RQ be that of m to n; then it will be, as $m : n :: x : \frac{nx}{m} =$ RQ; therefore PQ $= x + \frac{nx}{m}$: but PR $\times$ PQ $=$ PA $\times$ PB, or $x \times x + \frac{nx}{m} = ab$; therefore $mx^2 + nx^2 = mab$, and $x = \sqrt{\frac{mab}{m+n}}$.

PROB. VIII. *The sum of the two sides of an isosceles triangle* ABC, *being equal to the sum of the base and perpendicular, and the area of the triangle being given; to determine the sides.* See Fig. 43.

Put the semi-base AD $= x$, the perpendicular CD $= y$, and the given area ABC $= a^2$; so shall $xy = a^2$, and $2\sqrt{xx + yy} = 2x + y$ (by El. 47. 1. and the conditions of the problem). Now, squaring both sides of the last equation, we have $4xx + 4yy = 4xx + 4xy + yy$; whence $3yy = 4xy$, and consequently $y = \frac{4x}{3}$; which value, substituted in the former equation, gives $\frac{4xx}{3} = a^2$; from whence $x = \sqrt{\frac{3a^2}{4}} = \frac{1}{2}a\sqrt{3}$; $y \left(= \frac{4x}{3}\right) = \frac{2}{3}a\sqrt{3}$; and AC $\left(= \sqrt{xx + yy} = \sqrt{\frac{3aa}{4} + \frac{4aa}{3}} = \sqrt{\frac{25aa}{12}}\right) = \frac{5}{2}a\sqrt{\frac{1}{3}} = \frac{5}{6}a\sqrt{3}$.

PROB. IX. *The segments of the base* AD *and* BD, *and the ratio of the sides* AC *and* BC *of any plane triangle* ABC, *being given; to find the sides.* See Fig. 44.

Put AD $= a$, BD $= b$, AC $= x$; and let the given ratio of AC to BC, be as m to n, so shall BC $= \frac{nx}{m}$. But AC^2 $-$ AD^2 $(=$ DC$^2)$ $=$ BC^2 $-$ BD^2, that is, in species, $x^2 - a^2 = \frac{nnxx}{mm} - b^2$. Hence we have $m^2x^2 - n^2x^2 = m^2 \times aa - bb$, and $x = m\sqrt{\frac{aa - bb}{mm - nn}}$.

GEOMETRY, *usefulness of.* The usefulness of this science extends to almost every art and science. It is by the help of it that astronomers turn their observations to advantage, regulate the duration of times, seasons, years, cycles, and epochas; and measure the distance, motions, and magnitudes, of the heavenly bodies. It is by it that geographers determine the figure and magnitude of the whole earth, and delineate the extent and bearings of kingdoms, provinces, harbours, &c. It is from this science too that architects derive their just measures, in the construction of public edifices as well as of private houses. It is by the assistance of geometry that engineers conduct all their works, take the situation and plans of towns, the distances of places, and the measure of such things as are only accessible to the sight. It is not only an introduction to fortification, but highly necessary to most mechanics, especially carpenters, joiners, mathematical-instrument-makers, and all who profess designing. On geometry likewise depends the theory of music, optics, perspective, drawing, mechanics, hydraulics, pneumatics, &c.

GEORGE, or *knights of St. George.* See GARTER.

Religious of the order of St. GEORGE, form several congregations in Italy and other places.

GEORGIC, a poetical composition upon the subject of husbandry. See POETRY.

GERANIUM, *crane's-bill*, a genus of the decandria order, in the monadelphia class of plants, and in the natural method ranking under the 14th order, gruinales. Its characters are these: the flower has a permanent empalement, composed of five small oval leaves, and five oval or heart-shaped petals, spreading open, which are in some species equal, and in others the upper two are much larger than the three lower. It has ten stamina, alternately longer than each other, but shorter than the petals, and terminated by oblong summits. In the bottom of the flower is situated a five-cornered germen, which is permanent. The flower is succeeded by five seeds, each being wrapped up in the husk of the beak, where they are twisted together at the point, so as to form the resemblance of a stork's beak. There are 32 species.

The common wild sorts of this plant, and those also which are brought to the curious from the colder climates, are hardy enough, and require little care; but the southern species require care in their culture and propagation, and in general the protection of a greenhouse in the winter. The erodium, and the pelargorium, or African geranium, are vulgarly called by the name of geraniums, and indeed resemble this genus in every thing but the number of the stamina. The erodium has five stamina, and the pelargorium seven.

GERARDIA, in botany, a genus of the didynamia angiospermia class of plants, the corolla of which consists of a single ringent petal; the tube is roundish, and longer than the cup; the upper lip is erect, obtuse, plain, and emarginated; the lower lip is reflected, and divided into three segments: the fruit is an oval capsule, containing two cells, and consisting of two valves; the seeds are oval and single. There are ten species, herbaceous plants of America and the Cape. One species is much recommended in gouty disorders.

GERMEN. See BOTANY.

GERMINATION, in botany. Natural historians have proved, by a very complete induction of facts, that all plants arise from seeds. The pretended exceptions have disappeared, one after another, as our knowledge of vegetables increased; and now there remains scarcely a single objection intitled to the smallest regard. The late attempt of Girtanner to revive the doctrine of equivocal generation deserves no attention whatever; because his conclusions are absolutely incompatible with the experiments of Mr. Sennebier upon the very substance on which his theory is founded.

A seed consists of three parts, namely, the cotyledons, the radicle, and the plumula, which are usually inclosed in a cover.

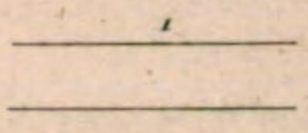
If we take a garden-bean, we may perceive each of these three parts with great ease; for this seed is of so large a size, that all its organs are exceedingly distinct. When we strip off the external coats of the bean, which are two, and of different degrees of thickness in different parts, we find that it easily divides into two lobes, pretty nearly of the same size and figure. Each of these lobes is called a cotyledon. The cotyledons of the bean, then, are two in number.

Near that part of the lobes which is contiguous to what is called the eye of the bean, there is a small round white body, which comes out between the two lobes. This body is called the radicle.

Attached to the radicle there is another small round body, which lies between the cotyledons, and wholly within them, so that it cannot be seen till they are separated from each other. This body is called the plumula.

The appearance and shape of these three parts differ very much in different seeds, but there is no seed which wants them. The figure and size of the seed depend chiefly upon the cotyledons. This is evidently the case with the bean, and it is so with all other seeds. The number of cotyledons is different in different seeds. Some seeds have only one cotyledon, as the seeds of wheat, oats, barley, and the whole tribe of grasses; some have three; others six, as the seeds of the garden-cress; but most seeds, like the bean, have two cotyledons.

When a seed is placed in a situation favourable to vegetation, it very soon changes its appearance. The radicle is converted into a root, and sinks into the earth; the plumula, on the other hand, rises above the earth, and becomes the trunk or stem. When these changes take place the seed is said to germi-



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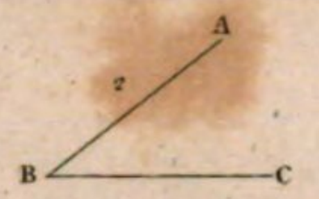

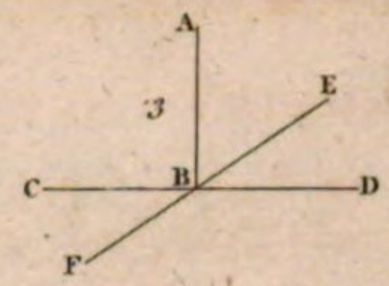

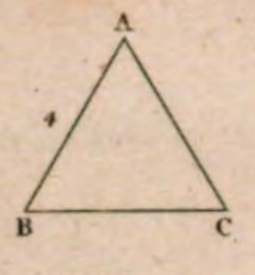

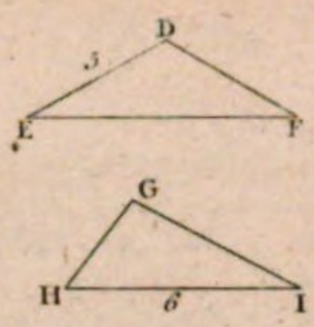

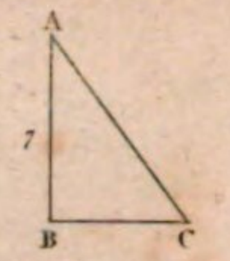

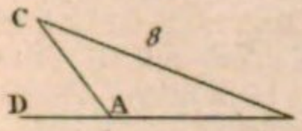

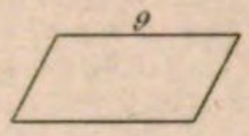
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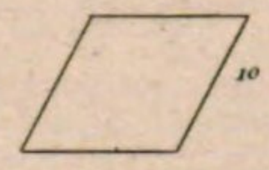
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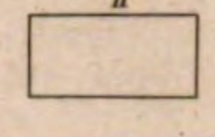
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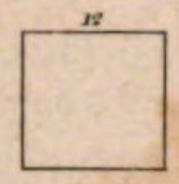
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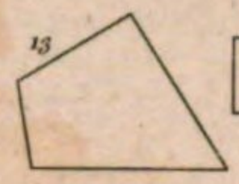
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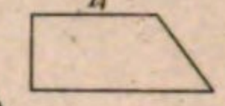
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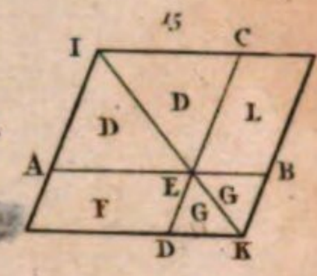

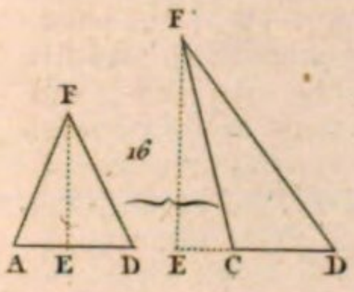

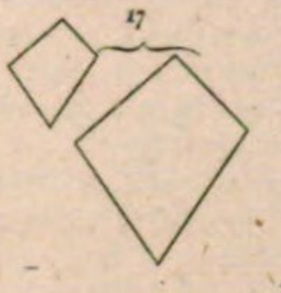
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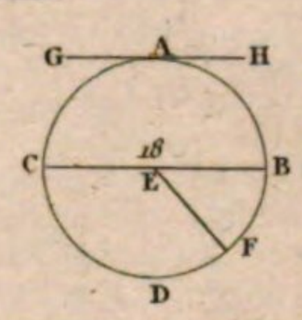

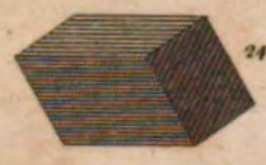
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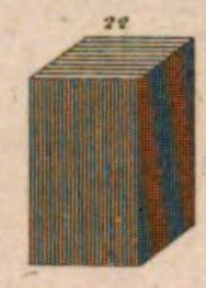
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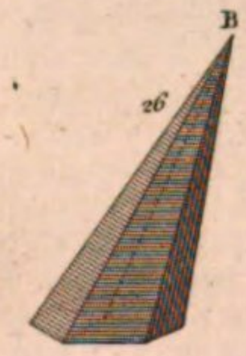
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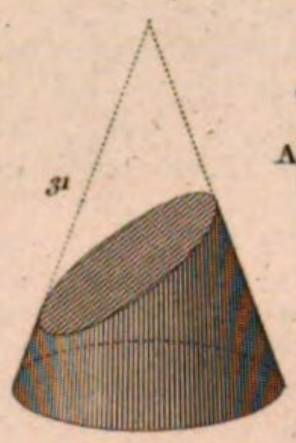
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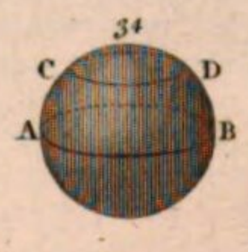
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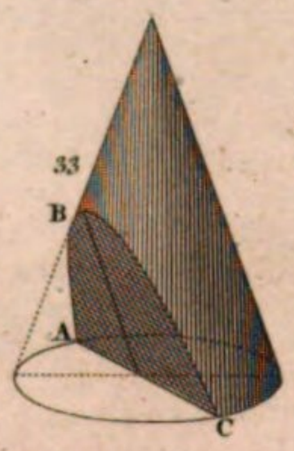
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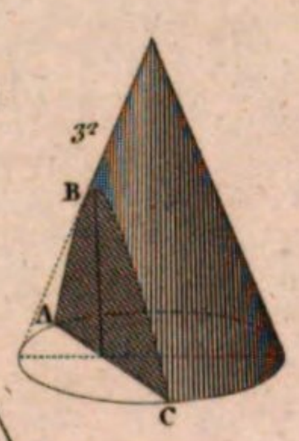
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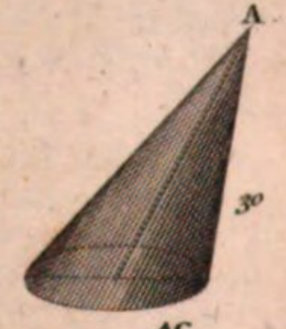
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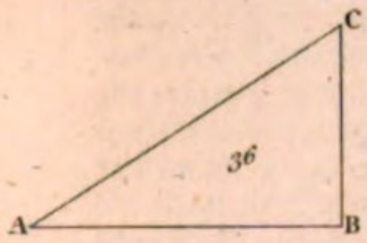
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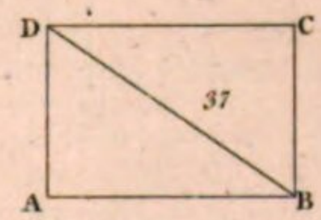
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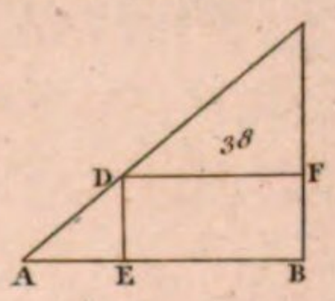

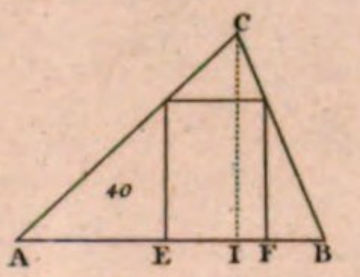

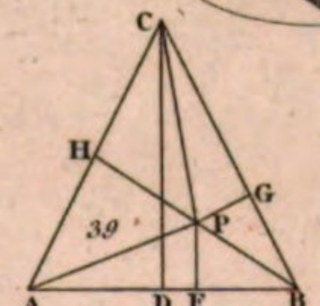

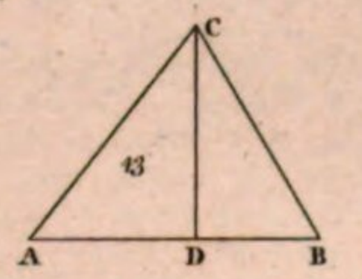

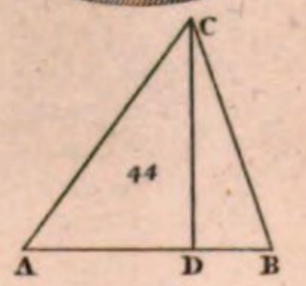

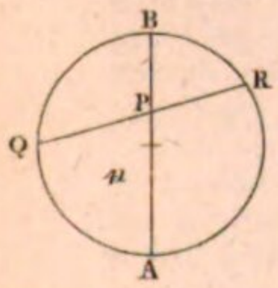

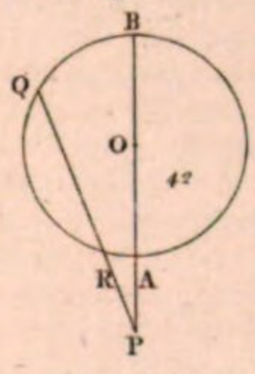

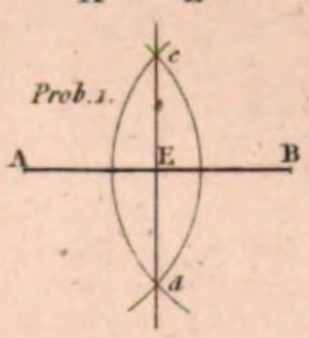

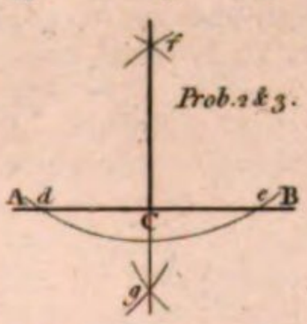

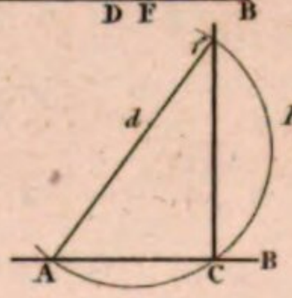

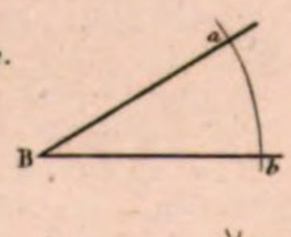

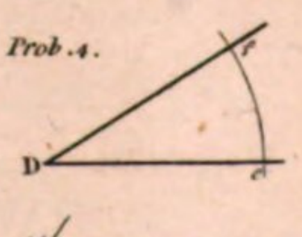

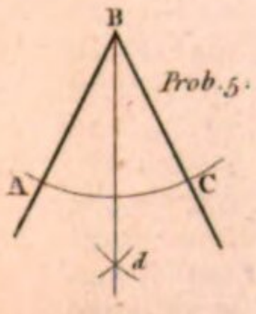

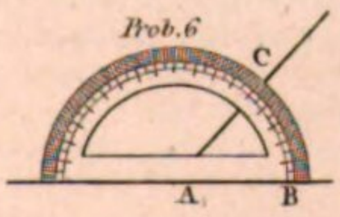

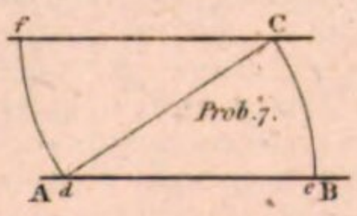

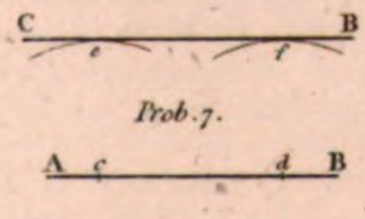

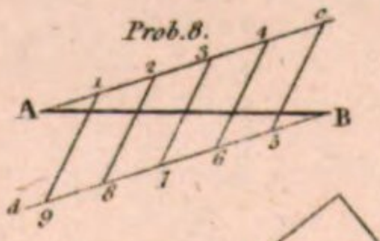

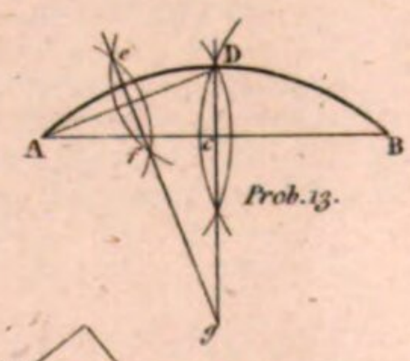

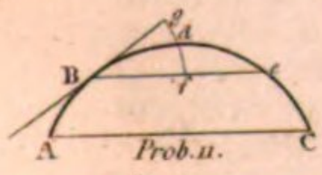

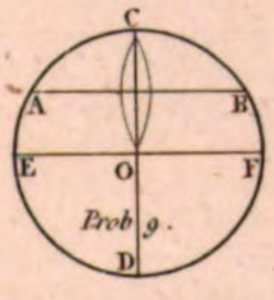

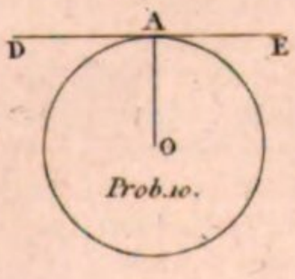

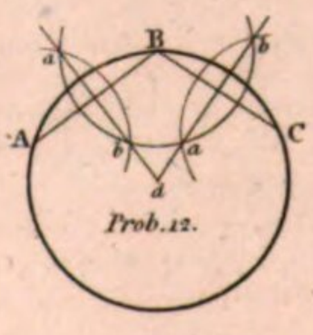

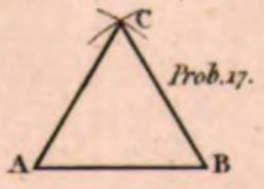

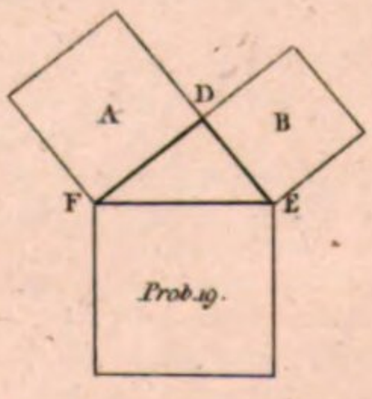

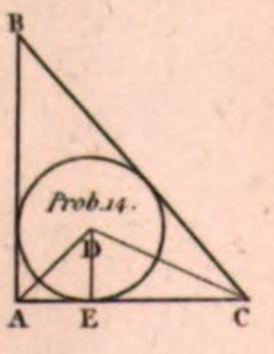

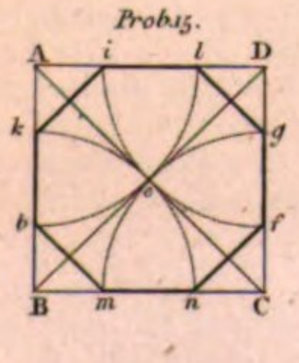

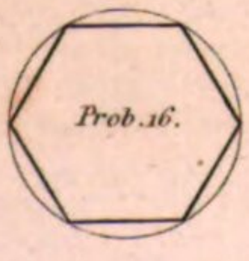

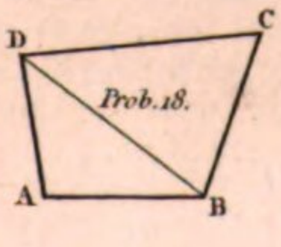

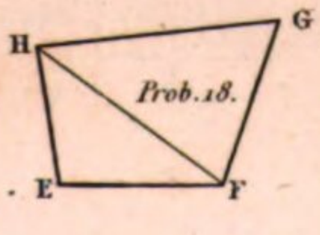

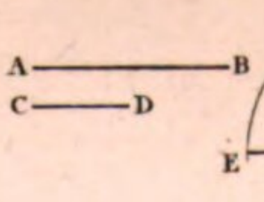

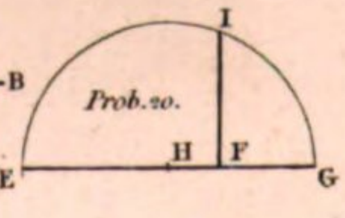

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Cooper Sculp.

nate: the process itself has been called germination. Seeds do not germinate equally and indifferently in all places and seasons. Germination, therefore, is a process which does not depend upon the seed alone: something external must also affect it.

It is a well-known fact, that seeds will not germinate without moisture; for seeds, if they are kept perfectly dry, never vegetate at all, and yet their power of vegetating is not destroyed. Water, then, is essential to germination. Too much water, however, is no less prejudicial to most seeds than none at all. The seeds of water-plants, indeed, germinate and vegetate extremely well in water; but most other seeds, if they are kept in water beyond a certain time, are rotted and destroyed altogether.

It is well known also, that seeds will not germinate, even though supplied with water, provided the temperature is below a certain degree. No seed, for instance, on which the experiment has been tried, can be made to vegetate at or below the freezing-point: yet this degree of cold does not injure the vegetating power of seeds; for many seeds will vegetate as well as ever after having been frozen, or after having been kept in frozen water. We may conclude, then, that a certain degree of heat is necessary for the germination of seeds. And every species of plants seems to have a degree peculiar to itself, at which its seeds begin to germinate; for every seed has a peculiar season at which it begins to germinate, and this season varies with the temperature of the air. Mr. Adanson found that seeds, when sown at the same time in France and in Senegal, always appeared sooner above ground in the latter country, where the climate is hotter, than in France.

Seeds, although supplied with moisture, and placed in a proper temperature, will not germinate, if atmospherical air is completely excluded from them. Mr. Ray found that grains of lettuce did not germinate in the vacuum of an air-pump, but they began to grow as soon as air was admitted to them. Homberg made a number of experiments on the same subject, which were published in the Memoirs of the French Academy for the year 1693. He found that the greater number of seeds which he tried refused to vegetate in the vacuum of an air-pump. Some, however, did germinate; but Boyle, Muschenbroek, and Boerhaave, who made experiments on the same subject in succession, proved beyond a doubt that no plant vegetates in the vacuum of an air-pump; and that in those cases in which Homberg's seeds germinated, the vacuum was far from perfect, a quantity of air still remaining in the receiver. It follows, therefore, that no seed will germinate unless atmospherical air, or some air having the same properties, has access to it. It is for this reason that seeds will not germinate at a certain depth below the surface of the earth.

Mr. Scheele found that beans would not germinate except oxygen gas was present. Mr. Achard afterwards proved that oxygen gas is absolutely necessary for the germination of all seeds, and that no seed will germinate in azotic gas, or hydrogen gas, or carbonic acid gas, unless these gases contain a mixture of oxygen gas. These experiments have been confirmed by Mr. Gough, Mr. Cruickshank, and many other philosophers. It follows, therefore, that it is not the whole atmospheric air, but merely the oxygen gas which it contains, that is necessary for the germination of seeds.

Nay, M. Humboldt has ascertained that seeds vegetate more rapidly when steeped in oxymuriatic acid, or when watered with it; and this acid is well known for the facility with which it parts with oxygen. This acid seems even to augment the vegetative power of seeds. At Vienna several seeds which had been long kept, and which had constantly refused to germinate, grew readily when treated with this acid.

Light also has considerable influence on the germination of seeds. Ingenhousz found that seeds always germinate faster in the dark than when exposed to the light. His experiments were repeated by Mr. Sennebier with equal success. But the abbé Bertholin, who distinguished himself so much by his labours to demonstrate the effect of electricity on vegetation, objected to the conclusions of these philosophers; and affirmed that the difference in the germination of seeds in the shade and in the light was owing, not to the light itself, but to the difference of the moisture in the two situations; the moisture evaporating much faster from the seeds in the light than from those in the shade; and he affirmed, that when precautions were taken to keep the seeds equally moist, those in the sun germinated sooner than those in the shade. But when Mr. Sennebier repeated his former experiments, and employed every possible precaution to ensure the equality of moisture in both situations, he constantly found the seeds in the shade germinate sooner than those in the light. We may conclude, therefore, that light is injurious to germination; and hence one reason for covering seeds with the soil in which they are to grow.

Thus we have seen that seeds will not germinate unless moisture, heat, and oxygen gas, are present; and that they do not germinate well if they are exposed to the action of light. Now, in what manner do these substances affect the seed? What are the changes which they produce?

It was observed before, that all seeds have one or more cotyledons. These cotyledons contain a quantity of farinaceous matter, laid up on purpose to supply the embryo plant with food as soon as it begins to require it. This food, however, must undergo some previous preparation before it can be applied by the plant to the formation or completion of its organs. Now all the phenomena of germination, which we can perceive, consist in the chemical changes which are produced in that food, and the consequent developement of the organs of the plant.

When a seed is placed in favourable circumstances, it gradually imbibes moisture, and very soon after emits a quantity of carbonic acid gas, even though no oxygen gas should be present. If no oxygen gas is present, the process stops here, and no germination takes place. But if oxygen gas is present, it is gradually absorbed by the seed; and at the same time the farina of the cotyledons assumes a sweet taste, resembling sugar: it is therefore converted into sugar, or some substance analogous to it. M. Saussure, jun. has ascertained that the quantity of oxygen gas absorbed during the germination is always proportional to the carbonic acid gas emitted; that is, the carbonic acid emitted contains in it precisely the same quantity of oxygen as has been absorbed. Hence it is evident that the farina is changed into sugar by diminishing its carbon, and of course by augmenting the proportion of its hydrogen and oxygen. This is precisely the process of malting, or of converting grain into malt; during which it is well known that there is a considerable heat evolved; so much indeed, that in certain circumstances grain improperly kept has even taken fire. We may conclude from this, that during the germination of seeds in the earth there is also an evolution of a considerable portion of heat. This indeed might have been expected, as it usually happens when oxygen gas is absorbed.

So far seems to be the work of chemistry alone, at least we have no right to conclude that any other agent interferes; since hay, when it happens to imbibe moisture, exhibits nearly the same processes. Carbonic acid gas is evolved, oxygen gas is absorbed, heat is produced so abundantly that the hay often takes fire: at the same time a quantity of sugar is formed. It is owing to a partial change of the same kind that old hay generally tastes much sweeter than new hay. Now we have no reason to suppose that any agents peculiar to the vegetable kingdom reside in hay: as all vegetation, and all power of vegetating, are evidently destroyed.

But when the farina in the seeds of vegetables is converted into sugar, a number of vessels make their appearance in the cotyledon. These vessels may indeed be detected in many seeds before germination commences; but they become much more distinct after it has made some progress. Branches from them have been demonstrated by Grew, Malpighi, and Hedwig, passing into the radicle, and distributed through every part of it. These evidently carry the nourishment prepared in the cotyledons to the radicle; for if the cotyledons are cut off, even after the processes above described are completed, germination, as Bonnet and Sennebier ascertained by experiment, immediately stops. The food therefore is conveyed from the cotyledons into the radicle; the radicle increases in size, assumes the form of a root, sinks down into the earth, and soon becomes capable of extracting the nourishment necessary for the future growth of the plant. Even at this period, after the radicle has become a perfect root, the plant, as Sennebier ascertained by experiment, ceases to vegetate if the cotyledons are cut off. They are still then absolutely necessary for the vegetation of the plant.

The cotyledons now assume the appearance of leaves, and appear above the ground, forming what are called the seminal leaves of the plant. After this the plumula gradually increases in size, rises out of the earth, and expands itself into branches and leaves. The seminal leaves, soon after this, decay and drop off; and the plant carries on all the processes of vegetation without their assistance.

Mr. Eller attempted to shew that there is a vessel in seeds which passes from the cotyledons to the plumula; but later anatomists have not been able to perceive any such vessel. Even Mr. Hedwig, one of the most patient, acute, and successful philosophers that

ever examined the structure of vegetables, could never discover any such vessel, although he traced the vessels of the cotyledons even through the radicle. As it does not appear, then, that there is any communication between the cotyledons and the plumula, it must follow that the nourishment passes into the plumula from the radicle: and accordingly we see that the plumula does not begin to vegetate till the radicle has made some progress. Since the plant ceases to vegetate, even after the radicle has been converted into a root, if the cotyledons are removed before the plumula is developed, it follows that the radicle is insufficient of itself to carry on the processes of vegetation, and that the cotyledons still continue to perform a part. Now we have seen already what that part is; they prepare food for the nourishment of the plant. The root, then, is of itself insufficient for this purpose. When the cotyledons assume the form of seminal leaves, it is evident that the nourishment, which was originally laid up in them for the support of the embryo plant, is exhausted, yet they still continue as necessary as ever. They must therefore receive the nourishment which is imbibed by the root; they must produce some changes on it, render it suitable for the purposes of vegetation, and then send it back again to be transmitted to the plumula.

After the plumula has acquired a certain size, which must be at least a line, if the cotyledons are cut off, the plant, as Mr. Bonnet ascertained by a number of experiments, afterwards repeated with equal success by Mr. Sennebier, does not cease to vegetate, but it continues always a mere pigmy: its size, when compared with that of a plant whose cotyledons are allowed to remain, being only as 2 to 7.

When the plumula has expanded completely into leaves, the cotyledons may be removed without injuring the plant, and they very soon decay of themselves. It appears, then, that this new office of the cotyledons is afterwards performed by that part of the plant which is above ground.

Thus we have traced the phenomena of germination as far as they have been detected. The facts are obvious; but the manner in which they are produced is a profound secret. We can neither explain how the food enters into the vessels, how it is conveyed to the different parts of the plant, how it is deposited in every organ, nor how it is employed to increase the size of the old parts, or to form new ones. These phenomena are analogous to nothing in mechanics or chemistry, but resemble exactly the organization and nourishment of animals. They belong therefore to that difficult branch of science known by the name of physiology.

GERUND, in grammar, a verbal noun of the neuter gender, partaking of the nature of a participle, declinable only in the singular number, through all the cases except the vocative: as, nom. *amandum*, gen. *amandi*, dat. *amando*, accus. *amandum*, abl. *amando*.

GEROPOGON, a genus of the syngenesia polygamia æqualis class and order. The calyx is simple; recept. with bristle-shaped chaffs; seeds of the disk with feathered down, of the ray with five awns. There are three species, all plants of Italy, having the same habit with the tragopogons.

GESNERIA, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is quinquefid, and placed on the germen; the corolla incurvated and then recurvated; the capsule inferior and bilocular. There are 12 species, herbs and shrubs of the West Indies.

GETHYLLIS, a genus of the monogynia order, in the dodecandria class of plants, and in the natural method ranking under the 9th order, spathaceæ. The corolla is six-cleft, and the stamina are in six different directions; the capsule is trilocular. There are four species, herbs of the Cape.

GEUM, *avens*, or *herb-bennet*, a genus of the polygamia order, in the icosandria class of plants, and in the natural method ranking under the 35th order, senticosæ. The calyx is cleft into ten parts; there are five petals, and each of the seeds has a jointed awn. There are nine species; of which the most remarkable are,

1. The urbanum, with thick fibrous roots, of an aromatic taste: rough, serrated leaves; and upright, round, hairy stalks, terminated by large yellow flowers, succeeded by globular fruit.

2. The rivale, with a very thick, fleshy, and fibrous root, hairy leaves, and upright stalks 10 or 12 inches high, terminated by purple flowers nodding on one side. Of this there are varieties with red and with yellow flowers. Both these are natives of Britain, and are easily propagated either by the root or seed. The roots of the first, gathered in the spring before the stem comes up, and infused in ale, give it a pleasant flavour, and prevent its growing sour: infused in wine they have a stomachic virtue. The taste is mildly austere and aromatic, especially when the plant grows in warm dry situations; but in moist shady places it has little virtue. Cows, goats, sheep, and swine, eat the plant; horses are not fond of it. The powdered root of the second species will cure tertian agues, and is daily used for that purpose by the Canadians. Sheep and goats eat the plant; cows, horses, and swine, are not fond of it.

GHINIA, a genus of the diandria monogynia class and order. The calyx is five-toothed and acuminate; cor. two-lipped; stam. four, with two barren anthers at the shorter filaments; per. a drupe, containing a four or five-celled nut, with a seed in each cell. There are two species, annuals of the West Indies.

GIANT'S-CAUSEWAY, a vast collection of basaltic pillars in the county of Antrim in Ireland. (See BASALTES.) The principal or grand causeway (for there are several less considerable and scattered fragments) consists of a most irregular arrangement of many hundred thousands of columns: almost all of them are of a pentagonal figure, but so closely and compactly situated on their sides, though perfectly distinct from top to bottom, that scarcely any thing can be introduced between them. The columns are of an unequal height and breadth; some of the highest, visible above the surface of the strand, and at the foot of the impending angular precipice, perhaps about 20 feet, they do not exceed this height, at least none of the principal arrangement. How deep they are fixed in the strand was never yet discovered. This grand arrangement extends nearly 200 yards, visible at low water; how far beyond is uncertain: from its declining appearance, however, at low water, it is probable it does not extend under water to a distance any thing equal to what is seen above. The breadth of the principal causeway which runs out in one continued range of columns, is, in general, from 20 to 30 feet; at one place or two it may be nearly 40 for a few yards. In this account are excluded the broken and scattered pieces of the same kind of construction, that are detached from the sides of the grand causeway, as they do not appear to have ever been contiguous to the principal arrangement, though they have frequently been taken into the width; which has been the cause of such wild and dissimilar representations of this causeway, which different accounts have exhibited. The highest part of this causeway is the narrowest, at the very spot of the impending cliff whence the whole projects, where, for four or five yards, it is not above ten or fifteen wide. The columns of this narrow part incline from a perpendicular a little to the westward, and form a slope on their tops, by the unequal height of the columns on the two sides; by which an ascent is made at the foot of the cliff, from the head of one column to the next above, gradatim, to the top of the great causeway, which, at the distance of half a dozen yards from the cliff, obtains a perpendicular position, and, lowering in its general height, widens to about 20, or between 20 and 30 feet, and for 100 yards nearly is always above water. The tops of the columns for this length being nearly of an equal height, they form a grand and singular parade that may be easily walked on, rather inclining to the water's edge. But from high-water mark, as it is perpetually washed by the beating surges on every return of the tide, the platform lowers considerably, and becomes more and more uneven, so as not to be walked on but with the greatest care. At the distance of 150 yards from the cliff, it turns a little to the east for 20 or 30 yards, and then sinks into the sea. The figure of these columns is almost unexceptionably pentagonal, or composed of five sides; there are but very few of any other figure introduced: some few there are of three, four, and six sides, but the generality of them are five-sided, and the spectator must look very nicely to find any of a different construction: yet what is very extraordinary, and particularly curious, there are not two columns in ten thousand to be found, that either have their sides equal among themselves, or whose figures are alike. Nor is the composition of these columns or pillars less deserving the attention of the curious spectator. They are not of one solid stone in an upright position, but composed of several short lengths, curiously joined, not with flat surfaces, but articulated into each other like a ball and socket, or like the joints in the vertebræ of some of the larger kind of fish, the one end at the joint having a cavity into which the convex end of the opposite is exactly fitted. This is not visible but by disjoining the two stones. The depth of the concavity or convexity is generally about two or three inches. And what is still farther remarkable of the joint, the convexity, and the correspondent concavity, are not conformed to the external angular figure of the column, but exactly round, and as large as the size or diameter of the co-

lumn will admit; and consequently as the angles of these columns are in general extremely unequal, the circular edges of the joint are seldom coincident with more than two or three sides of the pentagonal, and from the edge of the circular part of the joint to the exterior sides and angles they are quite plain. It is still farther very remarkable likewise, that the articulations of these joints are frequently inverted; in some the concavity is upwards, in others the reverse. This occasions that variety and mixture of concavities and convexities on the tops of the columns, which is observable throughout the platform of this causeway, yet without any discoverable design or regularity with respect to the number of either. The length also of these particular stones, from joint to joint, is various: in general they are from 18 to 24 inches long; and, for the most part, longer towards the bottom of the columns than nearer the top, and the articulation of the joints something deeper. The size or diameter likewise of the columns is as different as their length and figure; in general they are from 15 to 20 inches in diameter. There are no traces of uniformity or design discovered throughout the whole combination, except in the form of the joint, which is invariably by an articulation of the convex into the concave of the piece next above or below it; nor are there any traces of a finishing in any part, either in height, length, or breadth, of this curious causeway. If there is here and there a smooth top to any of the columns above water, there are others just by, of equal height, that are more or less convex or concave, which show them to have been joined to pieces that have been washed, or by other means taken off. And undoubtedly those parts that are always above water have, from time to time, been made as even as might be; and the remaining surfaces of the joints must naturally have been worn smoother by the constant friction of weather and walking, than where the sea, at every tide, is beating upon it, and continually removing some of the upper stones, and exposing fresh joints. And farther, as these columns preserve their diameters from top to bottom, in all the exterior ones, which have two or three sides exposed to view, the same may with reason be inferred of the interior columns whose tops only are visible. Yet, what is very extraordinary and equally curious in this phenomenon is, that notwithstanding the universal dissimilitude of the columns, both as to their figure and diameter, and though perfectly distinct from top to bottom, yet is the whole arrangement so closely combined at all points, that hardly a knife can be introduced between them either upon the sides or angles. And it is a most curious entertainment to examine the close contexture and nice insertion of such an infinite variety of angular figures as are exhibited on the surface of this grand parade. From the infinite dissimilarity of the figure of these columns, this will appear a most surprising circumstance to the curious spectator; and would incline him to believe it a work of human art, was it not, on the other hand, inconceivable that the genius or invention of man should construct and combine such an infinite number of columns, which should have a general apparent likeness, and yet be so universally dissimilar in their figure, as that, from the minutest examination, not two in ten or twenty thousand should be found whose angles and sides are equal among themselves, or of the one column to those of the other. That it is the work of nature there can be no doubt to an attentive spectator, who carefully surveys the general form and situation, with the infinitely various configuration of the several parts of this causeway. There are no traces of regularity or design in the outlines of this curious phenomenon; which, including the broken and detached pieces of the same kind of workmanship, are extremely scattered and confused; and, whatever they might be originally, do not at present appear to have any connection with the grand or principal causeway, as to any supposable design or use in its first construction, and as little design can be inferred from the figure or situation of the several constituent parts. The whole exhibition is, indeed, extremely confused, ununiform, and destitute of every appearance of use or design in its original construction. But what, beyond dispute, determines its original to have been from nature is, that the very cliffs, at a great distance from the causeway, especially in the bay to the eastward, exhibit at many places the same kind of columns, figured and jointed in all respects like those of the grand causeway: some of them are seen near to the top of the cliff, which, in general, in these bays to the east and west of the causeway, is near 300 feet in height; others again are seen about midway, and at different elevations from the strand. A very considerable exposure of them is seen in the very bottom of the bay to the eastward, near 100 roods from the causeway, where the earth has evidently fallen away from them upon the strand, and exhibits a most curious arrangement of many of these pentagonal columns, in a perpendicular position, supporting, in appearance, a cliff of different strata of earth, clay, rock, &c. to the height of 150 feet or more, above. Some of these columns are between 30 and 40 feet high, from the top of the sloping bank below them; and being longest in the middle of the arrangement, shortening on either hand in view, they have obtained the appellation of organs, from a rude likeness in this particular to the exterior or frontal tubes of that instrument; and as there are few broken pieces on the strand near it, it is probable that the outside range of columns that now appears is really the original exterior line, toward the sea, of this collection. But how far they extend internally into the bowels of the incumbent cliff is unknown. The very substance, indeed, of that part of the cliff which projects to a point, between the two bays on the east and west of the causeway, seems composed of this kind of materials; for, besides the many pieces that are seen on the sides of the cliff that circulate to the bottom of the bays, particularly the eastern side, there is, at the very point of the cliff, and just above the narrow and highest part of the causeway, a long collection of them seen, whose heads or tops just appearing without the sloping bank, plainly show them to be in an oblique position, and about half-way between the perpendicular and horizontal. The heads of these, likewise, are of mixed surfaces, convex and concave, and the columns evidently appear to have been removed from their original upright, to their present inclining or obiique position, by the sinking or falling of the cliff.

GIBBOUS, in astronomy, a term used in reference to the enlightened parts of the moon, whilst she is moving from the first quarter to the full, and from the full to the last quarter: for all that time the dark part appears horned or falcated, and the light one convex or gibbous.

GIBELINS, or GIBELLINS, a famous faction in Italy, opposite to another, called the Guelphs.

These two factions ravaged and laid waste Italy for a long series of years, so that the history of that country, for the space of two centuries, is no more than a detail of their mutual violences and slaughters. The Gibelins adhered to the emperor against the pope: but concerning their origin, and the reason of their names, we have but a very obscure account. According to the generality of authors, they rose about the year 1240, upon the emperor Frederic II.'s being excommunicated by pope Gregory IX. Other writers maintain, that the two factions arose ten years before, though still under the same pope and emperor. But the most probable opinion is that of Maimbourg, who says, that the two factions of Guelphs and Gibelins arose from a quarrel between two antient and illustrious houses on the confines of Germany, that of the Henries of Gibeling, and that of the Guelphs of Adorf.

GIFT, a transferring the property in a thing from one to another without a valuable consideration; for to transfer any thing upon a valuable consideration is a contract or sale: he who gives any thing is called the donor; and he to whom it is given is called the donee.

By the common law all chattels, real or personal, may be granted or given, without deed, except in some special cases; and a free gift is good without a consideration, if not to defraud creditors. Park. 57.

But no leases, estates, or interests, either of freehold, or term of years, or any uncertain interest, not being copyhold or customary interest, of, in, to, or out of, any messuage, manors, lands, tenements, or hereditaments, shall at any time be assigned, granted, or surrendered, unless it is by deed or act in writing, signed by the party so assigning, granting, or surrendering the same, or their agents thereunto lawfully authorised by writing, or by act and operation of law. 29 Car. II. c. 3.

A gift of any thing without a consideration, is good: but it is revocable before delivery to the donee, of the thing given. Jenk. 109 pl. 9.

GILBERTINES, a religious order founded in England by St. Gilbert, in the reign of Henry I. The nuns followed the rule of St. Benedict, and the monks that of St. Augustin. There were many monasteries of this order in different parts of England.

GILD. See GELD.

GILD MERCHANT, was a certain privilege or liberty granted to merchants, whereby they were enabled, among other things, to hold certain pleas of land within their own precincts; as the gild-merchant granted by king John to the burgesses of Nottingham.

GILDING, is the application of gold to the surfaces of bodies: it is of two principal kinds, according to the method of applying the gold.

Wood, leather, paper, and similar substances, are gilt by fastening on leaves of gold by means of some cement. But metals are gilt by a chemical application of the gold to the surface. This last is called water-gilding.

The gilding of wood, and similar substances, is of three kinds: oil-gilding, burnished gilding, and japanners' gilding, which we shall severally describe, after noticing the materials and tools necessary for the operations.

Of gold-leaf.—There are three kinds of gold-leaf in common use. Pure gold-leaf, which is made by hammering gold till it is sufficiently thin (see GOLD-BEATING). Pale leaf-gold, which has a greenish colour, and is made in the same way of gold alloyed with silver. Dutch gold, which is brought from Holland, and is in fact only copper-leaf coloured by the fumes of zinc. It is much cheaper than true leaf-gold, and is very useful where large quantities of gilding are wanted, which can be defended from the weather, and where great nicety is not required; but it changes its colour entirely when exposed to moisture; and indeed, in all cases, its beauty is soon impaired, unless well secured by varnish. It is therefore only a cheap substitute for true gold-leaf, which may be useful where durability is not an object.

Of the instruments necessary for gilding.—The first instrument is the cushion, for receiving the leaves of gold from the books in which they are bought. It is made by covering a board of about eight inches square, with a double thickness of flannel: and over that a piece of buff leather, and fastening it tight round the edges.

The knife for cutting the leaves into the requisite sizes should be made like a pallet-knife, and should not have its edge too sharp.

The tip is a tool made by fastening the long hairs of a squirrel's tail between two cards; and is used for taking up the gold-leaf after it is cut, and applying it to the article to be gilded.

A fitch pencil is used for the same purpose as the last, in taking up very small bits of gold-leaf. A ball of cotton is necessary for pressing down the leaf, after it is laid on. A large camel's-hair brush is used for dusting the work, and clearing away the superfluous gold.

Oil-gilding.—First prime your work with boiled linseed-oil and white-lead; and when that is dry, cover it over with a thin coat of gold size, made of stone-ochre ground in fat oil. When that is so dry as to feel clammy to the fingers, or to be what the gilders call tacky, it is fit for gilding. Having spread your leaves upon the cushion, cut them into slips of the proper width for covering your work. Then breathe upon your tip, which, by moistening it, will cause it to take up the leaves from the cushion. Having applied them by the tip on the proper parts of your work, press them down by the ball of cotton. Observe to repair, by putting small pieces of gold on, any parts which you have omitted to cover. When all your work is sufficiently covered, let it dry, and clean it off with the brush.

This sort of gilding is the easiest, least expensive, and stands the weather best, and may be cleaned with a little water at any time; but wants the lustre of burnished gilding.

Burnished gilding.—This is the sort of gilding generally used for picture-frames, looking-glasses, &c.

The wood intended to be gilt in this manner, should first be well sized, and then covered with seven or eight coats of size and whiting, so as to form a body of considerable thickness. Having got a sufficient quantity of whiting upon the work, it must be carefully cleaned, taking care to free all the cavities and hollows from the whiting that may have choked them up, and by proper moulds and tools restoring the sharpness of the mouldings intended to be shewn.

It is then to receive a coat of size, which is made by boiling armenian bole with parchment size. This must also remain till it is sufficiently dry for gold. It must not be quite dry, therefore it would not be prudent to lay on more at a time than can be gilt before it becomes too dry.

The work being thus prepared, place it a little declining from you; and having ready a cup of clean water, and some hair-pencils, moisten a part of the work, and then apply the gold by the tip to the moistened part. The gold will immediately adhere close to the work: proceed to wet the next part, and apply the gold as before, repeating this operation till the whole is completed; taking care not to let any drops of water come upon any part of the gold already laid on. Care should therefore be taken that no part be missed in going over it at first, as it is not so easily mended as the oil-gilding.

The work being thus gilt, it is suffered to remain about 24 hours; when the parts that are designed to be burnished, are polished with a dog's tooth, or, what is better, with an agate burnisher. The gilding must not be quite dry when burnished; there is a state proper for the purpose, which is only to be known by experience.

Japanners' gilding.—The gilding of japanned work consists in drawing with a hair-pencil, in gold size, the intended ornaments, and afterwards applying gold-leaf, or gold powder.

The gold size may be prepared in the following manner: Take of linseed-oil, and of gum animi, four ounces. Set the oil to boil in a proper vessel, and then add the gum animi gradually in powder, stirring each quantity about in the oil till it appears to be dissolved, and then putting in another, till the whole is mixed with the oil. Let the mixture continue to boil, till, on taking a small quantity out, it appears of a thicker consistence than tar, and then strain the whole through a coarse cloth, and keep it for use; but it must, when applied, be mixed with vermilion and oil of turpentine.

Having laid on the gold size, and suffered it to dry, the gold-leaf is applied in the usual way; or if it is not wanted to shine so much, gold powder is applied, which is made by grinding gold-leaf upon a stone with honey, and afterwards washing the honey away with water. If the gilding is to be varnished over, Dutch gold may be used, or aurum musivum may be used instead of real gold powder.

To write on paper with letters of gold.—Put some gum arabic into common writing-ink, and write with it in the usual way. When the writing is dry, breathe on it; the warmth and moisture soften the gum, and will cause it to fasten on the gold-leaf; which may be laid on in the usual way, and the superfluous part brushed off. Or instead of this, any japanners' size may be used.

To lay gold upon white earthenware, or glass.—Procure some japanners' gold size, and with it draw your design upon the vessel to be gilt, moistening the gold size, as you find necessary, with oil of turpentine. Set your work in a clean place to dry, for about an hour, and then place it so near the fire, that you could but just bear the heat of it with your hand for a few seconds. Let it remain there till it feels quite tacky or clammy; then, having procured a cushion, and some leaf-gold, cut it into slips of the proper size, and lay it on with the little cotton ball. When the gold is all on, put the ware into an oven to be baked for two or three hours.

Glasses, &c. may also be gilt, by drawing the figures with shell gold mixed with gum arabic, and a little borax. Then apply sufficient heat to it; and, lastly, burnish it.

Gilding on glass or porcelain, by burning in.—Dissolve gold in aqua regia, and evaporate the acid by heat, you will obtain a gold powder; or precipitate the gold from the solution by pieces of copper. Lay this gold on with a strong solution of borax and gum water, and it will be ready for burning-in.

Gilding metals.—One method of applying gold upon metals is by first cleaning the metal to be gilt; then gold-leaf is laid on it, which, by means of rubbing with a polished blood-stone, and a certain degree of heat, are made to adhere perfectly well. In this manner silver-leaf is fixed and burnished upon brass, in the making of what is called French plate; and sometimes also gold-leaf is burnished upon copper and iron.

Gilding by amalgamation. A better method is, by previously forming the gold into paste, or amalgam, with mercury.

In order to obtain an amalgam of gold and mercury, the gold is first to be reduced into thin plates or grains, which are heated red-hot, and thrown into mercury previously heated, till it begins to smoke. Upon stirring the mercury with an iron rod, the gold totally disappears. The proportion of mercury to gold is generally as six or eight to one.

The method of gilding by amalgamation is chiefly used for gilding copper, or an alloy of copper, with a small portion of zinc, which more readily receives the amalgam, and is also preferable on account of its colour, which more resembles that of gold than the colour of copper.

When the metal to be gilt is wrought or chased, it ought to be previously covered with quicksilver before the amalgam is applied, that this may be easier spread; but when the surface of the metal is plane, the amalgam may be directly applied to it.

The metal required to be gilt is first rubbed over with a little aquafortis, by which the surfaces cleaned from any rust or tarnish that might prevent the union of the two metals. The amalgam being then equally spread over the surface by means of a brush, the mercury is evaporated by a heat just sufficient for that purpose; for if it is too great, part of the gold may also be expelled, and part of it will run together, and leave some of the sur-

face of the metal bare. While the mercury is evaporating the piece is to be, from time to time, taken from the fire, that it may be examined; that the amalgam may be spread more equally by means of a brush; that any defective parts of it may be again covered, and that the heat may not be too suddenly applied to it. When the mercury is evaporated, which is known by the surface becoming entirely of a dull-yellow colour, the metal must then undergo other operations, by which the fine gold-colour is given to it.

First, the gilded piece of metal is rubbed with a scratch-brush (which is a brush composed of brass wire) till its surface is made smooth; then it is covered over with a composition called gilding-wax, and is again exposed to the fire till the wax is burnt off. This wax is composed of bee's-wax, frequently mixed with some of the following substances: red ochre, verdigris, copper scales, alum, vitriol, borax; but, according to Dr. Lewis, the saline substances are sufficient, without any wax.

By this operation the colour of the gilding is heightened; and the effect seems to be produced by a perfect dissipation of some mercury remaining after the former operation.

The gilt surface is then covered over with a saline composition, consisting of nitre, alum, or vitriolic salt, ground together, and mixed up into a paste with water or urine. The piece of metal thus covered is exposed to a certain degree of heat, and then quenched in water. By this method its colour is further improved, and brought nearer to that of gold. This effect seems to be produced by the acid of the nitre (which is disengaged by the sulphuric acid of the alum, during the exposure to heat) acting upon any particles of copper which may happen to lie upon the gilded surface.

Lastly. Some artists think that they give an additional lustre to their gilt work, by dipping it in a liquor prepared by boiling some yellow materials, as sulphur, orpiment, or turmeric. The only advantage of this operation is, that part of the yellow matter remains in some of the hollows of the carved work, in which the gilding is apt to be more imperfect, and to which it gives a rich and solid appearance.

It may here be noticed, that the use of the aquafortis or nitric acid, mentioned in the beginning of the process, is not, as is generally supposed, confined merely to cleansing the surface of the metal to be gilt from rust or tarnish; but it also greatly facilitates the application of the amalgam to the surface of that metal, probably in the following manner: It first dissolves part of the mercury of the amalgam; and when the solution is applied to the copper, this latter metal, having a stronger disposition to unite with the nitrous acid than the mercury has, precipitates the mercury upon its surface, in the same manner as a polished piece of iron precipitates upon its surface copper from a solution of blue vitriol. When the metal to be gilt is thus covered with a thin coat of precipitated mercury, it readily receives the amalgam.

On the subject of gilding by amalgamation, Dr. Lewis has the following remarks: "There are two principal inconveniences in this business; one, that the workmen are exposed to the fumes of the mercury, and generally, sooner or later, have their health greatly impaired by them; the other, the loss of the mercury; for though part of it is said to be detained in the cavities made in the chimneys for that purpose, yet the greatest part of it is lost. From some trials I have made, it appeared that both these inconveniences, particularly the first and most considerable one, might be in a good measure avoided, by means of a furnace of a due construction."

If the communication of a furnace with its chimney, instead of being over the fire, is made under the grate, the ash-pit door, or other apertures beneath the grate, closed, and the mouth of the furnace left open, the current of air, which otherwise would have entered beneath, enters now at the top, and passing down through the grate to the chimney, carries with it completely both the vapour of the fuel, and the fumes of such matters as are placed upon it. The back part of the furnace should be raised a little higher above the fire than the fore part, and an iron plate laid over it, that the air may enter only at the front, where the workman stands, who will be thus effectually secured from the fumes, and from being incommoded by the heat, and at the same time have full liberty of introducing, inspecting, and removing, the work.

If such a furnace is made of strong forged (not milled) iron plate, it will be sufficiently durable. The upper end of the chimney may reach above a foot and a half higher than the level of the fire; over this is to be placed a larger tube, leaving an interval of an inch, or more, all round between it and the chimney, and reaching to the height of ten or twelve feet; the higher the better. The external air, passing up between the chimney and the outer pipe, prevents the latter from being much heated, so that the mercurial fumes will condense against its sides into running quicksilver, which falling down to the bottom, is there caught in a hollow rim, formed by turning inwards a portion of the lower part, and conveyed by a pipe at one side into a proper receiver.

Gilding iron or steel. In gilding iron or steel by means of an amalgam, as the metal has no affinity for the mercury, an agent must be employed to dispose the surface to receive the gilding. For this purpose a solution of mercury in nitrous acid (aquafortis), or what the workmen call quicksilver-water, is applied to the parts intended to be gilded; the acid, by a stronger affinity, seizes on a portion of the iron, and deposits in the place of it a thin coating of mercury, which will not refuse an union afterwards with the gold amalgam that may be applied; but by this process the surface of the metal is injured by the nitrous acid, and the union of the mercury is very slight, so that a bright and durable gilding cannot be obtained.

Another method. Sometimes a solution of blue vitriol is applied, with a camel's-hair pencil, to the parts of the steel intended to be gilt. By a chemical action, exactly similar to what we have described as taking place when a solution of nitrate of mercury is employed, a thin coating of copper is precipitated on the metal. Copper having an affinity for mercury, a kind of union may by this means be effected between the amalgam and the iron or steel, as the case may be. In whichever of these methods the amalgam is brought into union with the steel, the surface is injured by the action of the acid employed, and still a heat sufficient to volatilize the mercury must be afterwards used.

Gilding of iron by heat. When the surface is polished bright, it must be heated till it becomes blue. Gold leaf is then applied to its surface, and burnished down. It is then heated again, and another layer of gold burnished on it. In this manner three or four coats are given, according to the strength of the gilding intended. This is a more laborious process than the two last, but it is not attended with so much risk.

An improved process for gilding iron or steel. This process, which is less known among artists than it deserves to be, may prove useful to those who have occasion to gild iron or steel. The first part of the process consists in pouring over a solution of gold in nitro-muriatic acid (aqua regia) about twice as much ether, which must be done with caution, and in a large vessel. These liquids must then be shaken together; as soon as the mixture is at rest, the ether will be seen to separate itself from the nitro-muriatic acid, and to float on the surface. The nitro-muriatic acid becomes more transparent, and the other darker than they were before; the reason of which is, that the ether has taken the gold from the acid. The whole mixture is then to be poured into a glass funnel, the lower aperture of which is small; but this aperture must not be opened till the fluids have completely separated themselves from each other. It is then to be opened; by which means the liquid which has taken the lowest place by its greater gravity, viz. the nitro-muriatic acid, will run off; after which, the aperture is to be shut, and the funnel will then be found to contain nothing but ether mixed with the gold, which is to be put into well-closed bottles, and preserved for use. In order to gild iron or steel, the metal must be first well polished with the finest emery, or rather with the finest crocus martis or colcothar of vitriol, and common brandy. The auriferous ether is then to be applied with a small brush; the ether soon evaporates, and the gold remains on the surface of the metal. The metal may then be put into the fire, and afterwards polished. By means of this auriferous ether, all kinds of figures may be delineated on iron, by employing a pen, or fine brush. It is in this manner, we believe, that the Sohlinger sabre-blades are gilded.

Instead of ether, the essential oils may be used, such as oil of turpentine, or oil of lavender, which will also take gold from its solution.

Gilding of silver. Dissolve gold in the nitro-muriatic acid, and dip some linen rags in the solution; then burn them, and carefully preserve the ashes, which will be very black, and heavier than common. When any thing is to be gilded, it must be previously well burnished; a piece of cork is then to be dipped, first into a solution of salt in water, and afterwards into the black powder; and the piece, after being rubbed with it, must be burnished. This powder is frequently used for gilding delicate articles of silver.

Gilding of brass and copper. Fine instruments of brass, in order that their surface may be kept longer clean, may be gilded in the following manner.

Provide a saturated solution of gold, and having evaporated it to the consistence of oil, suffer it to shoot into crystals. These crystals must then be dissolved in pure water, and the articles to be gilded being immersed in it, are then to be washed in pure water, and afterwards burnished. This process may be repeated several times, till the articles have been well gilt. A solution of gold crystals is preferred to a mere solution of gold, because in the latter there is always a portion of free acid, which will not fail to exercise more or less action on the surface of the brass or copper, and injure its polish.

Grecian gilding. Dissolve some mercury in muriatic acid (spirit of salt), which will give a muriate of mercury. Mix equal parts of this and sal ammoniac, and dissolve them in aquafortis. Put some gold into this, and it will dissolve. When this is applied to silver, it becomes black; but by heating, it assumes the appearance of gilding.

To make shell-gold. Grind up gold-leaf with honey in a mortar; then wash away the honey with water, and mix the gold powder with gum water. This may be applied to any article with a camel's-hair pencil, in the same way as any other colour.

GILT-HEAD. See SPARUS.

GIMBALS, a contrivance by means of which barometers, vessels of oil, mariner's compasses, &c. may be suspended so as to arrange their upper parts horizontally. The nature of this contrivance will be at once understood by shewing its application to a mariner's compass. It consists of a hoop or ring supported upon two pins diametrically opposite each other, and issuing from the external surface of the ring in such a direction that both lie in the same diametrical line. When the hoop is suspended on these pins, it is at liberty to turn freely about the diameter, of which they constitute the prolongation. The notches or holes of support are disposed horizontally. The compass-box itself is placed in a similar ring with two projecting pivots; and these pivots are inserted in holes made in the former ring at equal distances from each of its pivots. If therefore the whole is left at liberty, the compass-box may vibrate upon the diametral line of the outer ring, as well as upon a line formed by its own pivots, at right angles to that diametral line. The consequence of this arrangement is, that the centre of gravity of the compass-box will dispose itself immediately beneath the intersection of both lines on which it is at liberty to move: that is, if the weight of the box and its component parts are properly disposed, the compass will assume a position in which the surface shall be horizontal.

GIN. See DISTILLATION.

GIN, in mechanics, a machine for driving piles, fitted with a windlass and winches at each end, where eight or nine men heave, and round which a rope is reeved, that goes over the wheel at the top: one end of this rope is seized to an iron monkey, that hooks to a beetle of different weights, according to the piles they are to drive, being from eight to thirteen hundred weight; and when hove up to a cross-piece near the wheel it unhooks the monkey, and lets the beetle fall on the upper end of the pile, and forces the same into the ground; then the monkey's own weight overhauls the windlass, in order for its being hooked again to the beetle.

GINANNIA, a genus of the class and order enneandria monogynia. The calyx is double, both one-leaved; petals three-fringed and spreading; germ pedicelled, with a membranaceous wing at top. Legume. There is one species, a shrub of Guiana.

GINKGO, or maidenhair-tree, of the dioecia class (order and character unknown), a large tree of Japan, with leaves resembling the adiantum, whence its popular name.

GINORA, a genus of the dodecandria monogynia class and order. The calyx is six-clefted; petals six; capsules one-seeded, four-celled, four-valved, coloured, many seeds. There is one species, an elegant shrub of Cuba, bearing handsome large red flowers.

GINGER. See AMOMUM.

GINSENG. See PANAX.

GIRDERS, in architecture, some of the largest pieces of timber in a floor.

By the building act, no girder is to lie less than 10 inches into the wall, and the ends to be laid in loam.

GIRDING-GIRT, in the sea language. A ship is girt, or has a girding-girt, when her cable is so tight or strained, upon the turning of the tide, that she cannot get over it, but lies across the tide.

GIRONNE', or GIRONNY, in heraldry, a coat of arms divided into girons or triangular figures, meeting in the centre of the shield, and alternately colour and metal.

GISEKIA, a genus of the class and order pentandria pentagynia. The calyx is five-leaved; corolla none; capsules five, approximating, roundish, one-seeded. There is one species, an annual of the East Indies.

GLABRASIA, a genus of the class and order polyadelphia polyandria. The calyx is five-cleft; nectarium composed of bristles; stamina 30, always in sixes; perianthium a drupe. There is one species, a large tree of the East Indies.

GLACIES MARIÆ. See MICA.

GLACIS, in fortification, that mass of earth which serves as a parapet to the covered way, sloping easily towards the champaign or field. See FORTIFICATION.

GLADIATORS, in antiquity, persons who fought generally in the arena at Rome, for the entertainment of the people.

The gladiators were usually slaves, and fought out of necessity, though sometimes freemen made profession of it, like our prize-fighters, for a livelihood. The Romans borrowed this cruel diversion from the Asiatics. They were all first sworn that they would fight till death; and if they failed they were put to death either by fire, swords, clubs, whips, &c. It was usual with the people or emperor to grant them life when they shewed no signs of fear. Augustus decreed that it should always be granted them.

After the engagement, several marks of favour were conferred on the victor, particularly a branch of palm-tree; and often a sum of money, perhaps gathered up among the spectators; but the most common rewards were the pileus and the rudis; the former being given only to such gladiators as were slaves, for a token of obtaining their freedom, but the rudis seems to have been bestowed both on slaves and freemen, with this difference, that it procured the former no more than a discharge from any further performance in public: the rudis, when given to such persons as, being free, had hired themselves out for these shows, restored them to a full enjoyment of their liberty.

From slaves and freedmen, the wanton sport spread to persons of rank, as we find in Nero's time. And Domitian exhibited combats of women in the night-time. We also read that dwarfs encountered with one another. Constantine the Great first prohibited these combats in the East; but the practice was not entirely abolished in the West before Theodoric king of the Ostrogoths, in the year 500.

The dying GLADIATOR, is a most valuable monument of antient sculpture, which is now preserved in the palace of Chighi. This man, when he had received the mortal stroke, is particularly careful *ut procumbat honestè*, that he might fall honourably. He is seated in a reclining posture on the ground, and has just strength sufficient to support himself on his right arm; and in his expiring moments it is plainly seen that he does not abandon himself to grief and dejection, but is solicitous to maintain that firmness of aspect which the gladiators valued themselves on preserving in this season of distress, and that attitude which they had learnt of the masters of defence. He fears not death, nor seems to betray any tokens of fear by his countenance, nor to shed one tear. We see, in this instance, notwithstanding his remaining strength, that he has but a moment to live; and we view him with attention, that we may see him expire and fall. Thus the antients knew how to animate marble, and to give it almost every expression of life.

GLADIOLUS, *corn-flag*, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking under the sixth order, ensatæ. The corolla is sexpartite and ringent, the stamina ascending and bending upwards. There are thirty species, of which the most generally known is the communis or common gladiolus. This has a round, compressed, tuberous root, long sword-shaped leaves, an erect flower-stalk, two or three feet high, the top adorned with several pretty large flowers of a red or white colour, having each six petals. They appear in May and June, and are succeeded by plenty of seed in August. The plants are very hardy, and will thrive in any soil or situation. They are propagated by offsets from the roots. The gladiolus cardinalis is a bulb of the Cape, exquisitely beautiful.

GLAMA. See CAMELUS.

GLAND. See ANATOMY.

GLANDERS. See FARRIERY.

GLAREOLA, in ornithology, a genus of birds of the order of grallæ. The generic character is: bill strong, short, straight, hooked at the tip; nostrils at the base of the bill linear, oblique; gape of the mouth large; feet four-toed; toes long, slender, connected at the base by a membrane; tail forked, consisting of 12 feathers. There are three species. The austriaca inhabits the heaths of Europe near the banks of rivers, is about nine inches long, feeds on worms and aquatic insects, is very restless and clamorous. See

Plate Nat. Hist. fig. 214. The senegallensis is found near the Senegal, and in several parts of Siberia: and the nævia is to be met with only in Germany.

GLASS, a transparent, brittle, factitious body, produced by the action of fire upon a fixed salt and sand, or stone, that readily melts.

The fixed alkalies have a strong affinity for several of the earths, particularly for silica and alumina, which they dissolve in considerable quantity, when assisted by heat. When a strong heat is applied to a mixture of fixed alkali and silica, it melts, and forms a transparent mass well known by the name of glass.

The method of making this useful compound was known at an early period. According to Pliny, the discovery was owing to an accident. Some merchants, with a ship-load of soda from Egypt, had cast anchor at the mouth of the river Belus in Phœnicia, and were dressing their dinner on the sand. They made use of large lumps of soda to support their kettles, and lighted fires under them. The heat melted the soda and the siliceous sand together, and the result was glass.

For some time after this accidental discovery, the manufacture of glass was confined to the river Belus. This manufacture seems to have been carried to a considerable degree of perfection among the antients. They mention drinking-glasses, glass prisms, and coloured glasses of various kinds. But perfectly transparent glass was considered as very valuable; for Nero gave 50,000*l.* for two glass cups with handles; a proof that their processes must have been far less perfect than ours. It was usual for them to melt the materials of their glass into a black mass called ammonitrum, of which statues were sometimes made. This ammonitrum was again melted and purified by refiners. Glass panes seem to have been first used in windows in the third century; but they did not come into common use till long after.

The materials employed in the manufactory of glass may be reduced under three classes, namely, alkalies, earths, and metallic oxides.

The fixed alkalies may be employed indifferently; but soda is preferred in this country. The soda of commerce is usually mixed with common salt, and combined with carbonic acid. It is proper to purify it from both of these foreign bodies before using it. This, however, is seldom done.

The earths are silica, lime, and sometimes a little alumina. Silica constitutes the basis of glass. It is employed in the state of fine sand or flints; and sometimes for making very fine glass, rock crystal is employed. When sand is used, it ought if possible to be perfectly white; for when it is coloured with metallic oxides, the transparency of the glass is injured. Such sand can only be employed for very coarse glasses. It is necessary to free the sand from all the loose earthy particles with which it may be mixed, which is done by washing it well with water.

Lime renders glass less brittle, and enables it to withstand better the action of the atmosphere. It ought in no case to exceed the twentieth part of the silica employed, otherwise it corrodes the glass pots. This indeed may be prevented by throwing a little clay into the melted glass; but in that case a green glass only is obtained.

The metallic oxides employed are the red oxide of lead or litharge, and the white oxide of arsenic. The red oxide of lead, when added in sufficient quantity, enters into fusion with silica, and forms a glass without the addition of any other ingredient. Five parts of minium and two of silica form a glass of an orange-colour and full of striæ. Its specific gravity is 5. The red oxide of lead renders glass less brittle and more fusible; but when added beyond a certain proportion, it injures the transparency and the whiteness of glass.

The white oxide of arsenic answers the same purposes with that of lead; but on account of its poisonous qualities it is seldom used. It is customary to add a little nitre to the white oxide of arsenic, to prevent the heat from reviving it, and rendering it volatile. When added beyond a certain proportion, it renders glass opaque and milky like the dial-plate of a watch. When any combustible body is present, it is usual in some manufactures to add a little white oxide of arsenic. This supplying oxygen, the combustible is burnt, and flies off; while the revived arsenic is at the same time volatilized.

After mixing the alkali and sand together, it is usual to expose them for some time to a moderate heat. This serves several purposes. It drives off all combustible bodies which may happen to be mixed with the sand; it produces a commencement of combination which makes the glass afterwards less liable to corrode the clay pots in which it is melted; and the alkali, by this incipient combination, is not so apt to be volatilized, which might be the case if the materials were exposed at once to a violent heat. The mixture, after being thus heated, is called the frit. Through the domes in which the frit is heated, it is usual to see very thin bubbles of glass passing; a proof that some of the materials are volatilized during this first part of the process.

The frit, while still hot, is introduced into large pots made of a mixture of pure clay and baked clay, and exposed to a heat sufficient to melt it completely. The fusion must be continued till the effervescence occasioned by the separation of the carbonic acid from the soda has subsided, and the opaque scum, known by the name of glass-gall, which collects on the surface of the glass, must be removed. This scum is occasioned by the common salt and other foreign bodies which are always mixed with the soda of commerce. When the fusion has been continued the proper time, the furnace is allowed to cool a little. In that state the glass is exceedingly ductile, and readily assumes any shape that the workman pleases.

If the glass vessels, after being formed, were cooled rapidly, they would contract unequally, and become in consequence so brittle as to fall to pieces whenever they were handled. To prevent this inconvenience, they are put into a large red-hot furnace, which is allowed to cool very slowly to the temperature of the air. This process is called annealing.

The properties that distinguish good glass are well known. It is perfectly transparent; its hardness is very considerable; its specific gravity varies from 2.3 to 4, according to the proportion of metallic oxide which it contains. When cold it is brittle; but at a red heat it is one of the most ductile bodies known, and may be drawn out into threads so fine as to be scarcely visible to the naked eye. (See DUCTILITY.) It is almost perfectly elastic, and of course is one of the most sonorous of bodies. There are but few chemical agents which have any action on it. Fluoric acid dissolves it with great rapidity, and so do the fixed alkalies when assisted by heat. Dr. Priestley has shown also, that the long-continued action of hot water is capable of decomposing it; a discovery which explains sufficiently the siliceous earth obtained by Boyle and Margraff, when they subjected water to tedious distillations in glass vessels.

There are different kinds of glass manufactured for different purposes: the principal of these are flint glass, crown glass, and bottle glass.

Flint glass is formed of soda, pounded flints, and oxide of lead. It is the densest, most transparent, and most beautiful glass, and is often called crystal. Crown glass contains no lead. It is composed of soda and fine sand. This kind is used for the panes of windows. Bottle glass is the coarsest of all. It is composed of kelp, or the refuse of soap-boilers, and common sand. Its green colour is owing to the presence of iron. Of these species the most fusible is flint glass, and the least fusible bottle glass. According to the experiments of Saussure, flint glass melts at the temperature of 19° Wedgewood, crown glass at 30°, and bottle glass at 47°.

Glass is often tinged of various colours by mixing with it while in fusion some one or other of the metallic oxides; and on this process, well conducted, depends the formation of pastes or factitious gems.

Blue glass is formed by means of oxide of cobalt.

Green, by the oxide of iron or of copper.

Violet, by oxide of manganese.

Red, by a mixture of the oxides of copper and iron.

Purple, by the purple oxide of gold.

White, by the oxide of arsenic and of zinc.

Yellow, by the oxide of silver and by combustible bodies.

Opticians, who employ glass for optical instruments, often complain of the many defects under which it labours. The chief of these are the following:

Streaks. These are waved lines, often visible in glass, which interrupt distinct vision. They are probably owing sometimes to want of complete fusion, which prevents the different materials from combining sufficiently; but in some cases also they may be produced by the workmen lifting up, at two different times, the glass which is to go to the formation of one vessel or instrument.

Tears. These are white specks or knots, occasioned by the vitrified clay of the furnaces, or by the presence of some foreign salt.

Bubbles. These are air-bubbles which have not been allowed to escape. They indicate want of complete fusion, either from too little alkali, or the application of too little heat.

Cords. These are asperities on the surface of the glass, in consequence of too little heat.

Blowing of glass vessels. The furnace for this (fig. 5. Plate Manufacture of Glass) has several mouths, according to the number of workmen. Each mouth consists of three holes, ABD; D is a hole through which the workman takes his metal from the melting-pot; A is the hole at which he afterwards heats his metal; and B is a small hole at which he heats the ends of his blowing-pipe and iron rods *aa*, which are supported by an iron bar across the mouth of the furnace. The furnace is built of fire-bricks, and has three domed chambers, one above another, within it; the fire is made upon a large grate in the middle of the lower one, to which the air is admitted by an arch underground; the flame goes through an opening in the dome of this chamber, and strikes against the top of the next chamber, and is thereby reverberated upon the pots, which stand upon the floor, just within the hole D; the smoke goes through the floor and roof of the next chamber, which is used as an annealing oven. This furnace is inclosed within a large building, like an inverted funnel, with a chimney at the top.

The principal implements used by the glass-blower are, a blowing-pipe, fig. 1, which is an iron pipe about two feet long, with rope-yarn wrapped round it at A, where the workman takes hold of it; two or three iron rods, fig. 2, of the same length; a pair of blunt shears, fig. 3; and several different sized ladles, shovels, pokers, &c. He has also two stools, figs. 6 and 7, to be hereafter described.

For explaining the operation, we shall describe the method of making a goblet. The workman dips the end D of his blowing-pipe, fig. 1, which is hot, through the hole D, fig. 5, into the melting-pot, which contains the glass in a state of fusion; and by turning it about, a small quantity of the glass, which is called metal, sticks to the iron: this he repeats three or four times (between each dip rolling it on an iron plate, fixed on the stool, fig. 7, to bring it into form) till he has got metal enough: he then blows at the end B of the pipe, which expands the metal into a hollow globular form; and then by swinging it round his head, it lengthens out in the shape of a bladder. The workman then sits down on the stool, fig. 6, between the two bars H and I, across which he lays the blowing-iron, and rolls it along under his left hand, following it at the same time with the shears, fig. 3, in his right hand, the blades *nn* of which embrace it, and by gently putting them in the proper place, he brings the glass into the form shewn in fig. 10; meanwhile, the boy who attends him brings a lump of metal from the furnace on the end of one of the iron rods fig. 2, which he sticks on the bottom, or part *a*, fig. 10, and by twisting the rod round, he separates the metal from the rod, and leaves it on the glass vessel; the workman then rolls the rod and vessel as before, and with his shears, as shewn in fig. 9, brings the lump of glass into the form of a stem and foot, as there described. The boy then holds the tool, fig. 4, against the bottom of the foot *b*, while it is turning, to flatten it. The boy next takes another iron rod, fig. 2, and gets a very small piece of metal on its end: this he applies to the centre of the bottom of the foot, so as to connect it to the rod; when the workman, by touching it at the neck *d* with a wet iron, cracks the glass, so that a slight blow upon the rod with the hand will separate it at *d*, from the blowing-pipe M. The glass has by this time become too cold to work without heating again, which is done before the fire A, fig. 5; the workman then returns to the stool, fig. 6, and again rolls the rod round with his left hand as before, and with the point of one of the blades *n* of the shears opens the end *d*, fig. 8, of the glass; after which he inserts both points, and finally works it into the form of fig. 13. It is now separated from the rod N, and is carried on a shovel like a baker's peel by the boy to the annealing furnace, or oven in the upper part of the furnace, where it remains in a low red-heat for many hours, by which its former extreme brittleness is removed.

Window-glass is made in a similar manner, except that the liquid mass at the end of the tube is formed into a cylindrical shape, which being cut longitudinally by scissars or shears, is gradually bent back until it becomes a flat plate.

Large plate-glass for looking-glasses, &c. is made by suffering the mass in a state of complete fusion to flow upon a table, with iron ledges to confine the melted matter, and as it cools a metallic roller is passed over it, to reduce it to an uniform thickness.

Good glass ware is often ornamented by the glass-cutter before it is offered for sale (see fig. 12.); this is generally performed by a machine, fig. 14, wherein AA is a large wheel to be turned by a man at the winch B. The band of this wheel passes round a pulley *a* on the axle of a wheel or cutter C, and thereby turns it with a great velocity: beneath the cutter a cistern D is placed, and above it a small cask E to contain water, the cock *b* of which is so placed and adjusted as to drop very slowly on the circumference of the cutter. The glass-grinder sits down on the stool F, and after dressing the edge of the cutter with emery paste, he applies successively the parts of the glass which are to be cut, as shewn in fig. 11, and dexterously moves the glass, as the parts intended to be cut are sufficiently ground away: after this another similar cutter is applied instead of C, or the same is dressed with finer emery paste, or mixture of tripoli and other polishing powders, in order to polish the parts which have been cut; such parts as are intended to have a white appearance are left rough. The cutters *c* are formed of hard wood or soft metal, and the workman is provided with several, of different sizes and thicknesses, particularly at the edge, according to the device which is to be cut on the glass. It is by the fine edge of these cutters that letters, flowers, &c. are cut on glasses by dexterous workmen.

GLASS, *painting on.* A few years since, Mr. Farrant obtained a patent for painting, spangling, gilding, and silvering glass, which was performed on the back of the crystal or glass, so as when finished to appear on the front; the colours prepared in oil or varnish as in other works. The parts of ornament which are gold must be first shadowed on the glass, and when dry the gold leaf must be laid on. Silver ornament is to be done in the same manner. For the spangling, leave the parts to be spangled to the last; then shadow them, and when dry varnish the parts with copal varnish, and strew the spangles on while it is wet; when they are dry, varnish them two or three times.

The antient manner of painting in glass was very simple, and consequently very easy: it consisted in the mere arrangement of pieces of glass of different colours in some sort of symmetry, and constituted what is now called mosaic work.

In process of time they came to attempt more regular designs, and also to represent figures heightened with all their shades: yet they proceeded no farther than the contours of the figures in black with water-colours, and hatching the draperies after the same manner on glasses of the colour of the object they designed to paint. For the carnation, they used glass of a bright-red colour, and upon this they drew the principal lineaments of the face, &c. with black.

But in time, the taste for this sort of painting improving considerably, and the art being found applicable to the adorning of churches, &c. they found out means of incorporating the colours in the glass itself, by heating them in the fire to a proper degree, having first laid on the colours. The colours used in painting or staining of glass are very different from those used in painting either in water or oil colours.

For black, take scales of iron one ounce, scales of copper one ounce, jet half an ounce; reduce them to powder, and mix them. For blue, take powder of blue one pound, sal nitre half a pound; mix them, and grind them well together. For carnation, take red chalk eight ounces, iron scales and litharge of silver of each two ounces, gum arabic half an ounce; dissolve in water; grind all together for half an hour as stiff as you can; then put it in a glass and stir it well, and let it stand to settle 14 days. For green, take red-lead one pound, scales of copper one pound, and flint five pounds; divide them into three parts, and add to them as much nitre; put them into a crucible, and melt them with a strong fire; and when it is cold, powder it, and grind it to a porphyry. For gold-colour, take silver an ounce, antimony half an ounce; melt them in a crucible; then pound the mass to powder, and grind it on a copper plate; add to it yellow ochre, or brick-dust calcined again, 15 ounces, and grind them well together with water. For purple, take minium one pound, brown stone one pound, white flint five pounds; divide them into three parts, and add to them as much nitre as one of these parts; calcine, melt, and grind it as you did the green. For red, take jet four ounces, litharge of silver two ounces, red chalk one ounce; powder them fine, and mix them. For white, take jet two parts, white flint, ground on a glass very fine, one part, mix them. For yellow, take Spanish brown ten parts, leaf silver one part, antimony half a part; put all into a crucible, and calcine them well.

In the windows of antient churches, &c. there are to be seen the most beautiful and vivid colours imaginable, which far exceed any of those used by the moderns, not so much because the secret of making those colours is entirely lost, as that the moderns will not go to the charge of them, nor be at the necessary pains. Those beautiful works which were made in the glass-houses were of two kinds.

In some, the colour was diffused through

MANUFACTURE OF GLASS.

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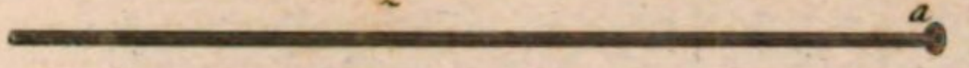

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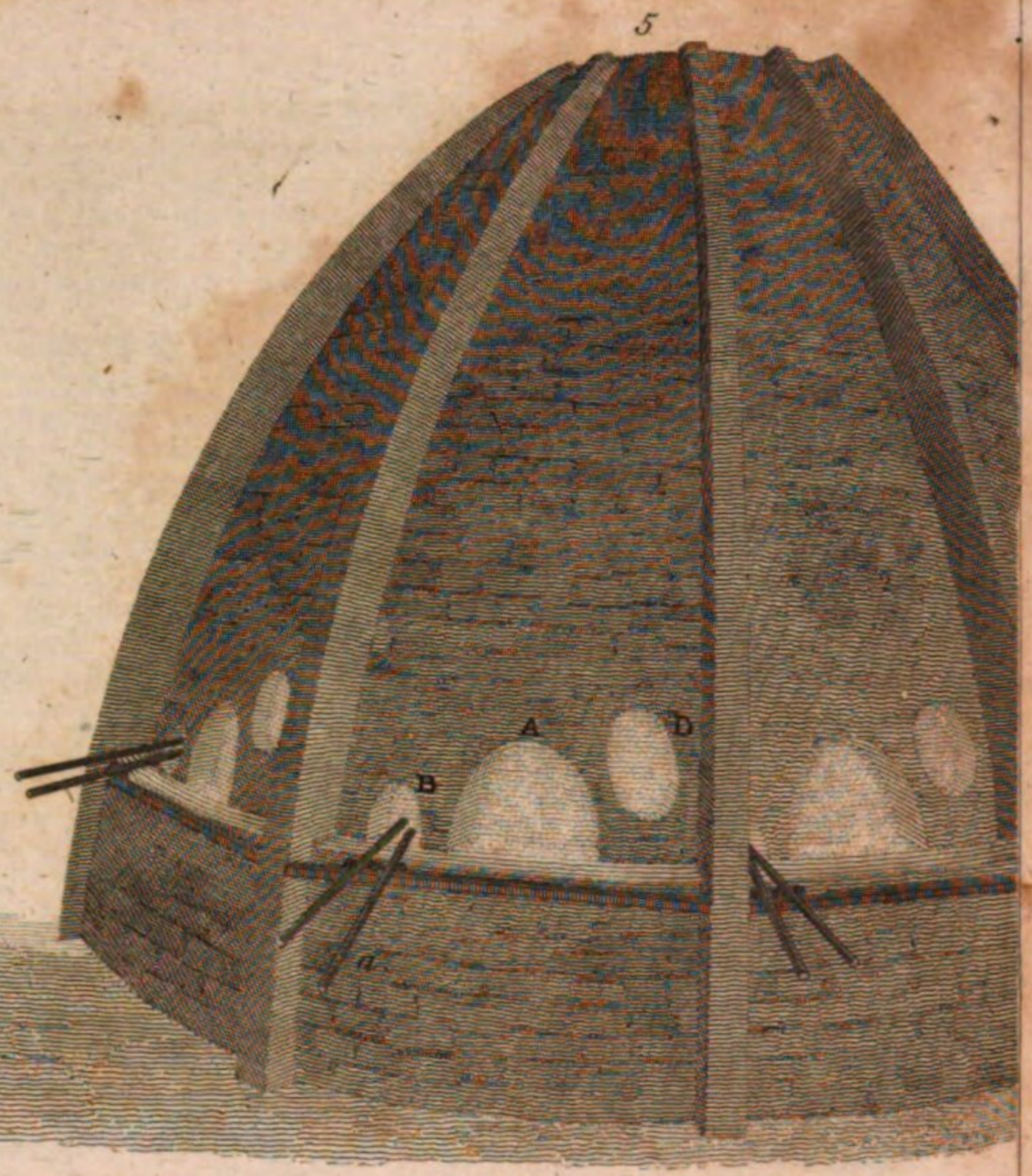

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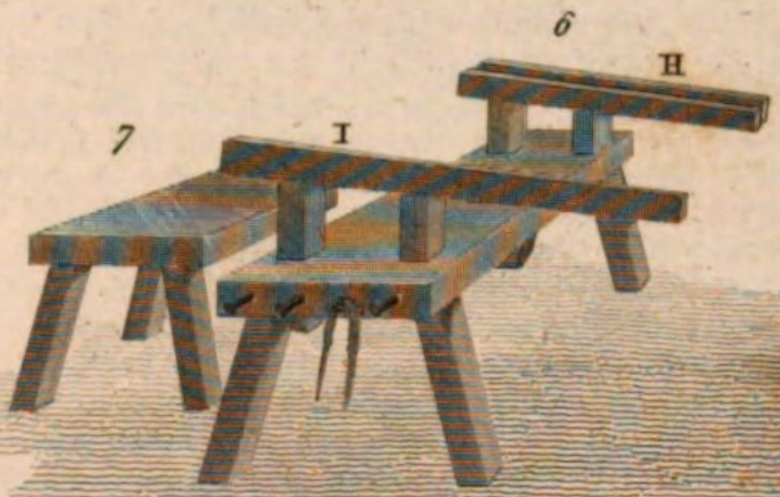

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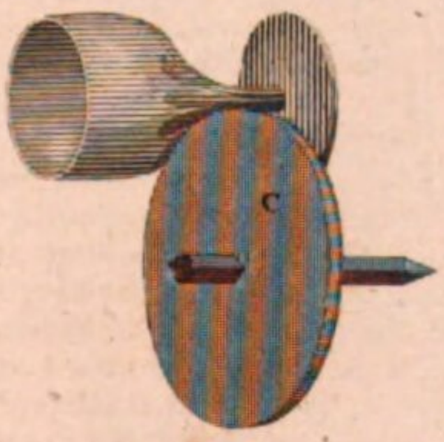

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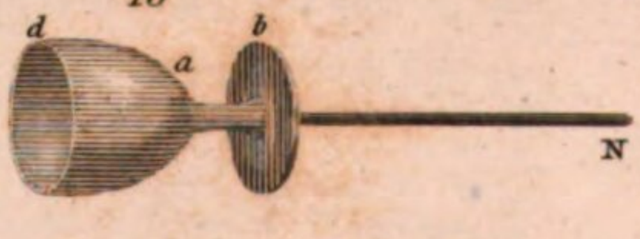

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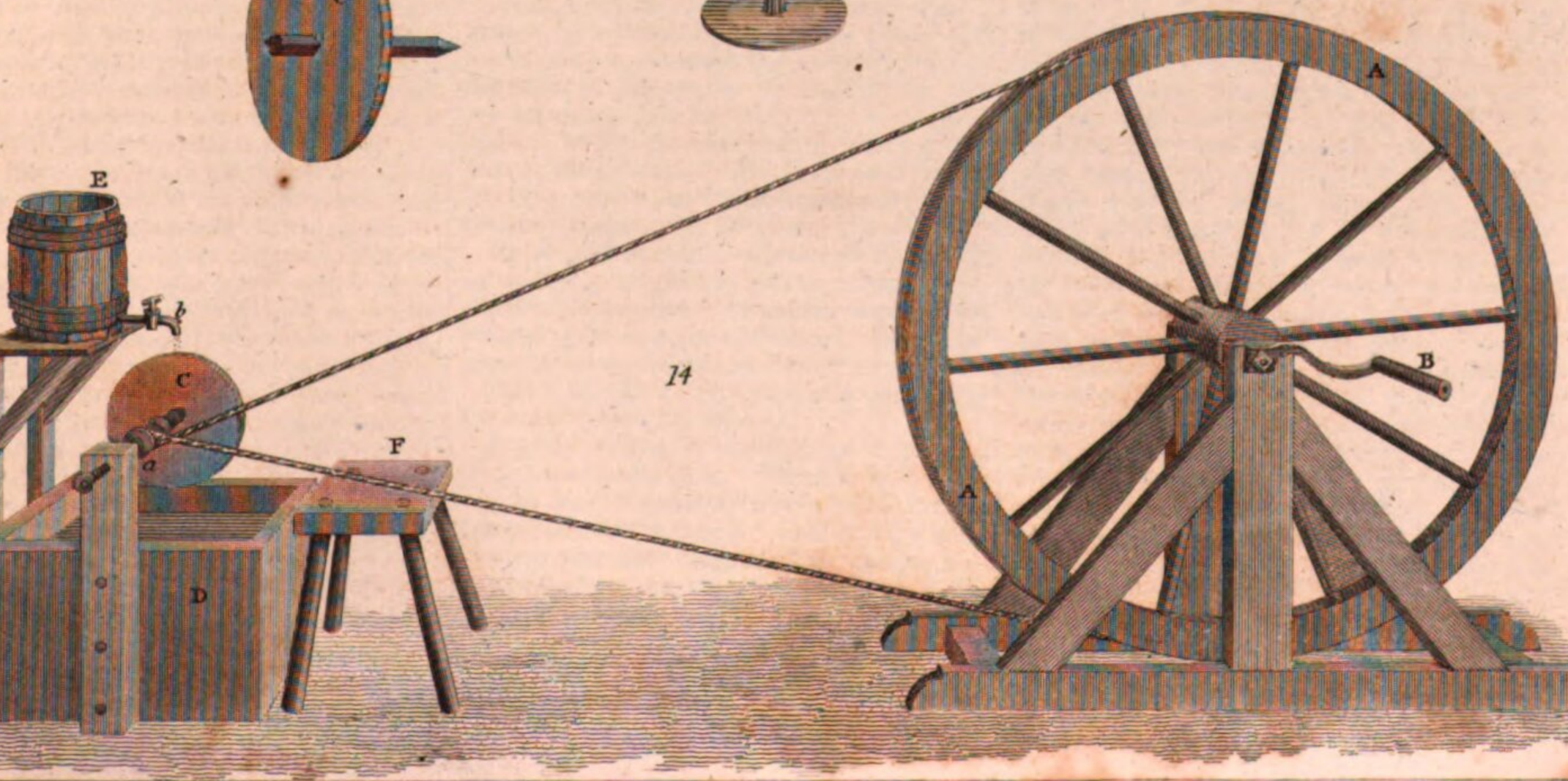

J. Farey Jun. del.

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J. Porter Sc.

the whole substance of the glass. In others, which were the more common, the colour was only on one side, scarcely penetrating within the substance above one-third of a line; though this was more or less according to the nature of the colour, the yellow being always found to enter the deepest. These last, though not so strong and beautiful as the former, were of more advantage to the workmen, since on the same glass, though already coloured, they could shew other kind of colours where there was occasion to embroider draperies, enrich them with foliage, or represent other ornaments of gold, silver, &c.

In order to this, they made use of emery, grinding or wearing down the surface of the glass, till they were got through the colour to the clear glass. This done, they applied the proper colours on the other side of the glass. By this means, the new colours were hindered from running and mixing with the former, when they exposed the glasses to the fire, as will appear hereafter.

When, indeed, the ornaments were to appear white, the glass was only bared of its colour with emery, without tinging the place with any colour at all; and this was the manner by which they wrought their lights and heightenings on all kinds of colour.

The first thing to be done in order to paint or stain glass in the modern way, is to design and even colour the whole subject on paper. They then choose such pieces of glass as are clear, even, and smooth, and proper to receive the several parts, and proceed to distribute the design itself, or papers it is drawn on, into pieces suitable to those of the glass; always taking care that the glasses may join in the contours of the figures and the folds of the draperies, that the carnations and other finer parts may not be impaired by the lead with which the pieces are to be joined together. The distribution being made, they mark all the glasses as well as papers, that they may be known again; which done, applying every part of the design upon the glass intended for it, they copy or transfer the design upon this glass with the black colour diluted in gum water, by tracing and following all the lines and strokes as they appear through the glass with the point of a pencil.

When these strokes are well dried, which will happen in about two days, the work being only in black and white, they give a slight wash over with urine, gum arabic, and a little black, and repeat it several times, according as the shades are desired to be heightened, with this precaution, never to apply a new wash till the former is sufficiently dried.

This done, the lights and risings are given by rubbing off the colour in the places with a wooden point, or the handle of the pencil.

As to the other colours above-mentioned, they are used with gum-water, much as in painting in miniature, taking care to apply them lightly for fear of effacing the outlines of the design; or even, for the greater security, to apply them on the other side; especially yellow, which is very pernicious to the other colours, by blending with them. And here too, as in pieces of black and white, particular regard must always be had not to lay colour on colour, or lay on a new lay till such time as the former are well dried.

It may be added, that the yellow is the only colour that penetrates through the glass, and incorporates with it by the fire; the rest, and particularly the blue, which is very difficult to use, remaining on the surface, or at least entering very little. When the painting of all the pieces is finished, they are carried to the furnace or oven, to anneal or bake the colours.

The furnace here used is small, built of brick, from 18 to 30 inches square; at six inches from the bottom is an aperture to put in the fuel, and maintain the fire. Over this aperture is a grate, made of three square bars of iron, which traverse the furnace, and divide it into two parts. Two inches above this partition is another little aperture, through which they take out pieces to examine how the coction goes forward. On the grate is placed a square earthen pan, six or seven inches deep, and five or six inches less every way than the perimeter of the furnace. On the one side is a little aperture, through which to make trials, placed directly opposite to that of the furnaces destined for the same end. In this pan are the pieces of glass to be placed in the following manner: First, the bottom of the pan is covered with three strata or layers, of quick lime pulverized; those strata being separated by two others of old broken glass, the design of which is to secure the painted glass from the too intense heat of the fire. This done, the glasses are laid horizontally on the last or uppermost layer of lime.

The first row of glass they cover over with a layer of the same powder, an inch deep; and over this they lay another range of glasses, and thus alternately till the pan is quite full, taking care that the whole heap always end with a layer of the lime-powder.

The pan being thus prepared, they cover up the furnace with tiles, on a square table of earthenware, closely luted all round, only leaving five little apertures, one at each corner, and another in the middle, to serve as chimneys. Things thus disposed, there remains nothing but to give the fire to the work. The fire for the first two hours must be very moderate, and must be increased in proportion as the coction advances, for the space of ten or twelve hours, in which time it is usually completed. At last the fire, which at first was charcoal, is to be of dry wood, so that the flame covers the whole pan, and even issues out at the chimneys.

During the last hours, they make essays, from time to time, by taking out pieces laid for the purpose through the little aperture of the furnace and pan, to see whether the yellow is perfect, and the other colours in good order. When the annealing is thought sufficient, they proceed with great haste to extinguish the fire, which otherwise would soon burn the colours, and break the glasses.

By several statutes, regulations are made for making, importing, and exporting glass, which is to be under the management of the officers of the customs and excise. See Complete Abridgement of the Excise Laws.

GLAUBER'S SALT, a cathartic or purging salt. See SODA, *sulphat of*.

GLAUCOPIS, in ornithology, a genus of birds of the order picæ. Bill incurvate, arched, the lower mandible shorter, and caruncular beneath at the base; nostrils depressed, half-covered with a membrane; tongue slit, and fringed at the tip; feet walkers. It inhabits New Zealand.

GLAUX, *milkwort*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 17th order, calycanthemæ. The calyx is monophyllous; there is no corolla; the capsule is unilocular, quinquevalved, and pentaspermous. There is one species.

GLAZIER, an artificer who works in glass. The principal part of a glazier's business consists in fitting panes of glass to the sashes and window-frames of houses, pictures, &c. and in cleaning the same when required.

GLAZIER'S VICE, is an instrument for drawing lead: see Plate Miscel. fig. 102. PG, QH, are two axles running in the frame KL, ML; C, D, two wheels of iron case-hardened, 1½ inch broad, and of the thickness of a pane of glass; these wheels are fixed to the axles, and run very near one another, their distance not exceeding one-tenth of an inch: across their edges several nicks are cut, the better to draw the lead through. E, F, are two pinions, each of twelve leaves, turning one another and going upon the ends of the axles, which are square, being kept fast there by the nuts P, Q, which are screwed fast with a key. A, B, are two cheeks of iron, case-hardened, and fixed on each side to the case with screws; these are cut with an opening near the two wheels, and set so near to the wheels as to leave a space equal to the thickness of the lead; so that between the wheels and the cheeks there is left a hole of the form represented at N, which is the shape of the lead when cut through. The frame KLML is held together by cross bars passing through the sides, and screwed on; and a cover is put over the machine to exclude the dust. The whole is screwed down fast to a bench by screw-nails LL. When the vice is used, the lead to be drawn is first cast in moulds, into pieces a foot long, with a gutter on each side. One of these pieces is taken, and an end of it sharpened with a knife; then being put into the hole between the wheels, by turning the handle I the lead is drawn through the vice, and receives the form designed.

GLAZING, the crusting over earthenware by a vitreous substance, the basis of which is commonly lead. The usual composition for glazing ware is formed of white sand 40 pounds, of red-lead 20 pounds, of pearl-ashes 20 pounds, and of common salt 12 pounds. Powder the sand by grinding it, and then add it to the other ingredients, and grind them together; after which calcine them for some time with a moderate heat, and when the mixture is cold, reduce it to powder, and when wanted for use temper it with water. The proportion of these ingredients may be occasionally varied. The ware, after being turned on the wheel and dried in the open air, is covered over with the above composition by means of a brush; and when set in the furnace, the violent heat soon reduces it to a perfect glass, covering the whole internal and external surface of the vessel. We may observe, however, that lead, being poisonous, ought to be excluded from the composition of glazings, and other fluxes substituted in its stead. A transparent glazing may be prepared without lead by calcining 40 pounds of white sand, 25 pounds of pearl-ashes, and 15 pounds of common salt, and proceeding as before: and a more perfect transparent glazing may be made of

sand 40 pounds, of wood-ashes perfectly burned 50 pounds, of pearl-ashes 10 pounds, and of common salt 12 pounds. The following receipts are taken for the most part from Kunckel, who says that they are the true glazings used at Delft and other Dutch manufactories.

Black is made of eight parts of red-lead, iron-filings three, copper-ashes three, and zaffer two measures. This when melted will make a brown-black, and if wanted blacker, add more zaffer to it.

Blue is thus prepared: Take lead-ashes or red-lead one pound; clear sand or powdered flints two pounds, common salt two pounds, white calcined tartar one pound, Venice or other glass half a pound, zaffer half a pound; mix them and melt them for several times, quenching them always in cold water. If you would have it fine and good, it will be proper to put the mixture into a glass-furnace for a day or two. Another blue glazing may be formed of one pound of tartar, a quarter of a pound of red-lead, half an ounce of zaffer, and a quarter of a pound of powdered flints, which are to be fused and managed as in the last receipt. Or, take two pounds of calcined lead and tin, add five pounds of common salt, five pounds of powdered flints, and of zaffer, tartar, and Venetian glass, each one pound. Calcine and fuse the mixture as before. Or again, take of red-lead one part, of sand three parts, and of zaffer one part. For a violet-blue glazing, take four ounces of tartar, two ounces of red-lead, five ounces of powdered flints, and half a dram of manganese.

Brown is made of red-lead and flints, of each 14 parts, and of manganese two parts fused, or of red-lead 12 parts, and manganese one part fused. A brown glazing, to be laid on a white ground, may be made of manganese two parts, and of red-lead and white glass, of each one part, twice fused.

Flesh-coloured is made of 12 parts of lead-ashes, and one of white glass.

Gold-coloured. Take of litharge three parts, of sand or calcined flint one part; pound and mix these very well together, then run them into a yellow glass with a strong fire. Pound this glass, and grind it into a subtile powder, which moisten with a well-saturated solution of silver; make it into a paste, which put into a crucible, and cover it with a cover. Give at first a gentle degree of fire; then increase it, and continue it till you have a glass, which will be green. Pound this glass again, and grind it to a fine powder; moisten this powder with some beer, so that by means of a hair-pencil you may apply it upon the vessels or any piece of earthenware. The vessels that are painted or covered over with this glazing must be first well heated, then put under a muffle; and as soon as the glass runs, you must smoke them by holding them over burning vegetables, and take out the vessels.

Kunckel gives several preparations for a gold-coloured yellow glazing. This may be produced by fusing a mixture of three parts of red-lead, two parts of antimony, and one part of saffron of Mars; by again melting the powdered mass, and repeating the operation four times, or by fusing four or five times a composition of red-lead and antimony, of each an ounce, and of scales of iron half an ounce; or by calcining and fusing together eight parts of red-lead, six parts of flint, one part of yellow ochre, one part of antimony, and one part of white glass. A transparent gold-coloured glazing may be obtained by twice fusing red-lead and white flints, of each 12 parts, and of filings of iron one part.

Green may be prepared of eight parts of litharge or red-lead, eight parts of Venice glass, four parts of brass-dust or filings of copper; or of ten parts of litharge, twelve of flint or pebble, and one of æs ustum or copper ashes. A fine green glazing may be produced by fusing one part of the Bohemian granite, one of filings of copper, one of red-lead, and one of Venetian glass; or by fusing one part of white glass, the same quantity of red-lead, and also of filings of copper; powdering the mass, and adding one part of Bohemian granite to two parts of this powder. A fine green may be obtained by mixing and grinding together any of the yellow glazings with equal quantities of the blue glazings; and all the shades and tints of green will be had by varying the proportion of the one to the other, and by the choice of the kind of yellow and blue.

Sea-green is made of five pounds of lead-ashes, one pound of tin-ashes, three pounds of flint, three quarters of a pound of salt, half a pound of tartar, and half a pound of copper-dust.

Iron-colour is prepared of 15 parts of lead-ashes or red-lead, 14 of white sand or flints, and five of calcined copper. This mixture is to be calcined and fused.

Liver-colour is prepared of 12 parts of litharge, eight of salt, six of pebble or flint, and one of manganese.

Purple brown consists of lead-ashes 15 parts, clean sand or powdered flints 18 parts, manganese one part, and white glass 15 measures, to which some add one measure of zaffer.

Red is made of antimony three pounds, litharge or red-lead three, and rust of iron one; grind them to a fine powder. Or, take two pounds of antimony, three of red-lead, and one of calcined saffron of Mars, and proceed as before.

White. The white glazing for common ware is made of 40 pounds of clear sand, 75 pounds of litharge or lead-ashes, 26 of pot-ashes, and 10 pounds of salt; these are three times melted into a cake, quenching it each time in clear cold water. Or it may be made of 50 pounds of clean sand, 70 of lead-ashes, 30 of wood-ashes, and 12 of salt. For a fine white, take two pounds of lead and one of tin; calcine them to ashes: of this take two parts; calcined flint, white sand, or broken white glass, one part; and salt, one part; mix them well together, and melt them into a cake for use. The trouble of calcining the tin and lead may be prevented by procuring them in a proper state. A very fine white glazing may be obtained by calcining two parts of lead and one part of tin, and taking one part of this mass, and of flints and common salt of each one part, and fusing the mixture. A white glazing may be also prepared by mixing 100 pounds of masticot, 60 of red-lead, 20 of calcined tin or putty, and 10 of common salt, and calcining and powdering the mixture several times.

Yellow is prepared of red-lead three pounds, calcined antimony and tin of each two pounds; or, according to some, of equal quantities of the three ingredients. These must be melted into a cake, then ground fine, and this operation repeated several times; or it may be made of 15 parts of lead-ore, three parts of litharge of silver, and 15 parts of sand. A fine yellow glazing may be procured by mixing five parts of red-lead, two parts of powdered brick, one part of sand, one part of the white glazings, and two parts of antimony, calcining the mixture and then fusing it. Or, take four parts of white glass, one part of antimony, three parts of red-lead, and one part of iron-scales, and fuse the mixture; or fuse 16 parts of flints, one part of iron-filings, and 24 parts of litharge. A light-yellow glazing may be produced with ten parts of red-lead, three parts of antimony, and three of glass, and two parts of calcined tin (see gold-colour above). A citron yellow is made of six parts of red-lead, seven parts of fine red brickdust, and two parts of antimony. This mixture must be calcined day and night for the space of four days, in the ash-hole of a glass-house furnace, and at last urged to fusion. See STONE WARE.

GLEANING. It has been said, that by the common law and custom of England the poor are allowed to enter and glean upon another's ground after the harvest, without being guilty of trespass; and this humane provision seems borrowed from the Mosaical law. 3 Black. 212.

But it is now positively settled, by a solemn judgment of the court of common pleas, that a right to glean in the harvest-field cannot be claimed by any person at common law; neither have the poor of a parish, legally settled, such a right. 1 H. Black. Rep. 51—63.

GLEBE. Glebe land is a portion of land, meadow, or pasture, belonging to, or parcel of, the parsonage or vicarage, over and above the tithes. Godolph. Rep. 409.

Glebe lands, in the hands of the parson, shall not pay tithes to the vicar; nor being in the hands of the vicar, shall they pay tithe to the parson. Deggs, Pars. Couns. c. 2.

By stat. 28 H. VIII. c. 11, every successor on a month's warning, after induction, shall have the mansion-house and the glebe belonging thereto, not sown at the time of the predecessor's death. He that is instituted may enter into the glebe land before induction, and plead right against all strangers.

When a parson or vicar has caused any of his glebe lands to be manured and sown, at his own charge, with corn or grain, he may by will devise all the profits and corn growing upon the said glebe; and in case he dies without disposing thereof, his executors shall have the same.

GLECHOMA, *ground-ivy*, a genus of the gymnospermia order, in the didynamia class of plants, and in the natural method ranking under the 42d order, verticillatæ. Each pair of the antheræ come together in the form of a cross; the calyx is quinquefid. There is one species, the hederacea, or common ground-ivy, which is so well known that it requires no description. Many virtues were formerly attributed to this plant, which it is now found not to be possessed of. Some however it has. The leaves are thrown into the vat with ale, to clarify it and give it a fla-

vour. Ale thus prepared is often drunk as an antiscorbutic. The expressed juice, mixed with a little wine, and applied morning and evening, is said to destroy specks upon horses' eyes. The plants that grow near it do not flourish. It is said to be hurtful to horses if they eat much of it. Sheep eat it; horses are not fond of it; cows, goats, and swine, refuse it.

GLEDITSIA, *triple-thorned acacia*, or *honey-locust*, a genus of the diœcia order, in the polygamia class of plants, and in the natural method ranking under the 33d order, lomentaceæ. The hermaphrodite calyx is quadrifid, the corolla tetrapetalous, the stamina six, one pistil and legumen. The male calyx is triphyllous; the corolla tripetalous, with six stamina. The female calyx is pentaphyllous; the corolla pentapetalous, one pistil and legumen.

There is one species. The triacanthos, a native of Virginia and Pennsylvania, is of an upright growth, and its trunk is guarded by thorns of three or four inches in length in a remarkable manner. These thorns have also others coming out of their sides at nearly right angles: their colour is red. The branches are smooth, and of a white colour. These are likewise armed with red thorns, that are proportionably smaller: they are of several directions, and at the ends of the branches often stand single. The young shoots of the preceding summer are perfectly smooth, of a reddish green, and retain their leaves often until the middle of November. Although there is a peculiar oddity in the nature and position of the spines, yet the leaves constitute the greatest beauty of these trees: they are doubly pinnated, and of a delightful shining green. The pinnated leaves that form the duplication do not always stand opposite by pairs on the middle rib; the pinnæ of which they are composed are small and numerous; no less than 10 or 11 pair belong to each of them; and as no less than four or five pair of small leaves are arranged along the middle rib, the whole compound leaf consists often of more than 200 pinnæ of this fine green colour. They sit close, and spread open in fine weather; though during bad weather they will droop, and their upper surfaces nearly join, as if in a sleeping state. The flowers are produced from the sides of the young branches in July: they are a greenish catkin, and make little show; though many are succeeded by pods that have a wonderful effect; for these are exceedingly large, more than a foot, sometimes a foot and a half in length, and two inches in breadth, and of a nut-brown colour when ripe, so that the effect, when hanging on the sides of the branches, may easily be imagined. We receive the seeds from America in the spring, which keep well in the pods, and are for the most part good. They generally arrive in February; and, as soon as possible after, they should be sown in a well-sheltered warm border of light sandy earth. If no border is to be found that is naturally so, it may be improved by applying drift sand, and making it fine. The seeds should be sown about half an inch deep, and they will for the most part come up the first spring. If the summer should prove dry, they must be constantly watered; and if shade could be afforded them in the heat of the day, they would make stronger plants by the autumn. A careful attention to this article is peculiarly requisite; for, as the ends of the branches are often killed, if the young plant has not made some progress, it will be liable to be wholly destroyed by the winter's frost, without protection: and this renders the sowing the seeds in a warm border under a hedge in a well-sheltered place necessary; for there these shrubs will endure our winters, even when seedlings, and so will require no farther trouble; nay, though the tops should be nipped, they will shoot out again lower, and will soon overcome it. It will be proper to let them remain two years in the seed-bed before they are planted out in the nursery. The spring is the best time for the work. These trees are late in the spring before they exhibit their leaves, but keep shooting long in the autumn.

GLINUS, a genus of the pentagynia order, in the decandria class of plants, and in the natural method ranking under the 22d class, caryophyllæi. The calyx is pentaphyllous; there is no corolla; the nectarium is composed of bifid bristles; the capsule is quinquangular, quinquelocular, quinquevalved, and polyspermous. There are three species, herbs of Arabia and the south of Europe.

GLIRES, the name given by Linnæus to the fourth order of the mammalia; the character of which is, fore-teeth cutting, two in each jaw; no tusks; feet with claws formed for running and bounding; food, bark, roots, vegetables, &c. which they gnaw. The order includes ten genera, viz. the hystrix, cavia, castor, mus, arctomys, sciurus, myoxus, dipus, lepus, and hyrax.

GLISTER, in surgery, the same with clyster.

GLOBBA, a genus of the monogynia order, in the monandria class of plants. The corolla is equal and trifid, the calyx trifid above, the capsule trilocular, with many seeds. There are four species, herbs of the East Indies.

GLOBE, in geometry, a round or spherical body, more usually called a sphere. See SPHERE.

GLOBE is more particularly used for an artificial sphere of metal, plaister, paper, or other matter, on whose convex surface is drawn a map or representation either of the earth or heavens, with the several circles conceived thereon.

Globes are of two kinds, terrestrial and celestial; each of very considerable use, the one in astronomy, and the other in geography, for performing many of the operations in an easy obvious manner, so as to be conceived without any knowledge of the mathematical grounds of those arts. The fundamental parts, common to both globes, are an axis, representing that of the world, and a spherical shell or cover, which makes the body of the globe, on the external surface of which the representation is drawn.

The globes commonly used are composed of plaister and paper in the following manner. A wooden axis is provided, somewhat less than the intended diameter of the globe, and into the extremes two iron wires are driven for poles: this axis is to be the beam or basis of the whole structure. On the axis are applied two spherical or rather hemispherical caps, formed on a kind of wooden mould or block. These caps consist of pasteboard or paper, laid one lay after another on the mould, to the thickness of a crown-piece; after which, having stood to dry and embody, making an incision along the middle, the two caps thus parted are slipped off the mould. They remain now to be applied on the poles of the axis, as before they were on those of the mould; and to fix them in their new place, the two edges are sewed together with packthread, &c.

The rudiments of the globe thus laid, they proceed to strengthen and make it smooth and regular. In order to this, the two poles are hasped in a metalline semicircle of the size intended; and a kind of plaister made of whiting, water, and glue, heated, melted, and incorporated together, is daubed all over the paper surface. In proportion as the plaster is applied, the ball is turned round in the semicircle, the edge of which pares off whatever is superfluous, and beyond the due dimension, leaving the rest adhering in places that are short of it. After such application of plaister, the ball stands to dry; which done it is put again in the semicircle, and fresh matter applied: thus they continue alternately to apply the composition and dry it, till the ball every where accurately touches the semicircle; in which state it is perfectly smooth, regular, and complete.

The ball thus finished, it remains to paste the map or description on it. In order to this, the map is projected in several gores or gussets, all which join accurately on the spherical surface, and cover the whole ball. To direct the application of these gores, lines are drawn by a semicircle on the surface of the ball, dividing it into a number of equal parts corresponding to those of the gores, and subdividing those again answerably to the lines and divisions of the gores.

The papers thus pasted on, there remains nothing but to colour and illuminate the globe, and to varnish it, the better to resist dust, moisture, &c. The globe itself thus finished, they hang it in a brass meridian, with an hour-circle and a quadrant of altitude, and thus fit it into a wooden horizon.

GLOBES, *use of*. By the assistance of the globes a great number of curious, useful, and entertaining problems are worked, some of which we shall proceed to describe. The globe consists of several parts: as (1) the two poles, being the ends of the axis on which the globe turns, representing the diurnal motion of the earth, and the apparent diurnal motion of the heavens. (2) The brazen meridian, on which are marked the degrees from the equator to the poles. (3) The wooden horizon or frame that supports the whole globe, on which are drawn several circles, as that on which the signs of the zodiac are marked; that containing the calendar or days of the month which correspond to the several degrees of the zodiac; and that on which are delineated the 32 points of the compass. (4) The hour-circle, divided into twice 12 hours, representing the division of time for the day and the night. And, (5) a thin slip of brass, called the quadrant of altitude, useful in several problems to measure the distances and directions of the places from each other.

There are ten principal circles represented upon globes, viz. six greater and four lesser ones. The greater circles are, the brazen

meridian, already described; the equinoctial, as it is called on the celestial, and equator on the terrestrial globe; the ecliptic drawn along the middle of the zodiac; and the two colures. The lesser circles, of principal use, are the two tropics and the two polar circles. Of these circles some are fixed, and always obtain the same position; others moveable, according to the position of the observer. The fixed circles are the equator and ecliptic, with their parallels and secondaries; which are usually delineated upon the surface of the globes. The moveable circles are the horizon, with its parallels and secondaries.

The horizon is that great and broad wooden circle surrounding the globe, and dividing it into two equal parts, called the upper and lower hemispheres. It has two notches, to let the brazen meridian slip up and down, according to the different heights of the pole. On the flat side of this circle are described the twelve signs, the months of the year, the points of the compass, &c. The brazen meridian is an annulus or ring of brass, divided into degrees. It divides the globe into two equal parts, called the eastern and western hemispheres. The quadrant of altitude is a thin pliable plate of brass, answering exactly to a quadrant of the meridian. It is divided into 90°, and has a notch, nut and screw, to fix to the brazen meridian in the zenith of any place, where it turns round a pivot, and supplies the room of vertical circles. The hour-circle is a flat ring of brass, divided into 24 equal parts or hour-distances; and on the pole of the globe is fixed an index that turns round with the globe, and points out the hours upon the hour-circle. Lastly, there are generally added a compass and needle upon the pediment of the frame.

The surface of the celestial globe may be esteemed a just representation of the concave expanse of the heavens, notwithstanding its convexity; for it is easy to conceive the eye placed in the centre of the globe, and viewing the stars on its surface, supposing it made of glass, as some globes are: also that if holes were made in the centre of each star, the eye in the centre of the globe, properly placed, would view through each of the holes the very stars in the heavens represented by them.

As it would be impossible to have any distinct notion of the stars, in respect to their number, order, and distances, without arranging them in certain forms, called constellations, this the first observers of the heavens took care to do; and these, like kingdoms and countries upon the terrestrial globe, serve to distinguish the different parts of the superficies of the celestial globe. The stars, therefore, are all disposed in constellations under the forms of various animals, whose names and figures are represented on the celestial globe, which were first invented by the antient astronomers and poets, and are still retained for the better distinction of these luminaries.

PROBLEMS ON THE CELESTIAL GLOBE.

1. *To rectify the globe:* that is, to place it in such a particular situation as is necessary for the solution of many problems. Raise or elevate the pole to the latitude of the place; screw the quadrant of altitude in the zenith; set the index of the hour-circle to the upper XII, and place the globe north and south by the compass and needle; then it is a just representation of the heavens for the given day at noon.

2. *To find the sun's place in the ecliptic.* Find the day of the month in the calendar on the horizon, and right against it is the degree of the ecliptic which the sun is in for that day.

3. *To find the sun's declination.* Rectify the globe, bring the sun's place in the ecliptic to the meridian, and that degree which it cuts in the meridian is the declination required.

4. *To find the sun's right ascension.* Bring the sun's place to the meridian, and the degree of the equinoctial cut by the meridian is the right ascension required.

5. *To find the sun's amplitude.* Bring the sun's place to the horizon, and the arch of the horizon intercepted between it and the east or west point, is the amplitude, north or south.

6. *To find the sun's amplitude for any given day and hour.* Bring the sun's place to the meridian, set the hour-index to the upper XII; then turn the globe till the index points to the given hour, where let it stand; then screwing the quadrant of altitude in the zenith, lay it over the sun's place, and the arch contained between it and the horizon will give the degrees of altitude required.

7. *To find the sun's azimuth for any hour of the day.* Every thing being done as in the last problem, the arch of the horizon contained between the north point and that where the quadrant of altitude cuts it, is the azimuth east or west as required.

8. *To find the time when the sun rises or sets.* Find the sun's place for the given day, bring it to the meridian, and set the hour-hand to XII; then turn the globe till the sun's place touches the east part of the horizon, the index will shew the hour of its rising; after that, turn the globe to the west part of the horizon, and the index will shew the time of its setting for the given day.

9. *To find the length of any given day or night.* This is easily known by taking the number of hours between the rising and setting of the sun for the length of the day; and the residue to 24, for the length of the night.

10. *To find the hour of the day, having the sun's altitude given.* Bring the sun's place to the meridian, and set the hour-hand to XII; then turn the globe in such a manner, that the sun's place may move along by the quadrant of altitude (fixed in the zenith) till it touches the degree of the given altitude, where stop it, and the index will shew on the horary circle the hour required.

11. *To find the place of the moon, or any planet, for any given day.* Take White's Ephemeris, and against the given day of the month you will find the degree and minute of the sign which the moon or planet possesses at noon, under the title of geocentric motions. The degree thus found being marked in the ecliptic on the globe by a small notch or otherwise, you may then proceed to find the declination, right ascension, latitude, longitude, altitude, azimuth, rising, southing, setting, &c. in the same manner as has been shewn for the sun.

12. *To explain the phænomena of the harvest moon.* In order to this we need only consider, that when the sun is in the beginning of Aries, the full moon on that day must be in the beginning of Libra: and since, when the sun sets or moon rises on that day, those equinoctial points will be in the horizon, and the ecliptic will then be least of all inclined thereto, the part or arch which the moon describes in one day, viz. 13°, will take up about an hour and a quarter ascending above the horizon; and, therefore, so long will be the time after sun-set, the next night, before the moon will rise. But at the opposite time of the year, when the sun is in the autumnal, and the full moon in the vernal, equinox, the ecliptic will, when the sun is setting, have the greatest inclination to the horizon; and, therefore, 13° will in this case soon ascend, viz. in about a quarter of an hour; and so long after sun-set will the moon rise the next day after the full: whence, at this time of the year, there is much more moonlight than in the spring; and hence this autumnal full moon came to be called the harvest moon, the hunter's or shepherd's moon; all which may be clearly shewn on the globe.

13. *To represent the face of the starry firmament for any given hour of the night.* Rectify the globe, and turn it about till the index points to the given hour; then will all the upper hemisphere of the globe represent the visible half of the heavens, and all the stars on the globe will be in such situations as exactly correspond to those in the heavens, which may therefore be easily found, as will be shewn in the 16th problem.

14. *To find the hour when any known star will rise, or come upon the meridian.* Rectify the globe, and set the index to XII; then turn the globe till the star comes to the horizon or meridian, and the index will shew the hour required.

15. *To find at what time of the year any given star will be on the meridian at* XII *at night.* Bring the star to the meridian, and observe what degree of the ecliptic is on the north meridian under the horizon; then find in the calendar on the horizon the day of the year against that degree, and it will be the day required.

16. *To find any particular star.* First find its altitude in the heavens by a quadrant, and the point of the compass it bears on; then, the globe being rectified, and the index turned to the given hour, if the quadrant of altitude is fixed on the zenith, and laid towards the point of the compass on which the star was observed, the star required will be found at the same degree of altitude on the said quadrant, as it was by observation in the heavens.

PROBLEMS ON THE TERRESTRIAL GLOBE.

1. *To find the latitude of any place.* Bring the given place to the brazen meridian, and observe what degree it is under, for that is the latitude required.

2. *To rectify the globe for any given place.* Raise the pole so many degrees above the horizon as are equal to the latitude of the place; then, finding the sun's place, bring it to the meridian, and proceed as directed in problem 1. on the celestial globe.

3. *To find the longitude of a given place.* Bring the place to the brazen meridian, and observe the degree of the equator under the same, for that expresses the longitude required.

4. *To find any place by the latitude and longitude given.* Bring the given degree of longitude to the meridian, and under the given degree of latitude you will see the place required.

5. *To find all those places which have the same latitude or longitude with those of any given place.* Bring the given place to the meridian; then all those places which lie under the meridian have the same longitude: again, turn the globe round on its axis; then all those places which pass under the same degree of the meridian with any given place have the same latitude with it.

6. *To find all those places where it is noon at any given hour of the day in any place.* Bring the given place to the meridian, set the index to the given hour; then turn the globe till the said index points to the upper XII, and observe what places lie under the brass meridian; for to them it is noon at that time.

7. *When it is noon at any one place, to find what hour it is at any other given place.* Bring the first given place to the meridian, and set the index to the upper XII; then turn the globe till the other given place comes to the meridian, and the index will point to the hour required.

8. *For any given hour of the day in the place where you are, to find the hour of the day in any other place.* Bring the place where you are to the meridian, set the index to the given hour, then turn the globe about; and when the other place comes to the meridian, the index will shew the hour of the day there as required.

9. *To find the distance between any two places in English miles.* Bring one place to the meridian, over which fix the quadrant of altitude; and then laying it over the other place, count the number of degrees thereon contained between them; which number multiply by 69½ (the number of miles in one degree), and the product is the number of English miles required.

10. *To find how any one place bears from another.* Bring one place to the brass meridian, and lay the quadrant of altitude over the other, and it will shew on the horizon the point of the compass on which the latter bears from the former.

11. *To find those places to which the sun is vertical in the torrid zone for any given day.* Find the sun's place in the ecliptic for the given time, and bring it to the meridian, and observe what degree thereof it cuts; then turn the globe about, and all those places which pass under that degree of the meridian, are those required.

12. *To find what day of the year the sun will be vertical to any given place in the torrid zone.* Bring the given place to the meridian, and mark the degree exactly over it; then turn the globe round, and observe the two points of the ecliptic which pass under that degree of the meridian: lastly, see on the wooden horizon on what days of the year the sun is in those points of the ecliptic; for those are the days required.

13. *To find those places in the north frigid zone where the sun begins to shine constantly without setting, on any given day between the 21st of March and the 21st of June.* Find the sun's place in the ecliptic for the given day, bring it to the brazen meridian, and observe the degrees of declination; then all those places which are the same number of degrees distant from the pole are the places required to be found.

14. *To find on what day the sun begins to shine constantly without setting, on any given place in the north frigid zone, and how long.* Rectify the globe to the latitude of the place, and, turning it about, observe what point of the ecliptic between Aries and Cancer, and also between Cancer and Libra, coincides with the north point of the horizon; then find, by the calendar on the horizon, what days the sun will enter those degrees of the ecliptic, and they will satisfy the problem.

15. *To find the place over which the sun is vertical on any given day and hour.* Find the sun's place, and bring it to the meridian, and mark the degree of declination for the given hour; then find those places which have the sun in the meridian at that moment; and among them that which passes under the degree of declination is the place desired.

16. *To find, for any given day and hour, those places wherein the sun is then rising and setting, or on the meridian; also those places which are enlightened, and those which are not.* Find the place to which the sun is vertical at the given time, and bring the same to the meridian, and elevate the pole to the latitude of the place; then all those places which are in the western semicircle of the horizon have the sun rising, and those in the eastern semicircle see it setting; and to those under the meridian it is noon. Lastly, all places above the horizon are enlightened, and all below it are in darkness or night.

17. *The day and hour of a solar or lunar eclipse being given, to find all those places in which the same will be visible.* Find the place to which the sun is vertical at the given instant, and elevate the globe to the latitude of the place; then in most of those places above the horizon will the sun be visible during his eclipse; and all those places below the horizon will see the moon pass through the shadow of the earth in her eclipse.

18. *The length of a degree being given, to find the number of miles in a great circle of the earth, and thence the diameter of the earth.* Admit that one degree contains 69½ English statute miles; then multiply 360 (the number of degrees in a great circle) by 69½, and the product will be 25020, the miles which measure the circumference of the earth. If this number be divided by 3.14 16, the quotient will be 7963 $\frac{86}{100}$ miles for the diameter of the earth.

19. *The diameter of the earth being known, to find the surface in square miles, and its solidity in cubic miles.* Admit the diameter to be 7964 miles; then multiply the square o the diameter by 3.1416, and the product will be 199250205 very near, which are the square miles in the surface of the earth. Again, multiply the cube of the diameter by 0.5236, and the product 264466789170 will be the number of the cubic miles in the whole globe of the earth.

20. *To express the velocity of the diurnal motion of the earth.* Since a place in the equator describes a circle of 25020 miles in 24 hours, it is evident, that the velocity with which it moves is at the rate of 1042½ in one hour, or 17$\frac{3}{10}$ miles per minute. The velocity in any parallel of latitude decreases in the proportion of the co-sine of the latitude to the radius. Thus for the latitude of London, 51° 30′, say,

As radius	10.000000
To the co-sine of lat. 51° 30′	9.794149
So is the velocity in the equator, 17$\frac{3}{10}$′	1.232046
To the velocity of the city of London, 10$\frac{8}{10}$′	1.032195

That is, the city of London moves about the axis of the earth at the rate of 10 $\frac{8}{10}$ miles every minute of time.

GLOBULAR CHART, a name given to the representation of the surface, or of some part of the surface, of the terrestrial globe upon a plane, wherein the parallels of latitude are circles nearly concentric, the meridian curves bending towards the poles, and the rhomb-lines are also curves.

GLOBULAR SAILING. See SAILING.

GLOBULARIA, *globular blue daisy*, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 48th order, aggregatæ. The common calyx is imbricated, the proper one tubulated inferior, the upper lip of the florets bipartite, the under one tripartite, the receptacle paleaceous. There are eight species, but one only is commonly to be met with in our gardens, viz. the vulgaris, or common blue daisy. It has broad thick radical leaves, three-parted at the ends, upright stalks from about six to ten or twelve inches high, with spear-shaped leaves, and the top crowned by a globular head of fine blue flowers, composed of many florets in one cup. It flowers in June, and makes a good appearance, but thrives best in a moist shady situation. It is propagated by parting the roots in September.

GLORIOSA, *superb lily*, a genus of the hexandria monogynia class of plants, the flower of which consists of six oblongo-lanceolated, undulated, and very long petals, reflex nearly to the base: the fruit is an oval pellucid capsule, containing three cells, and numerous globose seeds, disposed in a double series. There are two species, herbaceous plants of Guinea.

GLOSSOMA, a genus of the tetrandria monogynia class and order. The calyx is turbinate, four-toothed, superior; corolla four-petalled; antheras almost united with membranaceous scales at the end; stigmas four; drupe. There is one species, a shrub of Guiana.

GLOSSOPETALUM, a genus of the pentandria pentagynia class and order. The calyx is five-toothed; petals five, with a strap at the tip of each berry. There are two species, trees of Guiana.

GLOSSOPETRA, in natural history, a genus of extraneous fossils, so called from their having been supposed the tongues of serpents turned to stone, though they are really the teeth of sharks, and are found in the mouths of those fishes, wherever taken. The several sizes of teeth of the same species and the several different species of sharks, furnish us with a vast variety of these fossile teeth. Their usual colours are black, bluish, whitish, yellowish, or brown. In shape they are commonly somewhat approaching to triangular; some are simple, and others have a smaller point on each side the larger one; many of them are quite straight, but they are frequently met with crooked, and bent in all the different directions, some inwards,

some outwards, and some sideways: they are also of various sizes, the larger ones being four or five inches long, and the smaller less than a quarter of an inch. They are found with us in the strata of blue clay, and are very plentiful in the clay-pits of Richmond, and some other places; but they are no where so common as in the island of Malta.

GLOTTIS. See ANATOMY.

GLOVE, a covering for the hand and wrist. Gloves, with respect to commerce, are distinguished into leathern, silk, thread, cotton, worsted, &c. Leathern gloves are made of chamois, kid, lamb, doe, elk, buff, &c. To throw the glove, was a practice or ceremony very usual among our forefathers, being the challenge whereby another was defied to single combat. It is still retained at the coronation of our kings, when the king's champion casts his glove in Westminster-hall. Favyn supposes the custom to have arisen from the Eastern nations, who, in all their sales and deliveries of lands, goods, &c. used to give the purchaser their glove by way of livery or investiture. To this effect he quotes Ruth iv. 7. where the Chaldee paraphrase calls *glove* what the common version renders by *shoe*. He adds, that the rabbins interpret by *glove* that passage in the cviiith Psalm, In Idumean extendam calceamentum meum, "Over Edom will I cast my shoe." Accordingly, among us, he who took up the glove declared thereby his acceptance of the challenge; and as a part of the ceremony, continues Favyn, took the glove off his own right hand and cast it upon the ground, to be taken up by the challenger. This had the force of a mutual engagement on each side, to meet at the time and place which should be appointed by the king, parliament, or judges. The same author asserts, that the custom which once obtained of blessing gloves in the coronation of the kings of France, was a remain of the Eastern practice of giving possession with the glove, l. xvi. p. 1017, &c. Antiently it was prohibited the judges to wear gloves on the bench; and at present, in the stables of some princes, it is said to be unsafe going in without pulling off the gloves.

GLOW-WORM. See CICINDELA.

GLOXINIA, a genus of the didynamia angiospermia class and order. The calyx is superior, five-leaved; corolla bell-shaped, with the border oblique; filaments with the rudiment of a fifth inserted into the receptacle. There is one species, a herb of South America.

GLUCINA, a new earth, discovered in 1798, in the mountains of Siberia. According to the experiments of Vauquelin and Klaproth, we learn that

1. To obtain glucina pure, the beryl or emerald reduced to powder, is to be fused with thrice its weight of potass. The mass is to be diluted with water, dissolved in muriatic acid, and the solution evaporated to dryness. The residuum is to be mixed with a great quantity of water, and the whole thrown on a filtre. The silica, which constitutes more than half the weight of the stone, remains behind; but the glucina and the other earths, being combined with muriatic acid, remain in solution. Precipitate them by means of carbonat of potass. Wash the precipitate, and then dissolve it in sulphuric acid. Add to the solution sulphat of potass; evaporate it to the proper consistence, and set it by to crystallize. Alum crystals gradually form. When as many of these as possible have been obtained, pour in the liquid carbonat of ammonia in excess, then filtre, and boil the liquid for some time. A white powder gradually appears, which is glucina.

2. Glucina, thus obtained, is a soft light white powder, without either taste or smell, which has the property of adhering strongly to the tongue. It has no action on vegetable colours. It is altogether infusible by heat; neither does it harden or contract in its dimensions, as is the case with alumina. Its specific gravity is 2.967.

It is insoluble in water, but forms with a small quantity of that liquid a paste which has a certain degree of ductility.

3. It does not combine with oxygen nor any of the simple combustibles; but sulphurated hydrogen dissolves it, and forms with it a hydrosulphurat, similar to other hydrosulphurats in its properties.

4. Azote has no action on it; but muriatic acid dissolves it, and forms with it a sweet-tasted salt, called muriat of glucina.

5. Glucina is soluble in the liquid fixed alkalies, in which it agrees with alumina. It is insoluble in ammonia, but soluble in carbonat of ammonia, in which respect it agrees with yttria; but it is about five times more soluble in carbonat of ammonia than that earth.

It combines with all the acids, and forms with them sweet-tasted salts, as is the case also with yttria.

GLUE, among artificers, a tenacious viscid matter, which serves as a cement to bind or connect things together. See GELATINE.

GLUTA, a genus of the class and order pentandria monogynia. The calyx is bell-shaped, deciduous; petals five; filaments inserted into the tip of the column; germ sitting in an oblong column. There is one species, a tree of Java.

GLUTÆUS. See ANATOMY.

GLUTEN. If wheat flour is kneaded into paste with a little water, it forms a tenacious, elastic, soft, ductile mass. This is to be washed cautiously, by kneading it under a small jet of water till the water no longer carries off any thing, but runs off colourless; what remains behind is called gluten. It was discovered by Beccaria, an Italian philosopher, to whom we are indebted for the first analysis of wheat flour.

1. Gluten, when thus obtained, is of a grey colour, exceedingly tenacious, ductile, and elastic, and may be extended to twenty times its original length. When very thin, it is of a whitish colour, and has a good deal of resemblance to animal tendon or membrane. In this state it adheres very tenaciously to other bodies, and has often been used to cement together broken pieces of porcelain. Its smell is peculiar. It has scarcely any taste, and does not lose its tenacity in the mouth. When exposed to the air, it assumes a brown colour, and becomes in a manner covered with a coat of oil.

When exposed to the air, it gradually dries; and when completely dry, it is pretty hard, brittle, slightly transparent, of a dark-brown colour, and has some resemblance to glue. It breaks like a piece of glass, and the edges of the fracture resemble in smoothness those of broken glass; that is, it breaks with a vitreous fracture.

It is insoluble in water, though it imbibes and retains a certain quantity of it with great obstinacy. To this water it owes its elasticity and tenacity. When boiled in water it loses both these properties.

When kept moist, it very soon begins to decompose, and to undergo a species of fermentation. It swells, and emits air-bubbles, which Proust has ascertained to consist of hydrogen and carbonic acid gases. It emits also a very offensive odour, similar to what is emitted by putrefying animal bodies. Cadet kept gluten for a week in a damp room. Its surface became covered with byssi, the fermentation just mentioned had commenced, and the odour was distinctly acid. In 24 days, on removing the upper crust, the gluten was found converted into a kind of paste, of a greyish-white colour, not unlike birdlime. In that state he gave it the name of fermented gluten. If the gluten is still left to itself, it gradually acquires the smell and the taste of cheese. This curious fact was first ascertained by Rouelle junior, to whom we are indebted for the most important dissertation on gluten which has yet appeared. In that state it is full of holes, and contains the very same juices which distinguish some kinds of cheese. Proust ascertained that it contains ammonia and vinegar; bodies which Vauquelin detected in cheese: and ammonia robs both equally of their smell and flavour.

When moist gluten is suddenly dried, it swells amazingly. Dry gluten, when exposed to heat, cracks, swells, melts, blackens, exhales a fetid odour, and burns precisely like feathers or horn. When distilled, there comes over water impregnated with ammonia and an empyreumatic oil; the charcoal which remains is with difficulty reduced to ashes.

2. Gluten is insoluble in water; it is equally insoluble in alcohol and in ether. But when the fermented gluten of Cadet is triturated with a little alcohol into a mucilage, and then mixed with a sufficient quantity of that liquid, a portion of it is dissolved. This solution constitutes an excellent varnish, possessed of considerable elasticity. It may be spread over paper or wood; and when dry resists other bodies as well as most varnishes. In this state too it may be employed to cement china; and triturated with paints, especially vegetable colours, it forms a very good ground. When this solution is mixed with a sufficient quantity of lime, it forms a very good lute; and bits of linen dipt in it adhere very strongly to other bodies.

All the acids dissolve it, even when very much diluted; alkalies precipitate it again, but it is deprived of its elasticity, and brought nearer to the state of extractive matter. Concentrated sulphuric acid renders it violet-coloured, and at last black; inflammable air escapes, and charcoal, water, and a portion of ammonia, are formed. When nitric acid is poured on it, and heat applied, there is a quantity of azotic gas emitted, as Berthollet discovered; and by continuing the heat, some little oxalic acid is formed, and like-

wise malic acid, while a number of yellow-coloured oily flakes make their appearance in the solution. Acetic acid acts but imperfectly, but it dissolves the fermented gluten of Cadet; and the solution may be substituted for the solution in alcohol as a varnish; but it does not answer to mix it with colours.

Alkalies dissolve gluten when they are assisted by heat. The solution is never perfectly transparent. Acids precipitate the gluten from alkalies, but it is destitute of its elasticity. Alkalies, when much concentrated, form with it a kind of soap, converting it into oil and ammonia, which last is dissipated during the trituration.

The action of the metallic oxides and their salts upon gluten has not been tried.

It has a strong affinity for the colouring matter of vegetables, and likewise for resinous bodies.

3. The properties of this substance clearly point out a resemblance between it and animal matter; and the phenomena of its fermentation and destructive distillation shew us that oxygen, hydrogen, carbon, and azote, are constituents of it. Proust has observed, that the vapour which it emits, while fermenting, blackens silver and lead, and of course contains sulphur.

4. Like all other vegetable principles, gluten is susceptible of various shades of properties, which constitute so many species. In wheat flour, it occurs in the greatest abundance, and from it we can extract it with the greatest ease. But the sagacity and industry of Rouelle and Proust have detected its presence in many other vegetable substances. Rouelle found it in the leaves of all the vegetable substances which he examined. The exactness of this opinion was called in question by Fourcroy, who treated the experiments of Rouelle with contempt; but it has been lately examined and confirmed by very decisive experiments of Proust.

When the juice of cabbage-leaves, cresses, scurvy-grass, and other similar plants, is extracted by pressure, and passed through a cloth, it still continues far from transparent. Its muddiness is owing to a fine soft silky green powder suspended in it, which subsides to the bottom so slowly as to take at least a week before it is deposited. This green powder has been distinguished by the name of the green fecula of plants. Rouelle first examined it with attention, and ascertained its properties; and the subject has been carried still farther by Proust. The slowness with which it subsides shows that its specific gravity does not differ much from that of water. When once it has fallen, it is insoluble. This substance consists chiefly of three principles: 1. A green matter to which it owes its colour, separated by digestion in alcohol, and which possesses the properties of a resin. 2. A substance which consists chiefly of woody fibres, and which is left behind when the fecula is digested in potass. 3. A species of gluten, which constitutes the greatest part of it, and to which it owes its characteristic properties.

When the juice of the plants is exposed to a heat of about 130°, the green fecula undergoes a kind of coagulation, concreting into large flakes, which subside very quickly. At this temperature, albumen is not altered by heat. This is the method commonly taken to clarify these juices. We see from it, that the fecula was united to the water by a very small force, which the addition of heat weakened sufficiently to enable the gluten to cohere. This coagulation by heat takes place how diluted soever the juices are with water, which is by no means the case with albumen. It is thrown down also by the addition of a little alcohol, by all acids, by ammonia, by sulphurated hydrogen gas, or by throwing into the liquid crystals of carbonat of potass, magnesia, common salt, muriat of potass, nitre, sal ammoniac, &c.

When separated from water, it soon dries, and becomes elastic, and has somewhat of the appearance of horn; and in that state is scarcely softened by hot water. When treated like gluten, it gradually acquires the cheesy taste and smell. When kept under water, it very soon begins to putrefy, and exhales a gas which blackens silver and solutions of lead. This speedy putrefaction in stagnant water takes place when flax and hemp are steeped. These substances contain green fecula in their rind, and the putrefaction occasions the separation of the whole, which could not otherwise be accomplished. The water which has been allowed to remain for a whole year over green fecula, contains sulphurated hydrogen, carbonat of ammonia, and gluten seemingly held in solution by the ammonia. The stench of putrefaction still continues even after the water has been boiled.

5. The number of plants containing gluten is very considerable. Proust found it in acorns, chesnuts, horse-chesnuts, rue, barley, rye, peas, and beans; and in apples and quinces. He found it also in the leaves of cabbage, sedums, cress, hemlock, borage, saffron, &c.; in the berries of the elder, the grape, &c.; in the petals of the rose, &c. It occurs also in several roots. Proust could find none in the potatoe.

6. Gluten must be considered as one of the most useful of the vegetable principles. It constitutes an essential ingredient in wheat, and is the substance which renders flour of wheat so fit for forming bread. It seems also to constitute the essential part of yeast. Its uses as a varnish, a ground for paint, &c. pointed out by Cadet, likewise deserve attention. The gluten of wheat is said, in many cases at least, to constitute the base of the substance called birdlime; though that substance is supposed to be a preparation obtained from the bark of the elm, &c. and in that case is, according to Proust, a kind of turpentine or resin, soluble in alcohol, and not in the least resembling gluten.

GLYCONIAN VERSE, in antient poetry, consists of three feet, whereof the first is a spondee, the second a choriambus, and the last a pyrrhichius; or the first may be a spondee, and the other two dactyls.

Thus, *Mens re- | gnum bona pos- | sidet.*
or, *Mens re- | gnum bona | possidet.*

GLYCINE, *knobbed-rooted liquorice-vetch*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is bilabiate; the carina of the corolla turning back the vexillum with its point. There are 25 species, one of which is commonly cultivated in our gardens, the frutescens, or Carolina kidney-bean tree. This has shrubby climbing stalks, twining round any support, 15 or 20 feet high, adorned with pinnated leaves of three pair of follicles terminated by an odd one, and from the axillas clusters of large blueish-purple flowers, succeeded by long pods like those of the climbing kidney-bean. It flowers in June and July, but the seeds do not ripen in this country. It is easily propagated, either by seeds imported from America, where it is native, or by layers.

The glycine coccinea is an elegant little plant, lately introduced into our stoves, and easily propagated by seed, which it perfects in this country.

GLYCIRRHIZA, *liquorice*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32d order, papilionaceæ. The calyx is bilabiate; the upper lip tripartite, and the under one entire; the legumen ovate and compressed. There are four species. The glabra,-or common liquorice, has a long, thick, creeping root, striking several feet deep into the ground; upright, firm, herbaceous stalks annually, three or four feet high, with winged leaves of four or five pair of oval lobes, terminated by an odd one; and from the axillas erect spikes of pale-blue flowers in July, succeeded by short smooth pods. The root of this is the useful part, which is replete with a sweet, balsamic, pectoral juice, much used in all compositions for coughs and disorders of the stomach. The echinata, or prickly-podded liquorice, is nearly like the common sort, only the seed-pods are prickly. Both these species are very hardy perennials; but the first is the sort commonly cultivated for use, its roots being fuller of juice and sweeter than the other. The roots are perennial; but the stalks rise in spring and decay in autumn.

Their propagation is effected by cuttings of the small roots issuing from the sides of the main ones near the surface of the earth, dividing them into lengths of six or eight inches, each having one or more good buds or eyes; and the proper season for procuring the sets for planting is any time in open weather from October till March, though from the middle of February till the middle of March is rather the most successful season for planting. An open situation is the most suitable for a plantation of these plants. Particular regard should also be had to the soil; it ought to be of a light loose composition, and three or four feet deep if possible; for the roots of the liquorice will arrive at that depth and more, and the longer the roots the more valuable they are for sale by weight.

In three years after planting, the roots of the liquorice will be fit to take up; and the proper season for this is, any time from the beginning of November till February; for it should neither be taken up before the stalks are fully decayed, nor deferred till late in spring, otherwise the roots will be apt to shrivel, and diminish in weight. In taking them up, the small side-roots are trimmed off, and the best divided into lengths for fresh sets, and the main roots are tied in bundles ready for sale.

Liquorice is almost the only sweet that quenches thirst; whence it was called by the Greeks adipson. Galen takes notice, that it was employed in this intention in hydropic

cases, to prevent the necessity of drinking. Mr. Fuller, in his Medicina Gymnastica, recommends this root as a very useful pectoral; an assertion warranted by experience. An extract is directed to be made from it in the shops; yet this preparation is chiefly brought from abroad, though the foreign extract is not the best.

GMELINA, a genus of the angiospermia order, in the didynamia class of plants, and in the natural method ranking under the 40th order, personatæ. The calyx is nearly quadridentated; the corolla campanulated or bell-shaped; there are two bipartite and two simple antheræ; the fruit is a plum with a bilocular kernel. There is one species, a tree of Malabar.

GNAPHALIUM, *cudweed, goldy locks, eternal flower*, &c. a genus of the polygamia superflua order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked; the pappus feathered; the calyx imbricated, with the marginal scales roundish, parched, and coloured. There are 66 species; the most remarkable of which are: 1. The margaritaceum, or pearly-white eternal flower, has creeping, very spreading roots, crowned with broad, spear-shaped, white, hoary leaves; herbaceous, thick, woolly stalks, a foot and a half high, branching outward, with long, acute-pointed, white, woolly leaves, and terminated by a corymbose cluster of yellowish flowers, which appear in June and July, and are very ornamental. 2. The plantaginium has large woolly radical leaves, decumbent running roots, and herbaceous simple stalks, rising six or eight inches, terminated by a corymbus of white flowers in June, July, &c. 3. The stechas has a shrubby stalk, dividing into slender branches three feet long, terminated by corymbose clusters of yellow flowers, appearing in May and June. 4. The orientale has three varieties, with yellow, gold-coloured, and white silvery flowers. They have shrubby stalks, rising two or three feet high. 5. The odoratissimum, or sweet-scented eternal flower, has shrubby winged stalks, branching irregularly a yard high, with corymbose clusters of bright-yellow flowers, changing to a dark yellow. 6. The arboreum, or tree gnaphalium, has a woody stem, branching four or five feet high, narrow sessile leaves, with revolute borders, smooth on their upper side, and roundish bunches of pale-yellow flowers. The first three sorts are hardy, and will thrive in any soil or situation. The first two increase exceedingly by their roots; and the third is easily propagated by slips. The fourth, fifth, and sixth sorts are somewhat tender, and therefore should be kept in pots, to be sheltered in a greenhouse or garden-frame in winter. Others may be planted in the full ground, in a dry and warm situation, especially the oriental kind and varieties, and likewise the sweet-scented kind; for these two species will struggle tolerably through an ordinary winter, and make a pretty appearance during the summer months. All these are propagated by slips or cuttings of their shoots. The flowers of all these species are remarkable for retaining their beauty for years, if carefully gathered in a dry day, soon after they are blown.

GNAT. See CULEX.

GNEISS, in mineralogy, is composed essentially of felspar, quartz, and mica, forming plates which are laid on each other, and separated by thin layers of mica. It differs from granite in being shistose. Gneiss rocks are usually stratified. Like granite, it sometimes contains shorl and garnet. The beds of gneiss sometimes alternate with layers of granular limestone, shistose, hornblende, and porphyry. It is rich in ores, almost every metal having been found in gneiss rocks, either in veins or beds.

GNETUM, a genus of the monadelphia order, in the monœcia class of plants. The amentum of the male is a single scale; there is no corolla, and but one filament with a pair of antheræ. The calyx of the female is of the same form; there is no corolla; the style with the stigma is trifid; the fruit a monospermous plum. There is one species, a herb of the East Indies.

GNIDIA, a genus of the monogynia order, in the octandria class of plants. The calyx is funnel-shaped and quadrifid, with four petals inserted into it; there is one seed somewhat resembling a berry. There are 11 species, shrubs of the Cape.

GNOMON, in dialling, the style, pin, or cock of a dial, which by its shadow shews the hour of the day. The gnomon of every dial represents the axis of the world. See DIAL and DIALLING.

GNOMON, in geometry. If in a parallelogram ABCD (plate Miscel. fig. 103.) the diameter AC be drawn; also two lines EF, HI, parallel to the sides of the parallelogram, and cutting the diameter in one and the same point G, so that the parallelogram is, by these parallels, divided into four parallelograms, then are the two parallelograms DG, BG, through which the diameter does not pass, called complements; those through which the diameter passes, EH, FI, are called the parallelograms about the diameter; and a gnomon consists of the two complements, and either of the parallelograms about the diameter, viz. GD + HE + EI, or GD + FI + GB.

GNOMON, in astronomy, a style erected perpendicular to the horizon, in order to find the altitude of the sun. Thus, in the right-angled triangle ABC, fig. 104., are given AB the length of the style, BC the length of its shadow, and the right angle ABC. Hence, making CB the radius, we have this analogy for finding the angle ACB, the sun's altitude, viz. BC : AB : : radius : tangent of the angle C. By means of a gnomon, the sun's meridian altitude, and consequently the latitude of the place, may be found more exactly than with the smaller quadrants. See QUADRANT.

By the same instrument the height of any object GH may be found; for as DF (fig. 105) the distance of the observer's eye from the gnomon, is to DE, the height of the style, so is FH, the distance of the observer's eye from the object, to GH its height.

The following example will serve to illustrate the above proposition. Pliny says, that at Rome, at the time of the equinoxes, the shadow is to the gnomon as 8 to 9.; therefore as 8 : 9 : : 1 or radius : $\frac{9}{8} = 1{\cdot}125$ a tangent, to which answers the angle 48° 22′, which is the height of the equator at Rome, and its complement 41° 38′ is therefore the height of the pole, or the latitude of the place.

Riccioli remarks the following defects in the observations of the sun's height, made with the gnomon by the antients, and some of the moderns, viz. that they neglected the sun's parallax, which makes his apparent altitude less, by the quantity of the parallax, than it would be if the gnomon were placed at the centre of the earth: 2d, they neglected also the refraction, by which the apparent height of the sun is a little increased: and 3dly, they made the calculations from the length of the shadow, as if it were terminated by a ray coming from the centre of the sun's disc, whereas the shadow is really terminated by a ray coming from the upper edge of the sun's disc; so that, instead of the height of the sun's centre, their calculations gave the height of the upper edge of his disc: and, therefore, to the altitude of the sun found by the gnomon, the sun's parallax must be added, and from the sum must be subtracted the sun's semidiameter, and refraction, which is different at different altitudes; which being done, the correct height of the equator at Rome will be 48° 4′ 12″, the complement of which, or 41° 55′ 46″, is the latitude.

The preceding problem may be resolved more accurately by means of a ray of light let in through a small hole, than by a shadow, thus: make a circular perforation in a brass plate EF (fig. 106.) to transmit enough of the sun's rays to exhibit his image on the floor, or a stage; fix the plate parallel to the horizon in a high place, proper for observation, the height of which above the floor let be accurately measured with a plummet. Let the floor, or stage, be perfectly plane and horizontal, and coloured over with some white substance, to shew the sun more distinctly. Upon this horizontal plane draw a meridian line passing through the foot or the centre of the gnomon, AG, *i. e.* the point upon which the plummet falls from the centre of the hole; and upon this line note the extreme points I and K of the sun's image or diameter, and from each end subtract the image of half the diameter of the aperture, viz. KH and LI; then will HL be the image of the sun's diameter, which, when bisected in B, gives the point on which the rays fall from the centre of the sun.

Now having given the line AB, and the altitude of the gnomon AG, besides the right angle A, the angle B, or the apparent altitude of the sun's centre, is easily found, thus: as AB : AG : : radius : tang. angle B.

GNOSTICS, in church-history, christians so called, it being a name which almost all the antient heretics affected to take to express that new knowledge and extraordinary light to which they made pretensions; the word gnostic signifying a learned or enlightened person.

GOAT. See CAPRA.

GOAT-SUCKER. See CAPRIMULGUS.

GOBIUS, GOBY, in ichthyology, a genus of fishes belonging to the order of thoracici. The generic character is, head small; eyes approximated; gill-membrane four-rayed; ventral fins united into the form of a funnel. There are eight species, of which the following are the principal.

1. Gobius niger. Common goby. This species grows to the length of six inches; the

body is soft, slippery, and of a slender form; the head rather large; the cheeks inflated; the teeth small, and disposed in two rows; from the head to the first dorsal fin is a small furrow; the first dorsal fin consists of six rays, the second, according to Linnæus, of fourteen; the pectoral of sixteen or seventeen, closely set together, and the middlemost the longest; the others on each side gradually shorter; the ventral fins coalesce, and form a sort of funnel, by which these fish are said to affix themselves immoveably to the rocks, for which reason they are called by the name of rock-fish; the tail is rounded at the end; the general colour of the fish is dusky or blackish; but this, on close inspection, is owing to numerous small dusky or blackish specks, accompanied by brown or olive-coloured bars and clouds disposed on a whitish ground; the dorsal and anal fins are of a pale blue; the rays marked with minute black spots. This fish is a native of the Mediterranean and northern seas, and sometimes enters the mouths of the larger rivers, particularly in the beginning of summer, at which season it deposits its spawn on stones near the shores. It is in the number of edible fish, but is in no particular estimation.

2. Gobius lanceolatus. Lance-tailed goby. This species is distinguished by the peculiar form of its tail, which is large in proportion to the animal, and sharp-pointed at the tip; the body is of a lengthened shape, and nearly of equal diameter throughout; the head is oblong, and truncated in front; the jaws of equal length, and armed with sharp teeth; the gill-covers consist of two small laminæ, and the opening of the gills is large; the vent is situated much nearer the head than the tail; the body is covered with scales, of which those toward the tail are much larger than those on the upper parts. This is a West Indian species: it is found in the rivers of Martinique and some other islands.

3. Gobius cæruleus. Blue goby. Described by Cepede from Commerson. A highly beautiful, though very small, species; colour fine blue, rather paler beneath; tail red, with a black border; length about a decimetre; mouth obtuse; teeth in the lower jaw sharp, and rather longer than those of the upper; eyes rather more distant than in others of the genus; body covered with small rough scales; first dorsal fin triangular, with the rays terminating in lengthened filaments; second dorsal terminated by a ray of twice the length of the rest; vent placed nearly in the middle of the body; tail rounded. Inhabits the seas about the eastern coasts of Africa, where it is used by the negroes as a bait for other fish. From the brilliancy of its colours it appears, when swimming in a calm sea, during a bright sunshine, like a small tube of sapphire, tipped with carbuncle.

4. Gobius jozo. Blue-finned goby. This species grows to the length of four or six inches, and is principally distinguished by the blue colour of its fins, and the streaks on the first dorsal fin; the jaws are of equal length, and armed with small sharp teeth; the lateral line runs in a straight direction along the middle of the body. It is a native of the Mediterranean and the Baltic, and commonly frequents the muddy shores, living on sea-insects, &c. It deposits its spawn on the soft mud; and though very prolific, is not observed to be very numerous, owing to the small fry becoming the prey of other fishes; as a food it is held in little or no esteem.

GODFATHERS and GODMOTHERS, persons who at the baptism of infants lay themselves under an indispensable obligation to instruct them, and watch over their conduct. This custom is of great antiquity in the christian church, and was probably instituted to prevent children being brought up in idolatry, in case their parents died before they arrived at years of discretion. The number of godfathers and godmothers is reduced to two in the church of Rome, and three in the church of England; but formerly they had as many as they pleased.

GOLD. See AURUM, and CHEMISTRY.

GOLD-WIRE, a cylindrical ingot of silver, superficially gilt, or covered with gold at the fire, and afterwards drawn successively through a great number of little round holes, of a wiredrawing-iron, each less than the other, till it is sometimes no bigger than a hair of the head. See WIREDRAWING.

It may be observed, that before the wire is reduced to this excessive fineness, it is drawn through above 140 different holes, and that each time they draw it, it is rubbed afresh over with new wax, both to facilitate its passage, and to prevent the silver appearing through it.

GOLD-WIRE, *flatted*, is the former wire flatted between two rollers of polished steel, to fit it to be spun on a stick, or to be used flat, as it is without spinning, in certain stuffs, laces, embroideries, &c.

GOLD-THREAD, or *spun-gold*, is a flatted gold, wrapped or laid over a thread of silk, by twisting it with a wheel and iron bobbins.

Manner of forming gold-wire and gold-thread, both round and flat. First, an ingot of silver, of 24 pounds, is forged into a cylinder, of about an inch in diameter; then it is drawn through eight or ten holes, of a large coarse wiredrawing-iron, both to finish the roundness, and to reduce it to about three-fourths of its former diameter. This done, they file it very carefully all over to take off any filth remaining from the forge; they then cut it in the middle: and thus make two equal ingots thereof, each about 26 inches long, which they draw through several new holes, to take off any inequalities the file may have left, and to render it as smooth and equable as possible.

The ingot thus far prepared, they heat it in a charcoal fire; then taking some gold-leaves, each about four inches square, and weighing twelve grains, they join four, eight, twelve, or sixteen of these, as the wire is intended to be more or less gilt; and when they are so joined as only to form a single leaf, they rub the ingots reeking-hot with a burnisher. These leaves being thus prepared, they apply over the whole surface of the ingot, to the number of six, over each other, burnishing or rubbing them well down with the blood-stone, to close and smooth them. When gilt, the ingots are laid anew in a coal fire; and when raised to a certain degree of heat, they go over them a second time with the blood-stone, both to solder the gold more perfectly, and to finish the polishing. The gilding finished, it remains to draw the ingot into wire.

In order to this, they pass it through 20 holes of a moderate drawing-iron, by which it is brought to the thickness of the tag of a lace: from this time the ingot loses its name, and commences gold-wire. Twenty holes more of a lesser iron leave it small enough for the least iron; the finest holes of which last, scarcely exceeding the hair of the head, finish the work.

To dispose the wire to be spun on silk, they pass it between two rollers of a little mill; these rollers are of nicely polished steel, and about three inches in diameter. They are set very close to each other, and turned by means of a handle fastened to one of them, which gives motion to the other. The gold-wire in passing between the two is rendered quite flat, but without losing any thing of it gilding, and is rendered so exceedingly thin and flexible, that it is easily spun on silk thread, by means of a hand-wheel, and so wound on a spool or bobbin.

GOLD-*beating*. They first melt a quantity of pure gold, and form it into an ingot: this they reduce, by forging, into a plate about the thickness of a sheet of paper; which done, they cut the plate into little pieces about an inch square, and lay them in the first or smallest mould to begin to stretch them; after they have been hammered here a while with the smallest hammer, they cut each of them into four, and put them into the second mould, to be extended further.

Upon taking them hence, they cut them again into four, and put them into the third mould, out of which they are taken, divided into four as before, and laid in the last or finishing mould, where they are beaten to the degree of thinness required.

The leaves thus finished, they take them out of the mould, and dispose them into little paper books, prepared with a little red bole for the gold to stick to: each book ordinarily contains 25 gold-leaves. There are two sizes of these books; 25 leaves of the smallest only weigh five or six grains, and the same number of the largest nine or ten grains.

It must be observed, that gold is beaten more or less, according to the kind or quality of the work it is intended for; that for the gold wire-drawers to gild their ingots with is left much thicker than that for gilding the frames of pictures, &c. See GILDING.

GOLD, *burnished*, that smoothed or polished with a burnisher.

GOLD, *mosaic*, that applied in pannels, on proper ground, distributed into squares, lozenges, and other compartments, part whereof is shadowed to heighten or raise the rest. See MOSAIC.

GOLD, *shell*, that used by the illuminers, and with which we write gold letters. It is made of the parings of leaf-gold, and even of the leaves themselves, reduced into an impalpable powder, by grinding on a marble with honey. After leaving it to infuse some time in aquafortis, they put it in shells, where it sticks. To use it, they dilute it with gum-water, or soap-water.

GOLD, *pure*, that purged by fire of all its impurities, and all alloy. The moderns frequently call it gold of 24 caracts, but in reality there is no such thing as gold so very pure, and there is always wanting at least a quarter of a caract. Gold of 22 caracts has one part of silver, and another of copper that of 23 caracts has half a part (that is, half a twenty-fourth) of each. See CARACT.

GOLD, in heraldry, is one of the metals, more usually called by the French name *or*.

GOLDEN NUMBER, in chronology, a number shewing what year of the moon's cycle any given year is. See CYCLE.

From what has been said under CYCLE OF THE MOON, it appears that the golden number will not shew the true change of the moon for more than 312 years, without being varied. It is to be observed, that the golden number is not so well adapted to the Gregorian as to the Julian calendar; the epact being more certain in the new style, to find which the golden number is of use. See EPACT, and CYCLE.

GOLDEN RULE, in arithmetic, is also called the rule of three, and the rule of porportion. See ARITHMETIC.

GOLDFINCH. See FRINGILLA.

GOLDSMITH, or, as some choose to express it, silversmith, an artist who makes vessels, utensils, and ornaments, in gold and silver.

The goldsmith's work is either performed in the mould, or beaten out with the hammer, or other engine. All works that have raised figures are cast in a mould, and afterwards polished and finished: plates or dishes of silver or gold are beaten out from thin flat plates; and tankards, and other vessels of that kind, are formed of plates soldered together, and their mouldings are beaten, not cast. The business of the goldsmith formerly required much more labour than it does at present; for they were obliged to hammer the metal from the ingot to the thinness they wanted: but the flatting-mills now in use reduce metals to the thinness that is required, at a very small expence. The goldsmith is to make his own moulds, and for that reason ought to be a good designer, and have a taste in sculpture; he also ought to know enough of metallurgy to be able to assay mixed metals, and to mix the alloy. See ASSAYING.

The goldsmiths in London employ several hands under them for the various articles of their trade; such are the jeweller, the snuff-box and toy-maker, the silver turner, the gilder, the burnisher, the chaser, the refiner, and the gold-beater. See JEWELLER, &c.

Goldsmiths are superior tradesmen; their wares must be assayed by the wardens of the company of this name in London, and marked: and gold is to be of a certain touch. No goldsmith may take above one shilling the ounce of gold, besides what he has for the fashioning, more than the buyer may be allowed for it at the king's exchange; and here any false metal shall be seized and forfeited to the king. The cities of York, Exeter, Bristol, &c. are places appointed for the assaying wrought plate of goldsmiths; also a duty is granted on silver plate of sixpence an ounce, &c. Plate made by goldsmiths shall be of a particular fineness, on pain of forfeiting 10*l.* and if any parcel of plate sent to the assayers is discovered to be of a coarser alloy than the respective standards, it may be broken, and defaced; and the fees for assaying are particularly limited.

GOMPHIA, a genus of the decandria monogynia class and order. The calyx is mo[illegible]ved; the corolla five-petalled; ber[illegible] five-le[illegible] (5 to 5) in a large receptacle. Seed ries two; [illegible]re are three species, trees of solitary. Th[illegible] the East and West Indies.

GOMPHRÆNA, *globe amaranth*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 54th order, miscellaneæ. The calyx is coloured; the exterior one triphyllous, or diphyllous, with two carinated convenient leaflets; the nectarium cylindrical, with ten teeth; the capsule monospermous. There are nine species, but only one of them is commonly cultivated in our gardens, viz. the globosa, or globe amaranth. It has an upright stalk branching all round, two or three feet high, with oval, lanceolate, and opposite leaves; and every branch and side-shoot terminated by a close globular head of flowers, composed of numerous very small starry florets, closely covered with dry scaly calices placed imbricatim, persistent, and beautifully coloured purple, white, red, or striped and variegated. The florets themselves are so small, and closely covered with the scaly calices, that they scarcely appear. The numerous closely placed scaly coverings being of a dry firm consistence, coloured and glittering, collected into a compact round head, about the size of an ordinary cherry, make a fine appearance. They are annual plants, natives of India, and require artificial heat to raise and forward them to a proper growth, so that they may flower in perfection, and produce ripe seed. They flower from June to November; and if the flowers are gathered when at full growth, and placed out of the sun, they will retain their beauty several months.

GONARCHA, in antiquity, a dial delineated on several surfaces, or planes, some horizontal, others erect, oblique, &c.

GONATOCARPUS, a genus of the tetrandria monogynia class and order. The corolla is four-cleft, drupe eight-cornered, one-seeded. There is one species, an annual of Nogasaki.

GONDOLA. a flat boat, very long and narrow, chiefly used at Venice to row on the canals. The word is Italian, gondola. Du Cange derives it from the vulgar Greek κουντελας, "a bark," or "little ship;" Lancelot deduces it from γονδυ, a term in Athenæus for a sort of vase. The middle-sized gondolas are upwards of thirty feet long and four broad; they always terminate at each end in a very sharp point, which is raised perpendicularly to the full height of a man. The address of the Venetian gondoleers, in passing along their narrow canals, is very remarkable: there are usually two to each gondola, and they row by pushing before them. The fore man rests his oar on the left side of the gondola: the hind man is placed on the stern, that he may see the head over the tilt or covering of the gondola, and rest his oar, which is very long, on the right side of the gondola. Gondola is also the name of a passage-boat of six or eight oars, used in other parts of the coast of Italy.

GONDOLA-SHELL, in natural history. See DOLIUM.

GONORRHŒA. See SURGERY.

GONIOMETRY, a method of measuring angles, so called by M. de Lagny, who gave several papers, on this method, in the Memoirs of the Royal Academy. M. de Lagny's method of goniometry consists in measuring the angles with a pair of compasses, and that without any scale whatever, except an undivided semicircle. Thus, having any angle drawn upon paper, to be measured, produce one of the sides of the angle backwards behind the angular point; then with a pair of fine compasses describe a pretty large semicircle from the angular point as a centre, cutting the sides of the proposed angle, which will intercept a part of the semicircle. Take then this intercepted part very exactly between the points of the compasses, and turn them successively over upon the arc of the semicircle, to find how often it is contained in it, after which there is commonly some remainder: then take this remainder in the compasses, and in like manner find how often it is contained in the last of the integral parts of the first arc, with again some remainder: find in like manner how often this last remainder is contained in the former; and so on continually, till the remainder become too small to be taken and applied as a measure. By this means he obtains a series of quotients, or fractional parts, one of another, which being properly reduced into one fraction, give the ratio of the first arc to the semicircle, or of the proposed angle to two right angles, or 180 degrees, and consequently that angle itself in degrees and minutes.

Thus suppose the angle BAC (plate Misc. fig. 107.) be proposed to be measured. Produce BA out towards *f*; and from the centre A describe the semicircle *abcf*, in which *ab* is the measure of the proposed angle. Take *ab* in the compasses, and apply it four times on the semicircle, as at *b*, *c*, *d*, and *e*; then take the remainder *fe*, and apply it back upon *ed*, which is but once, viz. at *g*; again take the remainder *gd*, and apply it five times on *ge*, as at *h*, *i*, *k*, *l*, and *m*; lastly, take the remainder *me*, and it is contained just two times in *ml*. Hence the series of quotients is 4, 1, 5, 2; consequently the fourth or last arc *em* is $\frac{1}{2}$ the third *ml* or *gd*, and therefore the 3d arc *gd* is $\frac{1}{5\frac{1}{2}}$, or $\frac{2}{11}$ of the 2d arc *ef*; and therefore, again this 2d arc *ef* is $\frac{1}{1\frac{2}{11}}$, or $\frac{11}{13}$ of the 1st arc *ab*; and consequently this 1st arc *ab* is $\frac{1}{4\frac{11}{13}}$, or $\frac{13}{63}$ of the whole semicircle *af*. But $\frac{13}{63}$ of 180° are $37\frac{1}{7}$ degrees, or 37° 8′ 34″$\frac{2}{7}$, which therefore is the measure of the angle sought: When the operation is nicely performed, this angle may be within two or three minutes of the truth; though M. de Lagny pretends to measure much nearer than that.

GONIUM, a genus of vermes, of the order infusoria. Worm very simple, flat, angular, invisible to the naked eye. There are five species. The pectoral, quadrangular, pellucid, with 16 spherical molucles, found in pure water; molecules oval, nearly equal in size, set in a quadrangular membrane, like diamonds in a ring, the lower ones a little larger than the rest. See Adams on the Microscope.

GOOD BEHAVIOUR: surety for the good behaviour is the bail or pledge for any person that he shall do or perform such a thing, as surety for the peace is the acknowledging a recognizance or bond to the king, taken by a competent judge of record, for keeping the king's peace. Dalt. c. 116.

A binding to the good behaviour is not by way of punishment; but it is to shew, that when a man has broken the good behaviour, he is not to be trusted. 12 Mod. 566.

Justices of peace may chastise rioters, barrators, and other offenders, and also imprison and punish them according to law, and by discretion and good advisement; and also bind persons of evil fame to the good behaviour, &c. 34 Ed. III. c. 1.

This statute being penned in such general words, seems in a great measure to have left it to the discretion of justices of the peace, to determine what persons should be bound to their good behaviour; and consequently seems to empower them, not only to bind over those who seem to be notoriously troublesome, and likely to break the peace, as evesdroppers, &c. but also those who are publicly scandalous, or contemners of justice, &c. as haunters of bawdy-houses, or keepers of lewd women in their own houses; common drunkards, or those who sleep in the day and go abroad in the night, or such as keep suspicious company, or such as are generally suspected as robbers; or such as speak contemptuous words of superior magistrates, as justices of peace, mayors, &c. not being in the actual execution of their office, or of inferior officers of justice, as constables, &c. being in the actual execution of their office; but it seems that rash, quarrelsome, or unmannerly words, spoken by one private person to another, unless they directly tend to a breach of the peace, are not sufficient cause to bind a man to his good behaviour. 1 Haw. 153.

GOODENIA, a genus of the pentandria monogynia class and order. The corolla is five-cleft; anthers linear; stigma cup-shaped, ciliated; caps. two-celled, two-valved. Seeds many, imbricated. There are nine species, shrubs of South Wales.

GOOSE. See Anas.

GOOSEBERRY, grossularia. See Ribes.

GOOSE-EMBER. See Margus.

GOOSE-NECK, in a ship, a piece of iron fixed on the end of the tiller, to which the laniard of the whip-staff, or the wheel-rope comes, for steering the ship.

Goose-wing, in the sea-language. When a ship sails before, or with, a quarter-wind on a fresh gale, to make the more haste, they launch out a boom, and sail on the lee-side; and a sail so fitted, is called a goose-wing.

GORDIUS, the *hair-worm*, a genus of insects belonging to the class of vermes intestina. There are several species: 1. The aquaticus, or water hair-worm, is 10 or 12 inches in length, and of about the thickness of a horse-hair; its skin is smooth, and somewhat glossy, without furrows; its colour pale-yellowish white all over, except the head and tail, which are black and glossy. The body is rounded, and very slender in proportion to its length; the mouth is small, and placed horizontally; the jaws are both of the same length, and obtuse at their extremities. This species is common in our fresh waters, more especially in clay, through which it passes as a fish does through the water, and is the author of many springs. It is a variety of this worm that in Guinea, and in some other of the hot countries, gets into the flesh of the natives, and occasions great mischief; with us, though frequent enough in water where people bathe, it never attempts this. 2. The argillaceous, or clay hair-worm, is only a variation of the preceding one in colour, being yellowish at the extremities. It chiefly inhabits the clay; Linnæus calls that its proper element, from its being generally dug out of it. 3. The medinensis, or muscular hair-worm, is all over of a pale-yellowish colour. It is a native of both Indies; frequent in the morning dew, whence it enters the naked feet of the slaves, and occasions a disease much known in those countries, and to which children are very liable; it creates the most troublesome itchings, and too often excites a fever and inflammation. It particularly attacks the muscles of the arms and legs, whence it may be drawn out by means of a piece of silk or thread tied round the head; but the greatest caution is necessary in this simple operation, lest the animal, by being strained too much, should break; for if any part remains under the skin, it quickly grows with redoubled vigour, and becomes a cruel, and sometimes fatal enemy to the poor slaves in particular. Baths with infusions of bitter plants, and all vermifuges, destroy it. 4. The marinus, or sea hair-worm, is filiform, twisted spirally and lying flat, about half an inch in length; of a whitish colour, smooth, and scarcely diminishing at the head. It is as great a tormentor of herrings, bleaks, and various other fish, as the gordius medinensis is of man. The fish, when infested with these animals, rise to the surface, and tumble about as if in great agony.

GORDONIA, a genus of the polyandria order, in the monadelphia class of plants. The calyx is simple; the style five-cornered, with the stigma quinquefid; the capsule quinquelocular; the seeds two-fold, with a leafy wing. There are three species. The lasianthus is a tall and very straight tree, with a regular pyramidal head. Its leaves are shaped like those of the common bay, but serrated. It begins to blossom in May, and continues bringing forth its flowers the greatest part of the summer. The flowers are fixed to footstalks, four or five inches long; are monopetalous, divided into five segments, encompassing a tuft of stamina headed with yellow apices; these flowers, in November, are succeeded by a conic capsula, having a divided calyx. The capsula, when ripe, opens and divides into five sections, disclosing many small half-winged seeds. This tree retains its leaves all the year, and grows only in wet places, and usually in water. The wood is somewhat soft; yet Mr. Catesby mentions his having seen some beautiful tables made of it. It grows in Carolina, but not in any of the more northern colonies.

GORGONIA, in natural history, a genus of zoophytes, which formerly were called ceratophytons, and are known in English by the names of sea-fans, sea-feathers, and sea-whips. Linnæus and Dr. Pallas consider them as of a mixed nature in their growth, between animals and vegetables: but Mr. Ellis shows them to be true animals of the polype kind, growing up in a branched form resembling a shrub, and in no part vegetable. They differ from the fresh-water polype in many of the qualities, and particularly in producing from their own substance a hard and solid support, serving many of the purposes of the bone in other animals. This is formed by a concreting juice, thrown out from a peculiar set of longitudinal parallel tubes, running along the internal surface of the fleshy part: in the coats of these tubes are a number of small orifices, through which the osseous liquor exudes, and concreting, forms the layers of that hard part of the annular circles, which some, judging from the consistence rather than the texture, have erroneously denominated wood. The surface of the gorgonia is composed of a kind of scales, so well adapted to each other, as to serve for defence from external injuries; and the flesh, or, as some have called it, the bark or cortex, consists of proper muscles and tendons for extending the opening of their cells; for sending forth from thence their polype suckers in search of food, and for drawing them in suddenly, and contracting the sphincter muscles of these starry cells, in order to secure these tender parts from danger; and also of proper secretory ducts, to furnish and deposit the osseous matter that forms the stem and branches as well as the base of the bone. Mr. Ellis affirms, that there are ovaries in these animals, and thinks it very probable that many of them are viviparous. See Corallines, and Zoophytes.

GORE, in heraldry, one of the abatements, which, according to Guillim, denotes a coward. It is a figure consisting of two arch lines drawn one from the sinister chief, and the other from the sinister base, both meeting in an acute angle in the middle of the fess point.

Gore, in law, signifies a narrow slip of ground.

GOREING, in the sea-language, sloping. A sail is cut goreing, when it is cut sloping by degrees, and is broader at the clew than at the earing, as all topsails and top-gallant sails are.

GORGE, in fortification, the entrance of the platform of any work. See Fortification.

In all the outworks, the gorge is the interval betwixt the wings on the side of the great ditch, as the gorge of a ravelin, half-moon, &c. These, it is to be observed, are all destitute of parapets; because if there were any, the besiegers, having taken possession of the work, might use it to defend themselves from the shot of the place; which is the reason that they are only fortified with palisadoes, to prevent a surprise.

The gorge of a bastion is nothing but the prolongation of the curtins from their angle with the flanks, to the centre of the bastion where they meet. When the bastion is flat, the gorge is a right line, which terminates the distance between the two flanks.

GORGED, in heraldry, the bearing of a crown, coronet, or the like, about the neck of a lion, a swan, &c. and in that case it is said, the lion or cygnet is gorged with a ducal coronet, &c.

GORTERIA, a genus of the class and order syngenesia polygamia frustranea class and order. The calyx is intricate; corolla of the ray ligulate; down, woolly; receptacle, naked. There are 13 species, mostly shrubby plants of the Cape.

GOSHAWK. See Falco.

GOSSAMER is the name of a fine filmy substance, like cobweb, which is seen to float in the air in clear days in autumn, and is more observable in stubble-fields, and upon furze and other low bushes. This is probably formed by the flying-spider, which, in

traversing the air for food, shoots out these threads from its anus, which are borne down by the dew, &c.

GOSSYPIUM, or cotton; a genus of the polyandria order, in the monadelphia class of plants, and in the natural method ranking under the 37th order, columniferæ. The calyx is double, the exterior one trifid; the capsule quadrilocular; the seeds wrapt in cotton-wool. There are six species, all of them natives of warm climates. 1. The herbaceum, or common herbaceous cotton, has an herbaceous smooth stalk two feet high, branching upwards; five-lobed smooth leaves; and yellow flowers from the ends of the branches, succeeded by roundish capsules full of seed and cotton. 2. The hirsutum, or hairy American cotton, has hairy stalks branching laterally two or three feet high; palmated, three and five-lobed hairy leaves; and yellow flowers, succeeded by large oval pods furnished with seeds and cotton. 3. The barbadense, or Barbadoes shrubby cotton, has a shrubby stalk branching four or five feet high, three-lobed smooth leaves, glandulous underneath; and yellow flowers succeeded by oval pods, containing seeds and cotton. 4. The arboreum, or tree cotton, has an upright woody perennial stalk, branching six or eight feet high; palmated, four or five-lobed smooth leaves, and yellow flowers, succeeded by large pods filled with seeds and cotton. The first three species are annual, but the fourth is perennial both in root and stalk. In warm countries these plants are cultivated in great quantities in the fields for the sake of the cotton they produce; but the first species is most generally cultivated. The pods are sometimes as large as middling-sized apples, closely filled with the cotton surrounding the seed. When these plants are raised in this country, they must be continually kept in a warm stove, where they will produce seeds and cotton. They are propagated by seeds.

The American islands produce cotton shrubs of various sizes, which rise and grow up without any culture, especially in low and marshy grounds. Their produce is of a pale red, some paler than others, but so short that it cannot be spun. None of this is brought to Europe, though it might be usefully employed in making hats. The little that is picked up serves to make mattrasses and pillows.

The cotton shrub that supplies our manufactures requires a dry and stony soil, and thrives best in grounds that have already been tilled. Not but the plant appears more flourishing in fresh lands than in those which are exhausted; but while it produces more wood, it bears less fruit. A western exposure is fittest for it. The culture of it begins in March and April, and continues during the first spring-rains. Holes are made at seven or eight feet distance from each other, and a few seeds thrown in. When they are grown to the height of five or six inches, all the stems are pulled up, except two or three of the strongest. These are cropped twice before the end of August. This precaution is the more necessary, as the wood bears no fruit till after the second pruning; and if the shrub was suffered to grow more than four feet high, the crop would not be the greater, nor the fruit so easily gathered. The same method is pursued for three years; for so long the shrub may continue, if it cannot conveniently be renewed oftener with the prospect of an advantage that will compensate the trouble. This useful plant will not thrive if great attention is not paid to pluck up the weeds that grow about it. Frequent rains will promote its growth, but they must not be incessant. Dry weather is particularly necessary in the months of March and April, which is the time of gathering the cotton, to prevent it from being discoloured and spotted. When it is all gathered in, the seeds must be picked out from the wool with which they are naturally mixed. This is done by means of a cotton-mill, which is an engine composed of two rods of hard wood, about 18 feet long, 18 lines in circumference, and fluted two lines deep. They are confined at both ends, so as to leave no more distance between them than is necessary for the seed to slip through. At one end is a kind of little millstone, which, being put in motion with the foot, turns the rods in contrary directions. They separate the cotton, and throw out the seed contained in it.

GOUANIA, a genus of the monoecia order, in the polygamia class of plants. The calyx of the hermaphrodite is quinquefid; there is no corolla; there are five antheræ covered with an elastic calyptra or hood; the style trifid; the fruit, inferior to the receptacle of the flower, divisible into three seeds. The male is like the hermaphrodite, but wanting stigma and germen. There is one species, a shrubby plant of St Domingo.

GOUGE, an instrument or tool used by divers artificers; being a sort of round hollow chisel, for cutting holes, channels, grooves, &c. either in wood or stone.

GOURD. See CUCURBITA.

GOUT. See MEDICINE.

GRACE, *act of*, an act of parliament for a general and free pardon, and for setting at liberty insolvent debtors.

GRACE, *days of*, in commerce. See BILLS OF EXCHANGE.

GRACULA, the grakle, in ornithology, a genus belonging to the order of picæ. The bill is convex, cultrated, and bare at the point; the tongue is not cloven, but is fleshy and sharp; it has three toes before and one behind. 1. The religiosa, lesser grakle, or Indian stare, is about the size of a blackbird; the bill an inch and a half long, and of an orange colour. The general colour of the plumage is black, glossed with violet, purple, and green, in different reflections of light; on the quills is a bar of white; the feathers and legs are an orange-yellow, and the claws of a pale brown. This species, which is found in several parts of the East Indies, in the Isle of Hainan, and almost every isle beyond the Ganges, is remarkable for whistling, singing, and talking well, much better than any of the parrot genus, and in particular very distinct. Its food is of the vegetable kind. Those kept in this climate are observed to be very fond of cherries and grapes; if cherries are offered to one, and it does not immediately get them, it cries and whines like a young child, till it has obtained its desire. It is a very tame and familiar bird. 2. The barita, or boat-tailed grakle, is about the size of a cuckow. The bill is sharp, black, and an inch and a half in length; the general colour of the plumage is black, with a gloss of purple, especially on the upper parts; the legs and claws are black, the latter hooked. There is a singularity in the folding up of the tail-feathers, which, instead of forming a plain surface at top, sink into a hollow like a deep gutter. It always carries its tail expanded when on the ground, folding it up in the above singular manner only when perched or flying. It inhabits Jamaica; and it feeds on maize, beetles, and other insects, as well as on the fruit of the banana. It is likewise common in North America, keeping company with the flocks of the maize-thieves, and red-winged oriole. These breed in the swamps, and migrate in September, after which none are seen. 3. The quiscula, purple jackdaw, or Barbadoes blackbird, is about the size of a blackbird: the male bird is black, but most beautifully and richly glossed with purple, especially on the head and neck. The female is wholly of a brown colour, deepest on the wings and tail. This species inhabits Carolina, Mexico, and other parts of North America, also Jamaica. These birds for the most part feed on maize, whence the name of maize-thieves has been given them; but this is not their only food, for they are known also to feed on many other things. In spring, soon after the maize-seed is put into the ground, they scratch it up again; and as soon as the leaf comes out, they take it up with their bills, root and all; but when it is ripe they do still more damage, for at that time they come in troops of thousands, and are so bold, that if disturbed in one part of the field they only go to another. In New Jersey and Pennsylvania three pence per dozen was once given for the dead birds, and by means of the premium they were nearly extirpated in 1750: when the persecution of them was abated on account of the great increase of worms which had taken place in the meadows, and which in the preceding year had left so little hay in New England as to occasion an importation from other parts. The grakles were therefore again tolerated, as it was observed that they fed on these worms till the maize was ripe. These birds build in trees. They are said to pass the winter in swamps which are quite overgrown with wood, thence only appearing in mild weather; and after the maize is got in, are content to feed on other things, as the aquatic tare-grass, and if pressed by hunger, buck-wheat and oats, &c.: they are said also to destroy that pernicious insect the bruchus pisi. Their note is pretty and agreeable, but their flesh is not good to eat. 4. The cristatella, or Chinese starling, is a little bigger than a blackbird. The bill is yellow or orange, and the general colour of the plumage blackish with a tinge of blue; the legs are of a dull yellow. These birds, which are said to talk and whistle very well, are common in China, where they are very much esteemed, and the figures of them are seen frequently in Chinese paintings. Their food is rice, insects, worms, and such-like. They are seldom brought to England alive, requiring the greatest care in the passage. There are eight other species of gracula.

GRADUATION, in mathematics, the act of dividing any thing into degrees, or equal parts.

GRAFTING, or *graffing*, in gardening, is the insertion of a scion into a stock or stem raised for the purpose, and is necessary to

the ensuring of good fruit; *i.e.* to have the same (or at least with little difference) produced on the new tree, as that of the old one whence the graft was taken: it is sometimes performed on the branches of trees, and may be on the roots, a piece being raised out of the ground for the purpose.

If the seeds of fruit were left to grow up to trees without grafting, they would produce a different kind from that they came from; by chance a better, but most commonly a worse. The varieties of fruit we have, were obviously obtained from seedling stocks, without grafting.

Grafting is like planting upon a plant, for though there is a union of the parts, there is in fact little other communication than a root has with the ground. The scion, or bud, draws nourishment from the stock, but no other than is properly adapted to its own peculiar vessels, and which it alters so as to become exclusively its own.

The art of grafting is a very curious discovery, and though it requires some ingenuity to perform it, a few trials may make it familiar, and it will prove an agreeable source of amusement and satisfaction. By being able to graft, young trees may be always at hand for replacing old, or unsuccessful ones; and the pleasure of obliging a friend from our stock in this way, is peculiarly gratifying.

Skill in this ingenious art is clearly best obtained by seeing the work performed; and at first trial, to have an adept at the elbow, would be a great advantage. There are few gardeners (even by profession), however, that practise this work, owing to the great number of nurserymen ready to supply trees. But though they raise fine trees, much disappointment has often happened in dealing with them (particularly in the sort); which might be avoided, by a man's being able to raise good trees for himself. Directions precisely descriptive of the business of grafting, are therefore here attempted, and if once understood, trials should be made without minding the discouragement of a few failures; for practice will make perfect.

Proper stocks being ready, and scions or buds procured, there will be wanting a good sharp narrow-bladed penknife, and a sharp smooth-edged pruning-knife, with some well-wrought loam or clay, and some good new bass, or strong yarn. The clay should be made up as mortar, mixed with short hair, or fine chopt hay, with a little cow-dung, and prepared a day or two beforehand; or if longer the better, being beaten up afresh with a little water every day.

The first thing to be done is, to cut off the head of the stock at the proper height, and in a fair part of the bark, making a smooth flat top; if the stock is too strong for the knife, and a saw is used, it must be smoothed with the knife after. The most proper size for stocks, is from half an inch to an inch diameter: a little more or less, however, may do. When a stock is too little, the scion is apt to overgrow it, and when too big, the scion does not so well, or so soon, cover the stock, as might be wished; yet stocks of any size can be used by one mode of grafting or other.

Dwarf trees are to be grafted within six inches of the ground, and standards as high as the stock will well bear, considering whether they are to be half or full standards; the former at about three or four feet, the latter at five or six. But trees designed for standards, may be grafted or inoculated at a lower height, the graft being trained to the desired length, by keeping it to a single stem.

The scions should be healthy and strong (not however of a soft, sappy, luxuriant growth), and taken from the outsides of fruitful trees, where the juices of the wood have been properly digested by sun and air; they should be taken (if it may be) from trees just in their prime, or at full bearing, and not before. Let them be cut two or three weeks sooner than wanted, and if kept longer they may not hurt, for they had better be cut a little too soon than too late, at full length, without any side shoots.

Let the scions of pears, plums, and cherries, be cut from the middle to the end of January, and at farthest not beyond the middle of February; the season must, however, somewhat govern. Keep them all over in dry mould, close under a south wall, or some shelter, covering them with straw in wet or severe weather. Some preserve them in a cool room, where they will do without mould, but it would be better to set them up on end in a garden-pot, half their length with mould or sand, nearly dry.

Scions cut early are prevented from getting too forward in bud: for if the buds begin to start, and look white, they seldom take. By having them as long as they may be kept before used, the sap of the stock gets in forwardness; for it must first begin to stir, and so be ready to push itself quickly into the scion (now somewhat exhausted), to form an union with it.

The middle of scions is fittest for the purpose; but do not cut off the tops till they are brought out to graft, for they keep best in length. If scions are to be transported to any distance, let their ends be stuck two or three inches in clay, and so matted round in a bundle; or, if wrapped round with a fine hay-rope, and smeared over with cow-dung, clay, or a strong earth, they will not soon wither.

Some gardeners say, scions should be only of the last year's growth, and others, that the wood of the year before is best; but it is so far a matter of indifference that they will take much older, though, perhaps, not so certainly. As a medium, if a little of the former year's wood is cut with a scion of the last, and this older wood used for the part grafted, it will be found to answer, in covering the stock sooner; though it must be acknowledged, that all new wood is the common practice of those who raise trees for sale; which circumstance is ordinarily a presumptive proof of right. If wood, however, of a year's growth is not strong enough, then, at least, some of the old wood ought to be cut with it; and the bigger the stock is, the more this practice commends itself, as the barks will be somewhat more equal in thickness.

Proceeding to graft, take off a little of the lower end of the scion first, and then cut it in length, so as to have three or four eyes to appear above the claying; two eyes will be sufficient for a standard, but four are better for a dwarf that is to be trained. In cutting scions into lengths, let the top eye be just in front, or just behind, but rather the former. Use not (except upon necessity), the upper part of a scion, as the wood is too raw for the purpose, and will be shrivelled; yet strong scions (properly inserted) seldom miss through drought; indeed they will take sooner than if quite fresh cut and full of sap.

The time for grafting is usually from mid-February to mid-March; but in a forward season sooner, and in a backward one sometimes later.

Cleft-grafting has been the most common method of propagation, and though it is not the neatest, yet it is a certain and easy way to young practitioners. The stocks for this mode of grafting should be strong, about three quarters of an inch diameter, or more; but it may be used with very young stocks, having scions of like thickness.

Cut off the head as before directed, so as to have (on the sunny side) a smooth part in the stock, where the scion is to be placed, and cutting a part of the stock off slopewise, opposite to this place, leave the top or the crown of the stock, about half an inch wide.

Then cleave the stock with a strong knife, or thin sharp chisel, about two inches deep, as near the middle as possible, so as not to divide the pith, and if any roughness appears in the slit, smooth it off with a penknife; but something of the wedge kind must be put into the slit to keep it open to receive the scion, leaving proper room to put it in. Cut the scion on each side to the form of a wedge at bottom, an inch or more long, making that side which is to be placed inwards in the stock, thinner by about one-third. Put the scion in, so that its bark and that of the stock may be level; and consequently that the two barks may unite and run into each other; for on this one principle depends the whole art of grafting. If the bark of the stock is thick, let the bark of the scion sink in a trifle, as the current of sap that unites them, runs betwixt the bark and wood. The scion being placed, take the wedge out that kept the stock open; yet if the stock is so strong as to pinch the scion too hard, ease it by a little bit of dry wood to be left in the cleft; so, however, as not to loosen the graft, which must be held firmly: or if the stock is very strong, the wedge of the scion may be nearly of equal thickness, inside and out, which eases the barked part.

The graft must be nicely whipped round with wet bass pulled tight, and the whole clayed over to an inch above and half an inch below, smoothing it off taper, with a trowel or knife dipped in water. And as this is done with a view to keep out wet, sun, and air, if the clay falls off or cracks, it must be immediately repaired, till the season comes to take off the bandage, which is about Midsummer, or rather sooner; yet at this time some clay should be still kept on the top, to secure the cleft from wet, and so continued till the cleft is grown up.

If it is desired to put in two scions, to form a tree for the wall, or espalier, there should be two clefts parallel to one another, one on each side the pith. Some put in two scions, merely in case one should miss; but it is not advisable. It need hardly be observed, that in this case the crown must be left whole.

Whip-grafting has the advantage of cleft-grafting in neatness, and not requiring the

stocks to be so old by a year or two, as very small ones will do in this way; for the stock is directly covered by the scion, and it takes with certainty if properly performed. Scions suitable to proper stocks cannot however always be had. Stock and scion are to be both of a size; or nearly so is better, the stock having the advantage in bigness; for thus it is not so likely to be overgrown, as it happens when the scion is of a more free nature. When the stock is overgrown by the scion, it will give it some opportunity to thicken, by slitting the bark through downwards, in two or three places. This circumstance is not, however, material in dwarf trees.

Having cut the head of the stock off, and the scion to its proper length, slope the lower end of the scion about an inch and a half, and to a point; then cut the stock to answer it (the cut of the stock, however, may be a trifle wider and longer) bark against bark, and tie them together exactly to their place, and clay it. But for the greater certainty of keeping a scion to the part, cut it so as to leave a small shoulder at the top of the slope, and the stock so as to leave a narrow bit of its crown to answer it, and to hold it.

There is a sort of whip-grafting that has been denominated slicing, or packing, which differs only from that just described, in this: that the stock is of any size; and this is performed by cutting the scion to a face, as before, and then taking off a slice from the (beheaded) stock, choosing a gibbous part of it so as exactly to correspond with the cut surface of the scion, taking care to fit them so that the scion may stand erect (or nearly) when clapped to. Shouldering is commonly practised also in this way.

Grafting in the bark, or *crown-grafting*, is perhaps as good a way as any, both for ease of operation and certainty of success; but it will hardly suit any other fruit than apples or pears, as other scions will be past use (most likely) before the bark of the stocks will peel, as the time for this business is towards the end of March, or beginning of April.

The head being cut off, make a straight slit down and through the bark from the top, at the place destined for the graft, which should be rather southerly or westerly. This score down the bark should be nearly as long as the slope cut of the scion, which may be one and a half or two inches. Loosen the bark a little at the top of the score, and then with some smooth instrument of dry hard wood, ivory, bone, or silver, rather than iron or steel, open the bark sufficiently to receive the scion, by pushing the instrument down a trifle below the bottom of the slit. This instrument should be thin, tapered and rounded towards the point, to suit the shape of the scion's face; one side of it flat, and the other a little convex, the flat side being applied to the wood of the stock; let it be rather narrower than the scion, that it may not loosen the bark too wide.

Cut a bit of the bark of the scion smooth off at the bottom that it may not turn up in pushing down. It will be proper to cut the scion with a small shoulder, to rest upon the stock. And because when the scion is in, it will bear the bark up hollow from the stock, score the bark on each side the scion, so that it may fall close to the stock, and to the edges of the scion. Bind and clay neatly. In this way of grafting there is a sort of agreement between the scion and stock necessary; the scion not being too big, or the stock too small, to prevent a proper bedding. If more than one scion is not put in, the stock on the opposite side to the scion should be sloped up about two inches in length, to half its thickness.

This way of grafting is used most properly with strong stocks; and sometimes is applied to large branches, and even trunks of old trees, to change the sorts or renew the wood. In proportion to the largeness of which, from two to five or six scions are put in, and sometimes of different sorts; and if the stock is large, the more the better, as it heals over the sooner, and as they insure the life of the stock, by receiving and carrying off the sap; in which respect a single branch of the head of an old stock may be left on, for the sap to pass off by when it begins to stir.

Side-grafting is done in the bark, much like inoculation, a scion being inserted instead of a bud; but remember, there must be a fluent sap first, *i. e.* the bark must part readily from the wood, before this mode of grafting is attempted. The head of the stock is not to be cut off, only thinned a little if it is large, and the side shoots taken away. The bark of the stock, where the insertion of the scion is to be, must be cut through in the form of the letter T, as wide and as long as is sufficient to receive the scion, cut as before, with a slope face of at least an inch long, taking advantage, (if it may be) of a part of the stock that is a little gibbous. Let the bark of the stock be neatly raised to receive it, but yet no more than necessary; a little bit of the bark may be sliced off the part that is over the cross cut, to receive the scion the better.

Approach-grafting, or *inarching*, is performed in April or May, when the stock we would graft, and the tree we would propagate, grow so near together, as to be conveniently in contact, and the nearer the graft and the stock are of a size the better. This mode of propagation is esteemed the surest of all; and in truth, some things cannot be so well propagated any other way. It is a method that is, or can be, seldom used for common fruit-trees; but if any one wishes to try the experiment, the stock or stocks must be planted at least a year before, first making the soil good, as it may need it, being so near another tree, for it of course must be close.

Plants in pots or tubs being easily brought together, are frequently propagated this way; so that inarching is used much in greenhouses and hot-houses for various things, as oranges, lemons, pomegranates, jasmines, and vines sometimes; oranges and lemons thus treated in May will be united by August.

The method of inarching is, bend the best-situated young branch of the tree or shrub to be propagated, to the stock to be grafted, and having determined on the part at which most conveniently to fix the shoot, cut the bark of that part of the shoot off, with nearly half the wood (not to touch the pith) to the length of about three inches for a strong branch, or less for a weaker. Then cut exactly so much of the bark and branch of the stock off, as will receive the cut part of the branch or shoot, so as to bring bark and bark in contact in every part; and if the contrivance of lipping is used, it will secure them better together. Bind and clay, and if in open ground, fix a stake to tie the work so that the wind may have no power over it; a tie also to a neat stick may be proper for those inarched in pots, &c.

Budding, or *inoculation*, though here last mentioned, is the most considerable mode of propagation. Apricots, peaches, and nectarines, are always propagated this way, and plums and cherries may be. Pears are sometimes budded, and apples have been, but the success is uncertain. Not only fruit, but forest, and ornamental trees and shrubs are inoculated. The branches also of trees as well as stems are sometimes budded, which is best done on two-years wood, though it may be on both younger and older.

Inoculation begins as soon as good shoots with good eyes, of the present year can be had, so that the season may be reckoned from mid-June to mid-August; but about old Midsummer, or rather after, is the usual and best time for the work; it should be done in a morning or evening (the latter rather best), except the day is cloudy, when any part of it will do.

Apricots being first ready, the budding season begins with them. The stocks to be used are those of the plum (raised from stones or suckers) when half an inch thick, a little under or over, and the operation is to take place from four to eight inches from the ground.

Peaches and nectarines are propagated on the same sort of stocks; but if the plum stock is first budded with an apricot (very low), and when of proper size budded with a peach, and especially a nectarine, the advantage is reckoned that it takes best so, and comes to a better bearing, producing an improved fruit, and particularly the red Roman nectarine. Apricots may be expected to be less luxuriant by double-budding, in which case the first bud should be of the Brussels sort.

Plums and cherries may be inoculated on sucker stocks of any kind; yet, if a free is required, (as for standards), stocks raised from stones are best; *i. e.* plums on plums, and cherries on cherries, though they will take upon each other.

Pears, if for standards, should be inoculated on pear stocks, and on those raised from seed, rather than suckers; but if for dwarfs, quince stocks may be best used, to keep the trees from growing off too fast; and so getting soon too big for their allotted space; white-thorn stocks are sometimes used with the same view, but the fruit gets stony. Stocks for budding dwarfs should be three years old; but for standards four or more.

Though the longer inoculation is deferred, the riper the shoots will be for furnishing buds; yet there is this advantage in beginning as early as may be, that if the budding appears not to have taken, the work may be done again before the season is out. Or, to ensure success, two buds may be inserted in the same stock (but not in a direction under one another), and if both fail this year, the stocks may do again the next, as the heads in grafting by inoculation are not to be cut off till the spring following, because the inserted buds do not push off till then.

Let the scions to procure buds for inoculation, be taken only from the outside branches of healthy and fruitful trees. If early budding is attempted, it will be proper to cut off some spare shoot (not fit for the purpose) to try first whether the bark will yet readily part from the wood.

The season being right, and the scions at hand, have a sharp narrow-bladed knife, and neat tough wet bass. Keep the buds, as much as may be, from sun and wind: they must not be taken from the upper part of the scions, as the bark and buds there are too raw. If scions or buds are brought from any distance, they should be conveyed in damp moss or grass, and never kept above a day and night, but the sooner they are used the better.

Before the buds are prepared, get the stock ready to receive them, by taking off lateral shoots, leaving an uncut single stem. At the part fixed on for the inoculation (which should be smooth, and rather on the north side) cut the bark through to the wood in form thus, T, the cross and the down slit being of the length necessary to take in the bud, which may be cut with from one to two inches of bark; putting the point of a knife (or some instrument rather not of iron or steel) in to the top of the down cut of the stock, raise the bark all the way to the bottom, so that it will just receive the bud easily. There are knives made on purpose for budding, with flat ivory hafts.

To procure proper buds, put your knife in (suppose) about three-fourths of an inch above the eye, and with a slope downwards cut the scion half through, then do it at the same distance below the eye, and sloping it upwards cut up the middle of the wood, till the knife meets the upper incision, so the eye, or bud, will be directly in the middle.

The next step is, to separate the wood from the bark, which is to be done thus: with your nail, or the point of a knife, loosen the bark at the top, and strip it from the wood; or rather with a swan or large goose quill, made in the form of an apple-scoop (having a regular smooth edge) push it down between the bark and wood, pressing it against the wood.

Examine the inside of the bark, and if there is a cavity just behind the eye or bud, it is good for nothing, and another must be procured; for the cavity shews, that the root of the bud is with the wood, instead of being with the bark.

The leaf that grows by the eye is to be cut down to near its footstalk, so as to leave only a little bit of it to hold the bud by, while inserting it in the stock.

See that the bark of the stock is loosened a proper length and breadth, and if, when the bud is put in, it should prove a little too long, cut the spare part off; so that the top of the bud being squared, falls in straight with the cross cut of the stock. Thus fixed, bind it moderately tight in its place with the wet bass, beginning at the bottom, and passing by the bud, go on till the top, or rather above it. Care must be taken that the bud is not hurt, and it is to be left only just starting out between the bass.

If the buds have taken, it will be seen in about three weeks or a month, by their appearing fresh and plump. As often as any shoots appear below the budding, cut them off, and also some of the shoots above, if there are many of them: for it is not proper that an inoculated stock should have a large head. In a month loosen the bandage, by taking it off, and putting it on gently again for another month.

In March, cut the head of the stock off with a keen knife, close behind the budding, in a sloping direction; some leave three or four inches of the stock above the bud till the following spring, and it will serve to tie the new shoot to, in order to keep it to a proper erect direction. Suffer no shoots from the stock, but rub the buds off as soon as they appear. It may be of use to shade inoculated buds a few days by a leaf, or a bit of paper.

GRAIN, a small weight, the twentieth part of a scruple in apothecaries' weight, and the twenty-fourth of a pennyweight troy. A grain-weight of gold bullion is worth about two-pence, and that of silver but half a farthing.

GRAIN also denotes the component particles of stones and metals, the veins of wood, &c. Hence cross-grained, or against the grain, is contrary to the fibres of wood, &c.

GRAINING-BOARD, among curriers, an instrument called also a pummel, used to give a grain to their leather.

GRAMMAR, the art of speaking and writing any language with propriety. It is usually divided into four parts, orthography, etymology, syntax, and prosody.

GRALLÆ, in ornithology, is an order of birds, in the Linnean system, which have a beak a little cylindric, rather blunt, and bare of feathers at the base. The tongue is entire and fleshy, pointed at the end, and beset with bristles. The legs are without feathers, above the knees. This order includes 20 genera, viz. the phænicopterus, platalea, palamedea, mycteria, tantalus, ardea, corrira, recurvirostra, scolopax, tringa, fulica, parra, vaginalis, psophia, cancroma, rallus, scopus, glareola, hæmatopus, and charadrius.

GRANADIER, a soldier armed with a sword, a firelock, a bayonet, and a pouch full of hand-granadoes. They wear high caps, are generally the tallest and briskest fellows, and are always the first upon all attacks. Every battalion of foot has generally a company of grenadiers belonging to it, or else four or five grenadiers belong to each company of the battalion; which, on occasion, are drawn out, and form a company of themselves. These always take the right of the battalion.

GRANADO, a hollow ball or shell, of iron or other metal, about two inches and a half in diameter; which being filled with fine powder, is set on fire by means of a small fusee fastened to the touch-hole, made of the same composition as that of a bomb; as soon as the fire enters the shell, it bursts into many pieces, much to the damage of all that stand near.

GRANARY. See HUSBANDRY.

GRANATITE, a stone found in Galicia in Spain, Brittany in France, and at St. Gothard. It is always crystallised in a very peculiar form; two six-sided prisms intersect each other, either at right angles or obliquely. Hence the name cross-stone, by which it was known in France and Spain. Mr. Hauy has proved, in a very ingenious manner, that the primitive form of the granatite is a rectangular prism, whose bases are rhombs, with angles of $129\frac{1}{2}^{\circ}$ and $50\frac{1}{2}^{\circ}$; and that the height of the prism is to the greater diagonal of a rhomb as 1 to 6; and that its integrant molecules are triangular prisms, similar to what would be obtained by cutting the primitive crystal in two, by a plane passing vertically through the shorter diagonal of the rhomboidal base. From this structure he has demonstrated the law of the formation of the cruciform varieties. The colour of granatite is greyish or reddish brown. Specific gravity 3.2861. Usually opaque. Glassy or greasy. Infusible before the blowpipe. Two specimens, analysed by Vauquelin, gave the following constituents:

From Brittany,
44.00 alumina
33.00 silica
13.00 oxide of iron
3.84 lime
1.00 oxide of manganese.

94.84

From St. Gothard,
47.06 alumina
30.59 silica
15.30 oxide of iron.
3.00 lime.

95.95

GRAND DAYS, are those days in the several terms, which are solemnly kept in the inns of the court of chancery, viz. Candlemas-day, Ascension-day, St. John the Baptist, and All Saints'-day.

GRAND JURY, is the jury which find bills of indictment before justices of peace and gaol-delivery, or of oyer and terminer, &c. against any offenders that may be tried for the fact. See JURY.

GRANITE, a genus of stones of the order of petræ, belonging to the class of saxa. The principal constituent parts of this stone are feltspar or rhombic quartz, mica, and quartz. These ingredients constitute the hardest sort of granite, and that most antiently known. That into which schoerl enters is more subject to decomposition. They never have any particular texture or regular form, but consist of enormous shapeless masses extremely hard. In the finer granites the quartz is transparent; in others generally white or grey, violet, or brown. The feltspar is generally the most copious ingredient, and of a white, yellow, red, black, or brown colour. The mica is also grey, brown, yellow, green, red, violet, or black; and commonly the least copious. The schoerl is generally black, and abounds in the granites that contain it. Hence the colour of the granites depends principally on that of the spar or schoerl. The red granites consist commonly of white quartz, red feltspar, and grey mica; the grey ones of white quartz grey or violet feltspar, and black mica. The black granites commonly contain schoerl instead of feltspar; and the green usually contain green quartz.

On exposing granite to the flame of a blowpipe, the component ingredients sepa-

rate from one another. Mr. Gerhard having melted some in a crucible, found the feltspar run into a transparent glass; below it the mica lay in form of a black slag, the quartz remaining unaltered. It melted somewhat better when all the three were powdered and mixed together; though even then the quartz was still discernible by a magnifying-glass. Hence we may explain the reason why grains of a white colour are sometimes found in volcanic lavas. The mixture of mica prevents the silex or quartz from splitting or cracking; and hence its infusibility and use in furnace-building.

Granites are seldom slated or laminated. In those which are of a close texture, the quartz and schoerl predominate. They take a good polish; for which reason the Egyptians formerly, and Italians still work them into large pieces of ornamental architecture, for which they are extremely fit, as not being liable to decay in the air. Farber, in his Letters from Italy, mentions a kind of stone named granitone, composed of feltspar and mica: a substance of this kind, which moulders in the air, is found in Finland; which is said to contain nitre, and sometimes common salt. In that country it is called rapakiri. Wallerius describes 18 species of granites, besides many others akin to this genus. Those particularly in use are,

1. The hard white granite, with black spots, commonly called moor-stone. This is a very valuable kind, consisting of a beautiful congeries of very variously constructed and differently coloured particles, not diffused among or running into one another, but each pure and distinct, though firmly adhering to whichever of the others it comes in contact with, and forming a very firm mass. It is much used in London for the steps of public buildings, and on other occasions where great strength and hardness are required.

2. The hard red granite variegated with black and white, and common in Egypt and Arabia.

3. The pale-whitish granite, variegated with black and yellow. This is sometimes found in strata, but more frequently in loose nodules, and is used for paving the streets.

Some of these kinds of stones are found in almost every country, and in many places they are found of immense size. The largest mass of this kind in the known world, lying as an unconnected stone, is found near the Cape of Good Hope in Africa, and of which we have the following description in the Philosoph. Transact. vol. 68, given by Mr. Anderson, in a letter to sir John Pringle: "The stone is so remarkable, that it is called by the people here, the tower of Babel, and by some the pearl diamond. It either takes the last name from a place near which it is situated, or it gives name to the tract of cultivated land called the Pearl. It lies upon the top of a ridge of low hills, beyond a large plain, at the distance of about thirty miles from the Cape Town; beyond which, at a little distance, is a range of hills of a much greater height. It is of an oblong shape, and lies north and south. The south end is highest: the east and west sides are steep and high; but the top is rounded, and slopes away gradually to the north end, so that you can ascend it that way, and enjoy a most extensive prospect of the whole country. I could not precisely determine its circumference, but it took us about half an hour to walk round it; and by making every allowance for the rugged way, and stopping a little, I think the most moderate computation must make it exceed half a mile. The same difficulty occurred with respect to knowing its height; but I think that at the south end it is nearly equal to half its length; or, were I to compare it to an object you are acquainted with, I should say it equalled the dome of St. Paul's church." He adds,

"I am uncertain whether it ought to be considered as the top of the hill, or a detached stone, because there is no positive proof of either, unless we were to dig about its base." A part of this stone being examined by sir William Hamilton, he determined it to be a granite, and of the same nature with the tops of some of the Alps; and supposes both of them to have been elevated by volcanic explosions.

GRANITELLO, a genus of stones of the order of petræ, belonging to the class of saxa. There are two species,

1. That composed of distinct particles, found in several of the mountainous parts of Sweden. In some of these there is a predominance of quartzose particles, in others of micaceous; in which last case the stone is slaty, and easily split.

2. Granitello composed of convoluted particles. This is met with of different colours, as whitish-grey, greenish, and reddish. Both these kinds of stone are used in building furnaces, on account of the powerful resistance they make to the fire; but the latter is preferable to the other, on account of its containing a little of a refractory clayish substance. It is likewise of great use in mills, where the fellow is a coarse sandstone.

GRANT, in law, a conveyance in writing of such things as cannot pass or be conveyed by word only; such are rents, reversions, services, advowsons in gross, tithes, &c.

The person making such a conveyance is called the grantor, and he to whom the grant is made the grantee.

A grant has usually the words *give and grant*, &c. which in a deed of what lies in grant, will amount either to a gift, grant, feoffment, or release, &c. and accordingly may be pleaded: though to every good grant it is requisite that there be a grantor, or person able to give; a grantee, capable of the thing granted; something granted, as grantable; that it be done in the manner the law requires; and that there be an agreement to, and an acceptance of, the grant by him to whom made, &c.

When persons non sanæ memoriæ make grants, they may be good as to themselves, though voidable by their heirs, &c. and notwithstanding infants and feme-coverts are prohibited by law to be grantors, yet they may be grantees: however an infant, when at his full age, may disagree to his grant, and the husband to that made to his wife. All grants are expounded according to the substance of the deed in a reasonable sense, and agreeable to the intent of the parties. In case a person grants a rent-charge out of land, and he has then nothing in the same, admitting he afterwards purchases the land, nevertheless the grant is void. And the law does not allow of grants of titles only, or imperfect interest, or of things that are merely future. Likewise grants may be void on account of uncertainty, impossibility, being against the law, &c.

GRANT *of the king* is good for himself and his successors, though they are not named therein: but the king may not grant away an estate-tail in the crown.

A grant tending to a monopoly cannot be made by the king, to the detriment of the interest and liberty of the subject; neither can the king make a grant non obstante any statute, made or to be made; for if he does, any subsequent statute prohibiting what is granted will be a revocation of the grant: yet there may be a non obstante to a former grant made by the king, where he has been deceived in such grant, as where it contains more than what was intended to be granted, or there is any deceit in the consideration, &c. by which the first grant becomes void.

GRANULATION. See CHEMISTRY.

GRAPE. See VITIS.

GRAPE-SHOT, in artillery, is a combination of small shot, put into a thick canvas bag, and corded strongly together, so as to form a kind of cylinder, whose diameter is equal to that of the ball adapted to the cannon. The number of shot in a grape varies according to the service, or size of the guns: in sea-service nine is always the number; but by land it is increased to any number or size, from an ounce and a quarter in weight to three or four pounds. In the sea-service the bottoms and pins are made of iron, whereas those used by land are of wood.

GRAPHIC, *gold ore*. See TELLURIUM.

GRAPHITES, in mineralogy, a mineral consisting principally of carbon with a little iron, and generally a little silica or alumina; when pure it burns with a reddish flame, emitting beautiful sparks, and a smell of sulphur, and leaving a little residuum. Its colour is dark iron-grey, or brownish black; when cut, blueish grey. Opaque: structure slaty. Texture fine-grained. Brittle. Specific gravity from 1.987 to 2.089; after being soaked in water 2.15; after being heated 2.3. Feels somewhat greasy, stains the fingers, and marks strongly. In modern chemistry it is denominated carburet of iron; and one of the species is plumbago; the use of which, when manufactured into pencils, is known to every one. When pure it consists of,

90 carbon
10 iron
—
100.

GRAPHOMETER, a mathematical instrument, otherwise called a semicircle, the use of which is to observe any angle, whose vertex is at the centre of the instrument in any plane (though it is most commonly horizontal, or nearly so), and to find how many degrees it contains.

The graphometer is a graduated semicircle ABC, made of wood, brass, or the like, and so fixed on a fulcrum GH, by means of a brass ball and socket, that it easily turns about, and retains any situation. It has two sights fixed on its diameter AC, and at the centre there are commonly a magnetical needle and compass in a box. There is likewise

a moveable ruler or index, ED, with two sights P, P; which turns round the centre, and retains any situation given it. See Plate Miscel. fig. 108.

To measure by this instrument any angle ACB (fig. 109), in any plane, and comprehended between the right lines AC and BC, drawn from two points A and B, to the place of station C. Let the graphometer be placed at C, supported by its fulcrum; and let the immoveable sights on the diameter of the instrument DE, be directed towards the point A; and likewise while the instrument remains immoveable, let the sights of the ruler FG, which is moveable about the centre C, be directed to the point B. Now it is evident that the moveable ruler cuts off an arch DG, which is the measure of the angle ACB, sought. Moreover, by the same method, the inclination of DE, or FG, may be observed with the meridian line, which is pointed out by the magnetic needle inclosed in the box, and moveable about the centre of the instrument.

GRAPNELS, a sort of anchors with four flooks, serving for boats to ride by.

There is also a kind called fire and chain-grapnels, made with four-barbed claws instead of flooks, and used to catch hold of the enemies' rigging, or any other part, in order for boarding them. See Plate Miscel. fig. 110.

GRASS. See BOTANY. For the culture of the different sorts of grass, see HUSBANDRY.

GRASSHOPPER, in zoology. See GRYLLUS.

GRATINGS, in a ship, a kind of lattice-work formed of ledges and battens, the square holes of which being three or four inches wide, are for the current footing of men over hatchways, to give air below, and vent for the smoke in an engagement.

GRATIOLA, *hedge-hyssop*, a genus of the monogynia order, in the diandria class of plants. The corolla is irregular; there are two barren stamina; the capsule is bilocular; the calyx has seven leaves, with the two exterior ones patulous. There are 12 species; the most remarkable of which is the officinalis, or common hedge-hyssop. This grows naturally in the Alps and other mountainous parts of Europe. It has a thick, fleshy, fibrous, creeping root, which propagates very much, when planted in a proper soil and situation. From this arise several upright square stalks, with narrow spear-shaped leaves, placed opposite. The flowers are produced on the side of the stalks at each joint; they are shaped like those of the foxglove, but are small, and of a pale-yellowish colour. This herb has an emetic and purgative virtue; to answer which intentions it was formerly used by the common people in England, but was never much prescribed by the physicians, and at last fell totally into disuse. Of late, however, it has been the subject of a dissertation by Dr. James Kostrzewski, of Warsaw, in Poland, who gives some remarkable accounts of its effects in mania and obstinate venereal cases. It was given in powder, or in extract, to the quantity of half a drachm of the first, and a whole drachm of the second, at each dose.

GRAVE, in music, is applied to a sound which is of a low or deep tone.

GRAVEL, in natural history and gardening, a congeries of pebbles, which, mixed with a stiff loam, makes lasting and elegant walks; an ornament peculiar to our gardens, and which gives them the advantage over those of all other nations.

GRAVEL. See MEDICINE.

GRAVIMETER, the name given by M. Guyton to an instrument for measuring specific gravities: he adopts this name rather than either areometer or hydrometer, because these latter terms are grounded upon the supposition that a fluid is always the thing weighed; whereas, with regard to solids, the liquid is the known term of comparison to which the unknown weight is referred.

Guyton's gravimeter is executed in glass, and is of a cylindric form, being that which requires the smallest quantity of fluid, and is on that account preferable, except so far as it is necessary to deviate for the security of a vertical position. It carries two basins; one of them superior, at the extremity of a thin stem, towards the middle of which the fixed point of immersion is marked. The other, or lower basin, terminates in a point; it contains the balls, and is attached to the cylinder by two branches. The moveable suspension by means of a hook has the inconvenience of shortening the lever which is to secure the vertical position.

The cylinder is 22 millimetres (0.71 inch) in diameter; and 21 centimetres (6.85 inches) in length. It carries in the upper basin an additional constant weight of five grammes (115 grains). These dimensions might be increased so as to render it capable of receiving a much more considerable weight; but this is unnecessary. M. Guyton has added a piece which he calls the plongeur, because in fact it is placed in the lower basin when used, and is consequently entirely immersed in the fluid. It is a bulb of glass loaded with a sufficient quantity of mercury, in order that its total weight may be equal to the constant additional weight, added to the weight of the volume of water displaced by this piece. It will be readily understood that the weight being determined at the same temperature at which the instrument was originally adjusted, it will sink to the same mark on the stem, whether it is loaded with a constant additional weight in the upper basin, or whether the effect of this weight be produced by the additional piece in the lower dish. From this explanation there will be no difficulty in seeing how this instrument may be adapted to every case in practice.

It may be used, 1. for solids. The only condition will be, that the absolute weight of the body to be examined shall be rather less than the constant additional weight, which in this instrument is five grammes, or 115 grains.

2. For liquids of less specific gravity than water the instrument, without the additional weight above-mentioned, weighs about two decagrammes (459 grains) in the dimensions before laid down. It would be easy to limit its weight to the utmost accuracy. We have therefore the range of one-fifth of buoyancy, and consequently the means of ascertaining all the intermediate densities from water to the most highly rectified spirit of wine, which is known to bear in this respect the ratio of eight to ten with regard to water.

3. When liquids of greater specific gravity than water are to be tried, the constant weight being applied below, by means of the additional piece, which weighs about six grammes (138 grains), the instrument can receive in the upper basin more than four times the usual additional weight, without losing the equilibrium of its vertical position. In this state it is capable of shewing the specific gravity of the most concentrated acids.

4. It possesses another property, namely, that it may be used as a balance to determine the absolute weight of such bodies as do not exceed its additional load.

5. Lastly, the purity of the water being known, it will indicate the degrees of rarefaction and condensation in proportion to its own bulk.

This instrument may be readily constructed by any workman in glass. The additional piece for the lower basin will require some attention to make it perfectly agree with the constant upper weight, as to the immersion of the instrument. But this object may, by careful adjustment, be ascertained with the utmost certainty and accuracy. The bulb of glass is for this purpose drawn out to a fine point; a sufficient quantity of mercury is then introduced to sink it, and the aperture closed with a little piece of wax. The bulb being then placed in the lower basin of the instrument, the upper basin is to be loaded until the mark on the stem becomes accurately coincident with the surface of the water. The sum of the weights added above is precisely equal to that of the quantity of mercury necessary to be added to that in the glass bulb; which done, nothing more is needed than to seal the point by fusion, taking care not to change its bulk.

The whole is rendered portable by means of a case in which all the delicate parts are secured from pressure, and the heavier parts supported in such a manner as to resist the excess of motion they are capable of acquiring by virtue of their mass. This last circumstance is frequently overlooked by such workmen as are employed in the package of instruments; whence it necessarily follows, that some strain or fracture must be produced when matters of very unequal density are exposed to receive a common impulse.

To find the specific gravity of any solid by the gravimeter, observe this rule: "From the weight in the upper dish, when the instrument is properly immersed in the unknown fluid, take the weight which is placed with the body in the same scale at the like adjustment. The remainder is the absolute weight of the solid. Multiply this by the specific gravity of the fluid, and reserve the product. From the additional weight when the body is placed in the lower basin, take the weight when it was placed in the upper. The remainder will be the loss of weight by immersion. Divide the reserved product by the loss by immersion, and the quotient will be the specific gravity of the solid with regard to distilled water at the standard temperature and pressure."

To find the specific gravity of a fluid proceed thus: "To the weight of the gravimeter add the weight required in the upper basin to sink it in the unknown fluid. Again, to the weight of the gravimeter add the

weight required in the same manner to sink it in distilled water. Divide the first sum by the latter, and the quotient will be the specific gravity of the fluid in question." See SPECIFIC GRAVITY, HYDROSTATICS, and HYDROMETER.

GRAVING, in the sea language, is bringing a ship aground, and then burning off with furze, reed, or broom, all the filth and foulness that sticks to her bottom withoutboard, in order to pay her anew.

GRAVITATION. See ATTRACTION, and GRAVITY.

GRAVITATION, *laws of*, are as follows: 1. It is common to all bodies, and mutual between them. 2. It is proportional to the quantity of matter in bodies. 3. It is exerted every way from the centre of the attracting body in right-lined directions. 4. It decreases as the squares of the distances increase: thus, if a body at A on the earth's surface, distant one semidiameter from the centre C, weighs 36.00 pounds, it will, at the distance of 2, 3, 4, 5, 6, semidiameters, weigh 9.00, 4.00, 2.25, 1.45, 1.00 pounds, which numbers decrease as the squares of the distances increase. The truth of this proposition is not to be had from experiments; the utmost distance we convey bodies to, from the surface of the earth, bearing no proportion to their distance from its centre, but is sufficiently clear from the motions observed by the heavenly bodies. Hence we learn, that all bodies have gravity, or are heavy, and that there is no such thing as absolute levity in nature; and by the second law, the gravitation of all bodies is proportional to the quantity of matter they contain: and hence, since bodies of equal bulk are found to have unequal quantities of matter, it evidently follows, that a vacuum, or solid void of matter, must necessarily exist, and that an absolute plenum is a doctrine unphilosophical, and equally false and absurd.

Also from the third law it follows, that all bodies descending freely by their gravity, tend towards the earth in right lines perpendicular to its surface, and with equal velocities, abating for the resistance of the air; as is evident from the second law above.

Again, since the gravitation is always as the quantity of matter, and inversely as the square of the distance, it follows, that were the internal parts of the earth a perfect void, or hollow concavity, a body placed any where therein would be absolutely light, or void of gravity; but supposing the earth a solid body throughout, the gravitation from the surface to the centre will decrease with the distance, or it will be directly proportional to the distance from the centre.

Gravitation being found by many experiments and observations to affect all the matter of bodies equally, we have hence more reason, says Mr. Maclaurin, to conclude its universality, since it appears to be a power that acts not only at the surfaces of bodies, and on such bodies as are removed at a distance from them, but to penetrate into their substances, and into that of all other bodies, even to their centres, to affect their internal parts with the same force as the external, to be obstructed in its action by no intervening body or obstacle, and to admit of no kind of variation in the same matter, but from its different distances only from that to which it gravitates.

This action of gravity on bodies arises from its action on their parts, and is the aggregate of these actions; so the gravitations of bodies must arise from the gravity of all their particles towards each other. The weight of a body towards the earth arises from the gravity of the parts of that body: the gravity of a mountain towards the earth arises from the gravitation of all the parts of the mountain towards it; the gravitation of the northern hemisphere towards the southern arises from the gravitation of all its parts towards it; and if we suppose the earth divided into two unequal segments, the gravitation of the greater towards the lesser arises from the gravitation of all the parts of the greater towards the lesser. In the same manner the gravity of the whole earth, one particle being excepted, toward that particle, must arise from the quantity of gravitation of all the other particles of the earth towards that particle; every particle, therefore, of the earth gravitates towards every other particle: and for the same reason every particle in the solar system gravitates towards every other particle in it.

GRAVITY, in physiology, the natural tendency of bodies towards a centre.

Gravity may be distinguished into particular and general.

Particular GRAVITY, is that which respects the earth, or by which bodies descend, or tend towards the centre of the earth; the phenomena or properties of which are as follow:

1. All circumterrestrial bodies tend towards a point, which is either accurately or very nearly the centre of magnitude of the terraqueous globe. Not that it is meant that there is really any virtue or charm in the point called the centre, by which it attracts bodies; but because this is the result of the gravitation of bodies towards all the parts of which the earth consists.

2. This point or centre is fixed within the earth, or at least has been so considered as far as any authentic history reaches. For a consequence of its shifting, though ever so little, would be the overflowing of the low lands on that side of the globe towards which it should approach. Dr. Halley suggests, that it would well account for the universal deluge, to have the centre of gravitation removed for a time towards the middle of the then inhabited world; for the change of its place but the 2000th part of the radius of the earth, or about two miles, would be sufficient to lay the tops of the highest hills under water.

3. In all places equidistant from the centre of the earth, the force of gravity is nearly equal. Indeed all parts of the earth's surface are not at equal distances from the centre, because the equatorial parts are higher than the polar parts by about 17 miles; as has been proved by the necessity of making the pendulum shorter in those places, before it will swing seconds. In the New Petersburgh Transactions, vol. 6 and 7, M. Krafft gives a formula for the proportion of gravity in different latitudes on the earth's surface, which is this:

$$y = (1 + 0.0052848 \sin^2 \lambda)\, g;$$

where g denotes the gravity at the equator, and y the gravity under any other latitude λ.

4. Gravity equally affects all bodies, without regard either to their bulk, figure, or matter: so that, abstracting from the resistance of the medium, the most compact and loose, the greatest and smallest bodies, would all descend through an equal space in the same time; as appears from the quick descent of very light bodies in an exhausted receiver. The space which bodies do actually fall in vacuo, is 16$\frac{1}{12}$ feet in the first second of time, in the latitude of London; and for other times, either greater or less than that, the spaces descended from rest are directly proportional to the squares of the times, while the falling body is not far from the earth's surface.

5. This power is the greatest at the earth's surface, whence it decreases both upwards and downwards, but not both ways in the same proportion; for upwards the force of gravity is, as we have seen, less, or decreases, as the square of the distance from the centre, above the surface, the force would be only one-fourth of what it is at the surface; but below the surface the power decreases in such a manner, that its intensity is in the direct ratio of the distance from the centre; so that at the distance of half a semidiameter from the centre, the force would be but half what it is at the surface; at one-third of a semidiameter the force would be one-third, and so on.

6. As all bodies gravitate towards the earth, so does the earth equally gravitate towards all bodies; as well as all bodies towards particular parts of the earth, as hills, &c. which has been proved by the attraction a hill has upon a plumb-line, insensibly drawing it aside. Hence the gravitating force of entire bodies consists of that of all their parts: for by adding or taking away any part of the matter of a body, its gravity is increased or decreased in the proportion of the quantity of such proportion to the whole mass. Hence also the gravitating powers of bodies, at the same distance from the centre, are proportional to the quantities of matter in the bodies.

General or universal GRAVITY, is that by which all the planets tend to one another, and indeed by which all the bodies and particles of matter in the universe tend towards one another.

The existence of the same principle of gravitation in the superior regions of the heavens, as on the earth, is one of the great discoveries of Newton, who made the proof of it as easy as that on the earth. At first it would seem that this was only conjecture with him: he observed that all bodies near the earth, and in its atmosphere, had the property of tending directly towards it; he soon conjectured that it probably extended much higher than any distance to which we could reach, or make experiments; and so on, from one distance to another, till he at length saw no reason why it might not extend as far as to the moon, by means of which she might be retained in her orbit as a stone in a sling is retained by the hand; and if so, he next inferred, why might not a similar principle exist in the other great bodies in the universe, the sun and all the other planets, both primary and secondary, which might all be retained in their orbits, and perform their revolutions, by means of the same universal principle of gravitation.

These conjectures he soon realized and verified by mathematical proofs. Kepler had found out, by contemplating the motions of the planets about the sun, that the area described by a line connecting the sun and planet, as this revolved in its orbit, was al-

Fluxions

Fig. 89

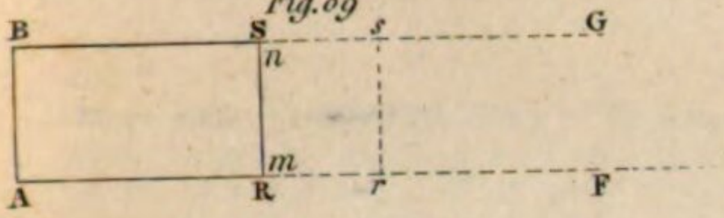


Fig. 90

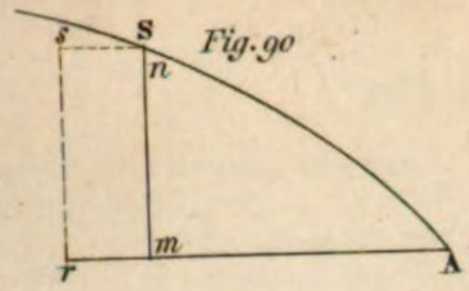
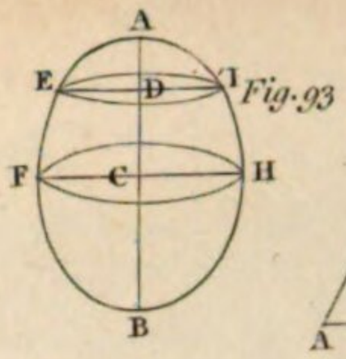


Fig. 93



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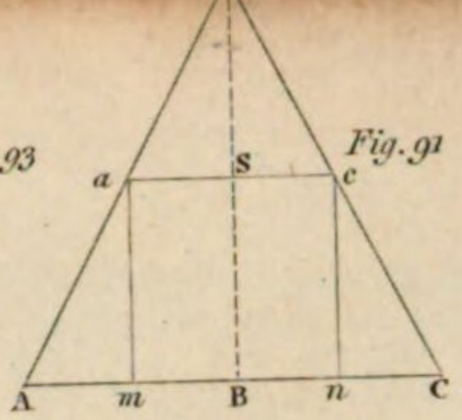
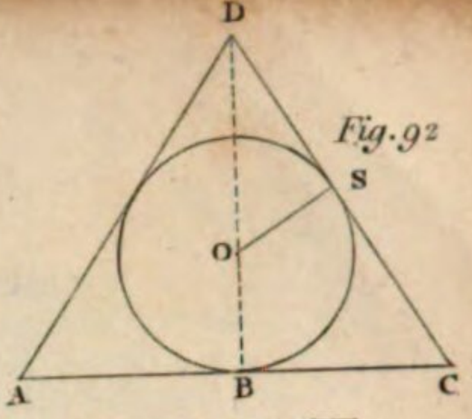


Fig. 92



Wind Gage

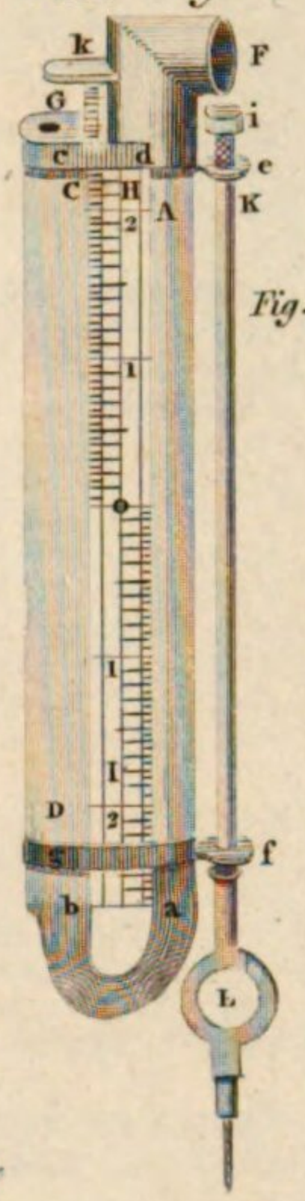


Fig. 98

Fig. 99

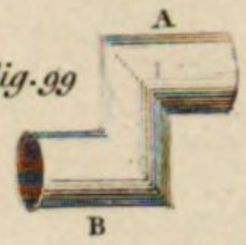


Fig. 101

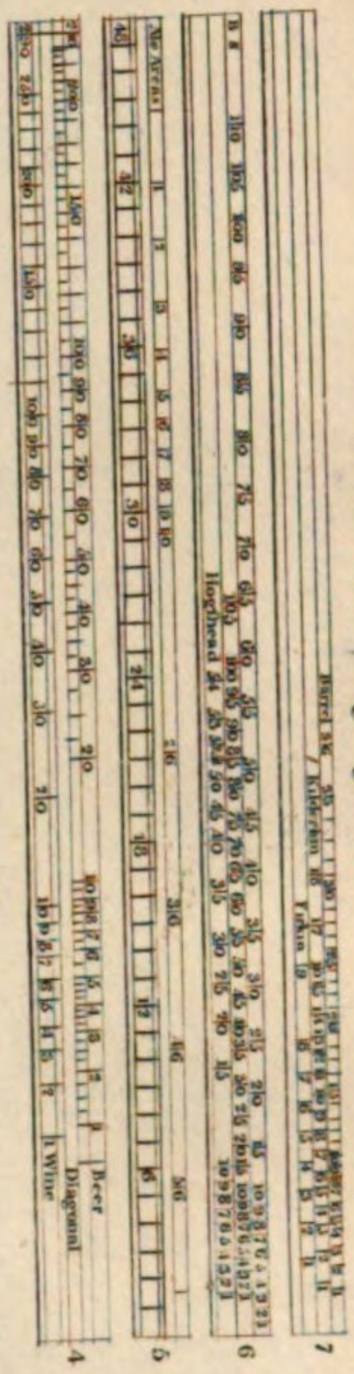
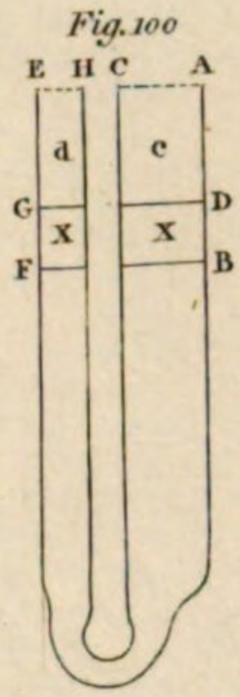


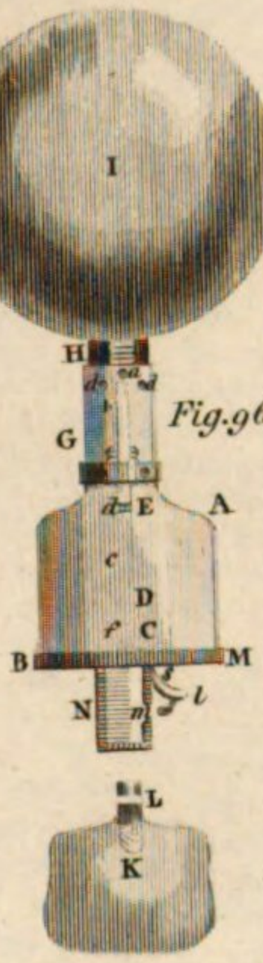
Fig. 100



Sea Gage

Fig. 97

Fig. 96



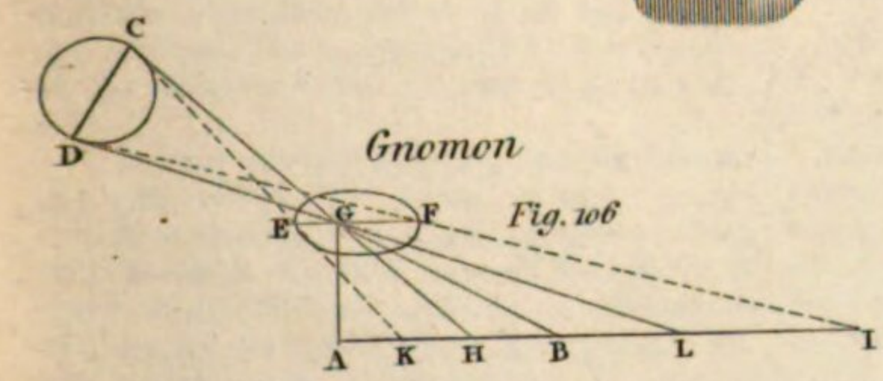
Friction Rollers

Fig. 94

Fig. 95

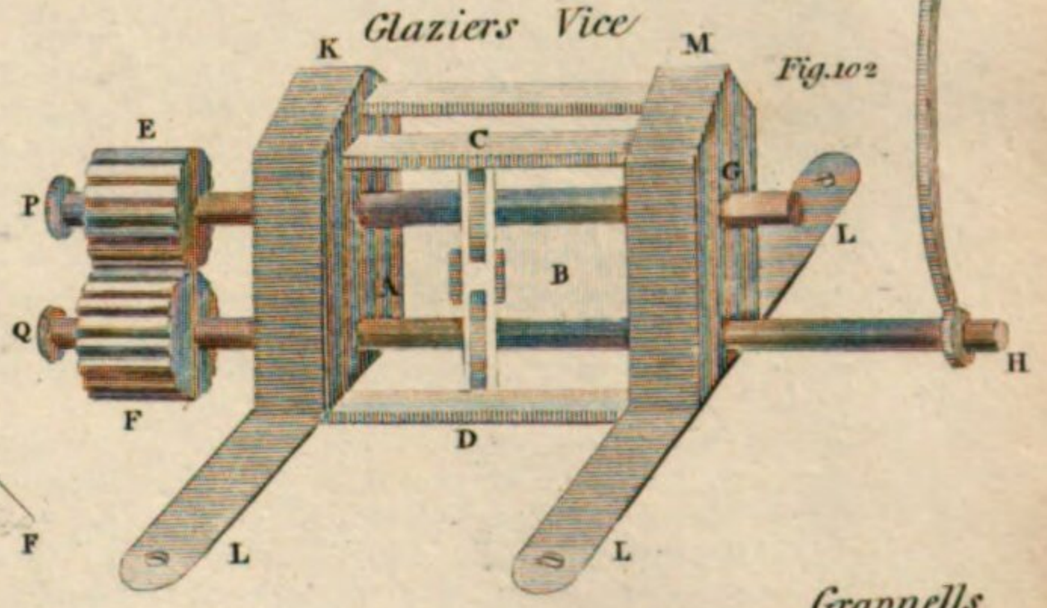
Gnomon

Fig. 106



Glaziers Vice

Fig. 102



Gnomon

Fig. 103

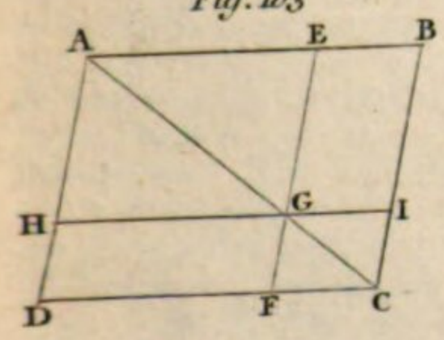


Fig. 104

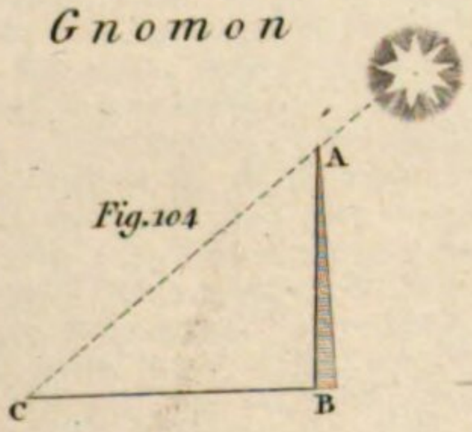
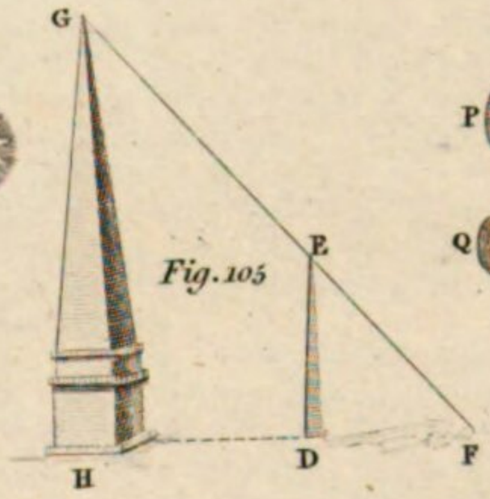


Fig. 105



Grapnells

Fig. 110

Graphometer

Fig. 108

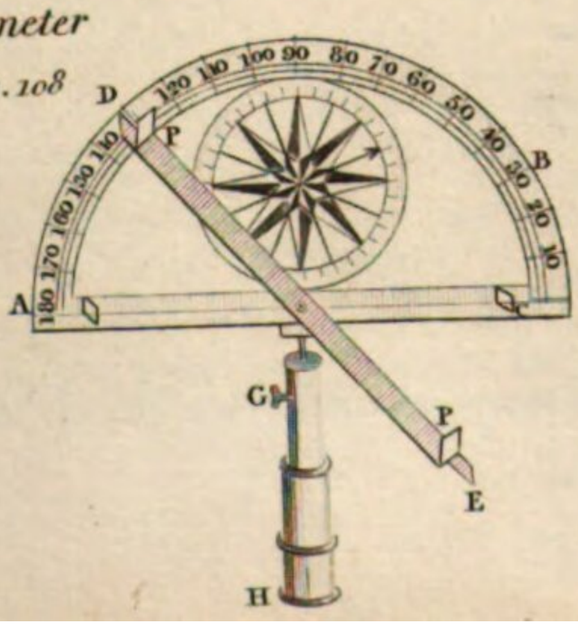
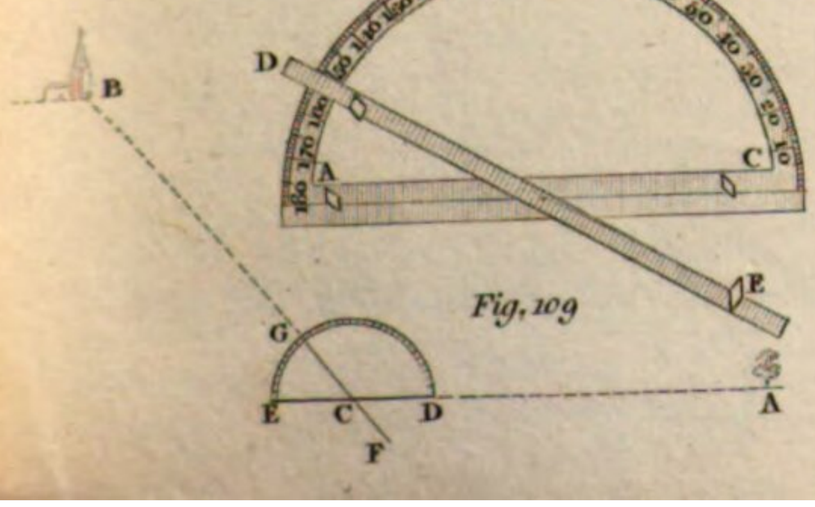
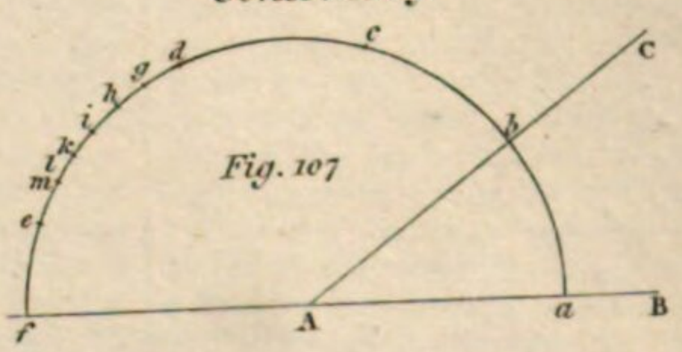


Fig. 109



Goniometry

Fig. 107



ways proportional to the time of its description; or that it described equal areas in equal times, in whatever part of its orbit the planet might be, moving always so much the quicker as its distance from the sun was less. And it is also found that the satellites, or secondary planets, respect the same law in revolving about their primaries. But it was soon proved by Newton, that all bodies moving in any curve line described on a plane, and which, by radii drawn to any certain point, describe areas about the point proportional to the times, are impelled or acted on by some power tending towards that point. Consequently the power by which all these planets revolve, and are retained in their orbits, is directed to the centre about which they move, viz. the primary planets to the sun, and the satellites to their several primaries.

Again, Newton demonstrated, that if several bodies revolve with an equable motion in several circles about the same centre, and that if the squares of their periodical times are in the same proportion as the cubes of their distances from the common centre, then the centripetal forces of the revolving bodies, by which they tend to their central body, will be in the reciprocal or inverse ratio of the squares of the distances. Or if bodies revolve in orbits approaching to circles, and the apses of those orbits are at rest, then also the centripetal forces of the revolving bodies will be reciprocally proportional to the squares of the distances. But it had been agreed on by the astronomers, and particularly Kepler, that both these cases obtain in all the planets. And therefore he inferred, that the centripetal forces of all the planets are reciprocally proportional to the squares of the distances from the centres of their orbits.

Upon the whole it appears, that the planets are retained in their orbits by some power which is continually acting upon them: that this power is directed towards the centre of their orbits: that the intensity or efficacy of this power increases upon an approach towards the centre, and diminishes on receding from the same, and that in the reciprocal duplicate ratio of the distances: and that, by comparing this centripetal force of the planets with the force of gravity on the earth, they are found to be perfectly alike, as may easily be shewn in various instances. For example, in the case of the moon, the nearest of all the planets. The rectilinear spaces described in any given time by a falling body, urged by any powers, reckoning from the beginning of its descent, are proportional to those powers. Consequently the centripetal force of the moon revolving in her orbit, will be to the force of gravity on the surface of the earth, as the space which the moon would describe in falling during any small time, by her centripetal force towards the earth, if she had no circular motion at all, to the space of a body near the earth would describe in falling by its gravity towards the same.

Now by an easy calculation of those two spaces, it appears that the former force is to the latter, as the square of the semidiameter of the earth is to the square of that of the moon's orbit. The moon's centripetal force therefore is equal to the force of gravity; and consequently these forces are not different, but they are one and the same: for if they were different, bodies acted on by the two powers conjointly would fall towards the earth with a velocity double to that arising from the sole power of gravity.

It is evident therefore that the moon's centripetal force, by which she is retained in her orbit, and prevented from running off in tangents, is the very power of gravity of the earth extended thither. See Newton's Princip. lib. 1, prop. 45, and lib. 3, prop. 3; where the numeral calculation may be seen at full length.

The moon therefore gravitates towards the earth, and reciprocally the earth towards the moon. And this is also farther confirmed by the phenomena of the tides.

The like reasoning may also be applied to the other planets. For as the revolutions of the primary planets round the sun, and those of the satellites of Jupiter and Saturn round their primaries, are phenomena of the same kind with the revolution of the moon about the earth; and as the centripetal powers of the primary are directed towards the centre of the sun, and those of the satellites towards the centres of their primaries; and, lastly, as all these powers are reciprocally as the squares of the distances from the centres, it may safely be concluded that the power and cause are the same in all.

As the moon, therefore, gravitates towards the earth, and the earth towards the moon; so do all the secondaries to their primaries, and these to their secondaries; and so also do the primaries to the sun, and the sun to the primaries. Newton's Princip. lib. 3, prop. 4, 5, 6; Greg. Astron. lib. 1, sect. 7, prop. 46 and 47.

The laws of universal gravity are the same as those of bodies gravitating towards the earth, before laid down.

Cause of gravity. Various theories have been advanced by the philosophers of different ages to account for this grand principle of gravitation. The antients, who were only acquainted with particular gravity, or the tendency of sublunar bodies towards the earth, aimed no farther than to establish a system that might answer the more obvious phenomena of it. Some hints, however, are found concerning the gravitation of celestial bodies in the account given of the doctrine of Thales and his successors; and it would seem that Pythagoras was still better acquainted with it, and which it is supposed he had in view in what he taught concerning the harmony of the spheres.

Aristotle and the Peripatetics content themselves with referring gravity or weight to a native inclination in heavy bodies to be in their proper place or sphere, the centre of the earth. And Copernicus ascribes it to an innate principle in all parts of matter, by which, when separated from their wholes, they endeavour to return to them again the nearest way.

Kepler, in his preface to the Commentaries concerning the planet Mars, speaks of gravity as of a power that was mutual between bodies; and says that the earth and moon tend towards each other, and would meet in a point so many times nearer to the earth than to the moon, as the earth is greater than the moon, if the motions did not hinder it. He adds, that the tides arise from the gravity of the waters towards the moon. To him we also owe the important discovery of the analogy between the distances of the several planets from the sun, and the periods in which they complete their revolutions, viz. that the squares of their periodic times are always in the same proportion as the cubes of their mean distances from the sun. However, Kepler, Gassendi, Gilbert, and others, ascribe gravity to a certain magnetic attraction of the earth; conceiving the earth to be one great magnet continually emitting effluvia, which take hold of all bodies, and draw them towards the earth. But this is inconsistent with the several phenomena.

Des Cartes and his followers, Rohault, &c. attribute gravity to an external impulse or trusion of some subtle matter. By the rotation of the earth, say they, all the parts and appendages of it necessarily endeavour to recede from the centre of rotation; but whence they cannot all actually recede, as there is no vacuum or space to receive them. But this hypothesis, founded on the supposition of a plenum, is overthrown by what has been since proved of the existence of a vacuum.

Dr. Halley, despairing of any satisfactory theory, chooses to have immediate recourse to the agency of the Deity. So Dr. Clarke, from a view of several properties of gravity, concludes that it is no adventitious effect of any motion, or subtle matter, but an original and general law impressed by God on all matter, and preserved in it by some efficient power penetrating the very solid and intimate substance of it; being found always proportional, not to the surfaces of bodies or corpuscles, but to their solid quantity and contents. It should therefore be no more enquired why bodies gravitate, than how they came to be first put in motion.

Gravesande, in his Introduct. ad Philos. Newton. contends, that the cause of gravity is utterly unknown; and that we are to consider it no otherwise than as a law of nature originally and immediately impressed by the Creator, without any dependance on any second law or cause at all. Of this he thinks the three following considerations sufficient proof. 1. That gravity requires the presence of the gravitating or attracting body: so that the satellites of Jupiter, for example gravitate towards Jupiter, wherever he may be. 2. That the distance being supposed the same, the velocity with which bodies are moved by the force of gravity, depends on the quantity of matter in the attracting body; and the velocity is not changed, whatever the mass of the gravitating body may be. 3. That if gravity depends on any known law of motion, it must be some impulse from an extraneous body; so that as gravity is continual, a continual stroke must also be required. Now if there is any such matter continually striking on bodies, it must be fluid and subtle enough to penetrate the substance of all bodies: but how shall a body subtle enough to penetrate the substance of the hardest bodies, and so rare as not sensibly to hinder the motion of bodies, be able to impel vast masses towards each other with such force? How does this force increase the ratio of the mass of the body, towards which the other body is moved? Whence is it that all bodies move with the same velocity, the distance and body gravitated to being the same? Can a fluid which only acts on the surface either of the bodies themselves, or their internal particles, communicate such a quantity of

motion to bodies, which in all bodies shall exactly follow the proportion of the quantity of matter in them?

Mr. Cotes goes yet farther. Giving a view of Newton's philosophy, he asserts that gravity is to be ranked among the primary qualities of all bodies; and deemed equally essential to matter as extension, mobility, or impenetrability. Præfat. ad Newt. Princip. But Newton himself disclaims this notion; and to shew that he does not take gravity to be essential to bodies, he declares his opinion of the cause; choosing to propose it by way of query, not being yet sufficiently satisfied about its experiments. Thus, after having shewn that there is a medium in nature vastly more subtle than air, by whose vibrations sound is propagated, by which light communicates heat to bodies, and by the different densities of which the refraction and reflection of light are performed; he proceeds to enquire: "Is not this medium much rarer within the dense bodies of the sun, stars, planets, and comets, than in the empty celestial spaces between them? And in passing from them to greater distances, doth it not grow denser and denser perpetually, and thereby cause the gravity of those great bodies towards one another, and of their parts towards the bodies; every body endeavouring to recede from the denser parts of the medium towards the rarer?

"For if this medium be supposed rarer within the Sun's body than at its surface, and rarer there than at the hundredth part of an inch from his body, and rarer there than at the fiftieth part of an inch from his body, and rarer there than at the orb of Saturn; I see no reason why the increase of density should stop any where, and not rather be continued through all distances from the Sun to Saturn, and beyond.

"And though this increase of density may at great distances be exceeding slow; yet if the elastic force of this medium be exceeding great, it may suffice to impel bodies from the denser parts of the medium towards the rarer with all that power which we call gravity.

"And that the elastic force of this medium is exceeding great, may be gathered from the swiftness of its vibrations. Sounds move about 1140 English feet in a second of time, and in seven or eight minutes of time they move about 100 English miles: light moves from the Sun to us in about seven or eight minutes of time; which distance is about 70,000,000 English miles, supposing the horizontal parallax of the Sun to be about twelve seconds; and the vibrations, or pulses of this medium, that they may cause the alternate fits of easy transmission, and easy reflection, must be swifter than light, and by consequence above 7000000 times swifter than sounds; and therefore the elastic force of this medium, in proportion to its density, must be above 7000000 × 7000000 (that is, above 490,000,000,000) times greater than the elastic force of the air is in proportion to its density: for the velocities of the pulses of elastic mediums are in a subduplicate ratio of the elasticities and the rarities of the mediums taken together.

"As magnetism is stronger in small loadstones than in great ones, in proportion to their bulk; and gravity is stronger on the surface of small planets than those of great ones, in proportion to their bulk; and small bodies are agitated much more by electric attraction than great ones: so the smallness of the rays of light may contribute very much to the power of the agent by which they are refracted; and if any one should suppose that æther (like our air) may contain particles which endeavour to recede from one another (for I do not know what this æther is), and that its particles are exceedingly smaller than those of air, or even than those of light; the exceeding smallness of such particles may contribute to the greatness of the force by which they recede from one another, and thereby make that medium exceedingly more rare and elastic than air, and of consequence exceedingly less able to resist the motions of projectiles, and exceedingly more able to press upon gross bodies by endeavouring to expand itself." Optics, p. 325, &c.

GRAVITY, in mechanics, denotes the tendency of bodies towards the centre of the earth. That part of mechanics which considers the equilibrium, or motion of bodies arising from gravity or weight, is particularly called statics.

Gravity in this view is distinguished into absolute and relative.

Absolute GRAVITY is that with which a body descends freely and perpendicularly through an unresisting medium. See MECHANICS.

Relative GRAVITY is that with which a body descends on an inclined plane, or through a resisting medium, or as opposed by some other resistance. See MECHANICS.

GRAVITY, in hydrostatics. The laws of bodies gravitating in fluids make the business of hydrostatics.

Gravity is here divided into absolute and specific.

Absolute, or *true* GRAVITY, is the whole force with which the body tends downwards.

Specific GRAVITY, is the relative, comparative, or apparent gravity in any body, in respect of that of an equal bulk or magnitude of another body; denoting that gravity or weight which is peculiar to each species or kind of body, and by which it is distinguished from all other kinds.

In this sense a body is said to be specifically heavier than another, when under the same bulk it contains a greater weight than that other; and reciprocally the latter is said to be specifically lighter than the former. Thus, if there are two equal spheres, each one foot in diameter; the one of lead, and the other of wood: since the leaden one is found heavier than the wooden one, it is said to be specifically, or in specie, heavier; and the wooden one specifically lighter.

This kind of gravity is by some called relative; in opposition to absolute gravity, which increases in proportion to the quantity or mass of the body.

Laws of the specific gravity of bodies.

I. If two bodies are equal in bulk, their specific gravities are to each other as their weights, or as their densities.

II. If two bodies are of the same specific gravity or density, their absolute weights will be as their magnitudes or bulks.

III. In bodies of the same weight, the specific gravities are reciprocally as their bulks.

IV. The specific gravities of all bodies are in a ratio compounded of the direct ratio of their weights and reciprocal ratio of their magnitudes. And hence again the specific gravities are as the densities.

V. The absolute gravities or weights of bodies are in the compound ratio of their specific gravities and magnitudes or bulks.

VI. The magnitudes of bodies are directly as their weights, and reciprocally as their specific gravities.

VII. A body specifically heavier than a fluid, loses as much of its weight when immersed in it, as is equal to the weight of a quantity of the fluid of the same bulk or magnitude.

Hence, since the specific gravities are as the absolute gravities under the same bulk; the specific gravity of the fluid, will be to that of the body immerged, as the part of the weight lost by the solid, is to the whole weight.

And hence the specific gravities of fluids are as the weights lost by the same solid immerged in them.

VIII. *To find the specific gravity of a fluid or of a solid.* On one arm of a balance suspend a globe of lead by a fine thread, and to the other fasten an equal weight, which may just balance it in the open air. Immerge the globe into the fluid, and observe what weight balances it then, and consequently what weight is lost, which is proportional to the specific gravity as above. And thus the proportion of the specific gravity of one fluid to another is determined by immersing the globe successively in all the fluids, and observing the weights lost in each, which will be the proportions of the specific gravities of the fluids sought.

This same operation determines also the specific gravity of the solid immerged, whether it is a globe, or of any other shape or bulk, supposing that of the fluid known. For the specific gravity of the fluid is to that of the solid, as the weight lost is to the whole weight.

Hence also may be found the specific gravity of a body that is lighter than the fluid, as follows:

IX. *To find the specific gravity of a solid that is lighter than the fluid, as water, in which it is put.* Annex to the lighter body another that is much heavier than the fluid, so that the compound mass may sink in the fluid. Weigh the heavier body and the compound mass separately, both in water and out of it; then find how much each loses in water, by subtracting its weight in water from its weight in air; and subtract the less of these remainders from the greater.

Then, As this last remainder,
Is to the weight of the light body in air,
So is the specific gravity of the fluid,
To the specific gravity of that body.

X. The specific gravities of bodies of equal weight, are reciprocally proportional to the quantities of weight lost in the same fluid. And hence is found the ratio of the specific gravities of solids, by weighing in the same fluids, masses of them that weigh equally in air, and noting the weights lost by each.

The specific gravities of many kinds of bodies, both solid and fluid, have been determined by various authors. It will be suffi-

cient here to give those of some of the most usual bodies that have been determined with the greater certainty. The numbers in this table express the number of avoirdupoise ounces in a cubic foot of each body, that of common water being just 1000 ounces, or 62½ lb.

A TABLE

OF THE SPECIFIC GRAVITIES OF DIFFERENT BODIES, ARRANGED ALPHABETICALLY.

Metals.

Antimony, crude	4064
—— glass of	4946
—— molten	6702
Arsenic, glass of, natural	3594
—— molten	5763
—— native orpiment	5452
Bismuth, molten	9823
—— native	9020
—— ore of, in plumes	4371
Brass, cast, not hammered	8396
—— ditto, wiredrawn	8544
—— cast, common	7824
Cobalt, molten	7812
—— blue glass of	2441
Copper, not hammered	7788
—— the same wiredrawn	8878
—— ore of soft copper, or natural verdigr.	3572
Gold, pure, of 24 carats, melted, but not hammered	19258
—— the same hammered	19362
—— Parisian standard, 22 car. not hammered	17486
—— the same hammered	17589
—— guinea of Geo. II.	17150
—— guinea of Geo. III.	17629
—— Spanish gold coin	17655
—— Holland ducats	19352
—— trinket standard, 20 car. not hammered	15709
—— the same hammered	15775
Iron, cast	7207
—— bar, either hardened or not	7788
Steel, neithered tempered nor hardened	7833
—— hardened, but not tempered	7840
—— tempered and hardened	7818
—— ditto not hardened	7816
Iron, ore prismatic	7355
—— ditto specular	5218
—— ditto lenticular	5012
Lead, molten	11352
—— ore of, cubic	7587
—— ditto horned	6072
—— ore of black lead	6745
—— ditto white lead	4059
—— ditto ditto vitreous	6558
—— ditto red lead	6027
—— ditto saturnite	5925
Manganese, striated	4756
Molybdena	4738
Mercury, solid, or congealed	15632
—— fluent	13568
—— natural calx of	9230
—— precipitate per se	10871
—— precipitate, red	8399
—— brown cinnabar	10218
—— red cinnabar	6902
Nickel, molten	7807
—— ore of, called kupfernickel of Saxe	6648
—— kupfernickel of Bohemia	6607
Platina, crude, in grains	15602
—— purified, not hammered	19500
Platina, purified, hammered	20337
—— ditto wiredrawn	21042
—— ditto rolled	22069
Silver, virgin, 12 deniers, fine, not hammered	10744
—— ditto hammered	10511
—— Paris standard	10175
—— shilling of Geo. II.	10000
—— shilling of Geo. III.	10534
—— French coin	10408
Tin, pure Cornish, melted, and not hardened	7291
—— the same hardened	7299
—— of Malacca, not hardened	7296
—— the same hardened	7307
—— ore of, red	6935
—— ore of, black	6901
—— ore of, white	6008
Tungsten	6066
Uranium	6440
Wolfram	7119
Zinc, molten	7191

Precious stones.

Beryl, or aqua-marine, oriental	3549
—— ditto occidental	2723
Chrysolite, of the jewellers	2782
—— of Brazil	2692
Chrystal, pure rock of Madagascar	2653
—— of Brazil	2653
—— European	2655
—— rose-coloured	2670
—— yellow	2654
—— violet, or amethyst	2654
—— white amethyst	2651
—— Carthaginian	2657
—— black	2654
Diamond, white oriental	3521
—— rose-coloured oriental	3531
—— orange ditto	3550
—— green ditto	3524
—— blue ditto	3525
—— Brazilian	3444
—— yellow	3519
Emerald of Peru	2775
Garnet of Bohemia	4189
—— of Syria	4000
—— dodecaedral	4063
—— volcanic, 24 faces	2468
Girasol	4000
Hyacinth, common	3687
Jargon of Ceylon	4416
Quartz, crystallised	2655
—— in the mass	2647
—— brown crystallised	2647
—— fragile	2640
—— milky	2652
—— fat, or greasy	2646
Ruby, oriental	4283
—— spinell	3760
—— ballas	3646
—— Brazilian	3531
Sapphire, oriental	3994
—— ditto white	3991
—— of Puys	4077
—— Brazilian	3131
Spar, white sparkling	2595
—— red ditto	2438
—— green ditto	2704
—— blue sparkling	2693
—— green and white ditto	3105
—— transparent ditto	2564
—— adamantine	3873
Topaz, oriental	4011
—— pistachio ditto	4061
—— Brazilian	3536
—— of Saxe	3564
Topaz, white ditto	3554
—— vermilion	4230

Silicious stones.

Agate, oriental	2590
—— onyx	2638
—— cloudy	2625
—— speckled	2607
—— veined	2667
—— stained	2632
Calcedony, common	2616
—— transparent	2664
—— veined	2606
—— reddish	2665
—— blueish	2587
—— onyx	2615
Carnelian, pale	2630
—— speckled	2612
—— veined	2623
—— onyx	2623
—— stalactite	2598
—— simple	2613
Flint, white	2594
—— black	2582
—— veined	2612
—— Egyptian	2565
Jade, white	2950
—— green	2966
—— olive	2983
Jasper, clear green	2539
—— brownish green	2681
—— red	2661
—— brown	2691
—— yellow	2710
—— violet	2711
—— cloudy	2735
—— veined	2696
—— onyx	2816
—— red and yellow	2750
—— bloody	2628
Opal	2114
Pearl, virgin oriental	2684
Pebble, onyx	2664
—— of Rennes	2654
—— English	2609
—— veined	2612
—— stained	2587
Prasium	2581
Sardonyx, pure	2603
—— pale	2606
—— speckled	2622
—— veined	2595
—— onyx	2595
—— blackish	2628
Schorl, black prism. hexaedral	3364
—— octaedral	3226
—— tourmalin of Ceylon	3054
—— antique basaltes	2923
—— Brazilian emerald	3156
—— cruciform	3286
Stone, paving	2416
—— cutler's	2111
—— grind	2143
—— mill	2500

Various stones, earths, &c.

Alabaster, oriental white	2730
—— ditto semitransparent	2762
—— yellow	2699
—— stained brown	2744
—— veined	2691
—— of Piedmont	2693
—— of Malta	2699
—— Spanish saline	2713
—— of Valencia	2638
—— of Malaga	2876
Amber, yellow transparent	1078

Ambergris	926
Amianthus, long	909
——— short	2313
Asbestos, ripe	2578
——— starry	3073
Basaltes from Giants' Causeway	2864
Bitumen, of Judea	1104
Brick	2000
Chalk, Spanish	2790
——— coarse Briançon	2727
——— British	2784
Gypsum, opaque	2168
——— semitransparent	2306
——— fine ditto	2274
——— rhomboidal	2311
——— ditto 10 faces	2312
——— cuneiform crystallised	2306
Glass, green	2642
——— white	2892
——— bottle	2733
——— Leith crystal	3189
——— fluid	3329
Granite, red Egyptian	2654
——— of Balbeck	3500
Hone, white razor	2876
Lapis nephriticus	2894
——— lazuli	3054
——— hæmatites	4360
——— calaminaris	5000
——— Judaicus	2500
——— manati	2270
Limestone	3179
——— white flour	3156
——— green	3182
Marble, green campanian	2742
——— red	2724
——— white Cassara	2717
——— white Parian	2838
——— Pyrenean	2726
——— black Biscayan	2695
——— Brocatelle	2650
——— Castilian	2700
——— Valencian	2710
——— white Grenadan	2705
——— Siennien	2678
——— Roman violet	2755
——— African	2708
——— violet Italian	2858
——— Norwegian	2728
——— Siberian	2718
——— green Egyptian	2668
——— Swisserland	2714
——— French	2649
Obsidian stone	2348
Peat, hard	1329
Phosphorus	1714
Porcelaine, Seves	2146
——— Limoges	2341
——— China	2385
Porphyry, red	2765
——— green	2676
——— red, from Dauphiny	2793
——— red, from Cordone	2754
——— green, from ditto	2728
Pyrites, coppery	4954
——— ferruginous cubic	3900
——— ditto round	4101
——— ditto of St. Domingo	3440
Serpentine, opaque, green Italian	2430
——— ditto, veined black and olive	2594
——— ditto, red and black	2627
——— semitranspar. grained	2586
——— ditto fibrous	3000
——— ditto, from Dauphiny	2669
Slate, common	2672
——— new	2854
——— black stone	2186
Slate, fresh polished	2766
Satlactite, transparent	2324
——— opake	2478
Stone, pumice	915
——— prismatic basaltes	2722
——— touch	2415
——— Siberian blue	2945
——— oriental ditto	2771
——— common	2520
——— Bristol	2510
——— Burford	2049
——— Portland	2496
——— rag	2470
——— rotten	1981
——— hard paving	2460
——— mill	2500
——— clicard, from Brachet	2357
——— ditto, from Ouchain	2274
——— Notre Dame	2378
——— St. Maur	2034
——— St. Cloud	2201
Sulphur, native	2033
——— molten	1991
Talc, of Muscovy	2792
——— black crayon	2089
——— ditto German	2246
——— yellow	2655
——— black	2900
——— white	2704

Liquors, oils, &c.

Acid, sulphuric	1841
——— ditto, highly concentrated	2125
——— nitric	1271
——— ditto, highly concentrated	1580
——— muriatic	1194
——— red acetous	1025
——— white acetous	1014
——— distilled ditto	1010
——— fluoric	1500
——— acetic	1063
——— phosphoric	1558
——— formic	994
Alcohol, commercial	837
——— highly rectified	829
Alcohol, mixed with water,	
15-16ths alcohol	853
14-16ths ditto	867
13-16ths ditto	882
12-16ths ditto	895
11-16ths ditto	908
10-16ths ditto	920
9-16ths ditto	932
8-16ths ditto	943
7-16ths ditto	952
6-16ths ditto	960
5-16ths ditto	967
4-16ths ditto	973
3-16ths ditto	979
2-16ths ditto	985
1-16th ditto	997
Ammoniac, liquid	897
Beer, pale	1024
——— brown	1038
Cyder	1018
Ether, sulphuric	739
——— nitric	909
——— muriatic	730
——— acetic	860
Milk, woman's	1020
——— cow's	1032
——— ass's	1036
——— ewe's	1041
——— goat's	1035
——— mare's	1034
——— cow's clarified	1019
Oil, essential, of turpentine	870
Oil, essential, of lavender	894
——— ditto, of cloves	1036
——— ditto, of cinnamon	1044
——— of olives	915
——— of sweet almonds	917
——— of filberts	916
——— linseed	940
——— of walnuts	923
——— of whale	923
——— of hempseed	926
——— of poppies	924
——— rapeseed	919
Spirit of wine. See Alcohol.	
Turpentine, liquid	991
Urine, human	1011
Water, rain	1000
——— distilled	1000
——— sea (average)	1026
——— of Dead Sea	1240
Wine, Burgundy	992
——— Bourdeaux	994
——— Madeira	1038
——— Port	997
——— Canary	1033

Resins, gums, and animal substances, &c.

Aloes, socotrine	1380
——— hepatic	1359
Assafœtida	1328
Bees'-wax, yellow	965
——— white	969
Bone of an ox	1656
Butter	942
Calculus humanus	1700
——— ditto	1240
——— ditto	1434
Camphor	989
Copal, opake	1140
——— Madagascar	1060
——— Chinese	1063
Crassamentum, human blood	1126
Dragon's blood	1205
Elemi	1018
Fat, beef	923
——— hog's	937
——— mutton	924
——— veal	934
Galbanum	1212
Gamboge	1222
Gum, ammoniac	1207
——— Arabic	1452
——— euphorbia	1124
——— seraphic	1201
——— tragacanth	1316
——— bdellium	1372
——— scammony of Smyrna	1274
——— ditto of Aleppo	1235
Gunpowder, shaken	932
——— in a loose heap	836
——— solid	1745
Honey	1450
Indigo	769
Ivory	1826
Juice of liquorice	1723
——— of acacia	1515
Labdanum	1186
Lard	948
Mastic	1074
Myrrh	1360
Opium	1336
Scammony. See Gum.	
Serum of human blood	1030
Spermaceti	943
Storax	1110
Tallow	942
Terra Japonica	1398
Tragacanth. See Gum.	

Wax. See Bees'-wax.	
——, shoemaker's	897
Woods.	
Alder	800
Apple-tree	793
Ash, the trunk	845
Bay-tree	822
Beech	852
Box, French	912
—— Dutch	1328
—— Brazilian red	1031
Campechy wood	913
Cedar, wild	596
——— Palestine	613
——— Indian	1315
——— American	561
Citron	726
Coco-wood	1040
Cherry-tree	715
Cork	240
Cypress, Spanish	644
Ebony, American	1331
——— Indian	1209
Elder-tree	695
Elm, trunk of	671
Filbert-tree	600
Fir, male	550
— female	498
Hazel	600
Jasmin, Spanish	770
Juniper-tree	556
Lemon-tree	703
Lignum vitæ	1333
Linden-tree	604
Logwood. See Campechy.	
Mastich-tree	849
Mahogany	1063
Maple	750
Medlar	944
Mulberry, Spanish	897
Oak, heart of, 60 years old	1170
Olive-tree	927
Orange-tree	705
Pear-tree	661
Pomegranate-tree	1354
Poplar	383
——, white, Spanish	529
Plum-tree	785
Quince-tree	705
Sassafras	482
Vine	1327
Walnut	671
Willow	585
Yew, Dutch	788
—— Spanish	807

Weight and specific gravities of different gases.

Fahrenheit's therm. 55° Spec. grav.	Barom. 30 inch. Wt. cub. foot.
Atmospheric air 1.2	525.0 grs.
Hydrogenous gas 0.1	43.75
Oxygenous gas 1.435	627.812
Azotic gas 1.182	517.125
Nitrous gas 1.4544	636.333
Ammoniac. gas .7311	319.832
Sulphur. acid gas 2.7614	1207.978

In this table the weights and specific gravities of the principal gases are given, as they correspond to a state of the barometer and thermometer which may be chosen for a medium. The specific gravity of any one gas to that of another will not conform to exactly the same ratio under different degrees of heat and other pressures of the atmosphere, because the various expansions by no means follow the same law.

These numbers being the weight of a cubic foot, or 1728 cubic inches, of each of the bodies, in avoirdupois ounces, by proportion the quantity in any other weight, or the weight of any other quantity, may be readily known.

For example. Required the content of an irregular block of millstone which weighs 1 cwt. or 112 lb. or 1792 ounces. Here, as 2500 : 1792 : : 1728 : 1228$\frac{4}{5}$ cubic inches the content.

Ex. 2. To find the weight of a block of granite, whose length is 63 feet, and breadth and thickness each 12 feet; being the dimensions of one of the stones of granite in the walls of Balbec. Here 63 × 12 × 12 = 9072 feet is the content of the stone; therefore as 1 : 9072 : : 3500 oz. 31752000 oz. or 885 tons 18 cwt. 3 qrs. the weight of the stone.

XI. A body descends in a fluid specifically lighter, or ascends in a fluid specifically heavier, with a force equal to the difference between its weight and that of an equal bulk of the fluid.

XII. A body sinks in a fluid specifically heavier, so far as that the weight of the body is equal to the weight of a quantity of the fluid of the same bulk as the part immersed. Hence, as the specific gravity of the fluid, is to that of the body, so is the whole magnitude of the body, to the magnitude of the part immersed.

XIII. The specific gravities of equal solids are as their parts immerged in the same fluid.

The several theorems here delivered are both demonstrable from the principles of mechanics, and are also equally conformable to experiment, which answers exactly to the calculation. See HYDROSTATICS.

GRAVITY, in music. Gravity is that modification of any sound by which it becomes deep or low in respect of some other sound: the gravity of sounds depends on the thickness and distension of the chords, or the length and diameter of the pipes, and in general on the mass, extent, and tension, of the sonorous bodies. The larger and more lax are the bodies, the slower will be the vibrations, and the graver the sounds.

GRAUSTEIN, in mineralogy, is a rock composed of small grains of felspar and hornblende, which graduate into each other, and form a mass almost homogenous of an ash-grey colour. It contains olivine and augite.

GREAT-CIRCLE SAILING, the manner of conducting a ship in, or rather pretty near, the arch of a great circle, that passes through the zenith of the two places, viz. whence she came, and to which she is bound.

GREEN-CLOTH, a board, or court of justice, held in the compting-house of the king's household, composed of the lord-steward, and officers under him, who sit daily. To this court are committed the charge and oversight of the king's household in matters of justice and government, with a power to correct all offenders, and to maintain the peace of the verge, or jurisdiction of the court-royal; which is every way about two hundred yards from the last gate of the palace where his majesty resides. It takes its name from a green cloth spread over the board where they sit. Without a warrant first obtained from this court, none of the king's servants can be arrested for debt.

GREEN-FINCH, in ornithology. See FRINGILLA.

GREEN-HOUSE, or conservatory, a house in a garden contrived for sheltering and preserving the most tender and curious exotic plants, which, in our climate, will not bear to be exposed to the open air during the winter season. These are generally large and beauful structures, equally ornamental and useful.

GREENLAND COMPANY. A joint stock of 40,000*l.* was by statute to be raised by subscribers, who were incorporated for 14 years from the 1st of October, 1693, and the company to use the trade of catching whales, &c. into and from Greenland and the Greenland seas. They make bye-laws for the government of the persons employed in their ships, &c. Stat. 4 and 5 W. III. cap. 17. This company was farther encouraged by parliament in 1696; but partly by unskilful management, and partly by real losses, it was under the necessity of entirely breaking up, before the expiration of the term assigned to it, ending in 1707. But any person who will adventure to Greenland for whale-fishing shall have all the privileges granted to the Greenland company by 1 Anne, cap. 16, and thus the trade was again laid open. Any subjects may import whale-fins, oil, &c. of fish caught in the Greenland seas, without paying any customs, &c. Stat. 10 Geo. I. cap. 16. And ships employed in the Greenland fishery are to be of a given burden, provided with boats, so many men, fishing-lines, harping-irons, &c. and be licensed to proceed; and on their return shall be paid 20*s.* per ton bounty for whale-fins, &c. imported. 6 Geo. II. cap. 33. The bounty was afterwards increased, but has been lately diminished; and since this diminution the trade has increased. See BALÆNA, and FISHERY.

GREGORIAN CALENDAR. See CALENDAR, and EPACT.

GREGORIAN EPOCH, the epocha or time whence the Gregorian calendar or computation took place.

GREGORIAN YEAR, the Julian year corrected or modelled, in such a manner as that three secular years, which in the Julian account are bissextile, are here common years, and only every fourth secular year is made a bissextile year.

The Julian computation is more than the solar year by eleven minutes, which in 131 years amounts to a whole day. By this calculation the vernal equinox was anticipated 10 days from the time of the general council of Nice, held in the year 325 of the christian æra, to the time of pope Gregory XIII. who therefore caused 10 days to be taken out of the month of October, in 1582, to make the equinox fall on the 21st of March, as it did at the time of that council; and to prevent the like variation for the future, he ordered that three days should be abated in every 400 years, by reducing the leap-year at the close of each century for three successive centuries to common years, and retaining the leap-year at the close of each fourth century only. This was at that time esteemed as exactly conformable to the true solar year, but it is found not to be strictly just, because that in 400 years it gets one hour and twenty minutes; and consequently in 7200 years, a whole day.

The greatest part of Europe have long

used the Gregorian style; but Great Britain retained the Julian till the year 1752, when by act of parliament this style was adjusted to the Gregorian; since which time Sweden, Denmark, and other European states, who computed time by the Julian account, have followed this example.

GREWIA, a genus of the polyandria order, in the gynandria class of plants, and in the natural method ranking under the 37th order, columniferæ. The calyx is pentaphyllous; there are five petals, each with a nectariferous scale at the base; the berry is quadrilocular. The species are 13. The most remarkable are:

1. The occidentalis, with oval crenated leaves, has long been preserved in many curious gardens both in England and Holland. It is a native of the Cape of Good Hope, and grows to the height of 10 or 12 feet. The stem and branches greatly resemble those of the small-leafed elm, the bark being smooth, and of the same colour with that when young. The leaves are also very like those of the elm, and fall off in autumn. The flowers are produced singly along the young branches from the wings of the leaves, and are of a bright purple colour.

2. The africana, with oval spear-shaped serrated leaves, is a native of Senegal in Africa, whence its seeds were brought by Mr. Adanson. In this country it rises with a shrubby stalk five or six feet high, sending out many lateral branches, with a brown hairy bark, and garnished with spear-shaped serrated leaves; but the plants have not flowered in Britain.

The first sort, though a native of a warm climate, will bear the open air in this country; only requiring to be sheltered in a greenhouse during the winter time. It may be propagated by cuttings or layers planted in pots filled with soft loamy earth. The second sort is tender, and must be kept constantly in a warm bark-stove. In summer they require a large share of the free air to be admitted to them, and should have water three or four times a week in warm weather; but in the winter they must be sparingly watered. The negroes of Senegal consider a decoction of the bark of this last species as a never-failing remedy against venereal complaints.

GREWT, among miners, signifies earth of a different colour from the rest, found on the banks of rivers as they are searching for mines.

GREYHOUND. See CANIS.

GRIAS, a genus of the monogynia order, in the polyandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is tetrapetalous; the calyx quadrifid; the stigma sessile and cruciform: the fruit is a plum with an eight-furrowed kernel. There is but one species, the cauliflora, or anchovy pear, a native of Jamaica. The leaves are nearly oval, and about three feet long. It has a straight stem, upon the upper part of which come forth the flowers. The fruit is large, and contains a stone with eight furrows. These fruits are eaten by the inhabitants.

GRIELUM, a genus of the pentagynia order, in the decandria class of plants. The calyx is quinquefid, there are five petals; the filaments persisting; and there are five monospermous seed-cases. There is one species, a herb of the Cape.

GRIFFON, in heraldry, an imaginary animal, feigned by the antients to be half eagle and half lion; by this form they intended to give an idea of strength and swiftness joined together, with an extraordinary vigilance in guarding the things entrusted to its care.

GRINDING, *trituratio*, the reducing hard substances to fine powders, either by the mortar, or by way of levigation, upon a marble. See MILLWORK.

GRIPE, in the sea language, is a piece of timber stayed against the lower piece of the stern, from the foremast end of the keel, joining with the knee of the head: its use is to defend the lower part of the stern from any injury; but it is often made the larger, to make the ship keep a good wind.

GRISLEA, a genus of the monogynia order, in the octandria class of plants, and in the natural method ranking under the 17th order, calycanthemæ. The calyx is quadrifid; and there are four petals, one from each incisure of it. The filaments are very long, ascending or turning upwards; the capsule is globose, superior, unilocular, and polyspermous. There are two species; one a tree of S. America, the other a shrub of the East Indies.

GRIST, in country-affairs, denotes corn ground, or ready for grinding. See FLOUR-MILL.

GRIT, a genus of argillaceous earths. Its texture is more or less porous, equable, and rough to the touch. It does not give fire with steel, nor effervesce with acids. When fresh broken and breathed upon, it exhales an earthy smell. Mr. Kirwan mentions two kinds; one from Hollington, near Uttoxeter, of a yellowish or whitish grey, and about the specific gravity of 2288. Another, from Knepersley in Staffordshire, is of the specific gravity of 2568, and so infusible as to be used for fire-stones. According to Fabroni the grit-stone is of greater or less hardness, mostly of a grey, and sometimes of a yellowish colour, composed of a siliceous and micaceous sand, but rarely of a sparry kind; with greater or smaller particles closely compacted by an argillaceous cement. It gives some sparks with steel, is indissoluble for the most part in acids, and vitrifiable in a strong fire. It is used for millstones and whetstones, and sometimes for filtring-stones and for building.

GROGRAM, a kind of stuff, made of silk and mohair.

GRONOVIA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking under the 34th order, cucurbitaceæ. There are five petals and stamina inserted into a campanulated calyx; the berry is dry, monospermous, and inferior. There is one species, an annual of La Vera Cruz.

GROOM, a name particularly applied to several superior officers belonging to the king's household, as groom of the chamber, groom of the stole.

GROOVE, among miners, is the shaft or pit sunk into the earth, sometimes in the vein, and sometimes not.

GROOVE, among joiners, the channel made by their plough in the edge of a moulding, style, or rail, to put their pannels in, in wainscotting.

GROSS, in law-books, signifies absolute or independent on another: thus, an advowson in gross, is one distinct and separate from the manor.

GROSS also denotes the quantity of twelve dozen, of things sold by tale.

GROSS-BEAK, in ornithology. See LOXIA.

GROSS-WEIGHT, the whole weight of merchandizes, with their dust and dross; as also the bag or chest wherein they are contained. An allowance is usually made out of the gross-weight for tare and tret. See TARE.

GROTESQUE, in sculpture and painting, something whimsical, extravagant, and monstrous; consisting either of things that are merely imaginary, and have no existence in nature, or of things so distorted, as to raise surprize and ridicule. Grotesque work is the same with what is sometimes called antique. The name is said to have taken its rise from the figures of this kind much used in adorning the grottos which in antient times were the tombs of eminent persons or families; such as that of Ovid, whose grotto was discovered near Rome about 100 years ago.

GROTTO, or GROTTA, a large deep cavern or den in a mountain or rock. The word is Italian, grotta; formed, according to Menage, &c. from the Latin crypta. Du Cange observes, that grotta was used in the same sense in the corrupt Latin. The ancient anchorites retired into dens and grottos, to apply themselves the more attentively to meditation. Okey-hole, Elden-hound, Peake's-hole, and Pool's-hole, are famous among the natural caverns or grottos of our country. The entrance to Okey-hole, on the south side of Mendip-hills, is in the fall of those hills, which is beset all about with rocks, and has near it a precipitate descent of near twelve fathoms deep, at the bottom of which there continually issues from the rocks a considerable current of water. The naked rocks above the entrance show themselves about 30 fathoms high, and the whole ascent of the hill above is about a mile, and is very steep. As you pass into this vault, you go at first upon a level; but advancing farther, the way is found to be rocky and uneven, sometimes ascending, and sometimes descending. The roof of this cavern, in the highest part, is about eight fathoms from the ground, but in many particular places it is so low, that a man must stoop to get along. The breadth is not less various than the height, for in some places it is five or six fathoms wide, and in others not more than one or two. It extends itself in length about two hundred yards. People talk much of certain stones in it, resembling men and women, and other things; but there is little matter of curiosity in these, being only shapeless lumps of a common spar. At the farthest part of the cavern there is a good stream of water, large enough to drive a mill, which passes all along one side of the cavern, and at length slides down about six or eight fathoms among the rocks, and then passing through the clefts of them, discharges itself into the valley. The river within the cavern is well stored with eels, and has some trouts in it; and these cannot have come from without, there being so great a fall near the entrance. In dry summers, a great number of frogs are seen all along this cavern, even to the farthest part of it; and on the roof of it, at certain places, hang vast numbers of bats, as they do in almost all caverns, the entrance of which is either level, or but slightly ascending or descending; and even in the more perpendicular ones they are sometimes found, provided they are not too narrow, and are

sufficiently high. The cattle that feed in the pastures through which this river runs have been known to die suddenly sometimes after a flood; this is probably owing to the waters having been impregnated, either naturally or accidentally, with lead ore.

Elden-hole is a huge profound perpendicular chasm, three miles from Buxton, ranked among the natural wonders of the Peak. Its depth is unknown, and is pretended to be unfathomable. Cotton tells us he sounded 884 yards, yet the plummet still drew. But he might easily be deceived, unless his plummet was very heavy; the weight of a rope of that length might well make the landing of the plummet scarcely perceivable.

Peak's-hole, and Pool's-hole, are two remarkable horizontal cavities under mountains; the one near Castleton, the other just by Buxton. They seem to have owed their origin to the springs which have their current through them; when the water had forced its way through the horizontal fissures of the strata, and had carried the loose earth away with it, the loose stones must fall down of course: and where the strata had few or no fissures, they remained entire; and so formed these very irregular arches, which are now so much wondered at. The water which passes through Pool'shole is impregnated with particles of limestone, and has incrusted the whole cavern in such a manner that it appears as one solid rock.

In grottos are frequently found crystals of the rock, stalactites, and other natural conglaciations, and those often of an amazing beauty. M. Homberg conjectures, from several circumstances, that the marble pillars in the grotto of Antiparos vegetate or grow. That author looks on this grotto as a garden, in which the pieces of marble are the plants; and endeavours to show, that they could only be produced by some vegtative principle.

At Foligno in Italy is another grotto, consisting of pillars and orders of architecture of marble, with their ornaments, &c. scarcely inferior to those of art; but they all grow downwards: so that if this too is a garden, the plants are turned upside down.

Grotto *del Cani*, is a little cavern near Pozzuoli, four leagues from Naples, the steams whereof are of a mephitical or noxious quality; whence also it is called bocca venenosa, the poisonous mouth. "Two miles from Naples (says Dr. Mead), just by the Lago de Agnano, is a celebrated mofeta, commonly called la Grotta del Cani, and equally destructive to all within the reach of its vapours. It is a small grotto about eight feet high, twelve long, and six broad; from the ground arises a thin, subtile, warm fume, visible enough to a discerning eye, which does not spring up in little parcels here and there, but in one continued stream, covering the whole surface of the bottom of the cave; having this remarkable difference from common vapours, that it does not, like smoke, disperse itself into the air, but quickly after its rise falls back again, and returns to the earth; the colour of the sides of the grotto being the measure of its ascent: for so far it is of a darkish green, but higher only common earth. And as I myself found no inconvenience by standing in it, so no animal, if its head is above this mark, is the least injured. But when, as the manner is, a dog, or any other creature, is forcibly kept below it; or, by reason of its smallness, cannot hold its head above it, it presently loses all motion, falls down as dead, or in a a swoon; the limbs convulsed and trembling, till at last no more signs of life appear than a very weak and almost insensible beating of the heart and arteries; which, if the animal is left a little longer, quickly ceases too, and then the case is irrevocable; but if it is snatched out and laid in the open air, it soon comes to life again, and sooner if thrown into the adjacent lake." The steam or moefite of the grotto del cani is now well known to be carbonic acid gas. See Chemistry.

Grotta del Serpi, is a subterraneous cavern near the village of Sassa, eight miles from the city of Braccano in Italy, described by Kircher thus: "The grotta del serpi is big enough to hold two persons. It is perforated with several fistular apertures, somewhat in the manner of a sieve; out of which, at the beginning of the spring season, issues a numerous brood of young snakes of divers colours, but all free from any particular poisonous quality. In this cave they expose their lepers, paralytics, arthritics, and elephantiac patients, quite naked; where, the warmth of the subterraneous steams resolving them into a sweat, and the serpents clinging variously all around, licking and sucking them, they become so thoroughly freed of all their vicious humours, that upon repeating the operation for some time, they become perfectly restored." This cave Kircher visited himself; and found it warm, and every way agreeable to the description given of it. He saw the holes, and heard a murmuring hissing noise in them. Though he missed seeing the serpents, it not being the season of their creeping out, yet he saw a great number of their exuviæ or sloughs, and an elm growing hard by laden with them. The discovery of the virtues of this cave was by the cure of a leper going from Rome to some baths near this place. Losing his way, and being benighted, he happened upon this cave. Finding it very warm, he pulled off his clothes; and being weary and sleepy, had the good fortune not to feel the serpents about him till they had wrought his cure.

Grotto, *Milky*, Crypta Lactea, a mile distant from the antient village of Bethlehem, is said to have been thus denominated on occasion of the Blessed Virgin, who let fall some drops of milk in giving suck to Jesus in this grotto. And hence it has been commonly supposed, that the earth of this cavern has the virtue of restoring milk to women that are grown dry, and even of curing fevers. Accordingly, they are always digging in it, and the earth is sold at a good rate to such as have folly enough to give credit to the fable. An altar has been built on the place, and a church just by it.

Grotto is also used for a little artificial edifice made in a garden, in imitation of a natural grotto. The outsides of these grottos are usually adorned with rustic architecture, and their inside with shell-work, fossils, &c. finished likewise with jets-d'eau or fountains, &c. A cement for artificial grottos may be made thus: Take 2 parts of white rosin, melt it clear, and add to it 4 parts of bees'-wax; when melted together, add 2 or 3 parts of the powder of the stone you design to cement, or so much as will give the cement the colour of the stone. With this cement, the stones, shells, &c. after being well dried before the fire, may be cemented. Artificial red coral branches, for the embellishment of grottos, may be made in the following manner: Take clear rosin, dissolve it in a brass-pan, to every ounce of which add two drams of the finest vermilion; when you have stirred them well together, and have chosen your twigs and branches, peeled and dried, take a pencil and paint the branches all over whilst the composition is warm; afterwards shape them in imitation of natural coral. This done, hold the branches over a gentle coal-fire, till all is smooth and even as if polished. In the same manner white coral may be prepared with white lead, and black coral with lamp-black. A grotto may be built with little expence, of glass, cinders, pebbles, pieces of large flint, shells, moss, stones, counterfeit coral, pieces of chalk, &c. all bound or cemented together with the above-described cement.

GROUND, in painting, the surface upon which the figures and other objects are represented. See Painting.

Ground-tackle, a ship's anchors, cables, and in general whatever is found necessary to make her ride safe at anchor.

Ground-ivy, in botany. See Glechoma.

Ground-*Pine*. See Teucrium.

GROUNDAGE, a custom or tribute paid for the ground on which a ship stands in port.

GROUNDSEL, in botany, &c. See Senecio.

GROUP, in painting and sculpture, is an assemblage of two or more figures of men, beasts, fruits, &c. which have some apparent relation to each other. See Painting.

GROUSE, or Growse. See Tetrao.

GROWAN, among the miners of Cornwall, a coarse gritty stone, of a greyish colour, which they are often obliged to dig through before they can reach the ore.

GRUNSTEIN, primitive, is a mixture of hornblende and felspar; and is divided into different varieties, according as its texture is granular or compact. See Rocks primitive.

GRY, a measure containing one-tenth of a line. A line is one-tenth of a digit, and a digit one-tenth of a foot, and a philosophical foot one-third of a pendulum whose diadromes, or vibrations, in the latitude of 45 degrees, are each equal to one second of time, or one-sixteenth of a minute.

GRYGALLUS, in ornithology, a name given to the urogallus, or tetrao. See Tetrao.

GRYLLUS, the *locust*, *grasshopper*, and *cricket*, in entomology, a genus of insects belonging to the order hemiptera. The generic character is, head inflected, armed with jaws, and furnished with feelers. Antennæ, in most species, either filiform or setaceous. Wings four, deflex, convoluted: lower wings pleated. Hind legs formed for leaping: claws double on all the feet. There are 61 species, of which the following are most worthy of notice:

1. Among the most numerous species is the gryllus migratorius of Linnæus, or common migratory locust, which of all the insects capable of injuring mankind seems to possess the most dreadful powers of destruction. Legions of these animals are from time to time observed in various parts of the

world, where the havock they commit is almost incredible: whole provinces are in a manner desolated by them in the space of a few days, and the air is darkened by their numbers: nay even when dead they are still terrible; since the putrefaction arising from their inconceivable number is such that it has been regarded as one of the probable causes of pestilence in the Eastern regions. This formidable locust is generally of a brownish colour, varied with pale red, or flesh-colour, and the legs are frequently blueish. In the year 1748, it appeared in irregular flights in several parts of Europe, as in Germany, France, and England; and in the capital itself and its neighbourhood great numbers were seen: they perished, however, in a short time, and were happily not productive of any material mischief, having been probably driven by some irregular wind out of their intended course, and weakened by the coolness of our climate.

From a paper published in the 18th volume of the Philosophical Transactions we find, that in the year 1693, swarms of this species of locust settled in some parts of Wales. Two vast flights were observed in the air not far from the town of Dolgalken, in Merionethshire: the others fell in Pembrokeshire. From a letter published in the 38th volume of the same work, it appears, that some parts of Germany, particularly in the march of Brandenburgh, &c. suffered considerable injury from the depredations of these animals. They made their appearance in the spring of the year 1732, from flights which had deposited their eggs in the ground the preceding year. They attacked and devoured the young spike of the wheat, &c. and this chiefly by night, and thus laid waste many acres at a time beyond all hope of recovery. In the 46th volume of the same Transactions we find a description of the ravages of these animals in Wallachia, Moldavia, Transylvania, Hungary, and Poland, in the years 1747 and 1748.

"The first swarms entered into Transylvania in August 1747: these were succeeded by others, which were so surprizingly numerous, that when they reached the Red Tower, they were full four hours in their passage over that place; and they flew so close that they made a sort of noise in the air by the beating of their wings against one another. The width of the swarm was some hundreds of fathoms, and its height or density may be easily imagined to be more considerable, inasmuch as they hid the sun and darkened the sky, even to that degree, when they flew low, that people could not know one another at the distance of twenty paces; but as they were to fly over a river that runs in the valleys of the Red Tower, and could find neither resting-place nor food; being at length tired of their flight, one part of them lighted on the unripe corn on this side of the Red Tower, such as millet, Turkish wheat, &c.; another pitched on a low wood, where, having miserably wasted the produce of the land, they continued their journey, as if a signal had actually been given for a march. The guards of the Red Tower attempted to stop their irruption into Transylvania by firing at them; and indeed, where the balls and shot swept through the swarm, they gave way and divided; but having filled up their ranks in a moment, they proceeded on their journey. In the month of September, some troops of them were thrown to the ground by great rains and other inclemency of the weather, and thoroughly soaked with wet: they crept along in quest of holes in the earth, dung, and straw; where being sheltered from the rains, they laid a vast number of eggs, which stuck together by a viscid juice, and were longer and smaller than what is commonly called an ant's egg (the chrysalis of the formica) very like grains of oats. In the spring of 1748, certain little blackish worms were seen lying in the fields and among the bushes, sticking together, and collecting in clusters, not unlike the hillocks of moles or ants. As nobody knew what they were, so there was little or no notice taken of them, and in May they were covered by the shooting of the corn sown in winter; but the subsequent June discovered what those worms were; for then, as the corn sown in spring was pretty high, these creatures began to spread over the fields, and become destructive to the vegetables by their numbers. At that time they differed little or nothing from our common grasshoppers; having their head, sides, and back, of a dark colour, with a yellow belly, and the rest of a reddish hue. About the middle of June, according as they were hatched sooner or later, they were generally a finger's length, or somewhat longer, but their shape and colour still continued. Towards the end of June they cast off their outward covering, and then it plainly appeared that they had wings; and as soon as any of them found themselves able to use their wings, they soared up, and by flying round the others, enticed them to join them. Wherever those troops happened to pitch, they spared no sort of vegetable: they ate up the young corn, and the very grass; but nothing was more dismal than to behold the lands in which they were hatched; for they so greedily devoured every thing green, before they could fly, that they left the ground quite bare.

"There is nothing to be feared in those places to which this plague did not reach before the autumn; for the locusts have not strength to fly to any considerable distance but in the months of July, August, and the beginning of September; and even then, in changing their places of residence, they seem to tend to warmer climates.

"Different methods are to be employed, according to the age and state of these insects; for some will be effectual as soon as they are hatched, others when they begin to crawl, and others when they begin to fly. It would be of great service to seek out the places where the females lodged; for nothing was more easy than carefully to visit those places in March and April, and to destroy their eggs or little worms with sticks or briars; but in the summer, when they have marched out of their spring-quarters, and have invaded the corn-fields, &c. it is almost impossible to extirpate them without thoroughly thrashing the whole piece of land that harbours them with sticks or flails, and thus crushing the locust with the produce of the land. Finally, when the corn is ripe or nearly so, there is no other method of getting rid of them, or even of diminishing their numbers, than to surround the ground with a multitude of people, who might fright them away with bells, brass vessels, and all other sorts of noise. But even this method will not succeed till the sun is pretty high.

"It will likewise be of use, where a large troop of them has pitched, to dig a long trench, of an ell width and depth, and place several persons along its edges, provided with brooms, while another numerous set of people form a semicircle that takes in both ends of the trench, and encompasses the locusts; and by making the noise above-mentioned, drive them into the trench, out of which if they attempt to escape, those on the edges are to sweep them back, and then crush them with their brooms and stakes, and bury them by throwing in the earth again. But when they have begun to fly, there should be horsemen upon the watch in the fields, who, upon any appearance of the swarm taking wing, should immediately alarm the neighbourhood by a certain signal, that they might come and fright them from their lands by all sorts of noise; and if, tired with flying, they happen to pitch on a waste piece of land, it will be very easy to kill them with sticks and brooms in the evening or early in the morning, while they are wet with the dew; or any time of the day in rainy weather, for then they are not able to fly."

We have before observed, that the locusts which fell in several parts of England, and in particular in the neighbourhood of the metropolis, in the year 1748, were evidently some straggling detachments from the vast flights which in that year visited many of the inland parts of the European continent.

The ravages of locusts in various parts of the world, at different periods, are recorded by numerous authors. In the year 593 of the Christian era, after a great drought, these animals appeared in such vast legions as to cause a famine in many countries. In 677 Syria and Mesopotamia were overrun by them. In 852, immense swarms took their flight from the Eastern regions into the West, flying with such a sound that they might have been mistaken for birds: they destroyed all vegetables, not sparing even the bark of trees and the thatch of houses; and devoured the corn so rapidly, as to destroy, on computation, a hundred and forty acres in a day: their daily marches or distances of flight were computed at twenty miles; and these were regulated by leaders or kings, who flew first, and settled on the spot which was to be visited at the same hour the next day by the whole legion: these marches were always undertaken at sunrise. These locusts were at length driven by the force of winds into the Belgic ocean, and being thrown back by the tide and left on the shores, caused a dreadful pestilence by their smell. In 1271, all the corn-fields of Milan were destroyed; and in the year 1339 all those of Lombardy. In 1541, incredible hosts afflicted Poland, Wallachia, and all the adjoining territories, darkening the sun with their numbers, and ravaging all the fruits of the earth.

2. One of the largest species of locust yet known is the gryllus cristatus of Linnæus, which is five or six times the size of the gryllus migratorius, and, together with some others of the larger kind, is made use of in some parts of the world as an article of food:

they are eaten both fresh and salted, in which last state they are publickly sold in the markets of some parts of the Levant. The quantity of edible substance which they afford is but small, especially in the male insects; but the females, on account of the ovaries, afford a more nutritious sustenance.

The gryllus cristatus is a highly beautiful animal; being of a bright red, with the body annulated with black; and the legs varied with yellow: the upper wings tesselated with alternate variegations of dark and pale green; the lower with transverse undulated streaks: the length of the animal from head to tail is about four inches, and the expanse of wings from tip to tip, when fully extended, hardly less than seven inches and a half.

3. Greatly allied to the preceding is the gryllus dux; it is of the same size and general appearance, but has the body green; the upper wings brown, with the front edge green; and the lower wings red, with numerous black spots disposed in such a manner as to form transverse streaks. It is a native of South America and the West Indian islands.

4. The gryllus viridissimus of Linnæus is one of the largest European species, and is often seen during the decline of summer in our own country. It is wholly of a pale grass-green, with a slight blueish cast on the head and under part of the thorax, which is marked above by a longitudinal reddish-brown line: the length of the insect, from the mouth to the tips of the wings, is about two inches and a half: the female is distinguished by a long sword-shaped process at the end of the body, being the instrument with which she pierces the ground in order to deposit her eggs: it consists of a pair of valves, through the whole length of which the eggs are protruded: they are of an oblong form, and of a pale brown colour.

5. The gryllus verrucivorus is also found in some parts of England, and is of an equal size with the viridissimus, but of a reddish-brown colour, with darker variegations: this animal, according to Linnæus, is frequently applied by the people of Sweden to warts on the hands, which it is suffered to bite off, and is said thus to prevent their return.

6. But of all the British insects of this genus the gryllus gryllotalpa or mole-cricket is by far the most curious; and in its colour and manners differs greatly from the rest. It is of an uncouth, and even formidable aspect, measuring more than two inches in length; and is of a broad and slightly flattened shape, of a dusky brown colour, with a ferruginous cast on the under parts, and is readily distinguished by the extraordinary structure of its fore-legs, which are excessively strong, and furnished with very broad feet, divided into several sharp, claw-shaped, segments, with which it is enabled to burrow under ground in the manner of a mole: the lower wings, which when expanded are very large, are, in their usual state, so complicated under the very short and small upper wings or sheaths, that their ends alone appear, reaching, in a sharpened form, along the middle of the back; the abdomen is terminated by a pair of sharp-pointed, lengthened, hairy processes, nearly equalling the length of the antennæ in front, and contributing to give this animal an appearance in some degree similar to that of a blatta.

The mole-cricket emerges from its subterraneous retreats only by night, when it creeps about the surface, and occasionally employs its wings in flight. It prepares for its eggs an oval nest, measuring about two inches in its longest diameter: this nest is situated a hand's breadth below the surface of the ground: it is accurately smoothed within, and is furnished with an obliquely curved passage leading to the surface. The eggs are about two hundred and fifty or three hundred in number, nearly round, of a deep brownish yellow colour, and of the size of common shot: on the approach of winter, or any great change of weather, these insects are said to remove the nest, by sinking it deeper, so as to secure it from the power of frost; and when the spring commences, again raising it in proportion to the warmth of the season, till at length it is brought so near the surface as to receive the full influence of the air and sunshine; but should unfavourable weather again take place, they again sink the precious deposit, and thus preserve it from danger. The eggs are usually deposited in the months of June or July, and the young are hatched in August. At their first exclusion they are about the size of ants, for which, on a cursory view, they might be mistaken; but on a close inspection are easily known by their broad feet, &c. In about the space of a month they are grown to the length of more than a quarter of an inch: in two months upwards of three quarters; and in three months to the length of more than an inch. Of this length they are usually seen during the close of autumn, after which they retire deep beneath the surface; not appearing again till the ensuing spring. During their growth they cast their skin three or four times.

The mole-cricket lives entirely on vegetables, devouring the young roots of grasses, corn, and various esculent plants, and commits great devastation in gardens. It is found in most parts of Europe, and in the northern parts of Asia and America.

7. The tettigonia or grasshopper, well known in our meadows, belongs to this genus.

8. The acheta or cricket, of which there are two varieties, the hearth and the field cricket.

9. The griseus is found in Italy. (See Plate Nat. Hist. fig. 215.)

10. The stridulus inhabits most parts of Europe. (See Plate Nat. Hist. fig. 216.)

GRYPHITES, in natural history, in English crow's-stone, an oblong fossil shell, very narrow at the head, and becoming gradually wider to the extremity, where it ends in a circular limb; the head or beak of this is very hooked or bent inward. They are frequently found in our gravel or clay-pits, in many counties. There are three or four distinct species of them; some are extremely rounded and convex on the back, others less so; and the plates of which they are composed, are in some smaller and thinner, in others thicker and larger, in specimens of the same bigness.

GUAIACUM, *lignum vitæ*, or *pockwood*; a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 14th order, gruinales. The calyx is quinquefid and unequal; the petals five, and inserted into the calyx; the capsule is angulated, and trilocular or quinquelocular. The species are 4: 1. The officinale, or common lignum vitæ used in medicine, is a native of the West India islands and the warmer parts of America. (See Plate Nat. Hist. fig. 217.) There it becomes a large tree, having a hard, brittle, brownish bark, not very thick. The wood is firm, solid, ponderous, very resinous, of a blackish yellow colour in the middle, and of a hot aromatic taste. The smaller branches have an ash-coloured bark, and leaves divided by pairs of a bright green colour. The flowers are produced in clusters at the end of the branches, and are composed of oval concave petals of a fine blue colour. 2. The sanctum, with many pairs of obtuse lobes, and many small lobes placed along the mid-rib by pairs of a darker green colour than those of the foregoing sort. The flowers are produced in loose bunches towards the end of the branches, and are of a fine blue colour, with petals fringed on the edges. This species is also a native of the West India islands, where it is called bastard lignum vitæ. 3. The afrum, with many blunt-pointed leaves, is a native of the Cape of Good Hope. The plants retain their leaves all the year, but have never yet flowered in this country. 4. The dubium, a native of the South Seas.

The first species can only be propagated by seeds, which must be procured from the countries where it naturally grows. They must be sown fresh in pots, and plunged into a good hotbed, where they will come up in six or eight weeks. While young, they may be kept in a hotbed of tan-bark under a frame during the summer; but in autumn they must be removed into the bark stove, where they should constantly remain. The second sort may be propagated the same way; but the third is to be propagated by layers, and will live all the winter in a good greenhouse.

The wood of the first species is of very considerable use both in medicine and in the mechanical arts. It is so compact and heavy as to sink in water. The outer part is often of a pale-yellowish colour; but the heart is blacker, or rather of a deep brown. Sometimes it is marbled with different colours. It is so hard as to break the tools which are employed in felling it, and is therefore seldom used as fire-wood, but is of great use to the sugar-planters for making wheels and cogs to sugar-mills. It is also frequently wrought into bowls, mortars, and other utensils. It is brought over hither in large pieces of four or five hundredweight each; and from its hardness and beauty is in great demand for various articles of turnery ware.

The wood, gum, bark, fruit, and even the flowers of this tree, have been found to possess medicinal virtues; but it is only the 3 first, and more particularly the wood and resin, which are now in general use in Europe. The wood has little or no smell, except when heated, or while rasping, and then a slight aromatic one is perceived. When chewed, it impresses a mild acrimony, biting the palate and fauces. Its pungency resides in its resinous matter, which it gives out in some degree to water by boiling, but spirit extracts it wholly.

The resin is obtained by wounding the bark in different parts of the body of the tree, or by what has been called jagging. It exudes copiously from these wounds, though gradually; and when a quantity is found accumulated upon the several wounded trees, hardened by exposure to the sun, it is gathered and packed in small kegs for exportation. This resin is of a friable texture, of a deep greenish colour, and sometimes of a reddish hue; it has a pungent acrid taste, but little or no smell unless heated. The tree also yields a spontaneous exudation from the bark, which is called the native gum, and is brought to us in small irregular pieces, of a bright semipellucid appearance, and differs from the former in being much purer.

Guaiacum was first introduced into Europe as a remedy for the venereal disease, and appears to have been used in Spain so early as 1508. The great success attending its administration before the proper use of mercury was known, brought it into such repute, that it is said to have been sold for seven old crowns a pound. It did not, however, continue to maintain its reputation; but was found generally to fail where the disease was inveterate, and was at length superseded by mercury, to which it now only serves occasionally as an adjuvant. The general virtues of guaiacum, are those of a warm stimulating medicine, strengthening the stomach and other viscera, and remarkably promoting the urinary and cuticular discharges: hence in cutaneous eruptions, it is deemed eminently useful; as well as in the rheumatism when given in a sufficient dose. The resin is the most active, and the efficacy of the wood, &c. depends upon the quantity of this contained in them. The resin is given from a few grains to a scruple or half a dram, which last dose proves for the most part considerably purgative. Dissolved in spirit of wine, and afterwards combined with water, by means of mucilage or the yolk of egg, or in form of the simple or volatile tincture, it is much employed in gout and chronic rheumatism. These last have been given to the extent of half an ounce twice a day, and are sometimes usefully combined with tincture of opium. See Resins.

GUARDIAN, one appointed by the wisdom and policy of the law, to take care of a person and his affairs, who by reason of his imbecility and want of understanding is incapable of acting for his own interest; and it seems by our law, that his office originally was to instruct the ward in the arts of war, as well as those of husbandry and tillage, that when he came of age he might be the better able to perform those services to his lord, whereby he held his own land. 2 Bac. Abr. 672.

There are several kinds of guardians, as, guardian by nature, guardian by the common law, guardian by statute, guardian by custom, guardian in chivalry, guardian in soccage, and guardian by appointment of the lord chancellor.

Guardian by nature, is the father or mother; and here it should be observed, that by the common law every father has a right of guardianship of the body of his son and heir, until he attains the age of twenty-one years. Co. Lit. 84.

This guardianship extends no further than the custody of the infant's person. 1 Inst. 84.

It yields as to the custody of the person, to guardianship in soccage, where the title to both guardianships concur in the same individuals. 1 Inst. 88 b.

But guardianship in soccage ending at 14, it seems that after that age, the father or other ancestor, having a like title to both guardianships, becomes guardians by nature till the infant's age of 21. Carth. 384.

Lastly, the father may disappoint the mother, and other ancestors, of the guardianship by nature, by appointing a testamentary guardian under the statutes 4 and 5 P. et M. and 12 Car. II.

Guardian by nature, has only the care of the person and education of the infant, and has nothing to do with his lands merely in virtue of his office; for such guardian may be though the infant have no lands at all, which a guardian in soccage cannot. Co. Lit. 88.

Guardian by the common law. If a tenant in soccage dies, his heir being under 14, whether he is his issue or cousin, male or female, the next of blood to the heir, to whom the inheritance cannot descend, shall be guardian of his body and land till his age of fourteen; and although the nature of soccage tenure is in some measure changed from what it originally was, yet it is still called soccage tenure, and the guardian in soccage is still only where lands of that kind, as most of the lands in England now are, descend to the heir within age; and though the heir after 14 may choose his own guardian, who shall continue till he is 21, yet as well the guardian before 14, as he whom the infant shall think fit to choose after 14, are both of the same nature, and have the same office and employment assigned to them by the law, without any intervention or direction of the infant himself: for they were therefore appointed, because the infant in regard of his minority, was supposed incapable of managing himself and his estate, and consequently derive their authority not from the infant, but from the law: and that is the reason they transact all affairs in their own name, and not in the name of the infant, as they would be obliged to do if their authority was derived from him. Co. Lit. 87.

Hence the law has invested them, not with a bare authority only, but also with an interest till the guardianship ceases; and to prevent their abuse of this authority and interest, the law has made them accountable to the infant, either when he comes to the age of 14 years, or at any time after, as he thinks fit; and therefore are not to have any thing to their own use, as the guardian in chivalry had. Co. Lit. 90. a.

Guardian by statute. By the common law, no person could appoint a guardian, because the law had appointed one, whether the father was tenant by knight service, or in soccage. 3 Co. 37.

The first statute that gave the father a power of appointing, was the 4 and 5 P and M. c. 8. which provides under severe penalties, such as fine and imprisonment for years, that no one shall take away any maid or woman child unmarried, being within the age of sixteen years, out of or from the possession, custody, or governance, and against the will, of the father of such maid or woman child, or of such person or persons to whom the father of such maid or woman child, by his last will and testament, or by any other act in his life-time, has or shall appoint, assign, bequeath, give, or grant the order, keeping, education and government, of such maid or woman child. 1 Sid. 362.

In the construction of this statute, the following opinion has been holden. That a testamentary guardian, or one formed according to this statute, comes in loco parentis, and is the same in office and interest with a guardian in soccage, and differs only as to the modus habendi, or in a few particular circumstances; as first that it may be held for a longer time, viz. till the heir attains the age of 21, whereas before it was but 14; secondly, it may be by other persons held, for before it was the next of kindred not inheritable could have it; and now who the father names shall have it. Vaugh. 178.

Guardian by custom. By the custom of the city of London, the custody and guardianship of orphans under age, unmarried, belongs to the city. 2 Bac. Abr. 675.

By the custom of Kent, where any tenant died, his heir being within age, the lord of the manor might and did commit the guardianship to the next relation within the court of justice in whose jurisdiction the land was; but the lord was bound on all occasions to call him to account, and if he did not see that the accounts were fair, the lord himself was bound to answer it. This province the lord chancellor has taken from inferior courts, only in Kent, where these customs are continued.

Guardian in chivalry. By the common law, if tenant by knight-service had died, his heir male being under the age of twenty-one years, the lord shall have the land holden of him, till such heir had arrived at that age, because till then he was not intended to be able to do such service; and such lord had likewise the custody of the body of the infant, to bring him up, and inure him to martial discipline, and was therefore called guardian in chivalry. Co. Lit. 74. This priviledge of wardship is now abolished.

Guardian in soccage. Guardians in soccage are also called guardians by the common law. Wardship is incident to tenure in soccage, but of a nature very different from that which was formerly incident to knight-service; for if the inheritance descends to an infant under 14, the wardship of him does not, nor ever did, belong to the lord of the fee; because in this tenure, no military or other personal service being required, there was no occasion for the lord to take the profits in order to provide a proper substitute for his infant tenant. Co. Lit. 84.

Guardian by appointment of the lord chancellor. It is not easy to state how this jurisdiction was acquired; it is certainly of no very ancient date, though now indisputable: for it is clearly agreed, that the king, as pater patriæ, is universal guardian of all infants, ideots, and lunatics, who cannot take care of themselves; and as this care cannot be exercised otherwise than by appointing them proper curators or committees, it seems also agreed, that the king may, as he has done, delegate the authority to his chancellor; and that therefore at this day, the court of

chancery is the only proper court, that has jurisdiction in appointing and removing guardians, and in preventing them and others from abusing their persons or estates. 2 Inst. 14. And as the court of chancery is now vested with this authority, hence in every day's practice, we find that court determining, as to the right of guardianship, who is the next of kin, and who the most proper guardian; as also orders are made by that court on petition or motion, for the provision of infants during any dispute therein; as likewise guardians removed or compelled to give security; they and others punished for abuses committed on infants, &c.

GUARDIAN of the spiritualities, the person to whom the spiritual jurisdiction of any diocese is committed, during the time the see is vacant. A guardian of the spiritualities may likewise be either such in law, as the archbishop is of any diocese within his province; or by delegation, as he whom the archbishop or vicar-general for the time appoints. Any such guardian has power to hold courts, grant licences, dispensations, probates of wills, &c.

GUAPERVA. See CHÆTODON.

GUAREA, a genus of the class and order octandria monogynia. The cal. is four-cleft; pet. four; nect. cylindric, bearing the anthers at its mouth; caps. four-valved, four-celled; seeds solitary. There is one species, a tree of the West Indies.

GUDGEON, in ichthyology. See CYPRINUS.

GUDGEONS, in a ship, are the eyes drove into the stern-post, into which the pintles of the rudder go, to hang it.

In vol. XI. of the Transactions of the Society for the Encouragement of Arts, &c. we have the following account of a gudgeon on an improved construction for the upright shafts of mills. "This gudgeon is formed of hard steel, and works on a hard steel bed; is circular, three inches in diameter, and three-fourths of an inch thick: from its upper side a rib projects, which being fixed in the bottom of an upright shaft, the gudgeon works horizontally on a square bed: and that now in the possession of the society has worked in a mill whose wheel and shaft weighed nearly six tons; and though it had continued to work seven years, had lost very little of its surface. It ran in a square box of cast iron, having oil therein: and a notch along the whole of the face of the gudgeon admits the oil to insinuate itself between the gudgeon and the bed."

GUETTARDA, a genus of the heptandria order, in the monœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ. The male calyx is cylindrical; the corolla cleft into seven parts, and funnel-shaped. The female calyx cylindrical; the corolla cleft into seven parts; one pistil, and the fruit a dry plum. There are four species, trees of the East and West Indies.

GUILANDINA, the nickar tree; a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 33d order, lomentaceæ. The calyx is monophyllous and salver-shaped; the petals inserted into the neck of the calyx, nearly equal. The seed-vessel a legumen. The species are six: the most remarkable are, 1. The bonduc, or yellow nickar. 2. The bonducella, or grey nickar. These are climbing plants, natives of the West Indies, where they rise to the height of 12 or 14 feet: the flowers come out at the wings of the stalks, and are composed of five concave yellow petals. They are succeeded by pods about three inches long and two broad, closely armed with slender spines, opening with two valves, each inclosing two hard seeds about the size of children's marbles, of a yellowish colour. 3. The moringa, or morunga nickar, is a native of the island of Ceylon, and some places on the Malabar coast. It rises to the height of 25 or 30 feet, having flowers produced in loose bunches from the sides of the branches, and composed of an unequal number of petals.

These plants, being natives of warm climates, require to be kept through the winter in a stove in this country. They are propagated by seeds; but those of the first sort are so hard, that unless they are soaked two or three days in water before they are put into the ground, or placed under the pots in the tan-bed to soften their covers, they will remain for years without vegetating. The roots of the third sort are scraped when young, and used by the inhabitants of Ceylon and Malabar as those of horse-radish are in Europe. The wood dyes a beautiful blue colour. It is the lignum nephriticum of the dispensatories, and is brought over in large, compact, ponderous pieces, without knots, of a whitish or pale-yellow colour on the outside, and dark-coloured or reddish within: the bark is usually rejected. This wood imparts to water or rectified spirit a deep tincture; appearing, when placed between the eye and the light, of a golden colour; in other situations blue: pieces of another wood are sometimes mixed with it, which give only a yellow colour to water. The nephritic wood has scarcely any smell, and very little taste. It stands recommended in difficulty of urine, and all nephritic complaints, and is said to have this peculiar advantage; that it does not, like the warmer diuretics, heat or irritate the urinary passages. Practitioners, however, have not found these praises warranted by experience.

GUILD (from the Saxon guildan "to pay"), signifies a fraternity or company, because every one was gildare, that is, to pay something towards the charge and support of the company. As to the original of these guilds or companies, it was a law among the Saxons, that every freeman of fourteen years of age should find sureties to keep the peace, or be committed: upon which certain neighbours, consisting of ten families, entered into an association, and became bound for each other, either to produce him who committed an offence, or to make satisfaction to the injured party: that they might the better do this, they raised a sum of money among themselves, which they put into a common stock; and when one of their pledges had committed an offence, and was fled, then the other nine made satisfaction out of this stock, by payment of money according to the offence. Because this association consisted of ten families, it was called a decennary: and hence proceeded later kinds of fraternities. But as to the precise time when these guilds had their origin in England, there is nothing of certainty to be found: since they were in use long before any formal licence was granted to them for such meetings. It seems to have been about the close of the eleventh century, says Anderson in his History of Commerce, vol. i. p. 70, that merchant-guilds, or fraternities, which were afterwards styled corporations, came first into general use in many parts of Europe. Mr. Madox, in his Firma Burgi, chap. i. § 9. thinks they were hardly known to our Saxon progenitors, and that they might be probably brought into England by the Normans, although they do not seem to have been very numerous in those days. The French and Normans might probably borrow them from the free cities of Italy, where trade and manufactures were much earlier propagated, and where possibly such communities were first in use. These guilds are now companies joined together, with laws and orders made by themselves, by the licence of the prince.

GUILD, in the royal boroughs of Scotland, is still used for a company of merchants, who are freemen of the borough. (See BOROUGH.) Every royal borough has a dean of guild, who is the next magistrate below the bailiff. He judges of controversies among men concerning trade; disputes between inhabitants touching buildings, lights, watercourses, and other nuisances; calls courts, at which his brethren of the guild are bound to attend; manages the common stock of the guild; and amerces and collects fines.

GUINEA-PIG. See CAVIA.

GUINEA-WORM. See DRACUNCULUS.

GUITAR, or GUITARRA, a musical instrument of the string-kind, with five double rows of strings, of which those that are bass, are in the middle, unless it be for the burden, an octave lower than the fourth.

GULA, or GOLA. See ARCHITECTURE.

GULES, in heraldry, signifies the colour red, which is expressed in engraving by perpendicular lines falling from the top of the escutcheon to the bottom.

GUM. A thick, transparent, tasteless fluid, which sometimes exudes from certain species of trees. It is very adhesive, and gradually hardens without losing its transparency; but easily softens again when moistened with water. The gum most commonly used is that which exudes from different species of the mimosa, particularly the nilotica. It is known by the name of gum arabic. Gum likewise exudes abundantly from the prunus avium, or common wild cherry-tree of this country.

Gum is usually obtained in small pieces like tears, moderately hard, and somewhat brittle while cold, so that it can be reduced by pounding to a fine powder. When pure it is colourless, but it has usually a yellowish tinge, and it is not destitute of lustre. It has no smell. Its taste is insipid. Its specific gravity varies from 1.31 to 1.48.

1. Gum undergoes no change from being exposed to the atmosphere; but the light of the sun makes it assume a white colour. Water dissolves it in large quantities. The solution which is known by the name of mucilage, is thick and adhesive: it is often used as a paste, and to give stiffness and lustre to linen. When spread out thin it soon dries, and has the appearance of a varnish; but it readily attracts moisture, and becomes glutinous. Water washes it away

entirely. When mucilage is evaporated the gum is obtained unaltered. This mucilaginous solution may be kept for years without undergoing putrefaction. Scarcely any vegetable substance is less liable to decomposition. At last, however, the odour of acetic acid becomes perceptible in it.

When gum is exposed to heat it softens and swells, but does not melt; it emits air-bubbles, blackens, and at last, when nearly reduced to charcoal, emits a low blue flame. This flame appears sooner if a flaming substance is held just above the gum. After the gum is consumed, there remains a small quantity of white ashes, composed chiefly of the carbonats of lime and potass.

2. It does not appear that gum is acted upon by oxygen gas. A solution of gum and water, when exposed to the air, soon becomes mouldy on the surface, but undergoes no farther change for a long time. The action of the simple combustibles on gum has scarcely been examined. Azotic gas seems to have no action on it whatever.

Gum does not act upon metals; but it has the property of combining with several of the metallic oxides, and forming compounds: at least, some of the salts occasion precipitates when dropt into solutions of gum. The most curious effect is that produced by the oxymuriat of iron. When this salt, concentrated, is dropt into a very strong mucilage, the whole becomes a brown semitransparent jelly, which is not readily dissolved by water. When dried, the jelly becomes lighter-coloured, and assumes nearly the appearance of gum. Its taste is that of gum mixed with iron.

Liquid potass first converts gum into a substance not unlike curd, and then dissolves it. The solution is of a light amber-colour, and transparent. When long kept, the gum again falls into the state of curd. Alcohol throws down the gum in white flakes still soluble in water; but it retains the potass obstinately, and is much more friable than before. Lime-water and ammonia likewise dissolve gum, and it may be afterwards separated little altered.

Charcoal powder, when mixed with a solution of gum in water, gives it a black colour, which cannot be removed by filtration, unless a very great proportion of the powder is added. In that case the water passes clear; but the whole of the gum is retained by the charcoal. Mr. Lowitz found that not less than 30 lbs. of charcoal powder must be mixed with water containing an ounce of gum dissolved in it, before the water is entirely deprived of the gum.

The vegetable acids dissolve gum without alteration; the strong acids decompose it. Sulphuric a id converts it into water, acetous acid, and charcoal. The same effect is said by Fourcroy to be produced by muriatic acid. But this is not accurate unless some heat is applied. When gum is dissolved in strong muriatic acid, a brown solution is obtained, which becomes perfectly transparent when diluted with water, while at the same time some charry matter falls. If the solution is now saturated with ammonia, evaporated to dryness, and the residue digested in alcohol, the alcohol assumes a deep-brown colour, and dissolves the whole except a very little sal ammoniac. The gum now bears some resemblance to sugar in its properties; at least when heated it melts, and gives out a very strong smell of caromel.

Oxymuriatic acid converts gum into citric acid, according to the experiments of Vauquelin. He passed a current of oxymuriatic acid gas through a diluted solution of gum in water. In a few days almost the whole of the gum was acidified; and he detected citric acid by the formation of citrat of lime, soluble in water, and decomposable by oxalic acid. If nitric acid is slightly heated upon gum till it has dissolved it, and till a little nitrous gas is exhaled, the solution on cooling deposits saclactic acid. Malic acid is formed at the same time; and if the heat is continued, the gum is at last changed into oxalic acid. Thus no less than three acids are developed by the action of nitric acid on gum. We are indebted to Mr. Cruikshank for the most precise experiments on the quantity of oxalic acid obtainable from gum by nitric acid. By digesting 480 grains of it with six ounces of nitric acid, he obtained 210 grains of oxalic acid, and six grains of oxalat of lime.

Gum is insoluble in alcohol. When alcohol is poured into mucilage, the gum immediately precipitates; because the affinity between water and alcohol is greater than that between water and gum. The gum in this case is in the state of soft opaque white flakes. Neither is gum soluble in ether. It is not soluble in oils; but when triturated with a little oil it renders the oil miscible with water.

The action of the hydrosulphurets, sulphurets, phosphurets, and of most of the salts on gum, has not been examined with any attention.

Gum and sugar readily unite together by dissolving both in water. By gentle evaporation a perfectly transparent solid substance is obtained, which does not crystallize. When treated with alcohol it becomes white, opaque, and soft. The greater part of the sugar is dissolved, and the gum remains united to a small portion. It has a sweetish taste, and very much resembles in appearance the substance of which the nests of wasps are formed.

3. When gum is distilled in a retort, the products are water impregnated with a considerable quantity of pyro-mucous acid, or acetic acid combined with oil, a little empyreumatic oil, carbonic acid gas, and carbureted hydrogen gas. When the pyromucous acid obtained by this process is saturated with lime, a quantity of ammonia is disengaged with which that acid had been combined. The charcoal which remained in the retort leaves behind it, after incineration, a little lime and phosphat of lime. Mr. Cruikshank, to whom we are indebted for these facts, gradually heated 480 grains of gum arabic to redness in a coated glass retort. The products were,

Pyromucous acid mixed with some oil	210 gr.
Charcoal	96
Lime and a little phosphat of lime	10
Carburated hydrogen and carbonic acid gas	164
Total	480.

The pyromucous acid liquid contained less acid than what was obtained from an equal weight of sugar, in the proportion o 118 to 150. The gases consisted of 93 ounce measures of carbonic acid, and 180 of carbureted hydrogen, composed of 5 parts charcoal to 1 of hydrogen. When the pyromucous acid was saturated with lime, ammonia was disengaged.

From these experiments it follows, that gum contains oxygen, hydrogen, carbon, azote, and lime. The lime may be detected by dropping nitric acid into a solution of gum; needleform crystals of sulphat of lime are slowly deposited. If we compare the products obtained by the distillation of sugar with those obtained from gum, we can scarcely doubt that the latter contains the greater proportion of carbon. As it yields less pyromucous acid, it is not improbable that it also contains less oxygen. Sugar is a triple compound; but gum contains five constituents.

4. The species of gum at present known amount to four; though it is likely that a more rigid examination of the vegetable kingdom will discover a greater number. These are gum arabic, gum tragacanth, cherry-tree gum, and the mucilage which is contained in the roots and leaves of many plants.

Gum arabic exudes from the mimosa nilotica, and other species of mimosa. It is the species described in the preceding part of this article.

5. Gum tragacanth is the produce of the astragalus tragacantha, a thorny shrub which grows in Candia and other islands of the Levant. The gum is said to exude about the end of June from the stem and larger branches, and soon dries in the sun. It is in the state of whitish vermiform pieces, not nearly so transparent as gum arabic. It is much stronger than gum arabic, not so easily dissolved in water, and is said to go farther. When Mr. Cruikshank distilled 480 grains of it in a glass retort, he obtained the following products:

Pyromucous acid	245 gr.
Charcoal	93
Lime with some phosphat	12
Carbonic acid gas and carbureted hyrogen gas	130
	480

When the pyromucous acid was saturated with lime, a considerably greater proportion of ammonia was disengaged than from the pyromucous acid of gum arabic. The gases were 78 ounce-measures of carbonic acid, and 91 of carbureted hydrogen. Hence we see that gum tragacanth contains more azote and lime, and perhaps more oxygen and less carbon, than gum arabic.

6. The prunus avium, the common cherry and plum trees, and the almond and apricot, likewise yield a gum which exudes in great abundance from natural or artificial openings in the stem. It is of a reddish-brown colour, in large masses, and much softer and more easily melted than gum arabic. But no precise set of experiments has been made to ascertain how far its properties coincide with those of the last two species.

7. Mucilage is contained in the roots and leaves of a vast number of plants. Almost all the bulbous roots and fleshy leaves yield it. For example, the roots of the hyacinthus nondescriptus, and the althea officinalis; the leaves of the althæa, of the malva sylvestris of many of the fuci, and of the greater num

ber of the lichens; the seeds of flax, quinces, fenugreec, &c.

The bulbs of the hyacinth contain so much mucilage, that when dried they may be employed as a substitute for gum arabic. This was first made known to the public by Mr. Willis. A mucilage may be extracted from most of the stringy lichens by water, which likewise answers all the purposes of a solution of gum. This was first discovered by lord Dundonald. The mucilaginous quality of most of the fuci is apparently much greater, though the mucilage obtained from them does not answer so well.

How far the mucilage extracted by water from these plants agrees with gum in its properties, has not been examined with much precision, if we except the mucilage of the hyacinth. From the experiments of Leroux, it appears that the mucilage of that plant is in every respect the same with gum. The bulbs are to be pounded, mixed with five times their weight of water, and subjected to the press. The residue is to be diluted afresh, and again pressed. The liquid thus obtained is to be allowed to repose for some days till it clarifies somewhat, and then evaporated to dryness. The gum remains.

8. It has been remarked by Mr. Barrow, and probably also by others, that all the plants which yield gum have an astringent bark. This rule, however, does not hold with respect to mucilage. Almost all the trees known to yield gum have been enumerated in the preceding part of this article. To attempt a list of all the plants containing mucilage, would, in the present state of our knowledge, be superfluous, even if it was possible. It exists most abundantly in young plants, and gradually disappears as they arrive at perfection. It forms a great proportion of the leaves and roots of many eatable plants.

9. Gum is a very nutritive food, though seldom employed for that purpose, except when in the state of mucilage. It is used frequently as a paste, and to give stiffness or lustre to linen. The calico-printers use it in great quantities to give their colours such a degree of consistency as prevents them from running upon the cloth. It forms an ingredient in ink for a similar reason. In medicine it forms the base of many mixtures.

GUM-RESINS. This class of vegetable substances has been long distinguished by physicians and apothecaries. It contains many active substances much employed in medicine; and they certainly possess a sufficient number of peculiar properties to entitle them to be ranked apart. Unfortunately these substances have not yet attracted much of the attention of chemists. Their properties and constituents of course are but imperfectly ascertained. They may, however, be distinguished by the following characters.

They are usually opaque, or at least their transparency is inferior to that of the resins. They are always solid, and most commonly very brittle, and have sometimes a fatty appearance.

When heated they do not melt as the resins do, neither are they so combustible. Heat, however, commonly softens them, and causes them to swell. They burn with a flame. They have almost always a strong smell, which in several instances is alliaceous. Their taste also is often acrid, and always much stronger than that of the resins. They are partially soluble in water; but the solution is always opaque, and usually milky.

Alcohol dissolves only a portion of them. The solution is transparent; but when diluted with water it becomes milky; yet no precipitate falls, nor is any thing obtained by filtring the solution. Vinegar and wine likewise dissolve them partially; and the solution, like the aqueous, is opaque or milky.

The action of alkalies on them has been examined only by Mr. Hatchett. All of them tried by that celebrated chemist dissolved readily in alkaline solutions when assisted by heat. We may therefore consider them as soluble in alkalies like resins. Mr. Hatchett also found them acted on by nitric acid, and dissolved by it just as the resinous bodies.

Their specific gravity is usually greater than that of the resins. Their other properties still continue unknown. They all either exude spontaneously from plants, or are obtained by incisions. At first they seem to be in a liquid state; but they gradually harden when exposed to the air and weather.

They have been usually considered by chemists as composed of gum and resin; but their properties are not consistent with that supposition. They all contain a volatile oil, or a substance intermediate between an oil and resin. To this substance we are to ascribe the milky solution which they form with water. The other constituent, in most cases, bears a much closer resemblance to extractive than to gum; perhaps, then, we shall not err very far, if we consider the gum-resins as composed of a gum or an extractive substance, and a body intermediate between oil and resin; to which last they owe their most peculiar properties.

The gum-resins which have been hitherto applied to any useful purpose are chiefly the following:

1. *Galbanum.* It is obtained from the bubon galbanum, a perennial plant, and a native of Africa. When this plant is cut across a little above the root, a milky juice flows out, which soon hardens and constitutes galbanum. It comes to this country from the Levant in small pieces composed of tears, agglutinated together of a yellowish or white colour. Its taste is acrid and bitter, and its smell peculiar. Water, vinegar, and wine, dissolve most of it, but the solution is milky. Alcohol acts but feebly; when distilled it yields volatile oil in considerable quantity. Its specific gravity is 1.2.

2. *Ammoniac.* This substance is brought from the East Indies. Nothing certain is known concerning the plant which yields it; though from analogy it has been suspected to be a species of ferula. It is in small pieces, and has a yellowish-white colour. Its smell is somewhat like that of galbanum, but more pleasant; its taste is a nauseous sweet mixed with bitter. It does not melt. Water dissolves a portion of it; the solution is milky, but gradually lets fall a resinous portion. One-half is soluble in alcohol. It seems then to contain resin completely formed: specific gravity is 1.2. Mr. Hatchett found it soluble in alkalies.

3. *Olibanum,* is obtained from the juniperus lycia, and is chiefly collected in Arabia. It is the frankincense of the antients; it is in transparent brittle masses about the size of a chesnut. Its colour is yellow. It has little taste; and when burnt diffuses an agreeable odour. Alcohol dissolves it; and with water it forms a milky liquid. When distilled it yields a little volatile oil. Its specific gravity is 1.173.

4. *Sagapanum.* The plant which yields this gum-resin is not well known; but it is suspected to be the ferula persica. The substance itself is brought to Europe from Alexandria. It is commonly in tears agglutinated together: colour yellow; taste hot and bitter; smell alliaceous; softens between the fingers, but does not melt when heated: sparingly soluble in water, but almost completely soluble in alcohol. When distilled it yields a volatile oil.

5. *Asafœtida.* This substance is obtained from the ferula asafœtida, a perennial plant which is a native of Persia. When the plant is about four years old, its roots are dug up and cleaned. Their extremity being then cut off, a milky juice exudes, which is collected. Then another portion is cut off, and more juice exudes. This is continued till the roots are exhausted. The juice thus collected soon hardens, and constitutes asafœtida. It comes to Europe in small grains of different colours, whitish, reddish, violet, brown: pretty hard, but brittle: its taste is acrid and bitter; its smell strongly alliaceous and fœtid. It is imperfectly soluble both in alcohol and water; but, like the other gum-resins, has been but carelessly analysed. Its specific gravity is 1.327.

6. *Scammony.* This substance is obtained from the convolvulus scammonia, a climbing plant which grows in Persia. The roots when cut yield a milky juice; this when collected and allowed to harden constitutes scammony. Colour, dark grey; smell, peculiar and nauseous; taste, bitter and acrid: with water it forms a greenish-coloured opaque liquid. Alcohol dissolves the greatest part of it; it is usually mixed with the expressed juice of the root, and frequently also with other impurities, which alter its appearance. In medicine it operates as a strong cathartic. Its specific gravity is 1.235.

7. *Opoponax.* This substance is obtained from the pastinaca opoponax, a plant which is a native of the countries round the Levant. The gum resin, like most others, is obtained by wounding the roots of the plant. The milky juice when dried in the sun constitutes the opoponax. It is in lumps of a reddish yellow colour, and white within; smell peculiar; taste bitter and acrid; with water it forms a milky solution. Its specific gravity is 1.622.

8. *Gamboge,* or *gumgutt.* This substance is obtained from the stalagmitis cambogioides, a tree which grows wild in the East Indies. In Siam it is obtained in drops by wounding the shoots; in Ceylon it exudes from wounds of the bark. It is brought to Europe in large cakes. Its colour is yellow; it is opaque, brittle, and breaks vitreous; it has no smell, and very little taste; with water it forms a yellow turbid liquid. Alcohol dissolves it almost completely: and when mixed with water it becomes turbid, unless the solution contains ammonia; in that case acids throw down an insoluble yellow precipitate. It operates,

when taken internally, as a most violent cathartic; its specific gravity is 1.221. It appears that it was brought to Europe by the Dutch about the middle of the 17th century.

9. *Myrrh.* The plant from which this substance is obtained is unknown; if we believe Bruce, it belongs to the genus of mimosa. It grows in Abyssinia and Arabia: it is in the form of tears; colour reddish-yellow; when pure somewhat transparent, but it is often opaque: odour peculiar: taste bitter and aromatic: does not melt when heated, and burns with difficulty. With water it forms a yellow opaque solution: the solution in alcohol becomes opaque when mixed with water, but no precipitate appears: by distillation it yields oil: its specific gravity is 1.360; it is employed in medicine: Mr. Hatchett found it soluble in alkalies.

10. *Euphorbium.* This substance is obtained from the euphorbia officinalis. The milky juice which exudes from that plant, when dried in the sun, constitutes euphorbium: it is brought from Africa in small yellow tears; it has no smell, and is mostly soluble in alcohol: its specific gravity is 1.124. It is considered as poisonous.

11. Little is known concerning the substances called bdellium and caranna, reckoned among the gum-resins. The specific gravity of the first is 1.371, of the second 1.124. Bdellium was celebrated by the antient physicians: it comes from Arabia. The substance extracted from ivy, and known by the name of gummi hederæ, is considered as a gum-resin Its specific gravity is 1.294.

12. From the experiments made upon ipecacuanha, the root of the cephelis ipecacuana, especially by Dr. Irvine, we learn that it also contains a gum-resin. The same remark applies to several other vegetable substances employed in medicine.

It deserves attention, that the gum-resins, when subjected to destructive distillation, yield all of them a portion of ammonia; a proof that they all contain azote. In this respect they agree with gum and extractives.

GUINEA, a gold coin struck in England. The value or rate of the guinea has varied. It was at first equal to 20 shillings; but by the scarcity of gold it was afterwards advanced to 21s. 6d.; though it is now sunk to 21s. The pound weight troy of gold is cut into 44 parts and a half, and each part makes a guinea, which is therefore equal to $\frac{2}{89}$lb. or $\frac{24}{89}$oz. or 5 dwts. $9\frac{39}{89}$ gr. This coin took its name, guinea, from the circumstance of the gold of which it was at first struck being brought from that part of Africa called Guinea, for which reason also it bore the impression of an elephant.

GUN, a fire-arm, or weapon of offence, which forcibly discharges a ball or other matter through a cylindrical tube, by means of inflamed gunpowder.

The word gun now includes most of the species of fire-arms; mortars and pistols being almost the only kind excepted from this denomination. They are divided into great and small guns; the former including all that are usually called cannon, ordnance, or artillery; and the latter including musquets, firelocks, carabines, musquetoons, blunderbusses, fowling-pieces, &c.

The first hint of the invention of guns is in the works of Roger Bacon, who flourished in the 13th century. In a treatise written by him about the year 1280, he proposes to apply the violent explosive force of gunpowder for the destruction of armies. And though it is certainly known that the composition of gunpowder is described by Bacon in the same work, yet the invention has usually, though improperly, been ascribed to Bartholdus Schwartz, a German monk, who it is said discovered it only in the year 1320; and the invention is related in the following manner: Schwartz having, for some purpose, pounded nitre, sulphur, and charcoal together, in a mortar, which he afterwards covered imperfectly with a stone, a spark of fire accidentally fell into the mortar, which setting the mixture on fire, the explosion blew the stone to a considerable distance. Hence it is probable that Schwartz might be taught the simplest method of applying it in war; for it rather seems that Bacon conceived the manner of using it to be by the violent effort of the flame unconfined, and which is indeed capable of producing astonishing effects. And the figure and name of mortars given to a species of old artillery, and their employment, in throwing large stone bullets at an elevation, very much favour this conjecture.

When, or by whom, guns were first made, is uncertain. It is known, however, that the Venetians used cannon at the siege of Claudia Jessa, now called Chioggia, in 1366, which were brought thither by two Germans, with some powder and leaden balls; as likewise in their wars with the Genoese in 1379. But before that, king Edward the Third made use of cannon at the battle of Cressy, in 1346, and at the siege of Calais, in 1347. Cannon were employed by the Turks at the siege of Constantinople, then in possession of the Christians, in 1394, and in that of 1452, which threw a weight of 100lb.; but they commonly burst at the first, second, or third firing. Louis the XIIth had one cast at Tours, of the same size, which threw a ball from the Bastille to Charenton: one of these extraordinary cannon was taken at the siege of Dieu, in 1546, by don John de Castro, and is now in the castle of St. Julian de Borra, 10 miles from Lisbon; the length of it is 20 feet 7 inches, its diameter at the middle 6 feet 3 inches, and it threw a ball of 100lb. weight. It has neither dolphins, rings, nor button; is of an unusual kind of metal; and it has a large Indostan inscription upon it, which says it was cast in 1400.

Cannon take their names from the weight of the proper ball. Thus, a piece that discharges a cast-iron ball of 24 pounds, is called a 24-pounder; one that carries a ball of 12 pounds, is called a 12-pounder; and so of the rest, divided into the following sorts, viz.

Ship-guns, consisting of 42, 36, 32, 24, 18, 12, 9, 6, and 3 pounders.

Garrison-guns, of 42, 32, 24, 18, 12, 9, and 6 pounders.

Battering-guns, of 24, 18, and 12 pounders.

Field-pieces, of 12, 9, 6, 3, 2, $1\frac{1}{2}$, 1, and $\frac{1}{2}$ pounders.

Mortars, it is thought, have been at least as antient as cannon. They were employed in the wars of Italy, to throw balls of red-hot iron, stones, &c. long before the invention of shells.

Mr. Malter, an English engineer, first taught the French the art of throwing shells, which they practised at the siege of Motte in 1634. The method of throwing red-hot balls out of mortars was first certainly put in practice at the siege of Stralsund in 1675 by the elector of Brandenburgh; though some say in 1653, at the siege of Bremen.

Another species of ordnance has been long in use, by the name of howitzer, which is a kind of medium as to its length, between the cannon and the mortar, and is a very useful piece, for discharging either shells or large balls, which is done either at point-blank, or at a small elevation.

A new species of ordnance has lately been introduced by the Carron company, and thence called a carronade, which is only a very short howitzer, and which possesses the advantage of being very light and easy to work.

The species of guns before-mentioned, are now made chiefly of cast-iron; except the howitzer, which is of brass, as well as some cannon and mortars.

Muskets were first used at the siege of Rhege, in the year 1521. The Spaniards were the first who armed part of their foot with these weapons. At first they were very heavy, and could not be used without a rest. They had matchlocks, and did execution at a great distance. On their march the soldiers carried only the rests and ammunition, having boys to bear their muskets after them. They were very slow in loading, not only from the unwieldiness of their pieces, and because they carried the ball and powder separate, but from the time it took to prepare and adjust the match; so that their fire was not near so brisk as ours is now. Afterwards a lighter matchlock musket came in use; and they carried their ammunition in bandeliers, to which were hung several little cases of wood covered with leather, each containing a charge of powder. The muskets with rests were used as late as the beginning of the civil wars in the time of Charles the First. The lighter kind succeeded them, and continued till the beginning of the present century, when they also were disused, and the troops throughout Europe armed with firelocks. These are usually made of hammered iron.

GUNDELIA, a genus of the class and order syngenesia polygamia segregata. There is scarcely any calyx; what there is, is 5-flowered; cor. tubular, male and hermaphrodite; recept. chaffy; down none. There is one species, a herb of the Levant, having the habit of a thistle.

GUNNERA, a genus of the class and order gynandria diandria. The character is, ament. with 1-flowered scales; calyx and corolla none; germen, 2-toothed; styles 2; seed one. There is one species, a herb of the Cape.

GUNNERY, the art of charging, directing, and exploding fire-arms, as cannon, mortars, muskets, &c. to the best advantage.

Gunnery is sometimes considered as a part of the military art, and sometimes as a part of pyrotechny. To the art of gunnery too belongs the knowledge of the force and effect of gunpowder, the dimensions of the pieces, and the proportions of the powder and ball they carry, with the methods of maanging, charging, pointing, spunging, &c.

The first application of gunpowder to military affairs, it seems, was made soon after the year 1300, for which the proposal of friar Bacon, about the year 1280, for applying its enormous explosion to the destruction of

armies, might give the first hint; and Schwartz, to whom the invention of gunpowder has been erroneously ascribed, on account of the accident above-mentioned under the article GUN, might have been the first who actually applied it in this way.

The first species of artillery, however, which were charged with gunpowder and stone bullets of a prodigious size, were of very clumsy and inconvenient structure and weight. Thus, when Mahomet the 2d besieged Constantinople, in 1453, he battered the walls with stones of this kind, and with pieces of the calibre of 1200 pounds; which could not be fired more than four times a day.

For the last 200 years, the formation of cannon has been very little improved: the battering cannon now approved, are those that were formerly called demi-cannon, carrying a ball of 24 pounds weight; this weight having been found fully sufficient. The method also of making a breach, by first cutting off the whole wall as low as possible before its upper part is attempted to be beaten down, seems to be a considerable modern improvement in the practical part of gunnery; but the most considerable improvement in the practice, is the method of firing with small quantities of powder, and elevating the piece but a little, so that the bullet may just go clear of the parapet of the enemy, and drop into their works, called ricochet firing: for by this means the ball, coming to the ground at a small angle, and with a small velocity, does not bury itself, but bounds or rolls along a great way, destroying all before it.

The Italians were the first people that made any attempts to ascertain the theory of projectiles, which they did about the beginning of the 16th century. It was then determined, that the greatest range of a shot was when discharged at an elevation of 45 degrees; and that no part of the path described by a ball is a right line. See PROJECTILES.

Mr. Robins informs us, in the preface to his New Principles of Gunnery, that he had met with no more than four authors who had treated experimentally on this subject. The first of these is Collado, in 1642, who has given the ranges of a falconet, carrying a three-pound shot, to every point of the gunner's quadrant, each point being the 12th part, or 7 degrees and a half. But from his numbers it is manifest that the piece was not charged with its usual allotment of powder.

It is extraordinary that before Mr. Robins, there were but four authors who had treated experimentally on gunnery, and those to little purpose; but the treatise of Mr. Robins is still regarded as the foundation of the science.

The first thing considered by him, and which is indeed the foundation of all other particulars relating to gunnery, is the explosive force of gunpowder. The intensity of this force Mr. Robins ascertained in different ways. One of these is by firing the powder in the air, thus: A small quantity of the powder is placed in the upper part of a glass tube, and the lower part of the tube is immerged in water, the water being made to rise so near the top, that only a small portion of air is left in that part where the powder is placed; in this situation the communication between the upper part of the tube and the external air being closed, the powder is fired by means of a burning-glass, or otherwise; the water descends upon the explosion, and stands lower in the tube than before, by a space proportioned to the quantity of powder fired. Another was by firing the powder in vacuo, viz. in an exhausted receiver, by dropping the grains of powder upon a hot iron excluded in the receiver. For the result of these experiments, see GUNPOWDER.

Having determined the force of the gunpowder, or intensity of the agent by which the projectile is to be urged, Mr. Robins next determined the effects it will produce, or the velocity with which it will impel a shot of a given weight from a piece of ordnance of given dimensions; which is a problem strictly limited, and perfectly soluble by mathematical rules, and is in general this: Given the first force, and the law of its variation, to determine the velocity with which it will impel a given body in passing through a given space, which is the length of the bore of the gun.

In the solution of this problem, Mr. Robins assumes these two postulates, viz. 1. That the action of the powder on the bullet ceases as soon as the bullet is out of the piece; and 2d. That all the powder of the charge is fired and converted into elastic fluid before the bullet is sensibly moved from its place: assumptions which for good reasons are found to be in many cases very near the truth. It is to be noted also, that the law by which the force of the elastic fluid varies, is this; viz. that its intensity is directly as its density, or reciprocally proportional to the space it occupies, being so much the stronger as the space is less; a principle well known, and common to all elastic fluids. Upon these principles then Mr. Robins resolves this problem, by means of the 39th proposition of Newton's Principia, in a direct way, and the result is equivalent to this theorem, where the quantities are expressed by algebraic symbols; viz. the velocity of the ball

$$v = 27130\sqrt{\frac{10a}{cd} \times \log.\ \frac{b}{a}}.$$

$$\text{or} = 100\sqrt{\frac{223ad^2}{w} \times \log.\ \frac{b}{a}}; \text{ whence}$$

v is the velocity of the ball,
a the length of the charge of powder,
b the whole length of the bore,
c the spec. grav. of the ball, or wt. of a cubic foot of the same matter in ounces,
d the diam. of the bore,
w the wt. of the ball in ounces.

For example, Suppose $a = 2\frac{5}{8}$ inc., $b = 45$ inc., $c = 11345$ oz. for a ball of lead. and $d = \frac{3}{4}$ inc.;

$$\text{then } v = 27130\sqrt{\frac{7}{2269} \times \log.\ \frac{120}{7}} = 1674$$

feet per second, the velocity of the ball.

Or, if the wt. of the bullet be $w = 1\frac{9}{20}$ oz. $= \frac{29}{20}$ oz. Then $x = 100\sqrt{\frac{1115 \times 189}{29 \times 32} \times \log.\ \frac{120}{7}}$ = 1674 feet, as before.

"Having in this proposition," says Mr. Robins, "shewn how the velocity, which any bullet acquires from the force of powder, may be computed upon the principles of the theory laid down in the preceding propositions; we shall next shew, that the actual velocities, with which bullets of different magnitudes are impelled from different pieces, with different quantities of powder, are really the same with the velocities assigned by these computations; and consequently, that this theory of the force of powder, here delivered, does unquestionably ascertain the true action and modification of this enormous power.

"But in order to compare the velocities communicated to bullets by the explosion, with the velocities resulting from the theory by computation, it is necessary that the actual velocities with which bullets move, should be capable of being discovered, which yet is impossible to be done by any methods hitherto made public. The only means hitherto practised by others for that purpose, have been either by observing the time of the flight of the shot through a given space; or by measuring the range of the shot at a given elevation, and thence computing, on the parabolic hypothesis, what velocity would produce this range. The first method labours under this insurmountable difficulty, that the velocities of these bodies are often so swift, and consequently the time observed is so short, that an imperceptible error in that time may occasion an error in the velocity thus found, of 2, 3, 4, 5, or 600 feet in a second. The other method is so fallacious, from the resistance of the air (to which inequality the first is also liable), that the velocities thus assigned may not be perhaps the tenth part of the actual velocities sought.

"To remedy then these inconveniences, I have invented a new method of finding the real velocities of bullets of all kinds; and this to such a degree of exactness (which may be augmented too at pleasure), that in a bullet moving with a velocity of 1700 feet in 1", the error in the estimation of it need never amount to its 500th part; and this without any extraordinary nicety in the construction of the machine."

Mr. Robins then gives an account of the machine by which he measures the velocities of the balls, which machine is simply this; viz. a pendulous block of wood suspended freely by a horizontal axis, against which block are to be fired the balls whose velocities are to be determined.

"This instrument thus fitted, if the weight of the pendulum is known, and likewise the respective distances of its centre of gravity, and of its centre of oscillation, from its axis of suspension, it will thence be known what motion will be communicated to this pendulum by the percussion of a body of a known weight moving with a known degree of celerity, and striking it in a given point; that is, if the pendulum is supposed at rest before the percussion, it will be known what vibration it ought to make in consequence of such a determined blow; and, on the contrary, if the pendulum, being at rest, is struck by a body of a known weight, and the vibration which the pendulum makes after the blow is known, the velocity of the striking body may thence be determined.

"Hence then, if a bullet of a known weight strikes the pendulum, and the vibration which the pendulum makes in consequence of the stroke is ascertained, the velocity with which the ball moved is thence to be known."

Mr. Robins then explains his method of computing velocities from experiments with this machine; which method is rather troublesome and perplexed, as well as the rules of Euler and Antoni, who followed him in

this business: but a much simpler rule is given in Dr. Hutton's Tracts, vol. i. p. 119, where the experiments are explained at full length, and this rule is expressed by either of the two following formulas:

$$v = 5{\cdot}6727cg \times \frac{p+b}{bir}\sqrt{o} = 614{\cdot}58cg \times \frac{p+b}{birn},$$

the velocity; where v denotes the velocity of the ball when it strikes the pendulum, p the weight of the pendulum, b the weight of the ball, c the chord of the arc described by the vibration to the radius r, g the distance below the axis of motion to the centre of gravity, o the distance to the centre of oscillation, i the distance to the point of impact, and n the number of oscillations the pendulum will perform in one minute, when made to oscillate in small arcs. The latter of these two theorems is much the easiest, both because it is free of radicals, and because the value of the radical $\sqrt{o}$, in the former, is to be first computed from the number x, or number of oscillations the pendulum is observed to make.

Soon after the first publication of Robins's New Principles of Gunnery, in 1742, the learned in several other nations, treading in his steps, repeated and farther extended the same subject, sometimes varying and enlarging the machinery; particularly Euler in Germany, D'Antoni in Italy, and Messrs. D'Arcy and Le Roy in France: but most of these, like Mr. Robins, with small fire-arms, such as muskets and fusils.

But in the year 1775, in conjunction with several able officers of the Royal Artillery, and other ingenious gentlemen, Dr. Hutton undertook a course of experiments with the ballistic pendulum, in which the machinery was extended to cannon-shot of 1, 2, and 3 pounds weight. An account of these experiments was published in the Philos. Trans. for 1778, "and for which," says the Dr., "the Royal Society honoured me with the prize of the gold medal. These were the only experiments that I know of which had been made with cannon-balls for this purpose, although the conclusions to be deduced from such, are of the greatest importance to those parts of natural philosophy which are dependant on the effects of fired gunpowder; nor do I know of any other practical method of ascertaining the initial velocities within any tolerable degree of the truth. The knowledge of this velocity is of the utmost consequence in gunnery; by means of it, together with the law of the resistance of the medium, every thing is determinable relative to that business; for, besides its being an excellent method of trying the strength of different sorts of powder, it gives us the law relative to the different quantities of powder, to the different weights of shot, and to the different lengths and sizes of guns. Besides these, there does not seem to be any thing wanting to answer any inquiry that can be made concerning the flight and ranges of shot, except the effects arising from the resistance of the medium. In these experiments the weights of the pendulums employed were from 300 to near 600 pounds." In that paper is described the method of constructing the machinery, of finding the centres of gravity and oscillation of the pendulum, and of making the experiments, which are all set down in the form of a journal, with all the minute and concomitant circumstances; as also the investigation of the new and easy rule, set down just above, for computing the velocity of the ball from the experiments. The charges of powder were varied from 2 to 8 ounces, and the shot from 1 to near 3 pounds. And from the whole were clearly deduced these principal inferences: viz.

"1. First, That gunpowder fires almost instantaneously. 2. That the velocities communicated to balls or shot, of the same weight, by different quantities of powder, are nearly in the subduplicate ratio of those quantities; a small variation, in defect, taking place when the quantities of powder became great. 3. And when shot of different weights are employed, with the same quantity of powder, the velocities communicated to them are nearly in the reciprocal subduplicate ratio of their weights. 4. So that, universally, shot which are of different weights, and impelled by the firing of different quantities of powder, acquire velocities which are directly as the square roots of the quantities of powder, and inversely as the square roots of the weights of the shot, nearly. 5. It would therefore be a great improvement in artillery, to make use of shot of a long form, or of heavier matter; for thus the momentum of a shot, when fired with the same weight of powder, would be increased in the ratio of the square root of the weight of the shot. 6. It would also be an improvement to diminish the windage; for by so doing, one-third or more of the quantity of powder might be saved. 7. When the improvements mentioned in the last two articles are considered as both taking place, it is evident that about half the quantity of powder might be saved, which is a very considerable object. But important as this saving may be, it seems to be still exceeded by that of the article of the guns; for thus a small gun may be made to have the effect and execution of another of two or three times its size in the present mode, by discharging a shot of two or three times the weight of its natural ball or round shot. And thus a small ship might discharge shot as heavy as those of the greatest now made use of.

"Finally, as the above experiments exhibit the regulations with regard to the weights of powder and balls, when fired from the same piece of ordnance, &c.; so by making similar experiments with a gun, varied in its length, by cutting off from it a certain part before each course of experiments, the effects and general rules for the different lengths of guns may be certainly determined by them. In short, the principles on which these experiments were made, are so fruitful in consequences, that, in conjunction with the effects resulting from the resistance of the medium, they seem to be sufficient for answering all the enquiries of the speculative philosopher, as well as those of the practical artillerist."

GUNPOWDER, a composition of nitre, sulphur, and charcoal, mixed together, and usually granulated.

It appears that Roger Bacon knew of gunpowder. He tells us, in his Treatise De Secretis Operibus Artis & Naturæ, & de Nullitate Magiæ, cap. 6, which is supposed by some to have been published at Oxford in 1216, "that from saltpetre and other ingredients, we are able to make a fire that shall burn at what distance we please." And Dr. Plott, in his History of Oxfordshire, p. 236, assures us that these "other ingredients were explained in a MS. copy of the same treatise, in the hands of Dr. G. Langbain, and seen by Dr. Wallis, to be sulphur and wood-coal."

As to the preparation of gunpowder, there are various compositions of it, with respect to the proportions of the three ingredients, to be met with in pyrotechnical writings; but the process of making it up is much the same in all.

For some time after the invention of artillery, gunpowder was of a much weaker composition than that now in use. But when guns of modern structure were introduced, gunpowder of the same composition as the present came also into use. In the time of Tartaglia the cannon-powder was made of 4 parts of nitre, one of sulphur, and one of charcoal: and the musket-powder of 48 parts of nitre, 7 parts of sulphur, and 8 parts of charcoal; or of 18 parts of nitre, 2 parts of sulphur, and 3 parts of charcoal; the modern composition is,

76 parts nitre
15 charcoal
9 sulphur

100.

These ingredients are first reduced to a fine powder separately, then mixed intimately, and formed into a thick paste with water. After this has dried a little, it is placed upon a kind of sieve full of small holes, through which it is forced. By that process it is divided into grains, the size of which depends upon the size of the holes through which they have been squeezed. The powder, when dry, is put into barrels, which are made to turn round on their axes. By this motion the grains of gunpowder rub against each other, their asperities are worn off, and their surfaces are made smooth. The powder is then said to be glazed.

Gunpowder, as is well known, explodes violently when a red heat is applied to it. This combustion takes place even in a vacuum; a vast quantity of gas is emitted, the sudden production of which is the cause of all the violent effects which this substance produces. Their combustion is evidently owing to the decomposition of the nitre by the charcoal and sulphur. The products are carbonic acid gas, azotic gas, sulphurous acid gas, and probably sulphureted hydrogen. Mr. Cruikshank has ascertained that no perceptible quantity of water is formed. What remains after the combustion is potass combined with a small portion of carbonic acid, sulphat of potass, a very small proportion of sulphuret of potass, and unconsumed charcoal. This mixture soon attracts moisture, and the sulphuret which it contains enables it to act strongly on metallic bodies.

To make gunpowder duly, regard is to be had to the purity or goodness of the ingredients, as well as the proportions of them; for the strength of the powder depends much on that circumstance, and also on the due working or mixing of them together.

To purify the nitre, by taking away the fixt or common salt, and earthy part. Dissolve it in a quantity of hot water over the fire; then filtrate it through a flannel bag, into an open vessel, and set it aside to cool, and to crystallize. These crystals may in like manner be dissolved and crystallized again; and so on, till they become quite pure

and white. Then put the crystals into a dry kettle over a moderate fire, which gradually increase till it begins to smoke, evaporate, lose its humidity, and grow very white: it must be kept continually stirring with a ladle, lest it should return to its former figure, by which its greasiness would be taken away; after that, so much water is to be poured into the kettle as will cover the nitre; and when it is dissolved, and reduced to the consistency of a thick liquor, it must be continually stirred with a ladle till all the moisture is again evaporated, and it is reduced to a dry and white meal.

The like regard is to be had to the sulphur; choosing that which is in large lumps, clear and perfectly yellow; not very hard, nor compact, but porous; not yet too much shining; and if, when set on fire, it freely burns all away, it is a sign of its goodness; so likewise, if it is pressed between the two iron plates that are hot enough to make it run, and in the running appear yellow, and that which remains of a reddish colour, it is then fit for the purpose. But in case it is foul, it may be purified in this manner; melt the sulphur in a large iron ladle or pot, over a very gentle coal-fire, well kindled, but not flaming; then scum off all that rises on the top, and swims upon the sulphur; take it presently after from the fire, and strain it through a double linen cloth, letting it pass leisurely; so will it be pure, the gross matter remaining behind in the cloth.

For the charcoal, the third ingredient, such should be chosen as is large, clear, and free from knots, well burnt, and cleaving. The charcoal of light woods is mostly preferred, as of willow, and that of the branches or twigs of a moderate thickness, as of an inch or two in diameter. Dogwood is now much esteemed for this purpose. And a method of charring the wood in a large iron cylinder has lately been recommended, and indeed proved, as yielding better charcoal than formerly.

The charcoal not only concurs with the sulphur in supplying the inflammable matter, which causes the detonation of the nitre, but also greatly adds to the explosive power of it by the quantity of carbonic acid gas, expelled during its combustion.

These three ingredients, in their purest state, being procured, long experience has shewn that they are then to be mixed together in the proportion before-mentioned, to have the best effect.

But it is not the due proportion of the materials only, which is necessary to the making of good powder; another circumstance, not less essential, is the mixing them well together; if this is not effectually done, some parts of the composition will have too much nitre in them, and others too little; and in either case there will be a defect of strength in the powder.

After the materials have been reduced to fine dust, they are mixed together, and moistened with water, or vinegar, or urine, or spirit of wine, &c. and then beaten together with wooden pestles for 24 hours, either by hand, or by mills, and afterwards pressed into a hard, firm, and solid cake. When dry, it is grained or corned, which is done by breaking the cake of powder into small pieces, and so running it through a sieve; by which means the grains may have any size given them, according to the nature of the sieve employed, either finer or coarser; and thus also the dust is separated from the grains, and again mixed with other manufacturing powder, or worked up into cakes again.

Powder is smoothed, or glazed, as it is called, for small arms, by the following operation: a hollow cylinder or cask is mounted on an axis, turned by a wheel; this cask is half-filled with powder, and turned for six hours; and thus by the mutual friction of the grains of powder it is smoothed, or glazed. The fine mealy part, thus separated or worn off from the rest, is again granulated.

The nature, effects, &c. of powder. When the powder is separated as above, if the least spark is struck upon it from a steel and flint, the whole will immediately inflame, and burst out with extreme violence. The effect is not hard to account for: the charcoal part of the grain upon which the spark falls, catching fire like tinder, the sulphur and nitre are readily melted, and the former also breaks into flame; the contiguous grains at the same time undergoing the same fate.

The explosion of gunpowder therefore arises from the violent action, by which all the mixture being quickly and vehemently heated, is rarefied and converted into gas and vapour; which vapour, by the violence of that action becoming so hot as to shine, appears in the form of a flame.

To understand the force of gunpowder, it must be considered that, whether it is fired in a vacuum or in air, it produces by its explosion permanently elastic fluids. It also appears from experiment, that the elasticity or pressure of the fluids produced by the firing of gunpowder is, cæteris paribus, directly as its density.

To determine the elasticity and quantity of the elastic fluids produced from the explosion of a given quantity of gunpowder, Mr. Robins premises, that the elasticity of the fluids increases by heat, and diminishes by cold, in the same manner as that of the air; and that the density of this fluid, and consequently its weight, are the same with the weight of an equal bulk of air, having the same elasticity and the same temperature. From these principles, and from the experiments by which they are established, he concludes that the fluid produced by the firing of gunpowder is nearly three-tenths of the weight of the generating powder itself; and that the volume or bulk of this air or fluid, when expanded to the rarity of common atmospheric air, is about 244 times the bulk of the powder.

Hence it appears, that any quantity of powder fired in any confined space, which it adequately fills, exerts at the instant of its explosion against the sides of the vessel containing it, and the bodies it impels before it, a force at least 244 times greater than the elasticity of common air, or, which is the same thing, than the pressure of the atmosphere; and this without considering the great addition arising from the violent degree of heat with which it is endued at that time; the quantity of which augmentation is the next head of Mr. Robins's enquiry. He determines that the elasticity of the air is augmented in a proportion somewhat greater than that of 4 to 1, when heated to the extremest heat of red-hot iron; and supposing that the flame of fired gunpowder is not of a less degree of heat, increasing the former number a little more than four times, makes nearly 1000; which shews that the elasticity of the flame, at the moment of explosion, is about 1000 times stronger than the elasticity of common air, or than the pressure of the atmosphere. But, from the height of the barometer, it is known that the pressure of the atmosphere upon every square inch, is on a medium 14¾lb.; and therefore 1000 times this, or 14750lb. is the force or pressure of the flame of gunpowder, at the moment of explosion, upon a square inch, which is very nearly equivalent to six tons and a half.

This great force, however, diminishes as the fluid dilates itself, and in that proportion, viz. in proportion to the space it occupies, it being only half the strength when it occupies a double space, one-third the strength when triple the space, and so on.

Mr. Robins farther supposes the degree of heat above-mentioned to be a kind of medium heat; but that in the case of large quantities of powder the heat will be higher, and in very small quantities lower; and that therefore in the former case the force will be somewhat more, and in the latter somewhat less, than 1000 times the force of the atmosphere.

He farther found that the strength of powder is the same in all variations in the density of the atmosphere, but that the moisture of the air has a great effect upon it; for the same quantity which in a dry season would discharge a bullet with a velocity of 1700 feet in one second, will not in damp weather give it a velocity of more than 12 or 1300 feet in a second, or even less, if the powder is bad; and negligently kept. Farther, as there is a certain quantity of water which, when mixed with powder, will prevent its firing at all, it cannot be doubted that every degree of moisture must abate the violence of the explosion; and hence the effects of damp powder are not difficult to account for.

It is to be observed, that the moisture imbibed by powder does not render it less active when dried again. Indeed, if powder is exposed to very great damps without any caution, or when common salt abounds in it, as often happens through negligence in refining the nitre, in such cases the moisture it imbibes may perhaps be sufficient to dissolve some part of the nitre; which is a permanent damage that no drying can retrieve. But when tolerable care is taken in preserving powder, and the nitre it is composed of has been well purged from common salt, it will retain its force for a long time; and it is said that powder has been known to have been preserved for 50 years without any apparent damage from its age.

The velocity of expansion of the flame of gunpowder, when fired in a piece of artillery, without either bullet or other body before it, is prodigiously great, viz. 7000 feet per second, or upwards, as appears from the experiments of Mr. Robins. But Mr. Bernouilli and Mr. Euler suspect it is still much greater. Perhaps, indeed, it may not be less, at the moment of explosion, than four times as much.

It is this prodigious celerity of expansion of the flame of fired gunpowder, which is its

peculiar excellence, and the circumstance in which it so eminently surpasses all other inventions, either ancient or modern; for as to the momentum of these projectiles only, many of the warlike machines of the ancients produced in this a degree far surpassing that of our heaviest cannon-shot or shells; but the great celerity given to these bodies cannot be in the least approached by any other means but the flame of powder. The best means of proving gunpowder is that of the pendulum, already described under the article GUNNERY.

To recover damaged powder. The method of the powder-merchants is this: they put part of the powder on a sail-cloth, to which they add an equal weight of what is really good; then with a shovel they mingle it well together, dry it in the sun, and barrel it up, keeping it in a dry and proper place.

Others again, if it is very bad, restore it by moistening it with vinegar, water, urine, or brandy; then they beat it fine, sift it, and to every pound of powder add an ounce, or an ounce and a half, or two ounces (according as it is decayed), of melted nitre; and afterwards these ingredients are to be moistened and well mixed, so that no particular substance may be discerned: which may be known by cutting the mass, and then they granulate it as usual.

In case the powder is quite spoiled, the only thing to be done is to extract the saltpetre with water, in the usual way, by boiling, filtrating, evaporating, and crystallizing; and then, with fresh sulphur and charcoal, to make it up afresh.

GUNPOWDER *and combustibles, laws concerning.* No person shall make gunpowder but in the regular manufactories established at the time of making the stat. 12 Geo. III. c. 61. or licensed by the sessions, pursuant to certain provisions, under forfeiture of the gunpowder, and 2*s.* per lb. nor are pestle-mills to be used under a similar penalty.

Only 40 lbs. of powder to be made at one time under one pair of stones, except Battle-powder, made at Battle and elsewhere in Sussex.

Not more than 40 cwt. to be dried at one time in one stove; and the quantity only required for immediate use to be kept in or near the place of making, except in brick or stone magazines, 50 yards at least from the mill.

Not more than 25 barrels to be carried in any land carriage, nor more than 200 barrels by water, unless going by sea or coastwise, each barrel not to contain more than 100lbs.

No dealer to keep more than 200lbs. of powder, nor any person not a dealer, more than 50lbs. in the cities of London or Westminster, or within three miles thereof, or within any other city, borough, or market-town, or one mile thereof, or within two miles of the king's palaces or magazines, or half a mile of any parish-church, on pain of forfeiture; and 2*s.* per lb. except in licensed mills, or to the amount of 300 lbs. for the use of collieries, within 200 yards of them.

GUN-SMITHERY, the business of a gun-smith, or the art of making fire-arms of the smaller sort, as muskets, fowling-pieces, pistols, &c. The principal part of these instruments is the barrel, which ought to have the following properties: 1. Lightness, that it may incommode the person who carries it as little as possible. 2. Sufficient strength, and other properties requisite to prevent its bursting by a discharge. 3. It ought to be constructed in such a manner as not to recoil with violence. And, 4. it ought to be of sufficient length to carry the shot to as great a distance as the force of the powder employed is capable of doing.

The manufacture of fire-arms is now carried to such a degree of perfection by different European nations, that it may perhaps be justly doubted whether any farther improvement in the requisites just mentioned can be made. For the materials the softest iron that can be procured is to be employed. The best in this country are formed of stubs, as they are called, or old horse-shoe nails; which are procured by gun-smiths from farriers, and from poor people who subsist by picking them up on the great roads leading to London. These are sold at about ten shillings per cwt. and 28 pounds are requisite to form a single musket-barrel. The method of manufacturing them from this material is as follows: A hoop of about an inch broad, and six or seven inches diameter, is placed in a perpendicular situation, and the stubs, previously well cleaned, piled up in it with their heads outermost on each side, till the hoop is quite filled and wedged tight with them. The whole then resembles a rough circular cake of iron; which being heated to a white heat, and then strongly hammered, coalesces into one solid lump. The hoop is now removed, and the heatings and hammerings repeated till the iron is rendered very tough and close in the grain; when it is drawn out into pieces of about 24 inches in length, half an inch or more in breadth, and half an inch in thickness. It is, however, not easy to conceive how old stubs can be procured sufficient to supply iron for the number of barrels which go under this denomination. Nor do we, upon any principles of science, see any farther advantage to be derived from this manufacture, than that nail-iron is generally the best of iron, and well hammered.

Four of the pieces, prepared as has been described, are required for one barrel; but in the ordinary way a single bar of the best soft iron is employed. The workmen begin with hammering out this into the form of a flat ruler, having its length and breadth proportioned to the dimensions of the intended barrel. By repeated heating and hammering this plate is turned round a tempered iron-rod called a mandril, the diameter of which is considerably smaller than the intended bore of the barrel. One of the edges of the plate being laid over the other about half an inch, the whole is heated and welded by two or three inches at a time, hammering it briskly, but with moderate strokes, upon an anvil which has a number of semicircular furrows in it, adapted to the barrels of different sizes. Every time the barrel is withdrawn from the fire, the workman strikes it gently against the anvil once or twice in an horizontal direction. By this operation the particles of the metal are more perfectly consolidated, and every appearance of a seam in the barrel is obliterated. The mandril being then again introduced into the cavity of the barrel, the latter is very strongly hammered upon it in one of the semicircular hollows of the anvil, by small portions at a time; the heatings and hammerings being repeated until the whole barrel has undergone the operation, and its parts rendered as perfectly continuous as if they had been formed out of a solid piece. To effect this completely, three welding heats are necessary when the very best iron is made use of, and a greater number for the coarser kinds. The French workmen imagine that by giving the barrel, while in the fire, slight horizontal strokes with the hammer, so as to communicate a vibratory motion to the iron, those particles are thrown off which are in a state of fusion, and cannot easily be converted into malleable iron: but considering the great number of operations already described which the metal has undergone, we can scarcely suppose this to be of much consequence.

The next operation in forming the barrels is the boring of them, which is done in the following manner: Two beams of oak, each about six inches in diameter, and six or seven feet long, are placed horizontally, and parallel to one another; having each of their extremities mortised upon a strong upright piece about three feet high, and firmly fixed. A space of three or four inches is left between the horizontal pieces, in which a piece of wood is made to slide by having at either end a tenon let into a groove which runs on the inside of each beam throughout its whole length. Through this sliding piece a strong pin or bolt of iron is driven or screwed in a perpendicular direction, having at its upper end a round hole large enough to admit the breech of the barrel, which is secured in it by means of a piece of iron that serves as a wedge, and a vertical screw passing through the upper part of the hole. A chain is fastened to a staple in one side of the sliding piece which runs between the two horizontal beams; and passing over a pulley at one end of the machine, has a weight hooked on to it. An upright piece of timber is fixed above this pulley and between the ends of the beams, having its upper end perforated by the axis of an iron crank furnished with a square socket; the other axis being supported by the wall, or by a strong post, and loaded with a heavy wheel of cast iron to give it force. The axes of this crank are in a line with the hole in the bolt already mentioned. The borer being then fixed into the socket of the crank, has its other end, previously well oiled, introduced into the barrel, whose breech part is made fast in the hole of the bolt: the chain is then carried over the pulley, and the weight hooked on; the crank being then turned with the hand, the barrel advances as the borer cuts its way, till it has passed through the whole length. The boring bit consists of an iron-rod somewhat longer than the barrel, one end of which fits the socket of the crank; the other is adapted to a cylindrical piece of tempered steel, about an inch and a half in length, having its surface cut after the manner of a perpetual screw, with five or six threads, the obliquity of which is very small. The breadth of the furrows is the same with that of the threads, and their depth sufficient to let the metal cut by the threads pass through them easily. Thus the bit gets a strong hold of the metal; and the threads, being sharp at the edges, scoop out and remove all the inequalities and roughness from the inside of the barrel, and render the cavity smooth and equal throughout. A number of

bits, each a little larger than the former, are afterwards successively passed through the barrel in the same way, until the bore has acquired the magnitude intended. By this operation the barrel is very much heated, especially the first time the borer is passed through it, by which means it is apt to warp. To prevent this in some measure, the barrel is covered with a cloth kept constantly wetted, which not only preserves the barrel from an excess of heat, but likewise preserves the temper of the bit from being destroyed. The borer itself must also be withdrawn from time to time; both to clean it from the shavings of the metal and to oil it, or repair any damages it may have sustained. Every time a fresh bit has been passed through the barrel, the latter must be carefully examined, to see if it has warped; and likewise if there are any spots, by the workmen called *blacks*, on its inside. When warped, it must be straightened on the anvil, for which a few slight strokes on the convex parts will be sufficient; and this is termed *setting-up* the barrel. When black spots are perceived, the corresponding part on the outside must be marked, and driven in by gentle strokes with the hammer, when they will be completely removed by passing the borer another time through the piece.

The equality of the bore is of the utmost consequence to the perfection of a barrel; insomuch that the greatest possible accuracy in every other respect will not make amends for any deficiency in this. The method used by gunsmiths to ascertain this is by a cylindrical plug of tempered steel highly polished, about an inch in length, and fitting the bore exactly. This is screwed upon the end of an iron-rod, and introduced into the cavity of the barrel, where it is moved backwards and forwards; and the places where it passes with difficulty being marked, the boring bit is repeatedly passed until it moves with equal ease through every part. Any person who wishes to know the merit of his piece in this respect, may do it with tolerable accuracy by means of a plug of lead cast on a rod of iron; or even by a musket-ball filed exactly to the bore, and pushed through the barrel by a ramrod; taking care, however, not to use much force lest the ball be flattened, and its passage thus rendered difficult.

The first tool employed in forming the breech-screw is a plug of tempered steel, somewhat conical, with the threads of a male screw upon its surface, and by the workmen termed a *screw-tap*. This being introduced into the barrel, and worked from left to right and back again, until it has marked out the first four threads of the screw, another less conical tap is introduced; and when this has carried the impression of the screw as far as it is intended to go, a third one, nearly cylindrical, is made use of, scarcely differing from the plug of the breech intended to fill the screw thus formed in the barrel. The plug itself has its screw formed by means of a screw-plate of tempered steel, with several female screws, corresponding with the taps employed for forming that in the barrel. Seven or eight threads are a sufficient length for a plug: they ought to be neat and sharp, so as completely to fill the turns made in the barrel by the tap. The breech-plug is then to be case-hardened, or to have its surface converted into steel, by covering it with shavings of horn, or the parings of the hoofs of horses, and keeping it for some time red-hot after which it is plunged in cold water.

Thus the common barrels, for the purpose especially of sporting, are made; but there are some other methods of manufacture, by which the barrels are made to differ in some respects from those just described, and are thought to be considerably improved. One kind of these are called *twisted* barrels; and by the English workmen are formed out of the plates made of *stubs*, as above described. Four of these, of the size already mentioned, are requisite to make one barrel. One of them, heated red-hot for five or six inches, is turned like a corkscrew, by means of the hammer and anvil; the remaining parts being treated successively in the same manner until the whole is turned into a spiral, forming a tube, the diameter of which corresponds with the bore of the intended barrel. Four are generally sufficient to form a barrel of the ordinary length, *i. e.* from 32 to 38 inches; and the two which form the breech or strongest part, called the *reinforced part*, are considerably thicker than those which form the muzzle, or fore part of the barrel. One of these tubes is then welded to a part of an old barrel to serve as an handle; after which the turns of the spiral are united by heating the tube two or three inches at a time to a bright white heat, and striking the end of it several times against the anvil in a horizontal direction with considerable strength, which is called *jumping the barrel*; and the heats given for this purpose are called *jumping heats*. The next step is to introduce a mandril into the cavity, and to hammer the heated portion lightly, in order to flatten the ridges or burrs raised by the jumping at the place where the spirals are joined. As soon as one piece is jumped throughout its whole length, another is welded to it, and treated in the same manner, until the four pieces are united, when the part of the old barrel is cut off, as being no longer of any use. The welding is repeated three times at least, and is performed exactly in the same manner as directed for plain barrels; and the piece may afterwards be finished according to the directions already given.

The advantages of twisted barrels are, after all, somewhat problematical; where there is so much of welding, and that in a spiral form, the welding is more likely to be done in a careless manner, or with some imperfection in some part, than when it is a plain and obvious business: nor have we observed that twisted barrels are less liable to burst than plain ones, where the latter have been well and carefully forged.

The Spanish barrels have been long held in great estimation; yet as the Spanish iron is universally allowed to be unusually good, it is probable that the superiority of their barrels is owing more to the goodness of the materials than to the skill of the workmen. It must be observed, however, that instead of making the plates overlap *a little* in the place where they join, they give one of them a complete turn; so that every Spanish barrel may be said to be double throughout its whole length. The different portions of the iron are also forged in such a manner, that the grain of the iron is disposed in a spiral manner; whence it has the same effect with a ribbon or twisted barrel. The outside is finished by turning them in a lathe; whence probably they are always less elegantly wrought than the French and English pieces. The great value put upon them is also thought to be more owing to fancy than to any real good qualities they possess. Formerly they were made from three to three feet and a half long; their bore being such as to admit a bullet from 22 to 24 in the pound, and their weight from three to three pounds and a half. The reinforced part extends two-fifths of the length; and at 10 or 12 inches from the breech is placed a sight, such as is usually put upon rifle-barrels, or those intended only for ball. According to Espinas, arquebuss-bearer to Philip IV. the weight of a Spanish barrel ought to be four pounds and a half when the length is 42 inches; but both in weight and length they are now much reduced, and seldom exceed the dimensions already mentioned.

The principal imperfections to which gun-barrels are liable, are the chink, crack, and flaw. The first is a small rent in the direction of the length of the barrel; the second across it; and the third is a kind of scale or small plate adhering to the barrel by a narrow base, from which it spreads out like the head of a nail from its shank, and, when separated, leaves a pit or hollow in the metal. The chink or flaw are of much worse consequence than the crack in fire-arms, the force of the powder being exerted more upon the circumference than the length of the barrel. The flaw is much more frequent than the chink, the latter scarcely ever occurring but in plain barrels formed out of a single plate of iron, and then only when the metal is deficient in quality. When flaws happen on the outside they are of no great consequence; but in the inside they are apt to lodge moisture and foulness which corrode the iron, and thus the cavity enlarges continually till the piece bursts. This accident, however, may arise from many other causes besides the defect of the barrel itself. The best pieces will burst when the ball is not sufficiently rammed home, so that a space is left between it and the powder. A very small windage or passage for the inflamed powder between the sides of the barrel and ball will be sufficient to prevent the accident; but if the ball has been forcibly driven down with an iron ramrod, so as to fill up the cavity of the barrel very exactly, the piece will almost certainly burst, if only a very small space is left between it and the powder; and the greater the space is, the more certainly does the event take place. A piece will frequently burst from having its mouth stopped up with earth or snow; which accident sometimes happens to sportsmen in leaping a ditch, in which they have assisted themselves with their fowling-piece, putting the mouth of it to the ground; and when this did not happen, it is only to be accounted for from the stoppage being extremely slight. For the same reason a musket will certainly burst if it is fired with the muzzle immersed only a very little way in water. It will also burst from an overcharge; but when such an accident happens in other circumstances, it is most probably to be attributed to a defect in the workmanship, or in the iron itself. These defects are principally an imperfection in the welding, a deep flaw having taken place, or an inequality in the bore; which last is the most common of

any, especially in the low-priced barrels. The reason of a barrel's bursting from an inequality in the bore is, that the elastic fluid, set loose by the inflammation of the powder, and endeavouring to expand itself in every direction, being repelled by the stronger parts, acts with additional force against the weaker ones, and frequently bursts through them, which it would not have done had the sides been equally thick and strong throughout. With regard to defects arising from the bad quality of the iron, it is impossible to say any thing certain. As the choice of the materials depends entirely on the gunsmith, the only way to be assured of having a barrel made of proper metal is to purchase it from an artist of known reputation, and to give a liberal price for the piece.

The recoil of a piece becomes an object of importance only when it is very great; for every piece recoils in some degree when it is discharged. The most frequent cause of an excessive recoil is an inequality in the bore of the barrel; and by this it will be occasioned even when the inequality is too small to be perceived by the eye. The explanation of this upon mechanical principles indeed is not very easy: for as it is an invariable law, that action and reaction are equal to one another, we should be apt to suppose that every time a piece is discharged it should recoil with the whole difference between the velocity of the bullet and that of the inflamed powder. The cause to which too great a recoil in muskets has been usually attributed, is the placing of the touch-hole at some distance from the breech-plug; so that the powder is fired about the middle, or towards its fore part, rather than at its base. To avoid this some artists form a groove or channel in the breech-plug as deep as the second or third turn of the screw; the touch-hole opening into this channel, and thus firing the powder at its very lowest part. It appears, however, from a number of experiments made upon this subject by M. le Clerc, that it made very little difference with regard to the recoil, whether the touch-hole was close to the breech, or an inch distant from it. The only circumstance to be attended to with respect to its situation therefore is, that it be not quite close to the breech-plug; as in such a case it is found to be more apt to be choked up than when placed about a quarter of an inch from it.

The only other circumstance now to be determined with regard to musket-barrels is their proper length. Formerly it was supposed that the longer they were made, the greater would be the distance to which they carried the shot, and that without any limitation. This opinion continued to prevail till about half a century ago, when it was first proposed as a doubt whether long barrels carried farther than short ones. With regard to cannon, indeed, it had long before this time been known that they might be made too long; and Balthazar Killar, a celebrated cannon-founder in the reign of Louis XIV. was able to account for it. When asked by Mons. Suriry de St. Remy, why the culverin of Nancy, which is 22 feet long, did not carry a ball equally far with a shorter piece, he replied, that "the powder, when inflamed, ought to quit the cavity of the piece in a certain time, in order to exert its whole force upon the bullet; by a longer stay part of the force is lost; and the same cause may produce an inequality in the shots, by giving a variation to the bullet, so as to destroy its rectilineal course, and throw it to one side or other of the mark." Mr. Robins informs us, that "if a musket-barrel, of the common length and bore, is fired with a leaden bullet and half its weight of powder, and if the same barrel is afterwards shortened one-half, and fired with the same charge, the velocity of the bullet in this shortened barrel will be about one-sixth less than what it was when the barrel was entire; and if, instead of shortening the barrel, it is increased to twice its usual length, when it will be near eight feet long, the velocity of the bullet will not be augmented more than one-eighth part. And the greater the length of the barrel is in proportion to the diameter of the bullet, and the smaller the quantity of powder, the more inconsiderable will these alterations of velocity be." From these considerations it appears, that the advantages gained by long barrels are by no means equivalent to the disadvantages arising from the weight and incumbrance of using them; and from a multitude of experiments it is now apparent, that any one may choose what length he pleases, without any sensible detriment to the range of his piece. The most approved lengths are from 30 to 36 inches.

An opinion has generally prevailed among sportsmen, that by some unknown manœuvre the gunsmith is able to make a piece, loaded with small shot, throw the contents so close together, that even at the distance of 40 or 50 paces the whole will be confined within the breadth of a hat. From such experiments as have been made on this subject, however, it appears, that the closeness or wideness with which a piece throws its shot is liable to innumerable variations from causes which no skill in the gunsmith can possibly reach. So variable are these causes, that there is no possibility of making the same piece throw its shot equally close twice successively. In general, however, the closer the wadding is, the better disposed the shot seems to be to fall within a small compass. In firing with small shot a curious circumstance sometimes occurs, viz. that the grains, instead of being equally distributed over the space they strike, are thrown in clusters of 10, 12, 15, or more; whilst several considerable spaces are left without a grain in them. Sometimes one-third or one-half of the charge will be collected into a cluster of this kind; nay, sometimes, though much more rarely, the whole charge will be collected into one mass, so as to pierce a board near an inch thick at the distance of 40 or 45 paces. Small barrels are said to be more liable to this clustering than large ones; and M. de Marolles informs us, that this is especially the case when the barrels are new, and likewise when they are fresh-washed; though he acknowledges that it did not always happen with the barrels he employed even after they were washed. It is probable, therefore, that the closeness of the shot depends on some circumstance relative to the wadding rather than to the mechanism of the barrel.

GUN-SHOT WOUNDS are attended with much worse consequences than wounds made by sharp instruments; for the parts are more shattered and torn, especially when the shot falls upon the joints, bones, or any considerable part. See SURGERY.

GUNTER'S CHAIN, the chain in common use for measuring land, according to the true or statute measure; so called from Mr. Gunter, its reputed inventor.

The length of the chain is 66 feet, or 22 yards, or four poles of five yards and a half each; and it is divided into 100 links, of 7.92 inches each.

This chain is the most convenient of any thing for measuring land, because the contents thence computed are so easily turned into acres. The reason of which is, that an acre of land is just equal to 10 square chains, or 10 chains in length and one in breadth, or equal to 100,000 square links. Hence the dimensions being taken in chains, and multiplied together, it gives the content in square chains; which therefore being divided by 10, or a figure cut off for decimals, brings the content to acres: after which the decimals are reduced to roods and perches, by multiplying by 4 and 40. But the better way is to set the dimensions down in links as integers, considering each chain as 100 links; then, having multiplied the dimensions together, producing square links, divide these by 100,000 that is, cut off five places for decimals, the rest are acres, and the decimals are reduced to roods and perches as before.

Ex. Suppose, in measuring a rectangular piece of ground, its length be
795 links,
and its breadth 480 links.

63600
3180

Ac. 3.81600
4

Ro. 3.264
40

Per. 10.560

So the content is 3 acres 3 roods 10 perches.

GUNTER'S LINE, a logarithmic line, usually graduated upon scales, sectors, &c.

It is also called the line of lines, and line of numbers; being only the logarithms graduated upon a ruler, which therefore serves to solve problems instrumentally in the same manner as logarithms do arithmetically. It is usually divided into a hundred parts, every tenth of which is numbered, beginning with 1, and ending with 10; so that if the first great division, marked 1, stand for one-tenth of any integer, the next division, marked 2, will stand for two-tenths; 3, three-tenths, and so on; and the intermediate divisions will, in like manner, represent 100th parts of some integer. If each of the great divisions represent 10 integers, then will the lesser divisions stand for integers; and if the great divisions be supposed each 100, the subdivisions will be each 10.

USE OF GUNTER'S LINE.

1. *To find the product of two numbers.* From 1 extend the compasses to the multiplier; and the same extent, applied the same way from the multiplicand, will reach to the product. Thus if the product of 4 and 8 be required, extend the compasses from 1 to 4 and that extent laid from 8 the same way, will reach to 32, their product.

2. *To divide one number by another.* The extent from the divisor to unity will reach from the dividend to the quotient: thus to divide 36 by 4, extend the compasses from 4 to 1, and the same extent will reach from 36 to 9, the quotient sought.

3. *To three given numbers, to find a fourth proportional.* Suppose the numbers 6, 8, 9; extend the compasses from 6 to 8, and this extent, laid from 9 the same way, will reach to 12, the fourth proportional required.

4. *To find a mean proportional between any two given numbers.* Suppose 8 and 32: extend the compasses from 8 in the left-hand part of the line, to 32 in the right; then bisecting this distance, its half will reach from 8 forward, or from 32 backward, to 16, the mean proportional sought.

5. *To extract the square root of any number.* Suppose 25: bisect the distance between 1 on the scale and the point representing 25; then the half of this distance, set off from 1, will give the point representing the root 5. In the same manner the cube root, or that of any higher power, may be found by dividing the distance on the line, between 1 and the given number, into as many equal parts as the index of the power expresses; then one of those parts, set from 1, will find the point representing the root required.

GUNTER'S QUADRANT, one made of wood, brass, &c. containing a kind of stereographic projection of the sphere, on the plane of the equinoctial; the eye being supposed placed in one of the poles.

Besides the use of this quadrant in finding heights and distances, it serves also to find the hour of the day, the sun's azimuth, and other problems of the globe.

GUNTER'S SCALE, usually called by seamen *the Gunter*, is a large plane scale, having various lines upon it, of great use in working the cases or questions in navigation.

This scale is usually two feet long, and about an inch and a half broad, with various lines upon it, both natural and logarithmic, relating to trigonometry, navigation, &c.

On one side are the natural lines, and on the other the artificial or logarithmic ones. The former side is first divided into inches and tenths, and numbered from 1 to 24 inches, running the whole length near one edge. One-half the length of this side consists of two plane diagonal scales, for taking off dimensions to three places of figures. On the other half or foot of this side are contained various lines relating to trigonometry, in the natural numbers, and marked thus, viz.

Rumb, the rumb or points of the compass;
Chord, the line of chords;
Sine, the line of sines;
Tang. the tangents;
S. T. the semitangents; and at the other end of this half are,
Leag. leagues, or equal parts;
Rumb. another line of rumbs;
M. L. miles of longitude;
Chor. another line of chords.

Also in the middle of this foot are *L.* and *P.* two other lines of equal parts. And all these lines on this side of the scale serve for drawing or laying down the figures to the cases in trigonometry and navigation.

On the other side of the scale are the following artificial or logarithmic lines, which serve for working or resolving those cases, viz.

S. R. the sine rumbs;
T. R. the tangent rumbs;
Numb. line of numbers;
Sine, sines;
V. S. the versed sines;
Tang. the tangents;
Meri. meridional parts;
E. P. equal parts.

GUN-WALE, or GUNNEL, is the uppermost wale of a ship, or that piece of timber which reaches on either side from the quarter-deck to the forecastle, being the uppermost bend which finishes the upper works of the hull, in that part in which are put the stanchions which support the waste-trees.

GUSSET, in heraldry, is formed by a line drawn from the dexter or sinister chief points, and falling down perpendicularly to the extreme base. The gusset is an abatement of honour, denoting an effeminate person.

GUSTAVIA, a genus of the polyandria order, in the monadelphia class of plants. There is no calyx; the petals very numerous; the berry multilocular; the seeds appendaged. There is one species, a tree of Surinam.

GUTTÆ. See ARCHITECTURE.

GUTTA-SERENA, a disease in which the patient, without any apparent fault in the eye, is entirely deprived of sight. See SURGERY.

GUTTY, in heraldry, a term used when any thing is charged or sprinkled with drops. In blazoning, the colour of the drops is to be named, as gutty of sable, of gules, &c.

GUY, in a ship, is any rope used for keeping off things from bearing or falling against the ship's sides when they are hoisting in. That rope which at one end is made fast to the foremast, and seized to a single block at the pendant of the garnet, is called the guy of the garnet.

GUZES, in heraldry, roundles of a sanguine or murry colour. These, from their bloody hue, are by some supposed to represent wounds.

GYMNANTHES, a genus of the class and order monœcia monadelphia. The male has an ament naked; perianthium and corolla none; stamina pedicles, three-parted or three-forked, anther bearing. The female has an ament or germ pedicelled; corolla none; style trifid; capsule tricoccous, three-celled. There are two species, shrubs of the West Indies.

GYMNETRUS, a genus of fishes, of the order of thoracici. The generic character is, body extremely long, compressed; teeth numerous, subulate; gill membrane, four or five-rayed; anal fin wanting. The most remarkable species are:

1. Gymnetrus Ascanii, or Ascanian gymnetrus. This extraordinary fish is a native of the northern seas, and seems to have been first described by professor Ascanius, in his work entitled Icones rerum Natularium, &c. The length of the specimen was ten feet, and the diameter, which was equal throughout the whole length, about six inches: the head short, the mouth small, and the eyes rather large: on the upper part of the head, before the commencement of the dorsal fin, were situated 7 or 8 upright naked rays or processes, of moderate length: the dorsal fin, which was rather shallow, commenced at a small distance beyond these, and running along the whole length of the back, formed by its continuation the tail-fin: the ventral fins, if they can be said to deserve the name, consisted of a pair of extremely long single rays or processes terminated by a small ovate expanded tip or finny extremity: the gill-covers appeared to consist of five or six radiated laminæ: the colour of the whole body was bright silver, with a blueish cast diffused over the upper part of the back: the lateral line was strongly marked, and ran from the gill-covers to the tail, and the sides of the body were marked by several longitudinal double rows of slightly extant, very small dusky specks; the forehead was white; the fins pale brown.

This fish is said to be generally seen either preceding or accompanying the shoals of herrings in the northern seas, for which reason it is popularly known by the title of king of the herrings.

2. Blochian gymnetrus. This, which is a native of the Indian seas, and which appears also to be occasionally seen in those of Europe, is described by Dr. Bloch from a drawing communicated by J. Hawkins, Esq. In its general appearance it is much allied to the preceding kind, but appears to be furnished with two pair of ventral processes, which are of considerable length, and terminate in large, dilated, finny extremities, of an oval form: the back-fin is continued as far as the tail. The colour of this species is silvery, with a blueish cast on the upper parts, and several transverse, alternate, brownish shades continued along the body, accompanied by large, distant, round spots, of a similar colour: the fins and processes deep crimson: the pectoral fins pretty large in proportion.

It appears from a print published in the year 1798, that a specimen of this fish was thrown on the coast of Cornwall in the month of February in the same year. Its length was eight feet six inches, its breadth in the widest part ten inches and a half, and its thickness only two inches and three quarters; the tail in this specimen was wanting: the colours the same as in the specimen figured by Dr. Bloch.

GYMNOSOPHISTS, a sect of philosophers who clothed themselves no farther than modesty required. There were some of these sages in Africa; but the most celebrated clan of them was in India. The African gymnosophists dwelt upon a mountain in Ethiopia, near the Nile, without the accommodation either of house or cell. They did not form themselves into societies like those of India, but each had his private retirement, where he studied and performed his devotions by himself. If any person had killed another by chance, he applied to these sages for absolution, and submitted to whatever penances they enjoined. They observed an extraordinary frugality, and lived only upon the fruits of the earth. Lucan ascribes to these gymnosophists several new discoveries in astronomy.

The Indian gymnosophists dwelt in the woods, where they lived upon the wild products of the earth, and never drank wine, nor married. Some of them practised physic,

and travelled from one place to another: these were particularly famous for their remedies against barrenness. Some of them, likewise, pretended to practise magic, and to foretel future events.

GYMNOSPERMIA, in botany, from γυμνος naked, and σπερμα, seed; the first order in Linnæus's class of didynamia. It comprehends those plants of that class which have naked seeds. The seeds are constantly four in number, except in one genus, viz. phryma, which is monospermous.

GYMNOTUS, *gymnote*, a genus of fishes belonging to the apodes. The generic character is, head with lateral opercula; tentacula two on the upper lip; eyes covered by the common skin; gill-membrane five-rayed; body compressed, without dorsal fin (in most species), but carinated by a fin beneath. The most remarkable species, are:

1. The gymnotus electricus, a native of the warmer regions of Africa and America, where it inhabits the larger rivers, and is particularly found in those of Surinam. In Africa it is said chiefly to occur in the branches of the river Senegal. It is a fish of a disagreeable appearance; bearing a general resemblance to a large eel, though somewhat thicker in proportion, and of a much darker colour, being commonly of an uniform blackish-brown. It is usually seen of the length of three or four feet, but is said to arrive at a far larger size, specimens occasionally occurring of 6, 7, or even 10 feet in length. It was first made known to the philosophers of Europe about the year 1671, when its wonderful properties were announced to the French academy by Mons. Richer, one of the gentlemen sent out by the academy to conduct some mathematical observations in Cayenne. This account however seems to have been received with a degree of cautious scepticism by the major part of European naturalists; and it was not till towards the middle of the last century that a full and general conviction appears to have taken place; the observations of Mons. Condamine, Mr. Ingram, Mr. Gravesend, and others, then conspiring to prove that the power of this animal consists in a species of real electricity, being conducted by similar conducting substances, and intercepted by others of an opposite nature. Thus, on touching the fish with the fingers, the same sensation is perceived as on touching a charged phial; being sometimes felt as far as the elbows; and if touched by both hands, an electric shock is conveyed through the breast in the usual manner. Fermin, in particular, who, during his residence in Surinam, had frequent opportunities of examining the animal, demonstrated by experiment that 14 slaves, holding each other by the hands, received the shock at the same instant; the first touching the fish with a stick, and the last dipping his hand into the water in which it was kept. The experiments of Dr. Bancroft were equally satisfactory (see ELECTRICITY). It is by this extraordinary faculty that the gymnotus supports its existence: the smaller fishes and other animals which happen to approach it, being instantly stupified, and thus falling an easy prey to the electrical tyrant. So powerful is the shock which this fish, in its native waters, is capable of exerting, that it is said to deprive almost entirely of sense and motion those who are exposed to its approach, and is therefore much dreaded by those who bathe in the rivers which it inhabits. See Pl. Nat. Hist. fig. 218.

It has been affirmed that the gymnotus electricus, even for some time after its death, cannot be touched without feeling its electric shock. This is by no means incredible, when we consider the effect of the galvanic pile, so well known to modern philosophers.

2. Gymnotus carapo. The head of the carapo is of a compressed form, and the upper jaw projects beyond the lower: the tongue is short, thick, broad, and furnished like the jaws with a great many small sharp-pointed teeth: the eyes are very small, and the front of the head is marked, as in the preceding species, by a number of small round pores: the body gradually decreases towards the tail, which is extremely slender, and terminates in a point. The colour of the whole animal is brown, marked by a few irregular spots or patches of a deeper cast: the scales are small, and the lateral line straight. This fish is a native of the American seas, and is said to be most frequent about the coast of Surinam. It is supposed to live chiefly on small fishes, sea insects, &c. Whether it possesses any electric power, like the former species, may be doubted; yet the structure of the lower part of the body seems to imply somewhat of a similar contrivance of nature. The usual length of the carapo is from 1 to 2 feet; but it is sometimes found of the length of three feet, and of the weight of more than ten pounds. It is considered as an esculent fish by the South Americans.

3. Gymnotus rostratus, or rostrated gymnote. In its general aspect this species is much allied to the carapo, but is readily distinguished by the peculiar form of the head, which terminates in a narrow, slightly compressed, tubular snout, the jaws appearing in a manner connate: the colour of the body is pale reddish-brown, variegated with differently sized spots of a darker colour, and which are much smaller, as well as more numerous, on the fin than on the other parts: the pectoral fins are round, and rather small for the size of the animal: the eyes are very small: the scales, if any, are so small as to be not distinctly visible on a general view. This species is a native of Surinam, and seems to have been first described and figured by Seba.

4. Gymnotus acus, or needle gymnote. This species is described by Brunnich, in his history of the fish of Marseilles. It is whitish, with reddish and brown spots, which cause a kind of clouded variegation on the back, while a blueish tinge prevails towards the under parts: on the back is a kind of projection, which may be rather considered as a rudiment of a fin than a perfect one: the whole animal is of a long, compressed, and attenuated form, and the mouth is destitute of tentacula. This is the only European species of gymnote yet discovered, and is a native of the Mediterranean sea. Beside these there are 11 other species.

GYNANDRIA, from γυνη, a woman, and ανηρ, a man, the name of the 20th class in Linnæus's sexual system, consisting of plants with hermaphrodite flowers, in which the stamina are placed upon the style, or, to speak more properly, upon a pillar-shaped receptacle resembling a style, which rises in the middle of the flower, and bears both the stamina and pointal; that is, both the supposed organs of generation (see BOTANY). The flowers of this class, says Linnæus, have a monstrous appearance; arising, as he imagines, from the singular and unusual situation of the parts of fructification.

GYNOPOGON, a genus of the pentandria monogynia class and order. The calyx is half five-cleft; corolla five-parted; stigma globular, two-lobed; berry pedicelled, subglobular; seed cartilaginous. There are three species, herbs of the South Seas, of no note.

GYPSUM. See LIME, *sulphat of*.

What formerly was called gypsum, or selenite, is now known to be a sulphat of lime. It is also distinguished by the name of plaister stone, &c.

GYRINUS, or glimmerchaffer, a genus of insects of the coleoptera order. The generic character is, antennæ clavated, stiff, shorter than the head; eyes (apparently) four, two above and two below.

The genus gyrinus is furnished with extremely short, stiff antennæ, appearing to consist of an undivided piece or joint; but, if accurately inspected by means of a magnifier, they will be found to be composed of very numerous close-set joints: the eyes are so placed as to appear double on each side the head, viz. one above, and the other below the base of the antennæ.

The most remarkable European species is the gyrinus natator, a small insect, about a quarter of an inch in length, of an oval shape, with somewhat sharpened extremities, and of a black or grey-black colour, with so lucid a surface as to shine like a piece of looking-glass in the full sunshine. It is an inhabitant of the waters, and is chiefly found in rivulets, being generally seen in great multitudes, and in very brisk motion. It is difficult to catch, diving with astonishing celerity when disturbed; the hinder legs being very broad, finely webbed with minute hairs, and most curiously formed for exercising the office of fins or oars. The larva is of a highly singular aspect, having a very lengthened body, furnished, exclusive of six legs on the foreparts, with a great many lateral appendages or processes down the body; those towards the extremity considerably exceeding the rest. In its motions it is extremely agile, swimming in a kind of serpentine manner, and preying on the smaller and weaker water-insects, minute worms, &c.; the head is armed with a pair of forceps, pierced on each side the tip with a small foramen, through which it sucks the juices of the animals on which it preys; the colour of this larva is a very pale or whitish brown, with a high degree of transparency, which renders it a very curious object for the microscope: its length, when full-grown, is about three quarters of an inch. When the time of its changes arrives, it forms for itself a small oval cell or case on a leaf of sedge, or other convenient water-plant, and, after casting its skin, becomes a chrysalis: this change usually takes place in the month of August, and the complete insect emerges in that of September.

When these animals are congregated together in great multitudes on the surface of the water, which frequently happens in hot

weather, they have been observed to diffuse a strong or disagreeable smell to a considerable distance. Like other water-beetles they fly only by night. They deposit their eggs, which are very small, white, and of a somewhat cylindric form, on the stems of water-plants; they hatch in the space of about eight days, and immediately begin to swim about with much briskness in quest of prey. There are only 2 species.

GYRFALCON. See FALCO.

GYPSIES. See EGYPTIANS.

GYPSOPHILA, a genus of the digynia order, in the decandria class of plants, and in the natural method ranking under the 22 d order, caryophillei. The calyx is monophyllous, campanulated, and angulated; the petals are five in number, ovate, and sessile; the capsule globose and unilocular. There are 12 species, herbs of Europe.

H.

H, the eighth letter in our alphabet; used as a numeral, denotes 200; and with a dash over it, $\overline{H}$, 200,000.

As an abbreviation, H was used by the antients to denote *homo*, *hæres*, *hora*, &c. Thus H. B. stood for hæres bonorum; and H. S. corruptly for L. L. S. a sesterce; and H. A. for Hadrianus.

HABDALA, a ceremony of the Jews, observed on the sabbath in the evening; intended to signify that the sabbath is over, and is from that moment divided from the day of labour which follows. For this reason the ceremony is called habdala, which signifies distinction.

HABEAS CORPUS. This writ formed part of the antient common law, but was much more restrained in its operation and effects; for the judges arrogated to themselves the power of granting or denying it: and the gaolers did not pay a proper attention to it, often putting the sufferer to the expence of an alias and pluries habeas corpus before they obeyed. These inconveniences produced the famous statute 31 Car. II. c. 2.

This great bulwark of English liberty, which may fairly be put upon a level with the celebrated Magna Charta, was occasioned by the unjust oppression of an insignificant individual in the reign of Charles the Second. The statute enacts,

1st. That the lord chancellor, or any of the judges in vacation, on complaint or written request of any person committed for any crime (except felony, or treason, or as accessary, or suspected of being accessary before the fact, to any petty treason, or felony, or charged in execution by legal process), upon seeing a copy of the warrant, or affidavit that copy is denied, shall award a habeas corpus for such prisoner, returnable immediately before himself, or any other of the judges (unless the party has suffered two terms to elapse before applying to the court for his liberation), and shall discharge the party, if bailable, on his giving proper security to appear.

2dly. That the writ shall be indorsed, as granted in pursuance of this act, and signed by the person awarding it.

3dly. That the writ shall be returned, and the prisoner brought up in a limited time, according to the distance, never exceeding 20 days.

4thly. That officers and keepers not making due returns, or not delivering to the party or his agent, within six hours after demand, a copy of the warrant of commitment, or shifting the custody of a prisoner without proper authority (as mentioned in the act), shall forfeit 100*l.* for the first offence, and 200*l.* for the second, to the sufferer, and be disabled from holding such office.

5thly. That any one detaining a person once delivered by habeas corpus for the same offence, shall forfeit 500*l.*

6thly. That every person committed for treason or felony shall, if he desires it, the first week of the next term, or the first day of the next session of oyer and terminer, be indicted in that term or session, or else admitted to bail, unless the witnesses for the crown cannot be produced at that time; and if acquitted, or not indicted, and tried in the second term or session, shall be discharged; but no person after the commencement of assizes for the county where he is detained, shall be removed by habeas corpus till they are ended.

7thly. That a prisoner can obtain his habeas corpus out of the chancery and exchequer, as well as out of the king's bench and common pleas; and if the chancellor and judges shall refuse the same on sight of the warrant or oath that it is denied, shall forfeit severally 500*l.* to the party grieved.

8thly. That this writ of habeas corpus shall run into the counties palatine, and all other privileged places, and the islands of Guernsey and Jersey.

9thly. That no inhabitants of England (unless at their desire, or having committed some capital offence in the place to which they are sent), shall be sent prisoners to Ireland, Scotland, Guernsey, and Jersey, or any places beyond the seas, within or without his majesty's dominions, on pain that the person committing, and his advisers and abettors, shall forfeit to the injured party a sum not less than 500*l.* to be recovered with treble costs, shall be disabled from holding any office, shall incur the penalties of præmunire, and be incapable of the king's pardon.

The writs in use under this act are various. Many kinds are used for removing prisoners from one court to another. Such are the *habeas corpus ad respondendum*, when a man has cause of action against one who is confined by process of an inferior court, in order to remove the prisoner, and charge him with this new action in the court above. *Ad satisfaciendum* is when judgment has, in an action, been given against a prisoner; and the plaintiff brings him up to a superior court to charge him with process of execution. Also the writs *ad prosequendum*, *testificandum*, *deliberandum*, which issue when it is necessary to remove a prisoner, in order to prosecute, or bear testimony, or to be tried in the proper jurisdiction wherein the fact was committed. And, lastly, the common writ *ad faciendum et recipiendum*, which issues out of any of the courts above, when a person is sued in some inferior jurisdiction, and desires to remove the action into the superior court, commanding the inferior judges to produce the body of the defendant, with the day and cause of his detainer, to do and receive what the king's court shall determine. This writ is grantable of common right, without moving the court, and supersedes all inferior proceedings. But to prevent the surreptitious discharge of prisoners, the statute 1 and 2 P. & M. c. 13, enacts, that no habeas corpus shall issue to remove any prisoner out of gaol, unless signed by some judge of the court out of which it is awarded. And by a statute of the present reign it is enacted, that no cause under the value of 10*l.* shall be removed into a superior court, unless the defendant, on removing the same, gives security for payment of debt and costs.

But the writ which forms so great a part of the liberty of the subject in all manner of illegal confinement, is the *habeas corpus ad subjiciendum*, commanding the person detaining a prisoner to produce him, with the day and cause of his detention, to submit to whatever the judge or court awarding such writ shall determine. This is a high prerogative writ, and therefore, by the common law, issuing out of the court of king's bench, not only in term time, but vacation, by a fiat from any of the judges, and running into all the king's dominions. And a man has now the benefit of the common law writ, either in the king's bench or common pleas, as he chooses; and in both those courts it is necessary to apply for it by motion, as it does not issue of course, without shewing some reason for the granting it. But if good grounds be shewn that the party is imprisoned without just cause, it becomes a writ of common right, and must not be denied, even though a man is detained by the highest authority.

This celebrated act has been subject to temporary suspensions, by authority of parliament, in times of riot or rebellion; and the late minister subjected himself to considerable unpopularity by that measure during the last war.

HABENDUM, in a deed, is to determine what estate or interest is granted by the deed,

the certainty thereof, for what time, and to what use. It sometimes qualifies the estate, so that the general implication thereof, which, by construction of law, passes in the premises, may by the habendum be controlled: in which case the habendum may lessen or enlarge the estate, but not totally contradict or be repugnant to it. As if a grant is to one and the heirs of his body, to leave to him and his heirs for ever, here he has an estate tail by the grant, and by the habendum he has a fee simple expectant thereon. But if it had been in the premises to him and his heirs, to have for life, the habendum would be utterly void; for an estate of inheritance is vested in him before the habendum comes, and shall not afterwards be taken away, or divested by it. 2 Black. 298.

The habendum cannot pass any thing that is not expressly mentioned, or contained by implication in the premises of the deed; because the premises being part of the deed by which the thing is granted, and consequently that makes the gift; it follows that the habendum, which only limits the certainty and extent of the estate in the thing given, cannot increase or multiply the gift, because it would be absurd to say that the grantee shall hold a thing which was never given him. 2 Roll. Abr. 65. See DEED.

HABERDASHER, in commerce, a seller of hats, or of small wares.

The master and wardens of the company of haberdashers in London, calling to their assistance one of the company of cappers, and another of the hat-makers, and mayors, &c. of towns, may search the wares of all hatters that work hats with foreign wool, and have not been apprentices to the trade, or who dye them with any thing but copperas and galls, or woad and madder; in which case they are liable to penalties, by stat. 8 Eliz. c. 7, and 5 Geo. II. c. 22.

HABERE FACIAS SEISINAM, a writ of execution directed to the sheriff, commanding him to give to the plaintiff possession of a freehold: if it is a chattel interest, and not a freehold, then the writ is entitled habere facias possessionem. 3 Black. 412.

In the execution of these writs, the sheriff, if needful, may take with him the power of the county, and may justify breaking open doors, if the possession is not quietly delivered; but if it is peacefully delivered up, the yielding of a twig, a turf, or the ring of a door, in the name of seisin, is sufficient. Id.

HABERE FACIAS VISUM, a writ that lies in divers cases in real actions, as in dower, formedon, &c. where view is required to be taken of the lands or tenements in question.

HABERGEON, a small coat of mail, or only sleeves and gorget of mail, formed of little iron rings or meshes linked into each other.

HADDOCK. See GADUS.

HÆMANTHUS, the *blood flower*, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the ninth order, spathaceæ. The involucrum is hexaphyllous and multiflorous; the corolla sexpartite, superior; the berry trilocular. There are eight species, of which the principal are:

1. The coccineus, with plain tongue-shaped leaves, rises about a foot high, with a stalk supporting a cluster of bright-red tubulous flowers. It has a large bulbous root, from which in the autumn come out two broad flat leaves of a fleshy consistence, shaped like a tongue, which turn backward on each side, and spread on the ground, so that they have a strange appearance all the winter. In the spring these decay; so that from May to the beginning of August they are destitute of leaves. The flowers are produced in the autumn just before the leaves come out.

2. The carinatus, with keel-shaped leaves, has a taller stalk and paler flowers than the former; its leaves are not flat, but hollowed like the keel of a boat.

3. The puniceus, with large spear-shaped waved leaves, grows about a foot high, and has flowers of a yellowish-red colour. These are succeeded by berries, which are of a beautiful red colour when ripe. All these plants are natives of the Cape of Good Hope.

HÆMATITES, or *blood stone*, a hard mineral substance, red, black, or purple, but the powder of which is always red. It is found in masses sometimes spherical, semispherical, pyramidal, or cellular, that is, like a honeycomb. It contains a large quantity of iron. Forty pounds of that metal have been extracted from a quintal of stone; but the iron is of such a bad quality, that this ore is not commonly smelted. The great hardness of hæmatites renders it fit for burnishing and polishing metals. The specific gravity from 47 to 50. See Pl. Nat. Hist. fig. 220.

HÆMATOPUS, the *sea-pye*, in ornithology, a genus belonging to the order of grallæ. The beak is compressed, with an equal wedge-shaped point; the nostrils are linear; and the feet have three toes without nails. There is but one species, viz. the ostralegus, or oyster-catcher, a native of Europe and America. See Pl. N. H. fig. 219. It feeds upon shell-fish near the sea-shore, particularly oysters and limpets. On observing an oyster which gapes wide enough for the insertion of its bill, it thrusts it in, and takes out the inhabitant: it will also force the limpets from their adhesion to the rocks with sufficient ease. Occasionally it feeds on marine insects and worms. With us these birds are often seen in considerable flocks in winter: in the summer they are met with only in pairs, though chiefly in the neighbourhood of the sea or salt rivers.

HÆMATOXYLUM, *logwood*, or *Campeachy wood*, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 33d order, lomentaceæ. The calyx is quinquepartite; the petals five; the capsule lanceolated, unilocular, and bivalved; the valves navicular, or keeled like a boat. Of this genus there is only one species, viz. the campechianum, which grows naturally in the bay of Campeachy at Honduras, and other parts of the Spanish West Indies, where it rises from 16 to 24 feet high. The stems are generally crooked, and very deformed, and seldom thicker than a man's thigh. The branches, which come out on each side, are crooked, irregular, and armed with strong thorns, and winged leaves, composed of three pair of obscure lobes indented at the top. The flowers come in a racemus from the wings of the leaves, standing erect, and are of a pale-yellowish colour, with a purple empalement. They are succeeded by flat oblong pods, each containing two or three kidney-seeds.

Logwood is used in great quantities for dyeing purple, but especially black colours. All the colours, however, which can be prepared from it, are of a fading nature, and cannot by any art be made equally durable with those prepared from some other materials. Of all the colours prepared from logwood, the black is the most durable. Doctor Lewis recommends it as an ingredient in making ink. "In dyeing cloth (says he), vitriol and galls, in whatever proportions they are used, produce only browns of different shades: I have often been surprised that with these capital materials of the black dye I never could obtain any true blackness in white cloth, and attributed the failure to some unheeded mismanagement in the process, till I found it to be a known fact among the dyers. Logwood is the material which adds blackness to the vitriol and gall brown; and this black dye, tho' not of the most durable kind, is the most common. On blue cloth a good black may be dyed by vitriol and galls alone; but even here an addition of logwood contributes not a little to improve the colour." Mr. Delaval, however, in his Essay on Colours, informs us, that with an infusion of galls and iron-filings, he not only made an exceeding black and durable ink, but also dyed linen cloth of a very deep black.

HÆMOPTOSIS, in medicine, a spitting of blood. See MEDICINE.

HÆMORRHAGE, in medicine, a flux of blood from any part of the body. See MEDICINE.

HÆMORRHOIDS, or PILES. See MEDICINE.

HÆRUCA, in entomology, a genus of the order of vermes intestina. The body is round, the fore part two-necked, and surrounded with a single row of prickles. The H. muris is grey-white and wrinkled: it inhabits the intestines of the mouse, and is distinguished from the echin or hynchus, in wanting the retractile proboscis.

HAIL, in natural history, a meteor generally defined frozen rain, but differing from it in that the hailstones are not formed of single pieces of ice, but of many little spherules agglutinated together. Neither are these spherules all of the same consistence; some of them being hard and solid like perfect ice; others soft, and mostly like snow hardened by a severe frost. Sometimes the hailstone has a kind of core of this soft matter; but more frequently the core is solid and hard, while the outside is formed of a softer matter. Hailstones assume various figures, being sometimes round, at other times pyramidal, crenated, angular, thin, and flat, and sometimes stellated, with six radii like the small crystals of snow. See METEOROLOGY.

Natural historians furnish us with various accounts of surprising showers of hail, in which the hailstones were of extraordinary magnitude. Mezeray, speaking of the war of Louis XII. in Italy, in the year 1510, relates, that there was for some time a horrible darkness, thicker than that of night; after which the clouds broke into thunder and lightning, and there fell a shower of hailstones, or rather (as he calls them) pebblestones, which destroyed all the fish, birds, and beasts, of the country. It was attended with a strong smell of sulphur; and the stones

were of a blueish colour, some of them weighing a hundred pounds. Hist. de France, tom. ii. p. 339.

At Lisle, in Flanders, in 1686, fell hailstones of a very large size; some of which contained in the middle a dark-brown matter, which, thrown on the fire, gave a very great report. Phil. Trans. No. 203.

Dr. Halley and others also relate, that in Cheshire, Lancashire, &c. April 29, 1697, a thick black cloud coming from Carnarvonshire, disposed the vapours to congeal in such a manner, that for about the breadth of two miles, which was the limit of the cloud, in its progress, for the space of 60 miles, it did inconceivable damage; not only killing all sorts of fowls and other small animals, but splitting trees, knocking down horses and men, and even ploughing up the earth; so that the hailstones buried themselves under ground an inch or an inch and a half deep. The hailstones, many of which weighed five ounces, and some half a pound, and being five or six inches about, were of various figures; some round, others half-round; some smooth, others embossed and crenated: the icy substance of them was very transparent and hard, but there was a snowy kernel in the middle of them.

In Hertfordshire, May 4, the same year, after a severe storm of thunder and lightning, a shower of hail succeeded, which far exceeded the former: some persons were killed by it, and their bodies beaten all black and blue; vast oaks were split, and fields of rye cut down as with a scythe. The stones measured from 10 to 13 or 14 inches about. Their figures were various, some oval, others picked, and some flat. Philosoph. Trans. No. 229.

Methods have lately been proposed, in England and France, to draw off the lightning, and dissipate hail-storms. Monthly Magazine, July 1806.

HAIR. See PHYSIOLOGY.

Hair and feathers cover different parts of animals, and are obviously intended by nature to protect them from the cold. For this their softness and pliability, and the slowness with which they conduct heat, render them peculiarly proper.

1. Hair is usually distinguished into various kinds, according to its size and appearance. The strongest and stiffest of all is called bristle: of this kind is the hair on the back of hogs. When remarkably fine, soft, and pliable, it is called wool; and the finest of all is known by the name of down. But all these varieties resemble one another very closely in their composition.

Hair appears to be a kind of tube covered with a cuticle. Its surface is not smooth, but either covered with scales, or consisting of imbricated cones. Hence the roughness of its feel, and the disposition which it has to entangle itself, which has given origin to the processes of felting and fulling. It is constantly increasing in length, being protruded from the roots, and seems at first to be soft or nearly gelatinous. From the experiments which have been made on hair by Achard and Hatchett, it follows that it contains gelatine, to which it owes its suppleness and toughness. This substance may be separated by boiling the hair in water. When thus treated it becomes much more brittle than before. Indeed if the process is continued long enough, the hair crumbles to pieces between the fingers. The portion insoluble in water possesses the properties of coagulated albumen.

Mr. Hatchett has concluded, from his experiments, that the hair which loses its curl in moist weather, and which is the softest and most flexible, is that which yields its gelatine most easily; whereas strong and elastic hair yields it with the greatest difficulty, and in the smallest proportion. This conclusion has been confirmed by a very considerable hair-merchant in London, who assured him that the first kind of hair was much more injured by boiling than the second.

The rapidity with which hair burns, and the fusion which it undergoes in that case, shew us, however, that hair does not altogether correspond with coagulated albumen in its nature, but approaches towards the oils. When distilled, 1152 parts of hair yielded Berthollet the following products:

90	carbonat of ammonia
179	water smelling of burnt hair
288	oil
271	gases
324	coal
1152.	

The oil was of a brown colour, solid unless exposed to a heat equal to 73°, very soluble in alcohol, burnt with great brilliancy, and with scintillations like hair. The charcoal was difficult to incinerate, and was attracted by the magnet; of course it contained iron. From the experiments of Fourcroy and Vauquelin, we learn that horsehair, when burnt, leaves a residuum of 0.12, which is mostly phosphat of lime.

The alkalies dissolve hair at a boiling-heat, and form with it an animal soap; but lime appears to have but little action on it. When muriatic acid is poured into the solution of hair in potass, a quantity of sulphurated hydrogen gas is disengaged, and a black substance, doubtless charcoal, precipitates. Hence it follows that it contains sulphur. Accordingly, if a bit of silver is put into the solution, it instantly assumes a black colour.

Sulphuric acid dissolves hair by the assistance of heat, some charcoal is deposited, and carbonic acid gas separates. Nitric acid tinges it yellow, and dissolves it when assisted by heat; while a fat mattor separates, and oxalic acid is formed. Berthollet obtained from wool more than half its weight of oxalic acid. Muriatic acid dissolves it readily; but the solution does not become black, and has much the appearance of a solution of glue in the same acid. Oxymuriatic acid whitens hair, and destroys its strength. When the hair is plunged into the acid in the state of gas, it is very soon converted into a pulp.

2. Feathers seem to possess very nearly the same properties with hair. Mr. Hatchett has ascertained that the quill is composed chiefly of coagulated albumen. Though feathers were boiled for a long time in water, Mr. Hatchett could observe no traces of gelatine.

HAIR'S BREADTH, a measure of length, being the 48th part of an inch.

HALCYON. See ALCEDO.

HALE. See HAUL.

HALESIA, a genus of the monogynia order, in the dodecandria class of plants; and in the natural method ranking under the 18th order, bicornes. The calyx is quadridentated, superior; the corolla quadrifid; the nut quadrangular and dispermous. There are two species, herbaceous plants of N. America.

HALF-MOON, in fortification, an outwork composed of two faces, forming a saliant angle, whose gorge is in form of a crescent, or half-moon; whence the name. See FORTIFICATION.

HALF-SEAL, that used in the court of chancery for sealing commissions to delegates, upon any appeal, in ecclesiastical or marine causes.

HALIOTIS, the ear-shell, a genus of insects belonging to the order of vermes testacea. This is an animal of the snail kind, with an open shell resembling an ear. There are nineteen species, distinguished by the figure of their shells.

HALLERIA, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 40th order, personatæ. The calyx is trifid; the corolla quadrifid; the filaments longer than the corolla; the berry inferior and bilocular (the fruit not yet fully described). There is one species, a shrub of the Cape.

HALO, in physiology, a meteor in the form of a luminous ring or circle, of various colours, appearing round the bodies of the sun, moon, or stars. See OPTICS.

HAMELLIA, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking with those of which the order is doubtful. The corolla is quinquefid; the berry quinquelocular, inferior, polyspermous. There are four species, trees of the West Indies.

HAMMER, a well-known tool used by mechanics, consisting of an iron head, fixed crosswise upon a handle of wood.

There are several sorts of hammers used by blacksmiths; as, 1. The hand-hammer, which is of such weight that it may be wielded or governed with one hand at the anvil. 2. The up-hand sledge, used with both hands, and seldom lifted above the head. 3. The about-sledge, which is the largest hammer of all, and held by both hands at the farthest end of the handle, and being swung at arm's-length over the head, is made to fall upon the work with as heavy a blow as possible. There is also another hammer used by smiths, called a rivetting-hammer, which is the smallest of all, and is seldom used at the forge, unless upon small work.

HAMSOKEN, is used in Scotland for the crime of him that violently, and contrary to the king's peace, assaults a man in his own house, which is punishable equally with ravishing a woman.

HANAPER *office*, in the court of chancery, is that out of which issue all original writs that pass under the great seal, and all commissions of charitable uses, sewers, bankrupts, ideocy, lunacy, and such-like. These writs, relating to the business of the subject, and the returns to them, were originally kept in a hamper, in hanaperio; the other writs, relating to matters wherein the crown is immediately or mediately concerned, were preserved in a little sack or bag, in parva baga; and thence has arisen the distinction of the hanaper office and petty-bag office: both of which belong to the common law court in chancery. 3 Black. 48.

HANCES, in a ship, are falls or descents of the fife rails, which are placed from the stern down to the gangways.

HAND. See ANATOMY.

HAND-BARROW, a wheelbarrow which is of great use in fortification, for carrying earth from one place to another, and in a siege, for carrying bombs or cannon-balls along the trenches.

HAND-BREADTH, a measure of three inches.

HAND-CUFFS, an instrument formed of two circular pieces of iron, each fixed on a hinge at the ends of a very short iron bar, which being locked over the wrists of a malefactor, prevents his using his hands.

HAND-GRENADES. See GRENADES.

HARBINGER, an officer of the king's houshold, having four yeomen under him, who ride a day's journey before the court, when it travels, to provide lodgings.

HARDENING, the giving a greater degree of hardness to bodies than they had before. See the article HARDNESS.

There are several ways of hardening iron and steel, as by hammering them, quenching them, when hot, in cold water, case-hardening, &c. See IRON.

HARDNESS, in bodies, a property directly opposite to fluidity; by which they resist the impression of any other substance, sometimes in an extreme degree. As fluidity has been found to consist in the motion of the particles of a body upon one another in consequence of a certain action of the universal fluid or elementary fire among them; we must conclude that hardness consists in the absence of this action, or a deficiency of what is called latent heat. This is confirmed by observing that there is an intermediate state betwixt hardness and fluidity, in which bodies will yield to a certain force, though they still make a considerable resistance. This is principally observed in the metals, and is the foundation of their ductility. It appears, indeed, that this last property, as well as fluidity, is entirely dependant on a certain quantity of caloric absorbed, or otherwise acting within the substance itself; for all the metals are rendered hard by hammering, and soft by being put again into the fire and kept there for some time. The former operation renders them hot as well as hard; probably, as Dr. Black observes, because the particles of metal are thus forced nearer one another, and those of fire squeezed out from among them. By keeping them for some time in the fire, that element insinuates itself again among the particles, and arranges them in the same manner as before, so that the ductility returns. By a second hammering this property is again destroyed, returning on a repetition of the heating, or annealing as it is called; and so on, as often as we please.

Hardness appears to diminish the cohesion of bodies in some degree, though their fragility does not by any means keep pace with their hardness. Thus, glass is very hard and very brittle; but flint, though still harder than glass, is much less brittle. Among the metals, however, these two properties seem to be more connected, though even here the connection is by no means complete. Steel, the hardest of all the metals, is indeed the most brittle; but lead, the softest, is not the most ductile. Neither is hardness connected with the specific gravity of bodies; for a diamond, the hardest substance in nature, is little more than half the weight of the lightest metal. As little is it connected with the coldness, electrical properties, or any other quality with which we are acquainted: so that though the principle above laid down may be accepted as a general foundation for our inquiries, a great number of particulars remain yet to be discovered before we can offer any satisfactory explanation.

All bodies become harder by cold; but this is not the only means of their doing so, for some become hard by heat as well as cold.

Mr. Quist and others have constructed tables of the hardness of different substances. The method pursued in constructing these tables was by observing the order in which they were able to cut or make any impression upon one another. The following table, extracted from M. Magellan's edition of Cronstedt's Mineralogy, was taken from Dr. Quist, Bergman, and Mr. Kirvan. The first column shows the hardness, and the second the specific gravity.

	H.	S.G.
Diamond from Ormus	20	3,7
Pink diamond	19	3,4
Blueish diamond	19	3,3
Yellowish diamond	19	3,3
Cubic diamond	18	3,2
Ruby	17	4,2
Pale ruby from Brazil	16	3,5
Ruby spinell	13	3,4
Deep-blue sapphire	16	3,8
Ditto paler	17	3.8
Topaz	15	4,2
Whitish ditto	14	3,5
Bohemian ditto	11	2,8
Emerald	12	2,8
Garnet	12	4,4
Agate	12	2,6
Onyx	12	2,6
Sardonyx	12	2,6
Occid. amethyst	11	2,7
Crystal	11	2,6
Carnelian	11	2,7
Green jasper	11	2,7
Reddish-yellow ditto	9	2,6
Schoerl	10	3,6
Tourmaline	10	3,0
Quartz	10	2,7
Opal	10	2,6
Chrysolite	10	3,7
Zeolite	8	2,1
Fluor	7	3,5
Calcareous spar	6	2,7
Gypsum	5	2,3
Chalk	3	2,7

HARE. See LEPUS.

HARIOT. See HERIOT.

HARMATTAN. The harmattan is a very singular wind, which blows periodically from the interior parts of Africa towards the Atlantic Ocean. The season in which it prevails is during the months of December, January, and February; it comes on indiscriminately at any hour of the day, at any time of the tide, or at any period of the moon, and continues sometimes only a day or two, sometimes five or six days, and it has been known to last fifteen and sixteen days. There are generally three or four returns of it every season. It blows with a moderate force, but not quite so strong as the sea-breeze.

A fog or haze is one of the peculiarities which always accompany the harmattan. The English, French, and Portuguese forts at Whydah, are not quite a quarter of a mile asunder, yet are frequently quite invisible to each other; the sun, concealed the greatest part of the day, appears only about a few hours at noon, and then of a mild red, exciting no painful sensation on the eye. The particles which constitute this fog are deposited on the leaves of trees, on the skins of the negroes, &c. and make them appear whitish.

Extreme dryness makes another extraordinary property of this wind; no dew falls during its continuance; vegetables are withered, and the grass becomes dry like hay. The natives take this opportunity to clear the land, by setting fire to the trees and plants while in that dry and exhausted state. The dryness is so extreme, that the covers of books, even closely shut up in a trunk, are bent as if exposed to the fire. Houshold furniture is much damaged; the pannels of wainscots split, and fineered work flies to pieces. The joints of a well-laid floor of seasoned wood open sufficiently to admit the breadth of a finger between them; but become as close as before on the ceasing of the harmattan. The human body does not escape the parching effects of this wind; the eyes, nostrils, lips, and palate, are rendered dry and uneasy; the lips and nose become sore, and though the air is cool, there is a troublesome sensation of pricking heat on the skin. If the harmattan continues four or five days, the scarf-skin peels off, first from the hands and face, and afterwards from the rest of the body.

Though this wind is so fatal to vegetable life, and occasions these troublesome effects to the human species, it is nevertheless highly conducive to health; it stops the progress of epidemics, and relieves the patients labouring under fluxes and intermittent fevers. Infection is not easy at that time to be communicated, even by inoculation. It is also remarkable for the cure of ulcers and cutaneous diseases. Econ. of Nat. b. 5.

HARMONICA. This word, when originally appropriated by Dr. Franklin to that peculiar form or mode of musical glasses, which he himself, after a number of happy experiments, had constituted, was written Armonica. It is derived from the Greek word ἁρμονια. The radical word is αρω, to suit or fit one thing to another. Relations or aptitudes of sound, in particular, were understood by it; and in this view, Dr. Franklin could not have selected a name more expressive of its nature and genius for the instrument which we are now to describe; as, perhaps, no musical tone can possibly be finer, nor consequently susceptible of juster concords, than those which it produces.

"Mr. Puckridge, a gentleman from Ireland, was," says Dr. Franklin, "the first who thought of playing tunes formed of these tones. He collected a number of glasses of different sizes; fixed them near each other on a table; and tuned them, by putting into them water, more or less as each note required. The tones were brought out by pressing his fingers round their brims. He was unfortunately burnt here, with his instrument, in a fire which consumed the house that he lived in. Mr. E. Deleval, a most ingenious member of our royal society, made one in imitation of it,

with a better choice and form of glasses, which was the first I saw or heard. Being charmed with the sweetness of its tones, and the music he produced from it, I wished to see the glasses disposed in a more convenient form, and brought together in a narrower compass, so as to admit of a greater number of tones, and all within reach of hand to a person sitting before the instrument; which I accomplished, after various intermediate trials, and less commodious forms, both of glasses and construction, in the following manner:

"The glasses are blown as nearly as possible in the form of hemispheres, having each an open neck or socket in the middle. The thickness of the glass near the brim is about the tenth of an inch, or hardly so much, but thicker as it comes nearer the neck; which in the largest glasses is about an inch deep, and an inch and a half wide within; these dimensions lessening as the glasses themselves diminish in size, except that the neck of the smallest ought not to be shorter than half an inch. The largest glass is nine inches diameter, and the smallest three inches. Between these there are 23 different sizes, differing from each other a quarter of an inch in diameter. To make a single instrument there should be at least six glasses blown of each size; and out of this number one may probably pick 37 glasses (which are sufficient for three octaves with all the semitones) that will be each either the note one wants, or a little sharper than that note, and all fitting so well into each other as to taper pretty regularly from the largest to the smallest. It is true that there are not 37 sizes; but it often happens that two of the same size differ a note or half a note in tone, by reason of a difference in thickness, and these may be placed one in the other without sensibly hurting the regularity of the taper form.

"The glasses being chosen, and every one marked with a diamond the note you intend it for, they are to be tuned by diminishing the thickness of those that are too sharp. This is done by grinding them round from the neck towards the brim, the breadth of one or two inches as may be required; often trying the glass by a well-tuned harpsichord, comparing the note drawn from the glass by your finger with the note you want, as sounded by that string of the harpsichord. When you come near the matter, be careful to wipe the glass clean and dry before each trial, because the tone is something flatter when the glass is wet than it will be when dry; and grinding a very little between each trial, you will thereby tune to great exactness. The more care is necessary in this, because if you go below your required tone, there is no sharpening it again but by grinding somewhat off the brim, which will afterwards require polishing, and thus increase the trouble.

"The glasses being thus tuned, you are to be provided with a case for them, and a spindle on which they are to be fixed. My case is about three feet long, eleven inches every way wide within at the biggest end, and five inches at the smallest end; for it tapers all the way, to adapt it better to the conical figure of the set of glasses. This case opens in the middle of its height, and the upper part turns up by hinges fixed behind. The spindle is of hard iron, lies horizontally from end to end of the box within, exactly in the middle, and is made to turn on brass gudgeons at each end. It is round, an inch diameter at the thickest end, and tapering to a quarter of an inch at the smallest. A square shank comes from its thickest end through the box, on which shank a wheel is fixed by a screw. This wheel serves as a fly to make the motion equable, when the spindle, with the glasses, is turned by the foot like a spinning-wheel. My wheel is of mahogany, 18 inches diameter, and pretty thick, so as to conceal near its circumference about 25lb. of lead. An ivory pin is fixed in the face of this wheel, about four inches from the axis. Over the neck of this pin is put the loop of the string that comes up from the moveable step to give it motion. The case stands on a neat frame with four legs.

"To fix the glasses on the spindle, a cork is first to be fitted in each neck pretty tight, and projecting a little without the neck, that the neck of one may not touch the inside of another when put together, for that would make a jarring. These corks are to be perforated with holes of different diameters, so as to suit that part of the spindle on which they are to be fixed. When a glass is put on, by holding it stiffly between both hands, while another turns the spindle, it may be gradually brought to its place. But care must be taken that the hole be not too small, lest in forcing it up, the neck should split; nor too large, lest the glass, not being firmly fixed, should turn or move on the spindle, so as to touch or jar against its neighbouring glass. The glasses thus are placed one in another; the largest on the biggest end of the spindle, which is to the left hand: the neck of this glass is towards the wheel; and the next goes into it in the same position, only about an inch of its brim appearing beyond the brim of the first; thus proceeding, every glass when fixed shews about an inch of its brim (or three quarters of an inch, or half an inch, as they grow smaller) beyond the brim of the glass that contains it; and it is from these exposed parts of each glass that the tone is drawn, by laying a finger on one of them as the spindle and glasses turn round.

"My largest glass is G a little below the reach of a common voice, and my highest G, including three complete octaves. To distinguish the glasses more readily by the eye, I have painted the apparent parts of the glasses within side, every semitone white, and the other notes of the octave with the seven prismatic colours; viz, C, red; D, orange; E, yellow; F, green; G, blue; A, indigo; B, purple; and C, red again; so that the glasses of the same colour (the white excepted) are always octaves to each other.

"This instrument is played upon by sitting before the middle of the set of glasses, as before the keys of a harpsichord, turning them with the foot, and wetting them now and then with a spunge and clean water. The fingers should be first a little soaked in water, and quite free from all greasiness; a little fine chalk upon them is sometimes useful, to make them catch the glasses and bring out the tone more readily. Both hands are used, by which means different parts are played together. Observe, that the tones are best drawn out when the glasses turn *from* the ends of the fingers, not when they turn *to* them.

"The advantages of this instrument are, that its tones are incomparably sweet beyond those of any other; that they may be swelled and softened at pleasure by stronger or weaker pressures of the finger, and continued to any length; and that the instrument being once well tuned, never again wants tuning."

"Analogous to these sounds," says a writer in the Annual Register, "are those produced by bells: in those last, besides the tones produced by their elliptical vibrations, there are a set of tones which may be brought by gently rubbing their edges, and in which the whole instrument does not appear to vibrate in all its parts as before.

"Take, for instance, a bell finely polished at the edges; or, what will perhaps be more convenient, a drinking-glass: let the edges be as free from any thing oily as possible; then, by moistening the finger in water (I have found alum-water to be best), and rubbing it circularly round the edge of the glass, you will at length bring out the tone referred to.

"This note is possessed of infinite sweetness; it has all the excellences of the tone of a bell, without its defects. It is loud, has a sufficient body, is capable of being swelled and continued at pleasure; and besides, has naturally that vibratory softening which musicians endeavour to imitate by mixing with the note to be played a quarter-tone from below.

"To vary these tones, nothing more is required than to procure several bells or glasses of different tones, tuned as nearly as possible, which may be done by thinning the edges of either: or, for immediate satisfaction, the glasses may be tuned by pouring in water; the more water is poured in, the graver the tone will be.

"Let us suppose then a double octave of those glasses, thus tuned, to be procured. Any common tune may be executed by the fingers rubbing upon each glass successively; and this I have frequently done without the least difficulty, only choosing those tunes which are slow and easy. Here then are numbers of delicate tones, with which musicians have been till very lately unacquainted; and the only defect is, that they cannot be made to follow each other with that celerity and ease which is requisite for melody. In order to remedy this, I took a large drinking-glass, and by means of a wheel and gut, as in the electrical machine, made it to turn upon its axis with a moderately quick but equable motion; then moistening the finger as before, nothing more was required than merely to touch the glass at the edge, without any other motion, in order to bring out the tone.

"Instead of one glass only turning in this manner, if the whole number of glasses were so fixed as to keep continually turning by means of a wheel, it follows, that upon every touch of the finger a note would be expressed; and thus, by touching several glasses at once, a harmony of notes might be produced, as in a harpsichord.

"As I write rather to excite than satisfy the curious, I shall not pretend to direct the various ways this number of glasses may be contrived to turn; it may be sufficient to say, that if the glasses are placed in the segment of a circle, and then a strap, as in a cutler's wheel, is supposed to go round them all, the whole number will by this means be made to turn by a wheel.

"Instead of the finger, I have applied moistened leather to the edge of the glass, in order to bring out the tone: but, for want of a proper elasticity, this did not succeed. I tried cork, and this answered every purpose of the finger; but made the tone much louder than the finger could do. Instead, therefore, of the finger, if a number of corks were so contrived as to fall with a proper degree of pressure on the edge of the glass, by means of keys like the jacks of an organ, it is evident, that in such a case a new and tolerably perfect instrument would be produced; not so loud indeed as some, but infinitely more melodious than any."

HARMONICAL ARITHMETIC, that part of arithmetic which considers musical intervals, expressed by numbers, in order to our finding their mutual relations, compositions, and resolutions.

HARMONICAL PROPORTION. See PROPORTION.

HARMONICAL SERIES, a series of many numbers in continual harmonical proportion. Thus if there are four or more numbers, of which every three immediate terms are harmonical, the whole will make an harmonical series: such is 30: 20: 15: 12: 10. Or, if every four terms immediately next each other are harmonical, it is also a continual harmonical series, but of another species, as 3, 4, 6, 9, 18, 36, &c.

HARMONY, in music (from the Greek), the agreement or consonance of two or more united sounds. Harmony is either natural or artificial. Natural harmony, properly so called, consists of the harmonic triad, or common chord. Artificial harmony is a mixture of concords and discords, bearing relation to the harmonic triad of the fundamental note. The word harmony being originally a proper name, it is not easy to determine the exact sense in which it was used by the Greeks; but from the treatises they have left us on the subject, we have great reason to conclude that they limited its signification to that agreeable succession of sounds which we call air, or melody. The moderns, however, do not dignify a mere succession of single sounds with the appellation of harmony: for the formation of harmony they require an union of melodies, a succession of combined sounds composed of consonant intervals, and moving according to the stated laws of modulation. But as the laws of harmony were not established into a code but by very slow degrees, its principles for a long time consisted of no other than almost arbitrary rules, founded, indeed, on the approbation of the ear, but unsanctioned by that science which accounts for effects rationally, and deduces its conclusions from minute, profound, and satisfactory investigation. At length, however, writers arose, to whose patience, talents, and learning, the present age is indebted for a complete system of harmony and modulation, and to whose labours we only have to resort, to be informed on every point requisite both to its theory and practice.

HARMONY, FIGURED. Figured harmony is that in which, for the purpose of melody, one or more of the parts of a composition move during the continuance of a chord, through certain notes which do not form any of the constituent parts of that chord. These intermediate notes not being reckoned in the harmony, considerable judgment and skill are necessary so to dispose them that while the ear is gratified with their succession, it may not be offended at their dissonance with respect to the harmonic notes. See SOUNDS.

HARP, a stringed instrument, consisting of a triangular frame, and the chords of which are distended in parallel directions from the upper part to one of its sides. Its scale extends through the common compass, and the strings are tuned by semitonic intervals. It stands erect, and when used, is placed at the feet of the performer, who produces its tones by the action of the thumb and fingers of both hands on the strings. That the harp is among the most ancient of musical instruments, the frequent mention of it in scripture, and the splendid account transmitted to us of the Theban harp, both as to the beauty of its decorations and extent of scale, are sufficient evidences. The Irish and Welsh practised the harp long before the gammut of Guido was invented, and it is, indeed, their national instrument. In England also it was early introduced to general use, and the most ancient poems were sung to it on Sundays and all public festivals.

HARPING-IRON, or HARPOON, a large spear or javelin, made of forged iron, and five or six feet long; it is fastened to a line, and used in the whale-fishery.

HARPINGS, in a ship, properly denote her breadth at the bow. Some also give the same name to the ends of the bends that are fastened into the stern.

HARPOON-GUN, a sort of fire-arm for discharging harpoons at whales, and thereby killing them more expeditiously than when harpoons are thrown by the hand. See Transactions of the Society for the Encouragement of Arts, &c. 1786, 1789, &c.

HARPSICHORD, a stringed instrument, consisting of a case formed of mahogany or walnut-tree wood, and containing the belly or sounding-board, over which the wires are distended, supported by bridges. In the front the keys are disposed, the long ones of which are the naturals, and the short ones the sharps and flats. These keys being pressed by the fingers, their inclosed extremities raise little upright oblong slips of wood called jacks, furnished with crow-quill plectrums, which strike the wires. The great advantage of the harpsichord beyond most other stringed instruments, consists in its capacity of sounding many notes at once, and forming those combinations, and performing those evolutions of harmony, which a single instrument cannot command. This instrument, called by the Italians clave cymbala, by the French clavecin, and in Latin grave cymbalum, is an improvement upon the clarichord, which was borrowed from the harp, and has for more than a century been in the highest esteem, and in the most general use, both public and private, throughout Europe; but since the invention of that fine instrument the grand piano-forte, its practice has considerably declined.

HARQUEBUSS, a piece of fire-arms, of the length of a musquet, usually cocked with a wheel. It carried a ball that weighed one ounce seven eighths.

HARRIER. See CANIS.

HARROW. See HUSBANDRY.

HART. See CERVUS.

HARTOGIA, a genus of the pentandria order, in the monœcia class of plants; and in the natural method ranking under the 48th order, aggregatæ. The male calyx is pentaphyllous, the petals five; the female calyx triphyllous, with five petals, and five barren and five castrated stamina. There are three capsules; and the seeds are arillated, or inclosed in a deciduous case. There is one species, a tree of the Cape.

HARTSHORN, in chemistry. See AMMONIA.

HART'S HORNS, in pharmacy, the whole horns of the common male deer, as separated from the head, without farther preparation. See HORNS.

HASSELQUISTA, a genus of the class and order pentandria digynia. The cal. is radiated, in the disk male. Seeds in the circumference double, in the disk solitary. There are two species, herbs of Egypt.

HAT, a covering for the head, worn by the men in most parts of Europe. Those most in esteem are made of the pure hair of the castor or beaver; for they are also made of the hair or wool of divers other animals, and that by much the same process.

Hats are made either of wool, or hair of various animals, particularly of the castor, hare, rabbit, camel, &c. The process is much the same in all; for which reason we shall content ourselves with instancing that of the beaver. The skin of this animal is covered with two kinds of hair; the one long, stiff, glossy, and rather thin-set; this is what renders the skin or fur of so much value: the other is short, thick, and soft, which alone is used in hats. To tear off one of these kinds of hair, and cut the other, the hatters, or rather the women employed for that purpose, make use of two knives, a large one like a shoemaker's knife for the long hair, and a smaller, not unlike a vine-knife, wherewith they shave or scrape off the shorter hair.

When the hair is off, they mix the stuff; to one-third of dry castor putting two-thirds of old coat, *i. e.* of hair which has been worn some time by the savages, and card the whole with cards, like those used in the woollen-manufactory, only finer; this done, they weigh it, and take more or less according to the size or thickness of the hat intended. The stuff is now laid on the hurdle, which is a square table, parallel to the horizon, having longitudinal chinks cut through it; on this hurdle, with an instrument called a bow, much like that of a violin, but larger, whose string is worked with a little bow-stick, and thus made to play on the furs, they fly and mix together, the dust and filth at the same time passing through the chinks. This they reckon one of the most difficult operations in the whole, on account of the justness required in the hand to make the stuff fall precisely together, and that it may be every where of the same thickness. In lieu of a bow, some hatters make use of a sieve or searce of hair, through which they pass the stuff.

After this manner they form gores, or two capades, of an oval form, ending in an acute angle at top; and with what stuff remains, they supply and strengthen them in places where they happen to be slenderer than ordinary; though it is to be remembered, that they designedly make them thicker in the brim, near the crown, than toward the circumference, or in the crown itself.

The capades thus finished, they go on to harden them into closer and more consistent flakes by pressing down a hardening skin or leather thereon; this done, they are carried to the bason, which is a sort of bench with an iron plate fitted in it, and a little fire underneath; upon which laying one of the hardened capades, sprinkled over with water, and a sort of mould being applied, the heat of the fire, with the water and pressing, embody the matter into a slight hairy sort of stuff or felt; after which, turning up the edges all round the mould, they lay it by, and thus proceed to the other: this finished, the next two are joined together, so as to meet in an angle at the top, and only form one conical cap, after the manner of a manican hippocratis, or jelly-bag.

The hat thus basoned, they remove it to a large kind of receiver or trough, resembling a mill-hopper, going sloping or narrowing down from the edge or rim to the bottom, which is a copper kettle filled with water and grounds, kept hot for that purpose. On the descent or sloping side, called the plank, the basoned hat, being first dipped in the kettle, is laid; and here they proceed to work it, by rolling and unrolling it again and again, one part after another, first with the hand, and then with a little wooden roller, taking care to dip it from time to time, till at length, by thus fulling and thickening it four or five hours, it is reduced to the extent or dimensions of the hat intended.

The hat thus wrought, they proceed to give it the proper form, which is done by laying the conical cap on a wooden block, of the intended size of the crown of the hat, and then tying it round with a packthread: after which, with a piece of iron or copper bent for that purpose, and called a stamper, they gradually beat or drive it down all round, till it has reached the bottom of the block, and thus is the crown formed; what remains at bottom below the string being the brim.

The hat being now set to dry, they proceed to singe it, by holding it over a flare of straw or the like; then it is pounced, or rubbed over with pumice, to take off the coarser knap; then rubbed over afresh with seal-skin to lay the knap a little finer; and lastly, carded with a fine card to raise the fine cotton, with which the hat is afterwards to appear.

Things thus far advanced, the hat is thus sent, upon its block, and tied about with a packthread as before, to be dyed. The dye being completed, the hat is returned to the hatter, who proceeds to dry it, by hanging it in the top or roof of a stove or oven, at the bottom of which is a charcoal fire; when dry, it is to be stiffened, which is done with melted glue or gum senegal, applied thereon by first smearing it, and beating it over with a brush, and then rubbing it with the hand. The next thing is to steam it on the steaming-bason, which is a little hearth or fire-place. When steamed sufficiently, and dried, they put it again on the block, and brush and iron it on a table or bench for the purpose, called the stall-board; this they perform with a sort of irons like those commonly used in ironing linen, and heated like them, which being rubbed over and over each part of the hat, with the assistance of the brush, smooths and gives it a gloss, which is the last operation; nothing now remains but to clip the edges even with scissars, and sew a lining to the crown. For dyeing of hats, see DYEING.

A patent was granted in January, 1782, to Mr. Robert Golding, of Southwark, hat-dyer, for his method of dyeing, staining, and colouring, beaver hats green, or any other colour. The inventor directs the nap of the hat to be raised by means of a card, on the side intended to be dyed, and then boiled in alum argol. A thin paste should be made of flour, or clay, which is spread over every part that is not to be dyed, and then closed; or the hat may be previously pasted, and instead of being boiled, it should only be simmered in the same liquor. As soon as the paste is spread, plates of copper or other metal, shaped like a common funnel, are fixed over the paste, to prevent the dye from penetrating through. In this state the hat is immersed in the dye, till the colour is sufficiently fixed, when it is taken out, opened, and cleansed from the paste: but if any colouring particles have penetrated through the felt, they may be removed by rubbing them with a small quantity of spirit of salt, aquafortis, &c. The compounds employed in dyeing, are fustic, turmeric, ebony, saffron, alum, argol, indigo, and vitriol, with urine, or pearlash, at the option of the dyer; all which are used together, or separately, according to the colour required.

Mr. Dunnage, in 1794, obtained a patent for water-proof hats, in imitation of beaver. The articles he employs are similar to those commonly used for the making of hats, with which he mixes Bergam, Piedmont, or organzine silk. These are dressed and worked in a peculiar manner; though we understand that hats thus prepared become heavy and oppressive to the wearer, while they acquire an ugly colour. The same manufacturer procured another patent in November, 1798, for a method of ventilating the crowns of hats. This invention consists in separating the top from the sides of the crown, so that the tip, or top crown, may be either raised or let down at pleasure, in order to admit the external air, or to exclude it from circulating in the crown of the hat. The whole contrivance is effected by means of springs, sliders, sockets, grooves, loops, and cases, which are connected with the top and side-crown: thus the admission or exclusion of atmospheric air in front, behind, or on either side, may be regulated accordingly. See Repertory, vol. iv. and x.

Another patent was granted for the same thing to Messrs. Walker and Alphey, in the year 1801.

Hats are also made for women's wear, of chips, straw, or cane, by platting, and sewing the plats together; beginning with the centre of the crown, and working round till the whole is finished. Hats for the same purpose are also woven, and made of horse-hair, silk, &c. There are few manufactures in the kingdom in which so little capital is wanted, or the knowledge of the art so soon acquired, as in that of straw-platting. One guinea is quite sufficient for the purchase of the machines and materials for employing one hundred persons for several months.

The straw is cut at the joints; and the outer covering being removed, it is sorted of equal sizes, and made up into bundles of eight or ten inches in length, and a foot in circumference. They are then to be dipped in water, and shaken a little so as not to retain too much moisture; and then the bundles are to be placed on their edges, in a box which is sufficiently close to prevent the evaporation of smoke. In the middle of the box is an earthen dish containing brimstone broken in small pieces: this is set on fire, and the box covered over and kept in the open air several hours.

It will be the business of one person to split and select the straws for fifty others who are braiders. The splitting is done by a small machine made principally of wood. The straws, when split, are termed splints, of which each worker has a certain quantity: on one end is wrapped a linen cloth, and they are held under the arm, and drawn out as wanted.

Platters should be taught to use their second fingers and thumbs, instead of the fore-fingers, which are often required to assist in turning the splints, and very much facilitate the platting; and they should be cautioned against wetting the splints too much. Each platter should have a small linen work-bag, and a piece of pasteboard to roll the plat round. After five yards have been worked up, it should be wound about a piece of board half a yard wide, fastened at the top with yarn, and kept there several days to form it in a proper shape. Four of these parcels, or a score, is the measurement by which the plat is sold.

HATCHEL, HACKLE, or HITCHEL, a tool with which flax and hemp are combed into fine hairs. It consists of long iron pins, or teeth, regularly set in a piece of board.

There are several sorts of hatchels, each finer than the other, with which flax and hemp are prepared for spinning.

HATCHES, in a ship, a kind of trap-doors between the main-mast and fore-mast, through which all goods of bulk are let down into the hold.

HATCHES also denote flood-gates set in a river, &c. to stop the current of the water; particularly certain dams or mounds made of rubbish, clay, or earth, to prevent the water that issues from the stream-works and tin-washes in Cornwal, from running into the fresh rivers.

HATCHING, the maturating fecundated eggs, whether by the incubation and warmth of the parent bird, or by artificial heat, so as to produce young chickens alive.

The art of hatching chickens by means of ovens has long been practised in Egypt; but it is there only known to the inhabitants of a single village named Berme, and to those who live at a small distance from it. Towards the beginning of autumn they scatter themselves all over the country, where each person among them is ready to undertake the management of an oven, each of which is of a different size, but in general they are capable of containing from forty to fourscore thousand eggs. The number of these ovens placed up and down the country is about three hundred and eighty-six, and they usually kee them working for about six months: as therep fore each brood takes up in an oven, as under a hen, only twenty-one days, it is easy in every one of them to hatch eight different broods of chickens. Every Bermean is under

the obligation of delivering to the person who intrusts him with an oven, only two-thirds of as many chickens as there have been eggs put under his care; and he is a gainer by this bargain, as more than two-thirds of the eggs usually produce chickens. In order to make a calculation of the number of chickens yearly so hatched in Egypt, it has been supposed that only two-thirds of the eggs are hatched, and that each brood consists of at least thirty thousand chickens; and thus it would appear that the ovens of Egypt give life yearly to at least ninety-two millions six hundred and forty thousand of these animals.

This useful and advantageous method of hatching eggs has been employed in France, by the ingenious Mr. Reaumur, who, by a number of experiments, reduced the art to certain principles. He found by experience that the heat necessary for this purpose is nearly the same with that marked 32 on his thermometer, or that marked 96 on Fahrenheit's. This degree of heat is nearly that of the skin of the hen, and what is remarkable, of the skin of all other domestic fowls, and probably of all other kinds of birds. The degree of heat which brings about the developement of the cygnet, the gosling, and the turkey-poút, is the same as that which fits for hatching the canary-songster, and, in all probability, the smallest humming-bird: the difference is only in the time during which this heat ought to be communicated to the eggs of different birds: it will bring the canary-bird to perfection in eleven or twelve days, while the turkey-pout will require twenty-seven or twenty-eight.

Mr. Reaumur invented a sort of low boxes, without bottoms, and lined with furs. These, which he calls artificial parents, not only shelter the chickens from the injuries of the air, but afford a kindly warmth, so that they presently take the benefit of their shelter as readily as they would have done under the wings of a hen. After hatching, it will be necessary to keep the chickens for some time in a room artfully heated, and furnished with these boxes; but afterwards they may be safely exposed to the air in the court-yard, in which it may not be amiss to place one of these artificial parents to shelter them if there should be occasion for it.

As to the manner of feeding the young brood, they are generally a whole day after being hatched before they take any food at all; and then a few crumbs of bread may be given them for a day or two, after which they will begin to pick up insects and grass for themselves. But to save the trouble of attending them, capons may be taught to watch them in the same manner as hens do. Mr. Reaumur assures us that he has seen above two hundred chickens at once, all led about and defended only by three or four such capons. Nay, cocks may be taught to perform the same office, which they, as well as the capons, will continue to do all their lives after.

HATCHING, or *Haching*, in designing, &c. the making of lines with a pen, pencil, graver, or the like; and the intersecting or going across those lines with others drawn a contrary way, is called counter-hatching. The depths and shadows of draughts are usually formed by hatching.

HATTOCK, a shock of corn containing twelve sheaves: others make it only three sheaves laid together.

HAUL, or HALE, an expression peculiar to seamen, implying to pull a single rope, without the assistance of blocks or other such mechanical powers. To haul the wind, is to direct the ship's course nearer to that point of the compass from which the wind arises.

HAUTBOY, a musical instrument of the wind-kind, shaped much like the flute, only that it spreads and widens towards the bottom, and is sounded through a reed. The treble is two feet long; the tenor goes a fifth lower, when blown open: it has only eight holes; but the bass, which is five feet long, has eleven.

HAWK. See FALCO.

HAWKERS and PEDLARS, are such dealers or itinerary petty chapmen as travel to different fairs or towns with goods or wares, and are placed under the controul of commissioners, by whom they are licensed for that purpose pursuant to stat. 8 and 9 W. III. c. 25. and 29 Geo. III. c. 26. Traders in linen and woollen manufactories sending their goods to markets and fairs, and selling them by wholesale; manufacturers selling their own manufactures, and makers and sellers of English bone-lace going from house to house, &c. are excepted out of the acts, and not to be taken as hawkers.

HAWKING. See FALCONRY.

HAWSER, in the sea-language, a large rope, or a kind of small cable, serving for various uses aboard a ship, as to fasten the main and fore shrouds, to warp a ship as she lies at anchor, and wind her up by a capstern, &c. The hawser of a man of war may serve for a cable to the sheet-anchor of a small ship.

HAWSES, in a ship, are two large holes under the bow, through which the cables run when she lies at anchor. Thus the hawse-pieces are the large pieces of timber in which these holes are made. Hawse-bags, are bags of canvas made tapering, and stuffed full of oakum; which are generally allowed small ships, to prevent the sea from washing in at these holes: and hawse-plugs are plugs to stop the hawses, to prevent the water from washing into the manger.

There are also some terms in the sea-language that have an immediate relation to the hawses. Thus a bold hawse, is when the holes are high above the water. Fresh the hawse, or veer out more cable, is used when part of the cable that lies in the hawse is fretted or chafed, and it is ordered that more cable may be veered out, so that another part of it may rest in the hawses. Fresh the hawse, that is, lay new pieces upon the cable in the hawses, to preserve it from fretting. Burning in the hawse, is when the cables endure a violent stress. Clearing the hawses, is disentangling two cables that come through different hawses. To ride hawse-full, is when in stress of weather the ship falls with her head deep in the sea, so that the water runs in at the hawses.

HAY, any kind of grass, cut and dried, for the food of cattle. See HUSBANDRY.

HAZARD: a game on dice, without tables, is very properly so called, since it speedily makes a man, or undoes him.

It is played with only two dice; and as many may play it as can stand round the largest round table.

Two things are chiefly to be observed, viz. main and chance; the latter belonging to the caster, and the former, or main, to the other gamesters. There can be no main thrown above nine, nor under five; so that five, six, seven, eight, and nine, are the only mains flung at hazard. Chances and nicks are from four to ten: thus four is a chance to nine, five to eight, six to seven, seven to six, eight to five; and nine and ten a chance to five, six, seven, and eight: in short, four, five, six, seven, eight, nine, and ten, are chances to any main, if any of these nick it not. Now nicks are either when the chance is the same with the main, as five and five, or the like; or six and twelve, seven and eleven, eight and twelve. Here observe, that twelve is out to nine, seven, and five; eleven is out to nine, eight, six, and five; and ames-ace and deuce-ace are out to all mains whatever.

But to illustrate this game by a few examples: Suppose the main to be seven, and the caster throws five, which is his chance; he then throws again, and if five turn up, he wins all the money set him; but if seven is thrown, he must pay as much money as there is on the board: again, if seven is the main, and the caster throws eleven, or a nick, he sweeps away all the money on the table; but if he throws a chance, as in the first case, he must throw again: lastly, if seven is the main, and the caster throws ames-ace, deuce-ace, or twelve, he is out; but if he throws from four to ten, he has a chance; though they are accounted the worst chances on the dice, as seven is reputed the best and easiest main to be flung. Four and five are bad throws (the former of which being called by the tribe of nickers little dick-fisher), as having only two chances, viz. trey-ace and two deuces, or trey-deuce and quartre-ace: whereas seven has three chances, viz. cinque-deuce, sice-ace, and quartre-trey. Nine and ten are in the like condition with four and five, having only two chances. Six and eight have indeed the same number of chances with seven, viz. three; but experienced gamesters nevertheless prefer the seven, by reason of the difficulty to throw the doublets, two quarters, or two treys. It is also the opinion of most, that at the first throw the caster has the worst of it. On the whole, hazard is certainly one of the most bewitching and ruinous games played on the dice. Happy, therefore, the man who either never heard of it, or who has resolution enough to leave it off in time.

HAZEL. See CORYLUS.

HEAD. See ANATOMY.

HEAD. See ARCHITECTURE.

HEAD, in heraldry. The heads of men, beasts, or birds, are very frequent in armoury; and borne either full-faced, looking forward, or side-faced in profile, when only one half of the face appears, which differences ought to be mentioned in blazoning, to avoid mistakes; as a head, or heads fronting; or a head, or heads side-faced, or in profile: thus, vert, a chevron gules, between three turks'-heads couped side-faced proper, is borne by the name of Smith. And again, or, a cross gules, between four blackmoors' heads, couped at the shoulders proper, is borne by the name Juxon. As the head is the principal part of the body, so it is of course the noblest bearing.

Among medalists, the different heads on ancient coins, are distinguished by the different dresses. See MEDAL.

In the imperial medals, where the head is quite bare, it is usually a sign the person was not an emperor, but one of the children of an emperor, the presumptive heir of the empire. The heads which are covered, are either covered with a diadem, or a crown, or a simple cork, or a veil, with some other foreign covering, whereof the diadem is the most antient. The heads of deities are distinguished by some special symbol.

HEAD-ACHE. See MEDICINE.

HEADBORROW, or HEADBOROUGH, the chief of the frankpledge, and he that had the principal government of them within his own pledge. And as he was called headborrow, so was he called burrowhead, bursholder, thirdborrow, tithingman, chief-pledge, or borrow-elder, according to the diversity of terms in several places. The same officer is now occasionally called a constable. The headborough was the chief of the ten pledges: the other nine were called hardboroughs, or inferior pledges.

HEAD-LINES, in a ship, those ropes of all sails which are next to the yards, and by which the sails are made fast to the yard.

HEAD-SEA, is when a great wave or billow of the sea comes right ahead of the ship, as she is in her course.

HEAD-SAILS, in a ship, those which belong to the fore-mast and boltsprit: for it is by these that the head of the ship is governed, and made to fall off and keep out of the wind; and these in quarter-winds are the chief drawing sails.

HEAD *of a ship*, or other vessel, is the prow, or that part which goes foremost.

Dragon's HEAD, in astronomy, &c. is the ascending node of the moon, or other planet. See NODE.

HEARING, the sense whereby we perceive sounds. See ANATOMY, PHYSIOLOGY, and SOUNDS.

HEARSAY, is generally not to be admitted as evidence; for no evidence is to be allowed but what is upon oath; for if the first speech was without oath, another oath that there was such speech, makes it no more than a bare speaking, and so of no value in a court of justice; and besides, the adverse party has no opportunity of a cross-examination; and if the witness is living, what he has been heard to say is not the best evidence that the nature of the thing will admit. But in some cases hearsay evidence is allowed to be admissible; as to prove who was a man's grandfather when he married, what children he had, and the like; of which it is not reasonable to presume that there is better evidence. So in questions of prescription, it is allowed to give hearsay evidence, in order to prove general reputation; as where the issue was of a right to a way over the plaintiff's close, the defendant was admitted to give evidence of a conversation between persons not interested, then dead, wherein the right to the way was agreed. Theory of Evid. III. See EVIDENCE.

HEARSE. See HIND.

HEART. See ANATOMY.

HEAT, in physiology. See CALORIC.

HEAT, *Animal*. See RESPIRATION.

HEAT, in geography, the diversity of the heat of climates and seasons arising chiefly from the different angles under which the sun's rays strike upon the surface of the earth. Dr. Halley gives a mathematical computation of the effect of the sun under the different seasons and climates. Let it, however, be considered, that the different degrees of heat and cold in different places depend in a very great measure upon the accidents of situation, with regard to mountains and valleys, and the soil. The first greatly helps to chill the air by the winds which come over them, and which blow in eddies through the levels beyond; and mountains, sometimes turning a concave side to the sun, have the effects of a burning mirror upon the subject plain; and the like effect is sometimes had from the convex parts of clouds, either by refraction, or reflection. As to soils, a stony, sandy, or chalky earth, it is known, reflects most of the sun's rays into the air again, and retains but few, by which means a considerable accession of heat is derived to the air; as, on the contrary, black loose soils absorb most of the rays, and return few into the air, so that the ground is much the hotter.

The following table of the heat of different climates is computed for every tenth degree of latitude, to the equinoctial and tropical sun; by which an estimate may be made of the intermediate degrees.

Lat.	Sun in ♈ ♎	Sun in ♋	Sun in ♑
0	20000	18341	18341
10	19696	20290	15854
20	18797	21737	13166
30	17321	22651	10124
40	15321	23048	6944
50	12855	22991	3798
60	10000	22773	1075
70	6840	23543	000
80	3473	24673	000
90	0000	25055	000

Hence are deducible the following corollaries. 1. That the equinoctial heat, when the sun becomes vertical, is as twice the square of the radius, which may be proposed as a standard to compare with in all other cases. 2. That under the equinoctial, the heat is as the sine of the sun's declination. 3. That in the frigid zones, where the sun sets not, the heat is as the circumference of a circle into the sine of the altitude at 6; and consequently that in the same latitude these aggregates of warmth are as the sine of the sun's declination; and at the same declination of the sun, they are as the sines of the latitudes into the signs of the declination. 4. That the equinoctial day's heat is every where as the cosine of the latitude. 5. In all places where the sun sets, the difference between the summer and winter heats, when the declinations are contrary, is equal to a circle into the sine of the altitude at 6 in the summer parallel; and consequently these differences are as the sine of the latitude into or multiplied by the sines of declination. 6. From the foregoing table, it appears that the tropical sun under the equinoctial, has of all others the least force. Under the pole, it is greater than any other day's heat whatever; being to that of the equinoctial as 5 to 4.

HEATH. See ERICA.

HEBENSTRETIA, a genus of the angiospermia order, in the didynamia class of plants; and in the natural method ranking under the 48th order, aggregatæ. The calyx is emarginated, and divided below; the corolla unilabiate; the lip rising upwards, and quadrifid; the capsule dispermous; the stamina inserted into the margin of the limb of the corolla. There are six species, herbs of the Cape.

HECATOMBÆON, in ancient chronology, the first month of the Athenian year, consisting of thirty days, and answering to the latter part of our June and beginning of July.

HECTIC, or HECTIC FEVER. See MEDICINE.

HEDERA, IVY, a genus of the monogynia order, in the pentandria class of plants; and in the natural method giving name to the 46th order, hederacæ. There are five oblong petals; the berry is pentaspermous, girt by the calyx. There are six species; the most remarkable are: 1. The helix, or common ivy, which grows naturally in many parts of Britain; and, where it meets with any support, will rise to a great height, sending out roots on every side, which strike into the joints of walls or the bark of trees. If there is no support, they trail on the ground, and take root all their length, so that they closely cover the surface, and are difficult to eradicate. While these stalks are fixed to any support, or trail upon the ground, they are slender and flexible; but when they have reached to the top of their support, they shorten and become woody, forming themselves into large bushy heads; and their leaves are larger, more of an oval shape, and not divided into lobes like the lower leaves, so that it has a quite different appearance. There are two varieties of this species; one with silver-striped leaves, the other with yellowish leaves on the tops of the branches; and these are sometimes admitted into gardens. 2. The quinquefolia, or Virginia creeper, is a native of all the northern parts of America. It was first brought to Europe from Canada; and has been long cultivated in the British gardens, chiefly to plant against walls or buildings to cover them: which these plants will do in a short time; for they will shoot almost twenty feet in one year, and will mount up to the top of the highest building; but as the leaves fall off in autumn, the plants make but an indifferent appearance in winter, and therefore are proper only for such situations as will not admit of better plants; for this will thrive in the midst of cities, and is not injured by the smoke or the closeness of the air.

The roots of the ivy are used by leather-cutters to whet their knives upon. Apricots and peaches covered with ivy during the month of February, have been observed to bear fruit plentifully. The leaves have a nauseous taste; Haller says, they are given to children in Germany, as a specific for the atrophy. The common people of England apply them to issues; and an ointment made from them is in great esteem among the Highlanders of Scotland as a ready cure for burns. The berries have a little acidity. In warm climates, a resinous juice exudes from the stalks, which is said to be a powerful resolvent, and an excellent ingredient in plasters and ointments. Horses and sheep eat the plant; goats and cows refuse it.

HEDGE-Breakers, by 43 Eliz. c. 7. shall pay such damages as a justice of the peace shall think fit; and on nonpayment shall be whipped. And by 15 Car. II. c. 6. the constable may apprehend a person suspected, and by warrant of a justice, may search his houses and other places; and if any hedge-wood shall be found, and he shall not give a good account how he came by the same, he shall be adjudged the stealer thereof.

HEDGES. See Husbandry.

HEDWIGEN, a genus of the octandria monogynia class and order. The cal. is four-toothed; the cor. four-cleft; style none; caps. tricoceous; seed a nut. There is one species, a tree of St. Domingo.

HEDYCARYA, a genus of the icosandria order, in the diœcia class of plants. The calyx of the male is cleft in eight or ten parts; there is no corolla, nor are there any filaments; the antheræ are in the bottom of the calyx, four-furrowed, and bearded at top. The calyx and corolla of the female are as in the male; the germs pedicellated; the nuts pedicellated and monospermous. There is one species, a tree of Guiana.

HEDYCREA, a genus of the class and order pentandria monogynia. The cal. is one-leafed, hemispherical, five-toothed: cor. none: drupe oval, one-celled: nect. ovate, covered with fibres, one-celled; shell hard. There is one species, a tree of Guiana.

HEDYOSMUM, a genus of the class and order monœcia polyandria. The male is an ament with anthers; no cor. perianth. or filaments. The female has cal. three-toothed; cor. none; style one, three-cornered; berry three-cornered, one-seeded. There are two species, shrubs of Jamaica.

HEDYOTIS, a genus of the monogynia order, in the tetrandria class of plants; and in the natural method ranking under the 47th order, stellatæ. The corolla is monopetalous and funnel-shaped; the capsule is bilocular, polyspermous, inferior. There are eight species, herbs of Ceylon, &c.

HEDYPNOIS, a genus of the class and order syngenesia polygamia æqualis. The cal. is calycled, with short scales; seeds crowned with the calycle; recept. naked, hollow-dotted.

HEDYSARUM, a genus of the decandria order, in the diadelphia class of plants; and in the natural method ranking under the 32d order, papilionaceæ. The carina of the corolla is transversely obtuse; the seed-vessel a legumen with monospermous joints. There are 90 species of this plant, of which the most remarkable are: 1. The gyrans, or sensitive hedysarum, a native of the East Indies, where it is called burrum chundalli. It arrives at the height of four feet, and in autumn produces bunches of yellow flowers. The root is annual or biennial. It is a trifolious plant, and the lateral leaves are smaller than those at the end, and all day long they are in constant motion without any external impulse. They move up and down, and circularly. This last motion is performed by the twisting of the footstalks; and while the one leaf is rising, its associate is generally descending. The motion downwards is quicker and more irregular than the motion upwards, which is steady and uniform. These motions are observable for the space of 24 hours in the leaves of a branch which is lopped off from the shrub, if it is kept in water. If from any obstacle the motion is retarded, upon the removal of that obstacle it is resumed with a greater degree of velocity. 2. The coronarium, or common biennial French honeysuckle, has large deeply-striking biennial roots; upright, hollow, smooth, very branchy stalks, three or four feet high, with pinnated leaves; and from between the leaves proceed long spikes of beautiful red flowers, succeeded by jointed seed-pods. The first species, being a native of hot climates, requires the common culture of tender exotics; the second is easily raised from seed in any of the common borders, and is very ornamental.

HEEL. See Anatomy.

Heel, in the sea-language. If a ship leans on one side, whether she is aground or afloat, then it is said she heels astarboard, or aport; or that she heels offwards, or to the shore; that is, inclines more to one side than to another.

HEGIRA, in chronology, a celebrated epocha among the Mahometans. The event which gave rise to this epocha was the flight of Mahomet from Mecca, with his new proselytes, to avoid the persecution of the Koraischites; who, being then most powerful in the city, could not bear that Mahomet should abolish idolatry, and establish his new religion. This flight happened in the fourteenth year after Mahomet had commenced prophet: he retired to Medina, which he made the place of his residence.

HEIGHT, in geometry, is a perpendicular let fall from the vertex, or top, of any right-lined figure, upon the base or side subtending it. It is likewise the perpendicular height of any object above the horizon; and is found several ways: by two staffs, a plain mirror with the quadrant, theodolite, or some graduated instrument, &c.

The measuring of heights or distances is of two kinds: when the place or object is accessible, as when you can approach to its bottom; or inaccessible, when it cannot be approached.

Prob. I. *To measure an accessible height* AB, *by means of two staffs.* See plate Miscel. fig. 111.

Let there be placed perpendicularly in the ground, a longer staff DE, likewise a shorter one FG, so that the observer may see A, the top of the height to be measured, over the ends D, F, of the two staffs; let FH and DC, parallel to the horizon, meet DE and AB in H and C; then the triangles FHD, DCA, shall be equiangular; for the angles at C and H are right ones: likewise the angle A is equal to FDH; wherefore the remaining angles are also equal. Therefore, as FH, the distance of the two staffs, is to HD, the excess of the longer staff above the shorter; so is DC, the distance of the longer staff from the tower, to CA, the excess of the height of the tower above the longer staff; and thence CA will be found by the rule of three. To which if the length DE be added, you will have the whole height of the tower BA.

Scholium. Another method may be occasionally contrived for measuring an accessible height; as by the given length of the shadow BD (fig. 112), I find out the height AB: for let there be erected a staff CE, perpendicularly, producing the shadow EF; then it will be as EF, the shadow of the staff, is to EC, the staff itself; so is BD, the shadow of the tower, to BA, the height. Though the plane on which the shadow of the tower falls, be not parallel to the horizon, yet if the staff be erected in the same plane, the rule will be the same.

Prob. II. *To measure an accessible height by means of a plain mirror.*

Let AB (fig. 113) be the height to be measured; let the mirror be placed at C, in the horizontal plane BD, at a known distance BC: let the observer go back to D, till he see the image of the summit in the mirror, at a certain point of it, which he must diligently mark; and let DE be the height of the observer's eye. The triangles ABC and EDC, are equiangular; for the angles at D and B are right angles; and ACB, ECD, are equal, being the angles of incidence and reflection of the ray AC; wherefore the remaining angles at A and E, are also equal. Therefore it will be, as CD is to DE, so is CB to BA.

The observer will be more exact, if, at the point D, a staff be placed in the ground perpendicularly, over the top of which the observer may see a point of the glass exactly in a line betwixt him and the tower.

In place of a mirror may be used the surface of water, which naturally becomes parallel to the horizon.

Prob. III. *To measure an accessible height by the geometrical quadrant, theodolite, &c.*

Let the angle C (fig. 114) be found. Then in the triangle ABC, right-angled at B (BC being supposed the horizontal distance of the observer from the tower), having the angle C, and the side BC, the required height will be found by the first case of plan trigonometry. Thus, suppose the angle C. 37° 24′, and the horizontal distance, BC, 116, then the proportion will be as R : T. ∠C :: CB : BA, the height.

The tangent altitude 37° 24′	- -	9.88341
Log. CB 116	- - -	2.06446
	Added -	11.94787
	Radius -	10.00000
Height of the object AB 88.69		1.94787

Supposing the observation made on the top of the tower, and the height of the tower to be known, to find the distance of any object on the plane below; it is only the converse of the former case.

You may also, having the base and angles, easily find the hypothenuse AC, or how far it is from the top of the tower to the station, by the second case of right-angled triangles: and it is useful in many cases.

Prob. IV. *To measure an inaccessible height by the geometrical quadrant, &c. at two stations.*

Let the angle ACB be observed (fig. 115); let the observer go from C, to the second station D, in the right line BCD; and after measuring this distance CD, take the angle ADC likewise with the quadrant. Then in the triangle ACD, which is formed by the two visual rays AD, AC, and the distance of the two stations D and C, there is given the angle ADC, with the angle ACD, because the angle ACB was given before; therefore the remaining angle CAD is given likewise. But the distance of the stations C and D is also given; therefore by the second case of oblique-angled trigonometry, the side AC will be found. Wherefore, in the right-angled triangle ABC, all the angles and the hypothenuse AC are given; consequently by the third case of plain trigonometry, the height sought, AB, may be found; as also the distance of the station C, from AB, the perpendicular within the hill or inaccessible height.

Example. Suppose the angle at C 43° 30′, and the angle at D 32° 12′, and the distance CD, betwixt the two stations, 112 feet; then the angle DAC will be 11° 18′, and the angle CAB 46° 30′. Hence for CA, the proportion will be as S. ∠ DAC : DC :: S. ∠ D : CA.

The log. DC 112 - -	2.04922
Sine ∠ D 32° 12′ - -	9.72663
Added -	11.77585
S. ∠ DAC 11° 18′ - -	9.29214
CA = 304.6 - - -	2.48371

Then for AB, the height of the object, it will be as R : S. ∠ ACB :: CA : AB.

As radius - - -	10.00000
is to the sine of 43° 30′ -	9.83781
so is CA 304.6 - - -	2.48371
to AB 209.7 - - -	2.32152

Lastly, for CB, the distance of the object from the nearest station, it will be as R : S. ∠ CAB :: CA : BC.

As radius - - -	10 00000
is to the sine of CAB 46° 30′	9.86056
so is CA 304.6 - - -	2.48371
to BC 221 - - -	2.34427

If the height of the tower is wanted, the angle BCF (fig. 116) may be found with the quadrant, which being taken from the angle ACB already known, the angle ACF will remain; but the angle FAC was known before; therefore the remaining angle AFC will be known. But the side AC was supposed found by the last problem; therefore in the triangle AFC, all the angles, and one of the sides AC, being known, AF the height of the tower above the hill may be found by trigonometry

PROB. V. *To measure the distance of two places* A *and* B, *of which one,* A, *is accessible, by the theodolite,* fig. 117.

Let there be erected at two points, A and C (sufficiently distant), visible signs; then let the two angles BAC, BCA, be taken by the theodolite. Let the distance of the stations A and C be measured with a chain. Then the third angle being known, and the side AC; therefore, by the second case of oblique trigonometry, the distance required AB will be found.

PROB. VI. *To measure by the theodolite, &c. the distance of two places, neither of which is accessible,* fig. 118

Let two stations C and D be chosen, from each of which the places may be seen whose distance is sought: let the angles ACD, BCD. and likewise the angles BDC, BDA, CDA, be measured by the theodolite, &c and the distance of the stations C and D be measured by a chain, or, if necessary, by the last problem. Now in the triangle ACD, there are given two angles ACD and ADC; therefore the third CAD is likewise given: moreover the side CD is given; therefore by the second case of oblique trigonometry, the side AD will be found. After the same manner, in the triangle BCD, from all the angles, and one side CD given, the side BD is found. Wherefore, in the triangle ADB, from the given sides DA and DB, and the angle ADB contained by them, the side AB (the distance sought) is found too by the fourth case of oblique-angled trigonometry. Note, that it is not necessary that the points A, B, C, and D, be in one plane, and that any triangle is in one plane.

HEIR, is he to whom lands, tenements, or hereditaments, by the act of God and right of blood, descend of some estate of inheritance. Co. Lit. 7. b.

HEIR *apparent*. Here we must observe, that no person can be heir until the death of his ancestor; yet in common parlance, he who stands nearest in degree of kindred to the ancestor, is called even in his life-time, heir apparent. Co. Lit. 8. n. The law also takes notice of an heir apparent, so far as to allow the father to bring an action of trespass for taking away his son and heir, the father being guardian by nature to his son, where any lands descended to him. Co. Lit. 37.

Heir-general: the heir-general, or heir at common law, is he who after his father's or ancestor's death has a right to, and is introduced into, all his land, tenements, and hereditaments; but he must be of the whole blood, not a bastard, alien, &c. None but the heir-general, according to the course of the common law, can be heir to a warrantry, or sue an appeal of the death of his ancestors. Co. Lit. 14.

Customary heir: a custom in particular places varying the rules of descent at common law is good; such is the custom of gavelkind, by which all the sons shall inherit, and make but one heir to their ancestor; but the general custom of gavelkind lands extends to sons only; but a special custom, that if one brother dies without issue, all his brothers may inherit, is good. Co. Lit. 140 a.

To prevent the wrong and injury to creditors by the alienation of the lands descended, &c. by 3 and 4 W. & M. c. 14. it is enacted, that in all cases where any heir at law shall be liable to pay the debt of his ancestor, in regard of any lands, tenements, or hereditaments descending to him, and shall sell, alien, and make over, the same before any action brought or process sued out against him, such heir at law shall be answerable for such debt or debts in action or actions of debt to the value of the said land so by him sold, alienated, or made over; in which case all creditors shall be preferred, as in actions against executors and administrators: and such execution shall be taken out upon any judgment or judgments so obtained against such heirs, to the value of the said land, as if the same were his own proper debts; saving that the lands, tenements, and hereditaments, bona fine aliened before the action brought, shall not be liable to such execution. Provided, that where any action of debt upon any specialty, is brought against any heir, he may plead riens per descent at the time of the original writ brought, or the bill filed against him; any thing therein contained to the contrary notwithstanding. And the plaintiff in such action may reply, that he had lands, tenements, or hereditaments, from his ancestor before the original writ brought, or the bill filed; and if upon issue joined thereupon, it is found for the plaintiff, the jury shall inquire of the value of the lands, tenements, or hereditaments so descended, and thereupon judgment shall be given, and execution shall be awarded as aforesaid; but if judgment is given against such heir, by confession of the action with the assets descended, or upon demurrer, or nihil dixit, it shall be for the debt and damages, without any writ to enquire of the lands, tenements, or hereditaments, so descended.

Before this statute, if the ancestor had devised away the lands, a creditor by specialty had no remedy, either against the heir or devisee. Abr. Eq. 149.

But by the said statute, it is enacted that all wills and testaments, limitations, dispositions, or appointments, of or concerning any manors, messuages, lands, tenements, or hereditaments, or of any rent, profit, term, or charge out of the same, whereof any person at the time of his decease shall be seized in fee simple, possession, reversion, or remainder, or have power to dispose of the same by his last will and testament, shall be deemed and taken only against such creditor as aforesaid, his heirs, successors, executors, administrators and assigns, and every of them, to be fraudulent, and clearly, absolutely, and utterly void, frustrate, and of none effect; any pretence, colour, feigned or presumed consideration, or any other matter or thing, to the contrary notwithstanding.

And for the means, that such creditors may be enabled to recover their said debts, it is farther enacted, that in the cases before-mentioned, every such creditor shall and may maintain his action of debt, upon his said bonds and specialties, against the heir at law of such obligor, and such devisee and devisees jointly, by virtue of this act; and such devisee and devisees shall be liable and chargeable for a false plea by him or them pleaded, in the same manner as any heir should have been for false plea by him pleaded, or for not confessing the lands or tenements to him descended.

Provided, that where there has been or shall be any limitation or appointment, devise or disposition, of any manors, messuages, lands, tenements, or hereditaments, for the raising or payment of any real or just debt, or any portion, sum, or sums of money, for any child or children of any person, other than the heir at law, in pursuance of any marriage-contract or agreement in writing bona fide made before such marriage; the same and every of them shall be in full force, and the same manors, &c. may be holden and enjoyed by every such person, his heirs, executors, administrators, and assigns, for whom the said limitation, appointment, devise, or disposition was made, and by his trustee, his heirs, executors, administrators, and assigns, for such estate or interest as shall be so limited or appointed, devised, or disposed, until such debt or debts, portion or portions, shall be raised, paid, and satisfied; any thing contained in this act to the contrary notwithstanding.

And it is further enacted by the said statute, that all and every devisee and devisees made liable by this act, shall be liable and chargeable in the same manner as the heir at law, by force of this act, notwithstanding the lands, tenements, and hereditaments to him or them devised, shall be aliened before the action brought.

In the construction of this statute it has been holden, that though a man is prevented thereby from defeating his creditors by will, yet any settlement or disposition he shall make in his life-time of his lands, whether voluntary or not, will be good against bond creditors; for that was not provided against by the statute, which only took care to secure such creditors from any imposition which might be supposed in a man's last sickness; but if he gave away his estate in his life-time, this prevented the descent of so much to the heir, and consequently took away their remedy against him, who was only liable in respect of the lands descended; and as a bond is no lien whatsoever on the lands in the hands of the obligor, much less can it be so when they are given away to a stranger. Abr. Eq. 149.

HEIRESS, is a female heir to a person having an estate of inheritance of lands. If there are more than one, they are called co-

heiresses, or rather, in legal expression, coheirs. The offence of stealing an heiress is founded on the statute 3 Hen. VII. c. 2. which enacts, that if any man shall, for lucre, take any woman, being maid, widow, or wife, and having substance either in goods or lands, or being heir apparent to her ancestor, contrary to her will, and afterwards she be married to such misdoer, or by his consent to another, or defiled; he, his procurors, and abbettors, and such as knowingly receive such woman, shall be deemed principal felons; and by 39 Eliz. c. 9. the benefit of clergy is taken away from principals, procurors, and accessaries before. And it is not material whether a woman so taken contrary to her will, be at last married or defiled with her own consent or not, if she were under the force at the time.

HEIR-LOOMS, are such goods and personal chattles as, contrary to the nature of chattles, shall go by special custom to the heir, along with the inheritance, and not the executor of the last proprietor.

HEISTERIA, a genus of the monogynia order, in the decandria class of plants, and in the natural method ranking under the 12th order, holoraceæ. The calyx is quinquefid, the petals five; the fruit is a plum on a very large-coloured calyx. There is one species, a tree of Martinico.

HELENIUM, *bastard sun-flower*, a genus of the polygamia superflua order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked in the middle; under the radius, paleaceous; the pappus consists of five short awns; the calyx is simple and multipartite; the florets of the radius semitrifid. The species are: 1. The autumnale, with spear-shaped narrow leaves. 2. The pubescens, with pointed, spear-shaped, sawed leaves. Both these are natives of North America, where they grow wild in great plenty. They rise to the height of seven or eight feet in good ground. The roots, when large, send up a great number of stalks, which branch toward the top; the upper part of the stalk sustains one yellow flower, shaped like the sun-flower, but much smaller, having long rays, which are jagged pretty deep into four or five segments. These plants may be propagated by seeds, or by parting their roots; the latter is generally practised in this country. The best season to transplant and part the old roots is in October, when their leaves are past, or in the beginning of March just before they begin to shoot. They delight in a soil rather moist than dry, provided it is not too strong, or does not hold the wet in winter.

HELEPOLIS, in the antient art of war, a machine for battering down the walls of a place besieged, the invention of which is ascribed to Demetrius, the Poliorcete. Diodorus Siculus says, that each side of the helepolis was 405 cubits broad, and 90 in height; that it had nine stages, and was carried on four strong solid wheels eight cubits in diameter; that it was armed with large battering-rams, and had two roofs capable of supporting them; that in the lower stages there were different sorts of engines for casting stones; and in the middle they had large catapultas for lancing arrows, and smaller in those above, with a number of expert men for working all these machines.

HELIÆA, in Grecian antiquity, was the greatest and most frequented court in Athens, for the trial of civil affairs. The judges who sat in it were at least fifty, but the more usual number was either two or five hundred. When causes of great moment were to be tried, it was customary to call in the judges of the other courts: sometimes a thousand were called in, and then two courts are said to have been joined: sometimes fifteen hundred or two thousand were called in, and then three or four courts met together. They had cognizance of civil affairs of the greatest weight and importance, and were not permitted to give judgment till they had taken a solemn oath to do it with impartiality, and to give sentence according to the laws, &c.

HELIACAL, in astronomy, a term applied to the rising or setting of the stars, or, more strictly speaking, to their emersion out of and immersion into the rays and superior splendor of the sun.

A star is said to rise heliacally, when after having been in conjunction with the sun, and on that account invisible, it comes to be at such a distance from him, as to be seen in the morning before sun-rising; the sun, by his apparent motion, receding from the star towards the east: on the contrary, the heliacal setting is when the sun approaches so near a star as to hide it with his beams, which prevent the fainter light of the star from being perceived, so that the terms apparition and occultation would be more proper than rising and setting.

All the fixed stars in the zodiac, as also the superior planets, Mars, Jupiter, and Saturn, rise heliacally in the morning, a little before sun-rising, and a few days after they have set cosmically. Again, they set heliacally in the evening, a short time before their achronycal setting. But the moon, whose motion eastward is always quicker than the apparent motion of the sun, rises heliacally in the evening, after the new moon, and sets heliacally in the morning, when old and approaching to a conjunction with the sun.

The inferior planets, Venus and Mercury, which sometimes seem to go westward from the sun, and sometimes again have a quicker motion eastward, rise heliacally in the morning, when they are retrograde; but when direct in their motions, they rise heliacally in the evening. The heliacal rising or setting of the moon happens when she is 17° degrees distant from the sun; but for the other planets 20° are required; and for the fixed stars more or less according to their magnitude.

HELIANTHUS, *the great sun-flower*, a genus of the polygamia frustanea order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is paleaceous and plane; the pappus diphyllous; the calyx imbricated; the scales standing a little out at at the tops. There are 12 species, most of which are now very common in our gardens, though all of them are natives of America. They are all very hardy, and will thrive in almost any soil or situation. They may be propagated either by seeds or by parting their roots, but most of them are annual. The Jerusalem artichoke belongs to this genus.

HELICOID PARABOLA, or the *parabolic spiral*, is a curve arising from the supposition that the common or Apollonian parabola is bent or twisted, till the axis come into the periphery of a circle, the ordinates still retaining their places and perpendicular positions with respect to the circle, all these lines still remaining in the same plane. Thus, the axis of a parabola being bent into the circumference BCDM (Plate Miscell. fig. 119.), and the ordinates CF, DG, &c. still perpendicular to it, then the parabola itself, passing through the extremities of the ordinates, is twisted into the curve BFG, &c. called the helicoid, or parabolic spiral.

Hence all the ordinates CF, DG, &c. tend to the centre of the circle, being perpendicular to the circumference.

Also, the equation of the curve remains the same as when it was a parabola; viz. putting $x =$ any circular abscis BC, and $y =$ CF the corresponding ordinate, then is $px = y^2$, where p is the parameter of the parabola.

HELICONIA, a genus of the monogynia order, in the pentandria class of plants. The spatha is universal and partial; there is no calyx; the corolla has three petals, and the nectarium two leaves; the capsule is three-grained. There are three species, beautiful herbaceous stove plants from South America and the West Indies.

HELICTERES, *the screw-tree*, a genus of the decandria order, in the gynandria class of plants, and in the natural method ranking under the 37th order, columniferæ. The calyx is monophyllous and oblique; there are five petals, and the nectarium consists of five petal-like leaflets; the capsules are intorted or twisted inwards. There are nine species, all natives of warm climates. They are shrubby plants, rising from five to fourteen feet in height, adorned with flowers of a yellow colour. They are propagated by seeds, but are tender, and in this country must be kept in a stove during the winter.

HELIOCARPUS, a genus of the digynia order, in the dodecandria class of plants, and in the natural method ranking under the 37th order, columniferæ. The calyx is tetraphyllous; the petals four; the styles simple; the capsule bilocular, compressed, and radiated lengthwise on each side. There is one species, a tree of La Vera Cruz.

HELIOCENTRIC *latitude of a planet*, the inclination of a line drawn between the centre of the sun and the centre of a planet, to the plane of the ecliptic, which may be thus determined.

If the circle FGH (Plate Miscell. fig. 121.) represent the orbit of the earth round the sun, and the inner one ANB n, be so placed as to incline to the plane of the other (on which account it appears in the form of an ellipsis), then when the planet is in the node n, it will appear in the ecliptic, and so have no latitude. But if it move to P, then, being seen from the sun, it will appear to decline from the ecliptic, or to have latitude; and the inclination of the line SP to the plane of the ecliptic, is called the planet's heliocentric latitude; the measure of which is the angle PS p, supposing the line P p to be perpendicular to the plane of the ecliptic.

This heliocentric latitude will be continually increasing till the planet come to the point A, which they call the limit or utmost extent of it; and then it will decrease again till it reach the other node N, when it will

have no latitude; after which it will increase again, till it come to B, or its utmost latitude; and, lastly, decrease again, till the planet come to be in *n*, whence it set out.

HELIOCENTRIC *place of a planet*, in astronomy, the place of the ecliptic which in the planet would appear to a spectator placed at the centre of the sun.

The ingenious Dr. Halley gives the following method to find the heliocentrical places of a planet, and its distances from the sun, which supposes only that the periodical time of the planet is known. Let KLB (fig. 120.) be the orbit of the earth, S the sun, P the planet, or rather the point in the plane of the ecliptic, in which the perpendicular let fall from the planet meets that plane. And first when the earth is in K, observe the geocentric longitude of the planet, and having the theory of the earth, we have the apparent longitude of the sun, and, consequently, the angle PKS. The planet, after it has completed an entire revolution, returns again to the point P, at which time suppose the earth in L; and there again, let the planet be observed, and find the angle PLS, the planet's elongation from the sun. Having the times of observations, we have the places of the earth in the ecliptic, or the points K and L; and, consequently, the angle LSK, and the sides LS and SK: wherefore we shall have the angles SKL and SLK, and the side LK. From the known angles SKP and SLP, take away the known angles SKL and SLK, and we shall have the angles PKL and PLK known; therefore in the triangle PLK, having all the three angles, and the side LK, we shall find the side PL; and in the triangle PLS, having the sides PL and LS, and the intercepted angle PLS, we shall have the angle LSP, which determines the heliocentric place, and its distance from the node according to the ecliptic, as also the side SP. But as the tangent of the geocentric latitude is to the tangent of the heliocentric, so is the curtate distance of the planet from the sun to its curtate distance from the earth. But as the geocentric latitude may be found by observation, the heliocentric latitude will also be found; by which, and the curtate distance of the planet from the sun, we can find the true distance.

HELIOCOMETES, a phenomenon sometimes observed about sun-setting; being a large luminous tail or column of light proceeding from the body of the sun, and dragging after it, not unlike the tail of a comet; whence the name.

HELIOPHILA, a genus of the siliquosa order, in the tetradynamia class of plants, and in the natural method ranking under the 39th order, siliquosæ. There are two nectaria recurvated towards the vesicular base of the calyx. There are ten species, all herbaceous plants of the Cape.

HELIOSCOPE, in optics, a sort of telescope, peculiarly fitted for viewing the sun, without hurting the eyes. See OPTICS.

As the sun may be viewed through coloured glasses, without hurt to the eyes, if the object and eye-glasses of a telescope are made of coloured glass, as red or green, such a telescope will become an helioscope. But Mr. Huygens only used a plain glass, blacked at the flame of a candle on one side, and placed between the eye-glass and the eye, which answers the design of an helioscope very well.

HELIOSTATA, in optics, an instrument invented by the late learned Dr. S. Gravesande, who gave it this name, from its fixing apparently the rays of the sun in an horizontal direction across the dark chamber, all the while it is in use.

HELIOTROPE, a precious stone of a green colour, streaked with red veins. Pliny says it is thus called, because, when cast into a vessel of water, the sun's rays falling on it seem to be of a blood-colour; and that, when out of the water, it gives a faint reflection of the figure of the sun, and is proper to observe eclipses of the sun as a helioscope. The heliotrope is also called oriental jasper, on account of its ruddy spots. It is found in the East Indies, as also in Ethiopia, Germany, &c. According to Dr. Thompson, the colour of this stone is different shades of green, often stained or striped with olive, yellow, and red. Found in mass, and in angular pieces. Specific gravity 2.6. Brittle, infusible before the blow-pipe.

HELIOTROPIUM, *turnsole*, a genus of the polygynia order, in the pentandria class of plants, and in the natural method ranking under the 41st order, asperifoliæ. The corolla is salver-shaped and quinquefid, with lesser dents interjected alternately; the throat closed up by small arches formed in the corolla itself. There are 24 species, all of them natives of warm countries. Only one, called the tricoccum, grows in Europe, and is a native of France, Spain, and Italy. It is only remarkable for the property of its berries. See COLOUR-MAKING.

HELIX, in geometry, the same with spiral. In architecture some authors make a difference between the helix and the spiral. A stair-case, according to Daviler, is an helix, or is helical, when the stairs or steps wind round a cylindrical newel; whereas the spiral winds round a cone, and is continually approaching nearer and nearer its axis.

HELIX, *the snail*, in zoology, a genus belonging to the order of vermes testacea. The shell consists of one spiral, brittle, and almost diaphanous valve; and the aperture is narrow. There are 60 species, principally distinguished by the figure of their shells. They are of various sizes, from that of a small apple to less than half a pea. Some of them live on land, frequenting woods and gardens, or inhabiting clefts of rocks and dry sand-banks. Others of them are aquatic, inhabiting ponds, deep rivers, and the ocean. The principal species are,

The janthina, with a violet-coloured shell, is remarkable for the extreme thinness of its texture, which breaks with the least pressure, and seems therefore entirely calculated to keep the open sea, or at least to shun rocky shores. It inhabits the seas of Europe, especially the Mediterranean, those of Asia and Africa, and also the ocean. The living animal, when touched, exudes a juice which stains the hands of a violet-colour. Dr. Hawkesworth, in his Account of Cook's Voyage, mistakes this shell for that which yielded the purpura of the antients. But whoever looks into Pliny, can never have the least idea that the thin shell aforementioned could be the same with it. They had several shells which yielded the purple dye; but these were all rock-shells, and very different both in figure and hardness from the little helix janthina, which is not calculated for the neighbourhood of rocks.

2. The pomatia, or exotic snail, with five spires, most remarkably ventricose, and fasciated with a lighter and deeper brown, is a native of France, where it inhabits the woods, but has been naturalized in England, where it inhabits the woods in the southern counties. It was introduced, it is said, by sir Kenelm Digby, whether for medical purposes, or as food, is uncertain: tradition says, that to cure his beloved wife of a decay was the object. They are quite confined to our southern counties. An attempt was made to bring them into Northamptonshire, but they would not live there. These are used as a food in several parts of Europe during Lent, and are preserved in an escargatoire, or a large place boarded in, with a floor covered half a foot deep with herbs, in which the snails nestle and fatten. They were also a favourite dish with the Romans, who had their cochlearia, a nursery similar to the above. Fulvius Hirpinus was the first inventor of this luxury, a little before the civil wars between Cæsar and Pompey. The snails were fed with bran and sodden wine. If we could credit Varro, they grew so large, that the shells of some would hold ten quarts! People need not admire the temperance of the supper of the younger Pliny, which consisted of only a lettuce, three snails, two eggs, a barley-cake, sweet wine and snow, in case his snails bore any proportion in size to those of Hirpinus. Its name is derived not from any thing relating to an orchard, but from πωμα, an operculum, it having a very strong one. This seems to be the species described by Pliny, lib. viii. c. 39. which he says was scarce; that it covered itself with the opercle, and lodged under ground; and that they were at first found only about the maritime Alps, and more lately near Velitræ.

3. The hortensis, or garden-snail, is in form like the last, but less, and not umbilicated and clouded, or mottled with browns. It abounds with a viscid slimy juice, which it readily gives out by boiling in milk or water, so as to render them thick and glutinous. The decoctions in milk are apparently very nutritious and demulcent, and have been recommended in a thin acrimonious state of the humours, in consumptive cases and emaciations.

The eyes of snails are lodged in their horns, one at the end of each horn, which they can retract at pleasure. The manner of examining these eyes, which are four in number, is this: When the horns are out, cut off nimbly the extremity of one of them; and placing it before the microscope, you may discover the black spot at the end to be really a semiglobular eye. The dissection of this animal is very curious; for by this means the microscope not only discovers the heart beating just against the round hole near the neck, which seems the place of respiration, but also the liver, spleen, stomach, and intestines, with the veins, arteries, mouth and teeth, are plainly observable. The intestines of this creature are green, from its eating herbs, and are branched all over with fine capillary white veins; the mouth is like a hare's or rabbit's, with four or six needle-teeth, resembling those of leeches, and of a substance like horn. Snails are all hermaphrodites, having both sexes united in each individual. They

lay their eggs with great care in the earth, and the young ones are hatched with shells completely formed. Cutting off a snail's head, a little stone appears, which is supposed to be a great diuretic, and good in all nephritic disorders. Immediately under this stone the heart is seen beating; and the auricles are evidently distinguishable, and are membranous, and of a white colour; as are also the vessels which proceed from them.

Snails discharge their excrements at a hole in their neck; they also breathe by this hole, and their parts of generation are situated very near it.

So small an animal as the snail is not free from the plague of supporting other smaller animals on its body; and as in other animals we find these secondary ones either living on their surface, as lice, &c. or only in the intestines, as worms, it is very remarkable that the snail is infested in both these manners, lice being found sometimes on the surface of its body, and worms sometimes within its intestines. There is a part of the common garden snail, and of other of the like kinds, commonly called the collar. This surrounds the neck of the snail, and is considerably thick, and is the only part that is visible when the animal is retired quietly into its shell. In this state of the animal these insects which infest it are usually seen in considerable numbers marching about very nimbly on this part; besides, the snail, every time it has occasion to open its anus, gives them a place by which to enter into its intestines, and they often seize the opportunity.

Snails are great destroyers of fruit in our gardens, especially the better sorts of wall-fruit. Lime and ashes sprinkled on the ground where they most resort will drive them away, and destroy the young brood of them. It is a common practice to pull off the fruit they have bitten; but this should never be done, for they will eat no other till they have wholly eaten up this if it is left for them. See Plate Nat. Hist. fig. 223.

HELIX. See ANATOMY.

HELLEBORUS, *hellebore*, a genus of the polygynia order, in the polyandria class of plants, and in the natural method ranking under the 26th order, multisiliquæ. There is no calyx; but five or more petals; the nectaria are bilabiated and tubular; the capsules polyspermous, and a little erect. There are seven species, the most remarkable of which is the niger, commonly called Christmas-rose. It has roots composed of many thick fleshy spreading fibres, crowned by a large cluster of lobed leaves, consisting each of seven or eight obtuse fleshy lobes, united to one foot-stalk; and between the leaves several thick fleshy flower-stalks, three or four inches high, surmounted by large beautiful white flowers, of five roundish petals, and numerous filaments, appearing in winter, about or soon after Christmas.

This plant may be propagated either by seeds or parting the roots. It prospers in the open borders, or may be planted in pots to move when in bloom, in order to adorn any particular place; but it always flowers fairest and most abundantly in the front of a warm sunny border. The plants may be reremoved, and the roots divided for propagation, in September, October, or November; but the sooner in autumn it is done, the stronger will the plants flower at their proper season.

The root of this plant was antiently used as a cathartic. The taste of it is acrid and bitter. Its acrimony, as Dr. Grew observes, is first felt on the tip of the tongue, and then spreads itself immediately to the middle, without being much perceived in the intermediate part. On chewing the root for a few minutes, the tongue seems benumbed, and affected with a kind of paralytic stupor, as when burnt by eating any thing too hot. The fibres are more acrimonious than the head of the root whence they issue. Black hellebore root, taken from 15 to 30 grains, proves a strong cathartic, and as such has been celebrated for the cure of maniacal disorders, and such also as were attributed to what the antients called the atra bilis. In mania, however, this root appears by no means to be possessed of any specific power. It does not indeed appear that our black hellebore acts with so much violence as that of the antients, whence many have supposed it to be a different plant; and indeed the descriptions which the antients have left us of their hellebore, do not agree with those of any of the sorts usually taken notice of by modern botanists. Another species has been discovered in the eastern countries, which Tournefort distinguishes by the name of helleborus niger orientalis, amplissimo folio, caule prælto, flore purpurascente, and supposes to be the true antient hellebore, from its growing in plenty about Mount Olympus, and in the island of Anticyra, celebrated of old for the production of this antimaniacal drug: he relates, that a scruple of this sort given for a dose, occasioned convulsions. Our hellebore is looked upon principally as an alterative; and is sometimes employed in small doses for promoting the uterine and urinary discharges, &c. It proves a powerful emmenagogue in plethoric habits, where steel is ineffectual or improper. In some parts of Germany a species of black hellebore has been made use of, which frequently produced violent, and sometimes deleterious, effects. It appears to be the fetid kind of Linnæus, called in English settlewort, setterwort, or bastard hellebore. The roots of this may be distinguished from those of the true kind, by their being less black.

2. The hyemalis, with a beautiful yellow flower, which is the common harbinger of spring.

HELM *of a ship*, is a piece of timber fastened into the rudder, which comes forward into the steerage, or place where the person at the helm steers the ship, by holding the whipstaff in his hand, which is joined to the helm. They begin, however, to be left off, steering-wheels being used in their room.

There are several terms in the sea language relating to the helm: as, bear up the helm; that is, let the ship go more large before the wind: helm a mid-ship or right the helm; that is, keep it even with the middle of the ship: port the helm, put it over to the left side of the ship: starboard the helm, put it on the right side of the ship. See SHIP-BUILDING.

HELMET, an antient defensive armour worn by horsemen both in war and in tournaments. It covered both the head and face, only leaving an aperture in the front secured by bars, which was called the visor.

It is still used in heraldry by way of crest over the shield or coat of arms, in order to express the different degrees of nobility by the different manner in which it is borne. Thus a helmet in profile is given to gentlemen and esquires: to a knight, the helmet standing forward and the beaver a little open; the helmet in profile and open, with bars, belongs to all noblemen under the degree of a duke; and the helmet forward and open, with many bars, is assigned to kings, princes, and dukes. There is generally but one helmet upon a shield; but sometimes there are two, and even three: if there are two, they ought to face each other; and if three, the middlemost should stand directly forward, and the other two on the sides facing towards it.

HELMINTHOLITHUS, in natural history, a name given by Linnæus to petrified bodies resembling worms. Of these he reckons four genera. 1. Petrified lithophyta, found in the mountains of Sweden. 2. Petrified shells. 3. Petrified zoophytes. 4. Petrified reptiles. See LITHOPHYTA, &c.

HELONIAS, a genus of the trigynia order, in the hexandria class of plants, and in the natural method ranking under the 10th order, coronariæ. The corolla is hexapetalous; there is no calyx; and the capsule is trilocular. There are two species, herbs of America.

HELVELIA, a genus of the class and order cryptogamia fungi. There are two species, natives of this country.

HELXINE. See POLYGONUM.

HEMATOPUS, in ornithology, a genus of the grallæ order. The generic character is: the bill compressed, the lip an equal wedge; nostrils linear; tongue a third part as long as the bill; feet formed for running, three-toed, cleft.

The H. ostrolegus, or oyster-catcher, inhabits almost every sea-shore, is sixteen and a half inches long, feeds on marine worms and insects, but chiefly on oysters and limpets, which it extracts from the shell with great dexterity. Eggs, four to five; colour, olive-yellow, with irregular purplish spots. This is the only species. See Plate Nat. Hist. fig. 219.

HEMEROBIUS, in zoology, a genus of insects of the neuroptera order, the characters of which are these: the mouth is furnished with two teeth; the palpi are four; the wings are deflected but not plaited; and the antennæ are bristly and longer than the breast. There are 15 species, principally distinguished by their colours. This insect takes the name of hemerobius from the shortness of its life, which, however, continues several days. In the state of larva it is a great devourer of plant-lice, for which it has had bestowed upon it the appellation of lion of the plant-lice. The hemerobii, even after their transformation, preserve their carnivorous inclination. Not satisfied with making war upon the plant-lice, who tamely let themselves be devoured, they do not spare each other. The eggs of this insect are borne upon small pedicles, which are nothing but a gum spun out by the hemerobius by raising up the hinder part of its abdomen, and by that means the egg remains fastened to the upper part of the thread. Those eggs are deposited upon leaves, and set in the form of bunches. They have been taken for parasitic plants.

The larva, when hatched, finds there its food in the midst of plant-lice. In 15 or 16 days it has attained to its full growth. With its spinning-wheel at its tail, it makes itself a small, round, white, silky cod, of a close texture. In summer, at the end of three weeks, the hemerobius issues forth with its wings; but when the cod has not been spun till autumn, the chrysalis remains in it the whole winter, and does not undergo its final metamorphosis till the ensuing spring. The flight of this insect is heavy: some species have an excrementitious smell. One goes by the name of the water-hemerobius, because it lives mostly at the water-side. See Plate Nat. Hist. fig. 224.

HEMEROCALLIS, *day-lily*, or *lily-asphodel*, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 10th order, coronariæ. The corolla is campanulated, with the tube cylindrical; the stamina declining downard. There are five species, of which two are common here, viz.

1. The flava, or yellow day-lily, with strong fibrous roots, sending up large hollow keel-shaped leaves, two feet long, upright, leafless firm stalks, two feet high, dividing at top into several foot-stalks, each terminated by one large liliaceous yellow flower, of an agreeable odour. Of this there is a variety called the hemerocallis minor, or small yellow day-lily.

2. The fulva, reddish, or copper-coloured day-lily, has roots composed of strong fleshy fibres, and large oblong tubes; radical, keel-shaped, hollow, pointed leaves, a yard long, reflected at top, with leafless stalks, three or four feet high, and large copper-coloured liliaceous flowers. These have large stamina, charged with a kind of brown-coloured farina, which, on being touched or smelled to, is discharged in great plenty all over the hands and face. Both these species are hardy, and will thrive any where. They may be easily propagated by parting their roots in autumn, or almost any time after flowering, or before they begin to flower.

3. The japonica is a greenhouse plant, producing beautiful white flowers.

HEMERODROMI, in Grecian antiquity, centinels and guards appointed for the security and preservation of cities and other places. They went out of the city every morning as soon as the gates were opened, and kept patrolling all day about the place: sometimes also making excursions further into the country, to see that there were no enemies lying in wait to surprise them.

HEMERODROMI were also a sort of couriers among the antients, who only travelled one day, and then delivered their packets or dispatches to a fresh man, who run his day, and so on to the end of the journey.

HEMICYCLE. See ARCHITECTURE.

HEMIMERIS, a genus of the angiospermia order, in the didynamia class of plants. The capsule is biocular, with one of the cells more gibbous than the other; the corolla is wheel-shaped, with one division greater, and inverse heart-shaped; the interstice of the divisions nectar-bearing. There are three species, herbaceous plants of the Cape.

HEMINA, in Roman antiquity, a liquid measure which, according to Arbuthnot, was equal to half a wine-pint English measure; its contents being 2.818 solid inches.

HEMIONITIS, a genus of the natural order of filices, belonging to the cryptogamia class of plants. The fructifications are in lines, decussating or crossing each other. There are eight species, natives of the West Indies.

HEMIPLEGIA. See MEDICINE.

HEMIPTERA, derived from ἡμισυς *half*, πτερον *wing*, in the Linnæan system, the second order of insects, comprehending twelve genera, viz. the blatta, mantis, gryllus, fulgora, cicada, notonecta, nepa, cimex, aphis, chermes, coccus, and thrips, and a great number of species.

HEMISPHERE, in geometry, the half of a globe or sphere, when it is supposed to be cut through its centre in the plane of one of its great circles. Thus the equator divides the terrestrial globe into the northern and southern hemisphere: in the same manner the meridian divides the globe into the eastern and western hemisphere; and the horizon into two hemispheres, distinguished by the epithets upper and lower. The centre of gravity of an hemisphere is five-eights of the radius distant from the vertex.

HEMISPHERE is also used to denote a projection of half the terrestrial globe, or half the celestial sphere, on a plane, and frequently called planisphere.

HEMISTICH, in poetry, denotes half a verse, or a verse not completed. Of this there are frequent examples in Virgil's Æneid; but whether they were left unfinished by design or not, is disputed among the learned: such are *Ferro accincta vocat*, Æn. II. v. 614. And, *Italiam non sponte sequor*, Æn. IV. v. 361.

In reading common English verses, a short pause is required at the end of each hemistich, or half verse.

HEMLOCK. See CICUTA.

HEMP and FLAX. No hemp or flax is to be watered in any river, running water, stream, brook, or pond, where beasts are used to be watered, but only in their several ponds for that purpose, on pain of 20*s*. 33 Hen. VIII. c. 17.

Any persons may, in any place, corporate town, privileged or unprivileged, set up manufactories of hemp or flax; and persons coming from abroad, using the trade of hemp or flax-dressing, and of making thread, weaving cloth made of hemp or flax, or making tapestry hangings, twine or nets for fishery, cordage, &c. after three years, shall have the privileges of natural-born subjects. 15 Car. II. c. 15.

HEN. See PHASIANUS.

HENDECAGON, in geometry, a figure that has eleven sides, and as many angles. In fortification, hendecagon denotes a place defended by eleven bastions.

HENOTICON, in church history, a decree or edict of the emperor Zeno, made at Constantinople, in the year 482, by which he pretended to reconcile all parties under one faith.

HEPAR, a name formerly given to the combination of sulphur and alkali. It is now called sulphuret of potass.

HEPATIC GAS, the old name for the gas separated from sulphuret of alkali. It is now called sulphurated hydrogen gas.

HEPATICA. See ANEMONE.

HEPATITIS. See MEDICINE.

HEPTAGON, in geometry, a figure of seven sides and seven angles. When those sides and angles are all equal, the heptagon is said to be regular, otherwise it is irregular.

In a regular heptagon, the angle C, Plate Miscel. fig. 122, at the centre is $= 51^\circ\frac{3}{7}$, the angle DAB of the polygon is $= 128^\circ\frac{4}{7}$, and its half CAB $= 64^\circ\frac{2}{7}$. Also the area is $=$ the square of the side $AB^2 \times 3.6339124$, or $= AB^2 \times \frac{7}{4}t$, where t is the tangent of the angle CAB of $64^\circ\frac{2}{7}$ to the radius 1; or t is the root of the equation; $t^{12} - 26t^{10} + 143t^8 - 245t^6 + 143t^4 - 26t^2 + 1 = 0$; or $t = \sqrt{\frac{1+x}{1-x}} = \frac{1+\sqrt{1-y^2}}{y} = \frac{y}{1-\sqrt{1-y^2}}$, where the value of x and y are the roots of the equations

$$x^6 - \tfrac{5}{4}x^4 + \tfrac{3}{8}x^2 - \tfrac{1}{46} = 0,$$

$$y^6 = \tfrac{7}{4}y^4 + \tfrac{7}{8}y^2 - \tfrac{7}{64} = 0.$$

HEPTAGON, in Fortification, a place fortified or strengthened with seven bastions for its defence.

HEPTAGONAL NUMBERS, are a kind of polygonal numbers in which the difference of the terms of the corresponding arithmetical progression is 5. Thus,

Arithmeticals, 1, 6, 11, 16, 21, 26, &c.
Heptagonals, 1, 7, 18, 34, 55, 81, &c.

where the heptagonals are formed by adding continually the terms of the arithmeticals, above them, whose common difference is 5.

One property, among many others, of these heptagonal numbers is, that if any one of them be multiplied by 40, and to the product add 9, the sum will be a square number.

Thus $1 \times 40 + 9 = 49 = 7^2$;
and $7 \times 40 + 9 = 289 = 17^2$;
and $18 \times 40 + 9 = 729 = 27^2$;
and $34 \times 40 + 9 = 1369 = 37^2$; &c.

Where it is remarkable that the series of squares so formed is 7^2, 17^2, 27^2, 37^2, &c, the common difference of whose roots is 10, the double of the common difference of the arithmetical series from which the heptagonals are formed. See POLYGONALS.

HEPTAMERIS, in music, the seventh part of a meris, being, according to M. Sauveur, the forty-third part of the octave.

HEPTANDRIA, from επτα, septem, and ανηρ, a man, the seventh class in Linnæus's sexual method, consisting of plants with hermaphrodite flowers, which have seven stamina or male organs. The orders are four, derived from the number of styles or female organs. See BOTANY.

HEPTANGULAR FIGURE, in geometry, is one that has seven angles, and therefore also seven sides.

HERACLEUM, a genus of the pentandria digynia class of plants, the general flower of which is difform and radiated; the single flowers of the disc consist each of five equal petals, but those of the radius consist of five unequal petals. The fruit is elliptic, compressed, and striated on each side in the middle, and contains two oval compressed seeds. To this genus belongs the sphondylium or cow's parsnep of authors. There are six species.

HERACLIDÆ, or *return of the* HERACLIDÆ *into Peloponnesus*, in chronology, a famous epocha, that constitutes the beginning of prophane history; all the time preceding that period being accounted fabulous. This return happened in the year of the world 2862, an hundred years after they

were expelled, and eighty after the destruction of Troy.

HERALD, is an officer at arms, whose business is to denounce war, proclaim peace, or be otherwise employed by the king in martial messages or other business.

Heralds are the judges and examiners of gentlemen's coats of arms, and preservers of genealogies; and they marshal all solemnities at the coronation of princes, and funerals of great persons.

HERALDRY, the science which teaches how to blazon, or explain in proper terms, all that belongs to coats of arms; and how to marshal, or dispose regularly, divers arms on a field.

Arms, or coats of arms, are hereditary marks of honour, made up of fixed and determined colours and figures, granted by sovereign princes, as a reward for military valour, or some signal public service performed. These are intended to denote the descent and alliance of the bearer, or to distinguish states, cities, societies, &c. civil, ecclesiastical, and military.

Men in all ages have made use of figures of living creatures, or symbolical signs, to denote the bravery and courage either of their chief or nation, to render themselves the more terrible to their enemies, and even to distinguish themselves or families, as names do individuals. Thus the Egyptians bore an ox, the Athenians an owl, the Goths a bear, the Romans an eagle, the Franks a lion, and the Saxons a horse: the last is still borne in the arms of his present Britannic majesty. As to hereditary arms of families, William Camden, sir Henry Spelman, and other judicious heralds, agree, that they began no sooner than towards the latter end of the 11th century.

With tournaments first came up coats of arms; which were a sort of livery, made up of several lists, fillets, or narrow pieces of stuff of many colours, from whence came the fess, the bend, the pale, &c. which were the original charges of family-arms: for they who never had been at tournaments had not such marks of distinction. They who enlisted themselves in the croisades took up also several new figures hitherto unknown in armorial ensigns; such as alerions, bezants, escallop-shells, martlets, &c. but more particularly crosses, of different colours for distinction's sake. From this it may be concluded, that heraldry, like most human inventions, was insensibly introduced and established; and that, after having been rude and unsettled for many ages, it was at last methodized, perfected, and fixed, by the croisades and tournaments.

These marks of honour are called arms, from their being principally and first worn by military men at war and tournaments, who had them engraved, embossed, or depicted on shields, targets, banners, or other martial instruments. They are also called coat of arms, from the custom of the antients embroidering them on the coats they wore over their arms, as heralds do to this day.

Arms are distinguished by different names, to denote the causes of their bearing; such as arms of dominion; of pretension; of concession; of community; of patronage; of family; of alliance; of succession.

Arms of dominion, or sovereignty, are those which emperors, kings, and sovereign states do constantly bear; being annexed to the territories, kingdoms, and provinces, they possess. Thus the three lions are the arms of England, the harp those of Ireland, &c.

Arms of pretension are those of such kingdoms, provinces, or territories, to which a prince or lord has some claim, and which he adds to his own, although the said kingdoms or territories may be possessed by a foreign prince or lord. Thus the kings of England have quartered the arms of France with their own ever since Edward III. laid claim to the kingdom of France, which happened in the year 1330, on account of his being son to Isabella, sister to Charles the Handsome, who died without issue.

Arms of concession, or augmentation of honour, are either entire arms, or else one or more figures, given by princes as a reward for some extraordinary service. We read in history that Robert Bruce, king of Scotland, allowed the earl of Wintoun's ancestor to bear, in his coat-armour, a crown supported by a sword, to shew that he, and the clan Seaton, of which he was the head, supported his tottering crown.

Arms of community are those of bishoprics, cities, universities, academies, societies, companies, and other bodies corporate.

Arms of patronage are such as governors of provinces, lords of manors, patrons of benefices, &c. add to their family-arms, as a token of their superiority, rights, and jurisdiction. These arms have introduced into heraldry, castles, gates, wheels, ploughs, rakes, harrows, &c.

Arms of family, or paternal arms, are those that belong to one particular family, that distinguish it from others, and which no person is suffered to assume without committing a crime, which sovereigns have a right to restrain and punish.

Arms of alliance are those which families or private persons take up and join to their own, to denote the alliances they have contracted by marriage. This sort of arms is either impaled, or borne in an escutcheon of pretence, by those who have married heiresses.

Arms of succession are such as are taken up by them who inherit certain estates, manors, &c. either by will, entail, or donation, and which they either impale, or quarter with their own arms; which multiplies the titles of some families out of necessity, and not through ostentation, as many imagine.

These are the eight classes under which the different sorts of arms are generally ranged; but there is a sort which blazoners call assumptive arms, being such as are taken by the caprice or fancy of upstarts, though of ever so mean extraction, who, being advanced to a degree of fortune, assume them without a legal title.

The essential and integral parts of arms are these: 1. The escutcheon. 2. The tinctures. 3. The charges. 4. The ornaments.

Of the shield or escutcheon.—The shield or escutcheon is the field or ground whereon are represented the figures that make up a coat of arms: for these marks of distinction were put on bucklers or shields before they were placed on banners, standards, flags, and coat-armour; and wherever they may be fixed, they are still on a plane or superficies whose form resembles a shield.

Shields, in heraldry called escutcheons or scutcheons, from the Latin word scutum, have been, and still are, of different forms, according to different times and nations. Amongst antient shields, some were almost like a horseshoe, such as is represented by a few of the figures of escutcheons; others triangular, somewhat flat or rounded at the bottom. The English, French, Germans, and other nations, have their escutcheons formed different ways, according to the carver's or painter's fancy: of these various examples are contained in the plates of heraldry. But the shield of maids, widows, and of such as are born ladies, and are married to private gentlemen, is of the form of a lozenge (See Plate II).

Armorists distinguish several parts or points in escutcheons, in order to determine exactly the position of the bearings they are charged with; they are here denoted by the first nine letters of the alphabet, ranged in the following manner (See Plate I).

The knowledge of these points is of great importance, and ought to be well observed, for they are frequently occupied with several things of different kinds. It is necessary to observe, that the dexter side of the escutcheon is opposite to the left hand, and the sinister side to the right hand of the person that looks on it.

Distinctions of houses. These distinctions inform us how the bearer of each is descended from the same family; they also denote the subordinate degrees in each house from the original ancestors, viz.

First house. For the heir or first son the label; second son the crescent; third son the mullet; fourth son the martlet; fifth son the annulet; sixth son the fleur-de-lis.

Second house. The crescent, with the label on it, for the first son of the second son. The crescent on the crescent for the second son of the second son of the first house, &c. See the Plate.

By the *tinctures* or colours is meant that variety of hue of arms common both to shields and their charges: the colours generally used are red, blue, sable, vert, purpure. Note, yellow and white, termed or and argent, are metals; these colours are represented in engravings by dots and lines, as in the Plate.

Or is expressed by dots.

Argent is plain.

Gules, by perpendicular lines.

Azure, by horizontal lines.

Sable, by perpendicular and horizontal lines crossing each other.

Vert, by diagonal lines from the dexter chief to the sinister base point.

Purpure, by diagonal lines from the sinister chief to the dexter base point.

Furs.—There are different kinds, and represent the hairy skins of certain animals, prepared for the linings of robes of state; and antiently shields were covered with furred skins: they are used in coats of arms, viz.

Ermine, is black spots on a white field.

Ermines, is a field black with white spots.

Erminois, is a field gold with black spots.

Vair, is white and blue, represented by figures of small escutcheons arranged in a

line, so that the base argent is opposite to the base azure.

Potent-counter-potent, is a field covered with figures like crutch heads. See Plate.

Charges, are whatsoever bearings or figures are borne in the field of a coat of arms.

Rampant, signifies the lion standing erect on one of the hind legs.

Rampant-gardant, is a lion standing on his hind leg, looking full-faced.

Rampant-regardant, standing upon his hinder leg, looking back towards his tail.

Passant: this term is to express the lion in a walking position.

Sejant, for the lion sitting, as the example.

Saliant, is when the lion is leaping or springing forward, as the example.

Couchant, is a lion lying at rest, with the head erect.

Passant-gardant, for a beast, when walking, with its head looking full-faced.

Couped, cut off smooth and even, as the example.

Erased, signifying torn or plucked off, as the example.

Demy, is the half of any charge, as the example, a demy lion.

Dormant, for sleeping with its head resting on its fore paws.

Partition lines, by which is understood a shield divided or cut through by a line or lines, either horizontal, perpendicular, diagonal, or transverse: the engraved examples are the crooked lines of partition, viz. engrailed, invecked, wavy, nebule, imbattled, raguly indented, dancette, dove-tail. See Plate I.

Roundels are round figures, much used in arms: the English heralds vary their names according to their colour, thus:

Or,	is termed a	Bezant.
Argent,		Plate.
Gules,		Torteaux.
Azure,		Hurt.
Sable,		Pellett.
Vert,		Pomey.
Purpure,		Golpe.

Crescent, or half-moon, having its horns turned upwards.

Increscent, differs from the crescent, by having its horns turned to the dexter side.

Decrescent, is the reverse of the increscent, having its horns turned to the sinister side.

Rose, is represented, in heraldry, full-blown, with fine green barbs, and seeded in the middle.

Annulet, or ring, and by some authors supposed to be rings of mail.

Chess-rook. This piece is used in the game of chess.

Star, in heraldry, is termed an estoile, having six waved points.

Trefoil, or three-leaved grass.

Quatrefoil, or four-leaved grass.

Cinquefoil, or five-leaved grass.

Mascle, is in shape like the lozenge, but is always perforated, as the example.

Fountain, an heraldic term for a roundle barry wavy of six argents and azure.

Billet, a small parallelogram, supposed to be letters made up in the form of the example.

Rustre, is a lozenge pierced round in the middle.

Gutte, in heraldry, signifies drops of any thing liquid, and, according to their colour, are termed as follow: if

Or,	Gutte d'or.
Argent,	Gutte d'eau.
Vert,	Gutte de olive.
Gules,	Gutte de sang.
Azure,	Gutte de larmes.
Sable,	Gutte poix.

Fess, an ordinary composed of two horizontal lines drawn across the centre of the shield.

Chevron, an ordinary, in form like two rafters of a house, or a pair of compasses extended.

Bend, an ordinary, drawn diagonally from the dexter chief to the sinister base, and takes up one-third of the field.

Pale, an ordinary, which is placed perpendicular in the centre of the shield.

Chief, an ordinary, which always occupies the upper part of the shield, and contains in depth the third of the field.

Cross, an ordinary, composed of four lines, four perpendicular, and two transverse.

Saltire, an ordinary, in form like the cross of St. Andrew.

Bend-sinister, which is placed diagonally from the sinister chief to the dexter base of the shield.

Quarter, an ordinary, formed of two lines, one perpendicular, the other horizontal, taking up one-fourth of the field, as the example.

Canton, an ordinary, in form like the quarter, but the size is only the third part of the chief.

Pile, an ordinary, like the foot of the pile that is driven into the ground to make the foundation of a building in swampy ground.

Flanches, are composed of two circular lines, and are always borne double, as the example.

Flory, a cross, the ends terminating in fleurs-de-lis.

Moline, a cross, which turns round both ways at the extremities, like a hook.

Pattee, a cross, small in the centre, and widening to the ends, which are very broad.

Croslet, a cross, crossed again at the extremities at a small distance from each of the ends.

Lozenge, a four-cornered figure, like a pane of glass in old casements, supposed to be a physical composition given for colds, and was invented to distinguish eminent physicians.

Mullet, consists of five points, and pierced in the centre, and is supposed to represent a spur rowel.

Mill-rind, a cross, in form like the mill-ink which carries the millstone, and is perforated in the centre.

Water-boujet, antiently used as a vessel by soldiers for carrying water in long marches.

Helmets, were formerly worn as a defensive weapon to cover the bearer's head: a helmet is now placed over a coat of arms as its chief ornament, and a mark of gentility. The

First is a side-faced helmet of steel, with the vizor shut, for an esquire.

Second is a full-faced helmet of steel, with the vizor open, for knights or baronets.

Third is a side-faced helmet of steel, the bars and ornaments gold, for the nobility.

Fourth is a full-faced helmet, with bars all gold, for the sovereign and princes of the blood royal.

Close, signifies the wings of a bird are down, and close to the body.

Rising. This term is for a bird when in a position as if preparing to fly.

Displayed, signifies the wings of an eagle to be expanded, as the example.

Volant, a term for any bird represented flying.

Tripping, a term for a stag, antelope, or hind, when walking.

Courant, for a stag, or horse, or greyhound, running.

At gaze, is a term for a stag or hind; when looking full-faced, is termed at gaze.

Lodged, signifies the stag to be at rest on the ground.

Inverted, is for two wings conjoined, and the points of the wings downwards.

Erect, is for two wings conjoined, and th points erect, or upwards.

Hauriant. This term is for a fish when erect, paleways, as putting its head above water.

Naiant, for a fish, when borne horizontally across the shield, as swimming.

Cockatrice, a chimerical figure used in heraldry; its beak, wings, legs, comb, wattles, and spurs, partake of the fowl; and its body and tail of the snake.

Wyvern. This, like the former, is chimerical, and differs from the cockatrice in its head, having no comb, wattles, or spurs.

Dragon. This is an heraldic figure, as drawn by heralds. See the example.

Tiger. This, like the former, is of heraldic creation; being so different from the tiger of nature, it is termed the heraldic tiger.

Checky, is a shield or bearing, covered with small squares of different colours alternately.

Gyronny, is a shield divided into six or eight triangular parts of different colours, and the points all meeting in the centre of the shield.

Paly, is a shield divided into four, six, or more equal parts, by perpendicular lines, consisting of two colours.

Barry, is a shield divided into four, six, or more equal parts, by horizontal lines of two colours.

Bachelor.—The arms of a bachelor, whilst he remains such, he may quarter his paternal coat with other coats, if they belong to him, but he may not impale it till he is married.

Married man.—A married man is to conjoin the coat armours of himself and wife in one escutcheon paleways; the man's on the dexter side of the shield, and the woman's on the sinister side.

An heiress.—When an heiress is married, her arms are not to be impaled with her husband's, but are to be borne on an escutcheon of pretence, placed in the centre of the shield. Note, the escutcheon of pretence displays his pretension to her estate; and if the husband has issue by her, the heir of those two inheritors shall bear the hereditary coats of father and mother quarterly.

Quarterly.—Is an arms divided into four parts by a perpendicular and horizontal line crossing each other, in the centre of the shield, into four equal parts, termed quarters.

Maid.—The arms of a maid are to be placed in a lozenge; and if her father bore any difference in his coat the same is to be continued; for by the mark of cadency of her father's will be denoted what branch she is from.

Widow.—The arms of a widow are to be impaled with the arms of her late husband;

her husband on the dexter side, and her's on the sinister side, upon a lozenge, as the example.

Knight of the garter and his lady.—When a knight of the garter is married, his wife's arms must be placed in a distinct shield, because his arms are surrounded with the ensign of that order; for though the husband may give his equal share of the shield and hereditary honour, yet he cannot share his temporary order of knighthood with her.

Commoner and his lady.—The arms of a commoner married to a lady of quality: he is not to impale her arms with his own; they are to be set aside of one another in separate shields, as the lady still retains her title and rank. See the example.

Of the external ornaments of escutcheons.—The ornaments that accompany or surround escutcheons denote the birth, dignity, or office, of the person to whom the coat of arms appertaineth; and obtains both among the laity and clergy. The chief of which are as follow:

Crowns.—The first crowns were only diadems, bands, or fillets; afterwards they were composed of branches of divers trees, and then flowers were added to them. Among the Greeks, the crowns given to those who carried the prize at the Isthmian games, were of pine; at the Olympic, of laurel; and at the Nemean, of smallage. The Romans had various crowns to reward martial exploits and extraordinary services done to the republic. Examples of some of these crowns are frequently met with in modern achievements.

Modern crowns are only used as an ornament, which emperors, kings, and independent princes set on their heads, in great solemnities, to denote their sovereign authority. These are described in heraldry as follow:

The imperial crown is made of a circle of gold, adorned with precious stones and pearls, heightened with fleurs-de-lis, bordered and seeded with pearls, raised in the form of a cap voided at the top, like a crescent. From the middle of this cap rises an arched fillet enriched with pearls, and surmounted of a mound, whereon is a cross of pearls. See Plate II.

The crown of the kings of Great Britain is a circle of gold, bordered with ermine, enriched with pearls and precious stones, and heightened up with four crosses pattee, and four large fleurs-de-lis alternately; from these rise four arched diadems adorned with pearls, which close under a mound, surmounted of a cross like those at bottom.

The crowns of Spain and Portugal are a ducal coronet, heightened up with eight arched diadems that support a mound, ensigned with a plain cross. Those of Denmark and Sweden are both of the same form; and consist of eight arched diadems, rising from a marquis's coronet, which conjoin at the top under a mound ensigned with a cross botone. The crowns of most other kings in Europe are circles of gold, adorned with precious stones, and heightened up with large trefoils, and closed by four, six, or eight diadems, supporting a mound, surmounted of a cross.

The great Turk bears over his arms a turban, enriched with pearls and diamonds, under two coronets, the first of which is made of pyramidical points heightened up with large pearls, and the uppermost is surmounted with crescents.

The pope appropriates to himself a tiara or long cap of golden cloth, from which hang two pendants embroidered and fringed at the ends, semée of crosses of gold. This cap is inclosed by three marquis's coronets; and has on its top a mound of gold, whereon is a cross of the same, which cross is sometimes represented by engravers and painters pometted, recrossed, flowery, or plain. It is a difficult matter to ascertain the time when these haughty prelates assumed the three forementioned coronets. See Plate II.

Coronets.—The coronet of the prince of Wales, or eldest son of the king of Great Britain, was antiently a circle of gold set round with four crosses-pattee, and as many fleurs-de-lis alternately; but since the Restoration it has been closed with one arch only, adorned with pearls, and surmounted of a mound and cross, and bordered with ermine like the king's. But besides the coronet his royal highness has another distinguishing mark of honour, peculiar to himself, viz. a plume of three ostrich feathers, with an antient coronet of a prince of Wales. Under it, in a scroll, is this motto, Ich dien, which in the German or old Saxon language signifies "I serve." This device was at first taken by Edward prince of Wales, commonly called the black prince, after the famous battle of Cressy, in 1346, where having with his own hand killed John, king of Bohemia, he took from his head such a plume, and put it on his own. See Plate I.

The coronet of all the immediate sons and brothers of the kings of Great Britain is a circle of gold, bordered with ermine, heightened up with four fleurs-de-lis, and as many crosses-patee alternate. The particular and distinguishing form of such coronets as are appropriated to princes of the blood royal, is described and settled in a grant of Charles II. the 13th of his reign. See Plate I.

The coronet of the princesses of Great Britain is a circle of gold, bordered with ermine, and heightened up with crosses-pattee, fleurs-de-lis, and strawberry leaves alternate; whereas a prince's coronet has only fleurs-de-lis and crosses.

A duke's coronet is a circle of gold bordered with ermine, enriched with precious stones and pearls, and set round with eight large strawberry or parsley leaves. See Plate I.

A marquis's coronet is a circle of gold, bordered with ermine, set round with four strawberry leaves, and as many pearls on pyramidical points of equal height, alternate. See Plate I.

An earl's coronet is a circle of gold, bordered with ermine, heightened up with eight pyramidical points or rays, on the tops of which are as many large pearls, that are placed alternately with as many strawberry leaves, but the pearls much higher than the leaves. See Plate I.

A viscount's coronet differs from the preceding ones as being only a circle of gold bordered with ermine, with large pearls set close together on the rim, without any limited number, which is his prerogative above the baron, who is limited. See Plate I.

A baron's coronet, which it appears was granted by king Charles II., is formed with six pearls set at equal distances on a gold circle, bordered with ermine, four of which only are seen on engravings, paintings, &c. to shew he is inferior to the viscount. See Plate I.

The eldest sons of peers, above the degree of a baron, bear their father's arms and supporters with a label, and use the coronet appertaining to their father's second title; and all the younger sons bear their arms with proper differences, but use no coronets.

As the crown of the king of Great Britain is not quite like that of other potentates, so do most of the coronets of foreign noblemen differ a little from those of the British nobility.

Mitres.—The archbishops and bishops of England and Ireland place a mitre over their coat of arms. It is a round cap pointed and cleft at the top, from which hang two pendants fringed at both ends; with this difference, that the bishop's mitre is only surrounded with a fillet of gold, set with precious stones, whereas the archbishop's issues out of a ducal coronet. See Plate I.

This ornament, with other ecclesiastical garments, is still worn by all the archbishops and bishops of the church of Rome, whenever they officiate with solemnity; but it is never used in England otherwise than on coats of arms, as before mentioned.

The first archbishop's consecration in England was in the year 568. No mitre but an archbishop's is borne upon a ducal coronet, except the bishop of Durham, that see being a principality.

The first bishop's consecration in England was in the year 516.

Chapeaux, wreaths, and crests.—A chapeau is an antient hat, or rather cap, of dignity, worn by dukes, generally scarlet-coloured velvet on the outside, lined and turned up with fur; frequently to be met with above an helmet, instead of a wreath, under gentlemen's and noblemen's crests. Heretofore they were seldom to be found, as of right appertaining to primate families; but by the grants of Robert Cooke, Clarencieux, and other succeeding heralds, these, together with ducal coronets, are now frequently to be met with in families, who yet claim not above the degree of gentlemen. See Plate II.

The wreath is a kind of roll made of two skains of silk of different colours twisted together, which antient knights wore as a headdress when equipped for tournaments. The colours of the silk are always taken from the principal metal and colour contained in the coat of arms of the bearer. They are still accounted as one of the lesser ornaments of escutcheons, and are placed between the helmet and the crest (see Plate II.). In the time of Henry I. and long after, no man who was under the degree of a knight had his crest set on a wreath; but this, like other prerogatives, has been infringed so far that every body now-a-days wears a wreath.

The crest is the highest part of the ornaments of a coat of arms. It is called crest, from the Latin word crista, which signifies comb or tuft, such as many birds have upon their heads, as the peacock, pheasant, &c. in allusion to the place on which it is fixed. See Plate II. crest of the prince of Wales.

Crests were formerly great marks of honour, because they were only worn by heroes of great valour, or by such as were advanced to some superior military command, in order that they might be the better distinguished in an engagement, and thereby rally their men

HERALDRY.

Partition Lines.

Engrailed.
Invected.
Wavy.
Nebule.
Imbattled.
Raguly.
Indented.
Dancette.
Dove Tail.

Roundels &c.

Bezant. Plate. Torteaux. Hurt.
Pellet. Pomey. Golpe.

Increscent. Decrescent. Rose. Annulet.
Mascle. Lozenge. Billet. Fountain. Gultee.

Batchelor. Married Man. Heiress

Maid. Quarterly. Widow.

HONI SOIT QUI MAL Y PENSE

Knight of the Garter and his Lady.

Commoner and his Lady.

Papal Crown.

Archbishop

Bishop.

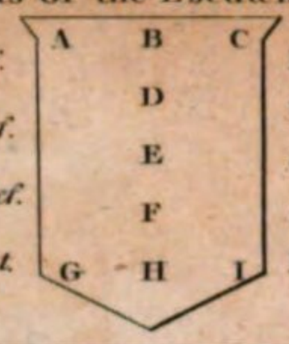
Colours.

Or. Gold
Argent. White
Gules. Red
Azure. Blue
Sable. Black
Vert. Green
Purpure. Purple
Ermine.
Ermines.
Erminois.
Vair.
Potent.

Charges.

Rampant. Rampant Gardant. Ramp.t Regardant. Passant.
Sejant. Saliant. Couchant. Passant Gardant.
Couped. Erased. Demy. Dormant.
King. Nobility. Knight. Esquire.
Close. Rising. Display'd. Volant.
Tripping. Courant. at Gaze. Lodged.
Inverted. Erect. Hauriant. Naiant.
Cockatrice. Wyvern. Dragon. Tyger.
Checky. Gyrony. Paly. Barry.

Points of the Escutcheon.



A. Dexter Chief.
B. Middle Chief.
C. Sinister Chief.
D. Honor Point.
E. Fess Point.
F. Nombril Point.
G. Dexter Base.
H. Middle Base.
I. Sinister Base.

Distinctions of Houses.

1 2 First House. 5 6
1 2 Second House. 5 6
1 2 Third House. 5 6
1 2 Fourth House. 5 6
1 2 Fifth House. 5 6
1 2 Sixth House. 5 6

Fess. Chevron. Bend. Pale.
Chief. Cross. Saltire. Bend Sinister.
Quarter. Canton. Pile. Flanches.
Flory. Moline. Pattee. Croslet.
Lozenge. Mullet. Mill Rind. Water Bouget.

Gutté or Drops.

Or Vert Sable
Argent Azure Gules

King's Crown & Helmet.

Prince of Wales.

Coronet of Princes of the Blood Royal.

Baron.

Duke.

Marquis.

Earl.

Viscount.

if dispersed; but they are at present considered as a mere ornament. The crest is frequently a part either of the supporters, or of the charge borne in the escutcheon. Thus the crest of the royal achievement of Great Britain is a "lion guardant crown'd." See Plate II. There are several instances of crests that are relative to alliances, employments, or names; and which on that account have been changed.

The scroll and supporters.—The scroll is the ornament usually placed below the crest, containing a motto, or short sentence, alluding thereto, or to the bearings, or to the bearer's name, as in the two following instances. The motto of the noble earl of Cholmondeley is, "Cassis tutissima virtus;" *i. e.* "Virtue is the safest helmet;" on account of the helmet in the coat of arms. The motto of the right hon. lord Fortescue is, "Forte scutum salus ducum;" *i. e.* "A strong shield is the safety of the commanders;" alluding to the name of that antient family. Sometimes it has reference to neither, but expresses something divine or heroic; as that of the earl of Scarborough, which is, "Murus æreus conscientia sana; *i. e.* "A good conscience is a wall of brass." Others are ænigmatical; as that of the royal achievement, which is, "Dieu et mon droit;" *i. e.* "God and my right;" introduced by Edward III. in 1340, when he assumed the arms and title of king of France, and began to prosecute his claim, which occasioned long and bloody wars, fatal, by turns, to both kingdoms. Mottos, though hereditary in the families that first took them up, have been changed on some particular occasions, and others appropriated in their stead, instances of which are sometimes met with in the history of families.

Supporters are figures standing on a scroll, and placed at the side of the escutcheon; they are so called because they seem to support or hold up the shield. Supporters have formerly been taken from such animals or birds as are borne in the shields, and sometimes they have been chosen as bearing some allusion to the names of those whose arms they are made to support. The supporters of the arms of Great Britain, since king James the First's accession to the throne, are, a lion rampant guardant crowned or, on the dexter side, and an unicorn argent, crowned, armed, unguled, maned and gorged with an antique crown, to which a chain is affixed, all or, on the sinister. See Plate II.

It is to be observed, that bearing coats of arms supported, is, according to the heraldic rules of England, the prerogative, 1st, Of those called nobiles majores, viz. dukes, marquisses, earls, viscounts, and barons; 2d, Of all knights of the garter, though they should be under the degree of barons; 3d, Of knights of the Bath, who both receive on their creation a grant of supporters; and, lastly, of such knights as the king chooses to bestow this honour upon.

Of the laws of heraldry, and the method of marshalling coats of arms.—1. The first and most general rule is, to express heraldic distinctions in proper terms, so as not to omit any thing that ought to be specified, and at the same time to be clear and concise without tautology. 2. Begin with the tincture of the field, and then proceed to the principal charges which possess the most honourable place in the shield, such as fess, cheveron, &c. always naming that charge first which lies next and immediately upon the field. 3. After naming the tincture of the field, the honourable ordinaries, or other principal figures, you must specify their attributes, and afterwards their metal or colour. 4. When an honourable ordinary, or some one figure, is placed upon another, whether it be a fess, cheveron, cross, &c. it is always to be named after the ordinary or figure over which it is placed, with one of these expressions, surtout, or over all. 5. In the blazoning of such ordinaries as are plain, the bare mention of them is sufficient; but if an ordinary should be made of any of the crooked lines mentioned above, its form must be specified; that is, whether it be engrailed, wavy, &c. 6. When a principal figure possesses the centre of the field, its position is not to be expressed, or (which amounts to the same thing) when a bearing is named, without specifying the point where it is placed, then it is understood to possess the middle of the shield. 7. The number of the points of mullets or stars must be specified when more than five; and also if a mullet or any other charge be pierced, it must be mentioned as such, to distinguish it from what is plain. 8. When a ray of the sun, or other single figure, is borne in any other part of the escutcheon than the centre, the point it issues from must be named. 9. The natural colour of trees, plants, fruits, birds, &c. is no otherwise to be expressed in blazoning but by the word proper; but if discoloured, that is, if they differ from their natural colour, it must be particularized. 10. When three figures are in a field, and their position is not mentioned in the blazoning, they are always understood to be placed two above, and one below. 11. When there are many figures of the same species borne in a coat of arms, their number must be observed as they stand, and must be distinctly expressed.

By marshalling coats of arms is to be understood the art of disposing divers of them in one escutcheon, and of distributing their contingent ornaments in proper places. Various causes may occasion arms to be thus conjoined, which are comprised under two heads, viz. manifest and obscure. What is meant by manifest causes in the marshalling of coats of arms, are such as betoken marriages, or a sovereign's gift, granted either through the special favour of the prince, or for some eminent services. Concerning marriages it is to be observed,

1. When the coats of arms of a married couple, descended of distinct families, are to be put together in one escutcheon, the field of their respective arms is conjoined paleways, and blazoned parted per bale, baron and femme, two coats; first, &c. In which case the baron's arms are always to be placed on the dexter side, and the femme's arms on the sinister side.

2. If a widower marry again, his late and present wife's arms are "to be placed on the sinister side, in the escutcheon with his own, and parted per pale. The first wife's coat shall stand on the chief, and the second on the base; or he may set them both in pale with his own, the first wife's coat next to himself, and his second outermost. If he should marry a third wife, then the two first matches shall stand on the chief, and the third shall have the whole base. And if he take a fourth wife, she must participate one-half of the base with the third wife, and so will they seem to be so many coats quartered." But it must be observed that these forms of impaling are meant of hereditary coats, whereby the husband stands in expectation of having the hereditary possessions of his wife united to his patrimony. Note. If a man marry a widow, he marshals her maiden arms only.

3. In the arms of femmes joined to the paternal coat of the baron, the proper differences by which they were borne by the fathers of such women must be inserted.

4. If a coat of arms that has a bordure be impaled with another, as by marriage, then the bordure must be wholly omitted in the side of the arms next the centre.

5. The person that marries an heiress, instead of impaling his arms with those of his wife, is to bear them in an escutcheon placed in the centre of his shield, which, on account of its showing forth his pretension to her estate, is called an escutcheon of pretence, and is blazoned surtout, that is, over-all. But the children are to bear the hereditary coat of arms of their father and mother quarterly, which denotes a fixed inheritance, and so transmit them to posterity. The first and fourth quarters generally contain the father's arms, and the second and third the mother's; except the heirs should derive not only their estate, but also their title and dignity, from their mother.

6. If a maiden or dowager lady of quality marry a commoner, or a nobleman inferior to her in rank, their coats of arms may be set beside one another, in two separate escutcheons, upon one mantle or drapery, and the lady's arms ornamented according to her title. See Plate II.

7. Archbishops and bishops impale their arms differently from the fore-mentioned coats, in giving the place of honour, that is, the dexter side, to the arms of their dignity, as it is expressed in Plate I. which represents the coat of arms of a supposed archbishop of Canterbury and bishop of an English see.

With respect to such armorial ensigns as the sovereign thinks fit to augment a coat of arms with, they may be marshalled in various ways, as may be seen in the arms of his grace the duke of Rutland, and many others.

So far the causes for marshalling divers arms in one shield, &c. are manifest. As to such as are called obscure, that is, when coats of arms are marshalled in such a manner that no probable reason can be given why they are so conjoined, the explanation of them must be left to the heralds.

Of the orders of knighthood, &c.—The baronet's mark of distinction, or the arms of the province of Ulster in Ireland, granted and made hereditary in the male line by king James I. who erected this dignity on the 22d of May, 1611, in the 9th year of his reign, in order to propagate a plantation in the forementioned province. This mark is argent, a sinister hand couped at the wrist, and erected gules; which may be borne either in a canton, or in an escutcheon, as will best suit the figures of the arms. The antient and respectable badge of the most noble order of the garter, was instituted by king Edward III. 1349, in the 27th year of his reign. This honourable augmentation is

a deep blue garter, surrounding the arms of such knights, and inscribed with his motto, "Honi soit qui mal y pense." See Plate II.

The arms of those who are knights of the orders of the Bath, of the Thistle, or of St. Patrick, are marshalled in the same manner, with this difference only, that the colour and motto accord with the order to which it belongs. Thus the motto, "Quis separabit 1783," on the light blue ribbon of the order, surrounds the escutcheon of a knight of St. Patrick. "Nemo me impune lacessit," on a green ribband, distinguishes a knight of the Thistle; and "Tria juncta in uno," on red, a knight of the Bath. It is to be observed that none of the orders of knighthood are hereditary. The honours of a baronet of Ulster, and of a baronet of Nova Scotia (created by patent in 1602), descend to the heirs male.

With regard to the emblazoning of the wife's arms in the case of the husband being noble; or where, on the other hand, the wife is noble in her own right, and the husband a commoner, these will be found exemplified in Plate II.

For representations of the badges of the several orders of knighthood, see Plate II. See ARMS, BLAZONING, PRECEDENCY, and the several terms of heraldry in alphabetical order.

HERBAL, is sometimes used for what is more usually called hortus siccus. See HORTUS SICCUS.

HERCULES, in astronomy, a constellation of the northern hemisphere, said to contain from 28 to 95 stars.

HEREDITAMENTS, all such things immoveable, whether corporeal or incorporeal, as a man may leave to his heirs, by way of inheritance; or not being otherwise devised, do naturally descend to him who is next heir of blood, and fall not within the compass of an executor or administrator, as chattels do. It is a word of large extent, and much used in conveyances; for by the grant of hereditaments, isles, seignories, manors, houses, and lands of all sorts, charters, rents, services, advowsons, commons, and whatever may be inherited, will pass. Co. Lit. 6.

Hereditaments are of two kinds, corporeal and incorporeal. Corporeal hereditaments consist wholly of substantial and permanent objects, all which may be comprehended under the general denomination of land only: for land comprehends in its legal signification any ground, soil, or earth whatsoever, as arable, meadows, pastures, woods, moors, waters, marshes, furzes, and heath. 1 Inst. 4.

Incorporeal hereditaments are not the object of sensation, neither can they be seen or handled, are creatures of the mind, and exist only in contemplation: they are principally of ten sorts, viz. advowsons, tithes, commons, ways, offices, dignities, franchises, corodies or presents, and rents. Black.

HERESY, among protestants, is said to be a false opinion, repugnant to some point of doctrine clearly revealed in scripture, and either absolutely essential to the christian faith, or at least of most high importance. 1 Haw. 3.

All old statutes that give a power to arrest or imprison persons for heresy, or introduced any forfeiture on that account, are repealed; yet by the common law an obstinate heretic being excommunicated is still liable to be proceeded by force of the writ, de excommunicato capiendo, till he makes satisfaction to the church. 1 Haw. 5.

And if any person having been educated in, or having made profession of the christian religion within this realm, shall be convicted in any of the courts at Westminster, or at the assizes, of denying any of the persons in the Holy Trinity to be God, or maintaining that there are more gods than one, or of denying the truth of the christian religion, or the divine authority of the holy scriptures, he shall, for the first offence, be adjudged incapable of any office; and for the second shall be disabled to sue any action, or to be guardian, executor, or administrator, or take by any legacy or deed of gift, or to bear any office civil or military, or benefice ecclesiastical, for ever, and shall also suffer imprisonment for three years, without bail or mainprise, from the time of such conviction.

HERIOT, signifies a tribute given to the lord for his better preparation towards war. And by the laws of Canute it appears, that at the death of the great men of this nation so many horses and arms were to be paid for as they were in their respective lifetimes obliged to keep for the king's service.

A heriot was first paid in arms and horses; it is now by custom sometimes the best live beast which the tenant dies possessed of; sometimes the best inanimate good, under which a jewel or piece of plate may be included. 2 Black. 422.

As to the several kinds of heriots, some are due by custom, some by tenure, and by reservation on deeds executed within time of memory; those due by custom are the most frequent, and arose by the contract or agreement of the lord and tenant, in consideration of some benefit or advantage accruing to the tenant, and for which an heriot, as the best beast, best piece of household furniture, &c. became due, and belonged to the lord either on the death or alienation of the tenant, and which the lord may seize, either within the manor or without, at his election. Dyer, 199, b.

It has been solemnly adjudged that for an heriot service, or for an heriot reserved by way of tenure, the lord may either seize or distrain; for when the tenant agrees that the lord shall on his death have the best beast, &c. the lord has his election which beast he will take, and by seizing thereof reduces that to his possession, wherein he had a property at the death of the tenant, without the concurring act of any other person; and it is not like the case where the tenant receives 20s. or a robe, for there the lessee has his election which he will pay, and being to do the first act, the lord cannot seize, but must distrain. Plowd. 96.

If the tenure be by rent and heriot service, viz. to have the best beast after the death of the tenant, and the lord distrain for the heriot, he cannot in his avowry shew which was the best beast that he was entitled to, nor of what value it was; for the tenant might have esloined the cattle, and thereby it might have been impossible for the lord to know which was the best beast; and the tenant at his peril is to render the best beast, or sufficient recompense. Cro. Car. 260.

Upon the whole, the custom of the manor is the law of it in all such like cases.

HERISSON, in fortification, a beam armed with a great number of iron spikes, with their points outwards, and supported by a pivot, on which it turns. These serve as a barrier to block up any passage, and are frequently placed before the gates, and more especially the wicket-doors of a town or fortress, to secure those passages which must of necessity be often opened and shut. See FORTIFICATION.

HERITIERA, a genus of the monœcia monadelphia class and order. The calyx is five-toothed; corolla none. Male, anthers 10, without filaments. Female, germ five; drupes with one globular seed. There is one species, a tree of the East Indies.

HERMÆA, in antiquity, antient Greek festivals, in honour of the god Hermes, or Mercury.

HERMANNIA, a genus of the pentandria order, in the monadelphia class of plants, and in the natural method ranking under the 37th order, columniferæ. The capsule is quinquelocular; the petals at the base are semitubulated and oblique. There are 21 species, the most remarkable are,

1. The lavendulifolia, which has a shrubby stalk and slender branches, very bushy, about a foot and a half high, small, spear-shaped, obtuse, and hairy leaves, with clusters of small yellow flowers along the sides of the branches, continuing from June to autumn.

2. The althæifolia has a shrubby stalk, and soft woolly branches, growing two feet high, with numerous yellow flowers in loose spikes growing at the end of the branches, and making their appearance in July.

3. The grossularifolia has a shrubby stalk and spreading branches, growing three or four feet high, with bright yellow flowers coming out in great numbers at the ends of all the shoots and branches in April or May.

4. The alnifolia has a shrubby stalk, and branches growing irregularly four or five feet high, with pale yellow flowers in short spikes from the sides and ends of the branches, appearing in April or May.

5. The hyssopifolia has a shrubby upright stalk, branching out laterally six or seven feet high, with pale yellow flowers in clusters from the sides of the branches, appearing in May and June. All these plants are natives of Africa, and therefore must be kept in a greenhouse during the winter in this country. They are propagated by cuttings of their young shoots, which may be planted in pots of rich earth any time from April to July.

HERMAS, a genus of the monœcia order, in the polygamia class of plants. The umbel in the hermaphrodite is terminal; there is an universal involucrum, and partial ones. The rays of the small umbels are lobed; the central one flower-bearing; there are five petals, and as many barren stamina; the seeds are two-fold, and suborbicular. In the male the lateral umbels have universal and partial involucra; the small umbels are many-flowered; there are five petals, and five fertile stamina. There are five species, herbs of the Cape.

HERMETICAL SEAL, among chemists, a method of stopping glass-vessels, used in chemical operations, so closely, that the most subtile spirit cannot escape through them. It is commonly done by heating the neck of the vessel in a flame, till ready to melt, and then twisting it close together with a pair of pincers. Or, vessels may be hermetically sealed, by stopping them with a glass plug,

DIEU ET MON DROIT

Earl and Baroness in her own Right.

Knight of the Garter.

HONI·SOIT·QUI·MAL·Y·PENSE

Baronet of Ulster.

Esquire or Gentleman.

Bar.t of Nova Scotia. Knight Bach.r

Method of Marshalling the ARMS of the Wife or Wives.

Husb.d Wife — Quarterings of his and his Wife's Arms.

Husband. Wife — The Wife not an Heir Female.

Husband. 2.d Wife. 1.st Wife — 2 Wives the 2.d Heir Female.

Husband. 1.st Wife. 2.nd Wife — 2 Wives not Heirs Female.

1.st Wife. 2.nd Wife — 2 Wives both Heirs Female.

Husband. 1.st Wife. 2.nd Wife — 3 Wives not Heirs Female.

a Commoner and his Lady, being a Baroness in her own right; without Supporters

HATCHMENTS.

Mural Crown.

Celestial Crown

Husband.

Wife.

Bachelor.

Widower.

Widow.

Lord Mayor.

Maid.

Prince of Wales's Crest

ICH DIEN

Cap of State borne by the Lord Mayor.

Garter King at Arms.

Knight of the Garter.

Baron & Married.

Bishop & Married.

Chaplet

Order of the Garter.

Order of the Thistle.

Order of the Bath.

Order of St. Patrick.

HONI·SOIT·QUI·MAL·Y·PENSE

NEMO·ME·IMPUNE·LACESSIT

TRIA·JUNCTA·IN·UNO

QUIS·SEPARABIT·MDCCXXIII

Collar of the Order.

Badge of St. George of the Order.

Chapeau or Cap of Dignity.

Imperial Crown.

well luted; or by covering the vessel with another ovum philosophicum.

HERNANDIA, *jack-in-a-box-tree*, a genus of the triandria order, belonging to the monœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ. The male calyx is tripartite; the corolla tripetalous; the female calyx is truncated, quite entire; the corolla hexapetalous; the plum hollow, and open at the mouth or upper part, with a loose kernel. The species are,

1. The sonora, or common jack-in-a-box, a native of both the Indies. It grows 20 or 30 feet high, with broad peltated leaves, and monœcious flowers, succeeded by a large swollen hollow fruit formed of the calyx; having a hole or opening at the end, and a hard nut within. The wind blowing into the cavity of this fruit makes a very whistling and rattling noise, whence comes the name.

2. The ovigera grows many feet high, with large oval leaves not peltated; and monœcious flowers, succeeded by a swollen fruit open at the end, and a nut within. It is said the sonora in Java affords a sure antidote against poison, if you either put its small roots on the wounds, or eat them; as was discovered to Rumphius by a captive woman in the war between the people of Macassar and the Dutch, in the year 1667. The soldiers of the former always carry this root about them, as a remedy against wounds with poisoned arrows. Both these plants being tender exotics, must be planted in pots of rich earth, and always kept in a hot-house; in which, notwithstanding all the care that can be taken, they seldom flower, and never grow beyond the height of common shrubs, though in the places where they are natives they arrive at the height of trees. They are propagated by seeds procured from the West Indies.

HERNIA. See MEDICINE and SURGERY.

HERNIARIA, *rupture-wort*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the eleventh order, holoraceæ. The calyx is quinquepartite; there is no corolla; there are five barren stamina, and a monospermous capsule. There are four species, of which the only remarkable one is the glabra, or smooth rupture-wort, a native of many parts of England. It is a low trailing plant, with leaves like the smaller chickweed; the flowers come out in clusters from the side of the stalks at the joints, and are of a yellowish green colour. This plant is a little saltish and astringent. The juice is useful to take away specks in the eye. Cows, sheep, and horses, eat the plant; goats and swine refuse it.

HERON, in ornithology. See ARDEA.

HERRING, in ichthyology. See CLUPEA and FISHERY.

HERRINGS, it is unlawful to buy or sell herrings at sea before the fishermen come into the haven, and the cable of the ship be drawn to the land. 31 Ed. III. c. 2.

No herrings shall be sold in any vessel but where the barrel contains 32 gallons, and half barrel and firkin accordingly; and they must be well packed, of one time's packing and salting, and be as good in the middle as at the ends; on pain of forfeiting 3s. 4d. a barrel.

Vessels with herrings are to be marked with the quantity and place where packed; and packers are to be appointed and sworn in all fishing ports, and under the penalty of 100*l*.

HERSE, in fortification, is a lattice or portcullice, made in the form of a harrow, and stuck full of iron spikes. See FORTIFICATION.

HESPERIS, *dame's violet*, or *queen's gilliflower*, a genus of the siliquosa order, in the tetradynamia class of plants, and in the natural method ranking under the 39th order, siliquosæ. The petals are turned obliquely; there is a glandule within the shorter stamina; the siliqua almost upright; the stigma forked at the base, connivent, or closing at the top. There are seven species, the most remarkable are,

1. The matronalis, or common sweet-scented garden rocket, having fibrous roots, crowned with a tuft of long, spear-shaped, rough, leaves; upright, single, hairy stalks, two feet high, terminated by large and long spikes of sweet-scented flowers of different colours and properties in the varieties, of which there is a great number. All the varieties of this species are so remarkable for imparting a fragrant odour, that the ladies were fond of having them in their apartments. Hence they derived the name of dame's violet; and bearing some resemblance to a stock-gilliflower were sometimes called queen's gilliflower, but are now most commonly called rocket.

2. The inodora, or scentless rocket, has upright stalks two feet high, all the branches terminated by large spikes of scentless flowers, with obtuse petals, of different colours and properties in the varieties.

3. The tristis, or dull-flowered night-smelling rocket, has upright, bristly stalks, two feet high, spear-shaped pointed leaves, and spikes of pale purple flowers, of great fragrance in the evening.

All the species are hardy, especially the first and second, which prosper in any of the open borders, and any common garden soil; but the third, being rather impatient of a severe frost, and of much moisture in winter, should have a dry warm situation, and a few may be placed in pots, to be sheltered in case of inclement weather. They may be propagated either by seeds, by offsets, or by cuttings off the stalks.

HESSIAN FLY. See TENTHREDO.

HETEROGENEOUS NUMBERS, mixed numbers, consisting of integers and fractions.

HETEROGENEOUS QUANTITIES, are those which are of such different kinds, as that one of them taken any number of times, never equals or exceeds the other.

HETEROGENEOUS SURDS, are such as have different radical signs, as $\sqrt[4]{aa}$, $\sqrt[5]{bb}$, $\sqrt[3]{9}$, $\sqrt[7]{18}$, &c. See SURD.

If the indices of the powers of the heterogeneous surds be divided by their greatest common divisor, and the quotients be set under the dividends; and those indices be multiplied crosswise by each others quotients; and before the products be set the common radical sign $\surd$, with its proper index; and if the powers of the given roots be involved alternately, according to the index of each others quotient, and the common radical sign be prefixed before those products, then will those two surds be reduced to others, having but one common radical sign. As to reduce

$\sqrt[2]{aa}$ and $\sqrt[4]{bb}$

$2)\sqrt{aa}\ (2 \quad \sqrt[4]{bb} \quad 1 \times 2$

$\sqrt[4]{bb} \quad \sqrt[4]{aaaa}$

HETEROSCII. See GEOGRAPHY.

HETEROUSIANS, a sect of Arians, who did not believe that the Son of God was of a substance like to that of the Father.

HEUCHERA, in botany, a genus of the pentandria digynia class of plants, the corolla whereof consists of five petals; the fruit is an ovato-accuminated capsule; semibifid, terminating in two reflex points, and containing two cells. There are two species.

HEXACHORD, in antient music, a concord called by the moderns a sixth.

HEXAEDRON, or HEXAHEDRON, one of the five regular or Platonic bodies; being indeed the same as the cube; and is so called from its having 6 faces.—The square of the side or edge of a hexahedron, is one-third of the square of the diameter of the circumscribing sphere; and hence the diameter of a sphere is to the side of its inscribed hexahedron, as $\sqrt{3}$ to 1.

In general, if A, B, and C, be put to denote respectively the linear side, the surface, and the solidity of a Hexahedron, or cube, also r the radius of the inscribed sphere, and R the radius of the circumscribed one; then we have these general equations or relations:

1. $A = 2r = \frac{2}{3}R\sqrt{3} = \sqrt{\frac{1}{6}B} = \sqrt[3]{C}$.
2. $B = 24r^2 = 8R^2 = 6A^2 = 6\sqrt[3]{C^2}$.
3. $C = 8r^3 = \frac{8}{9}R^3\sqrt{3} = A^3 = \frac{1}{6}B\sqrt{\frac{1}{6}B}$.
4. $R = r\sqrt{3} = \frac{1}{2}A\sqrt{3} = \frac{1}{2}\sqrt{\frac{1}{2}B} = \frac{1}{2}\sqrt{3} \times \sqrt[3]{C}$.
5. $r = \frac{1}{2}R\sqrt{3} = \frac{1}{2}A = \frac{1}{2}\sqrt{\frac{1}{6}B} = \frac{1}{2}\sqrt[3]{C}$.

HEXAGON, in geometry, a figure of six sides and angles; and if these sides and angles be equal, it is called a regular hexagon.

The side of every regular hexagon, inscribed in a circle, is equal in length to the radius of that circle. Hence, it is easy, by laying off the radius six times upon the circumference, to inscribe an hexagon in a circle.

To describe a regular hexagon on a given right line AB (plate Miscel fig. 123,) draw an equilateral triangle ACB, and the vertex C will be the centre of a circle which will circumscribe the hexagon required ABDEFG.

As 1 is to 1.672, so is the square of the side of any regular hexagon to the area thereof, nearly. Or the side of a hexagon being s, its area will be $= 2.5980762s^2 = \frac{3}{2}s^2 \times \text{tang. } 60^\circ = \frac{3}{2}s^2\sqrt{3}$.

HEXAGON, in fortification, is a place defended by six bastions.

HEXAMETER, in antient poetry, a kind of verse consisting of six feet; the first four of which may be indifferently, either spondees or dactyls; the fifth is generally a dactyl and the sixth always a spondee. Such is the following verse of Horace:

1	2	3	4	5	6
Aut pro	*desse vo*	*lunt, aut*	*delec*	*tare po*	*etæ.*

HEXANDRIA, in botany, a class of plants, the sixth in order, comprehending all those plants which have hermaphrodite flowers, and six stamina in each.

HIBISCUS, *Syrian mallow*, a genus of the polyandria order, in the monadelphia class of plants, and in the natural method ranking under the 37th order, columniferæ.

The calyx is double, the exterior one polyphyllous, the capsule quinquelocular and polyspermous. Of this genus there are 45 species; the most remarkable of which are,

1. The Syriacus, commonly called althæa frutex.

2. The rosa sinensis, with an arborescent stem, and egg-pointed as wed leaves. It is a native of the East Indies, whence it has obtained the name of China rose; but the seeds having been carried by the French to their West India settlements, it has thence obtained the name of Martinico rose. Of this there are the double and single flowering kinds; the seeds of the first frequently produce plants that have only single flowers, but the latter seldom vary to the double kind.

3. The mutabilis, or changeable rose, has a soft spongy stem, which by age becomes ligneous and pithy. It rises to the height of 12 or 14 feet, with heart-shaped leaves. The flowers are produced from the wings of the leaves; the single are composed of five petals, which spread open, and are at first white, but afterwards change to a blush rose-colour, and as they decay turn purple. In the West Indies all these alterations happen on the same day, and the flowers themselves are of no longer duration; but in Britain the changes are not so sudden.

4. The abelmoschus, or musk-seeded hibiscus, is a native of the West Indies, where the French cultivate great quantities of it. The stalks and leaves of this sort are very hairy. The flowers are large, of a sulphur colour, with purple bottoms; and are succeeded by pyramidical five-cornered capsules, which open in five cells, filled with large kidney-shaped seeds of a very musky odour.

5. The tiliaceus, or maho-tree, is a native of both the Indies. It rises with a woody, pithy stem, to the height of ten feet, with heart-shaped leaves ending in acute points. The flowers are produced in loose spikes at the end of the branches, and are of a whitish-yellow colour.

6. The trionum, Venice mallow, or flower of an hour, is a native of some parts of Italy, and has long been cultivated in the gardens of this country under the name of bladder ketmia.

7. The esculentus, or eatable hibiscus, rises to five or six feet; has broad five-parted leaves, and large yellow flowers. The pod or okra is from two to six inches long, and one inch diameter. When ripe it opens longitudinally in five different places, and discharges a number of heart-shaped seeds. "These (Dr. Wright informs us) are gathered green, cut into pieces, dried, and sent home as presents, or are boiled in broths or soups for food. It is the chief ingredient in the celebrated pepper-pot of the West Indies, which is no other than a rich olla: the other articles are either flesh meat, or dried fish and capsicum. This dish is very palatable and nourishing. As a medicine, okra is employed in all cases where emollients and lubricants are indicated."

HICKUP, or *hiccough*. See MEDICINE.

HIDE OF LAND, was such a quantity of land as might be plowed with one plough within the compass of a year, or so much as would maintain a family; some call it 60, some 80, and some 100 acres.

HIERACITES, in church history, christian heretics in the third century, so called from their leader Hierax, a philosopher of Egypt; who taught that Melchisedec was the Holy Ghost, denied the resurrection, and condemned marriage, &c.

HIERACIUM, *hawkweed*, a genus of the polygamia æqualis order, in the syngenesia class of plants, and in the natural method ranking under the 49th order, compositæ. The receptacle is naked, the calyx imbricated and ovate; the pappus simple and sessile. There are 55 species, of which the most remarkable are,

1. The aurantiacum, commonly called grim the collier, with an upright, single, hairy, and almost leafless stalk, a foot high, terminated by reddish orange-coloured flowers in a corymbus. These flowers have dark oval ash-coloured calyces; whence the name of grim the collier.

2. The pilosella, or mouse-ear, has blossoms red on the outside, and pale-yellow within; the cups set thick with black hairs. The flowers open at eight in the morning, and close about two in the afternoon.

3. The umbellatum grows to the height of three feet, with an erect and firm stalk, terminated with an umbel of yellow flowers.

HIEROGLYPHICS, in antiquity, mystical characters, or symbols, in use among the Egyptians, and that as well in their writings as inscriptions; being the figures of various animals, the parts of human bodies, and mechanical instruments.

The meaning of a few of these hieroglyphics has been preserved by antient writers. Thus we are told they represented the supreme Deity by a serpent with the head of a hawk. The hawk itself was the hieroglyphic of Osiris; the river-horse, of Typhon; the dog, of Mercury; the cat, of the moon, or Diana; the beetle, of a courageous warrior; a new-born child, of the rising sun; and the like.

HIEROGRAMMATISTS, holy registers, were an order of priests among the antient Egyptians, who presided over learning and religion.

HIGH, in music, an epithet given to any tone or note considerably acute in respect of some other. A word arbitrarily used, and of various meanings, as applied to bass, tenor, or treble voices, or instruments.

HIGHWAY, a public passage for the king's people, whence it is called the king's highway. It seems that antiently there were but four highways in England, which were free and common to all the king's subjects, and through which they might pass without any toll, unless there were a particular consideration for it; all others which we have at this day are supposed to have been made through the grounds of private persons, on writs of ad quod dammum, &c. which being an injury to the owner of the soil, it is said they may prescribe for toll, without any special consideration. 3 Bac. Abr. 54.

There are three kinds of ways, a foot-way, a pack and prime way, which is both a horse and foot-way, and a cart-way, which contains the other two. 1 Inst. 56.

But notwithstanding these distinctions, it seems that any of the said ways, which is common to all the king's subjects, whether it leads directly to a market-town, or only from town to town, may properly be called an highway; and that any such cart-way may be called the king's highway; that a river common to all men may also be called an highway; and that nuisances in any of the said ways are punishable by indictment; otherwise they would not be punished at all: for they are not actionable, unless they cause a special damage to some particular person; because if such action would lie a multiplicity of suits would ensue. 2 Durnf. and East.

But it seems that a way to a parish-church, or to the common field of a town, or to a village which terminates there, may be called a private way, because it belongs not to all the king's subjects, but only to the particular inhabitants of such parish, house, or village, each of which, as it seems, may have an action for a nuisance therein. 1 Haw. 201.

If passengers have used time out of mind, where the roads are bad, to go by outlets on the land adjoining to an highway in the open field, such outlets are parcel of the highway; and therefore if they are sown with corn, and the track foundrous, the king's subjects may go upon the corn. 1 Roll. Ab. 390.

If a way which a man has becomes impassable or very bad, by the owner of the land tearing it up with his carts, by which means it is filled with water; yet he who has the way cannot dig the ground to let out the water, for he has no interest in the soil. But he may bring his action against the owner of the land for spoiling the way. Godb. 52.

When a private way is spoiled by those who have a right to pass thereon, and not through the default of the owner of the land, it seems that they who have the use and benefit of the way ought to repair it, and not the owner of the soil, unless he is bound thereto by custom or special government. 2 Burn. 483.

Repairing highways. It seems agreed that by the common law the general charge of repairing all highways lies on the occupiers of the lands in the parish wherein they are. But it is said that the tenants of the lands adjoining are bound to scour their ditches. 1 Roll. Abr. 39.

Particular persons may be burdened with the general charge of repairing an highway, in two cases: in respect of an inclosure, or by prescription. As where the owner of lands not inclosed, next adjoining to the highway, incloses his lands on both sides thereof; in which case he is bound to make a perfect good way, and shall not be excused for making it as good as it was at the time of the inclosure, if it was then any way defective; because before the inclosure, when the way was bad, the people for their better passage, went over the fields adjoining, out of the common track, a liberty which the inclosure has deprived them of.

And particular persons may be bound to repair an highway by prescription; and it is said that a corporation aggregate may be compelled to do it by force of a general prescription, that it ought and has used to do it, without shewing that it used to do so in respect of the tenure of certain lands, or for other consideration; because such a corporation, in judgment of law, never dies, and therefore if it was ever bound to such duty, it must continue to be always so: neither is it any plea that such a corporation has always done it out of charity; for what it has always done, it shall be presumed to have been

always bound to do. But it is said that such a general prescription is not sufficient to charge a private person, because no man is bound to do a thing which his ancestors have done, unless it is for some special reason; as having lands descended to him holden by such service, &c. 1 Haw. 202, 203.

It seems certain in all cases whether a private person is bound to repair an highway by inclosure or prescription, that the parish cannot take the advantage of it on the general issue, but must plead it specially; and that, therefore, if to an indictment against the parish for not repairing an highway, they plead not guilty, this shall be intended only that the ways are in repair, but does not go to the right of reparation. 1 Mod. 112.

At common law, it is said that all the county ought to make good the reparations of an highway, where no particular persons are bound to do it, because the whole county have their ease and passage by the said way. Co. Rep. 13.

By the antient common law villages are to repair their highways, and may be punished for their decay; and if any does injury, or straightens the highway, he is punishable in the king's bench, or before the justices of peace in the court leet, &c. Cromp. Jurisd. 76.

Destroying any public turnpike-gate, or the rails or fences thereto belonging, subjects the offender to hard labour for three months, and to be publicly whipped. 1 Geo. II. c. 19.

On conviction at the assizes, the offender may be transported for seven years. And on a second offence, or on demolishing any turnpike-house, he shall be guilty of felony, and transported for seven years. But in both these cases the prosecution must be within six months; and on the convict's returning from transportation he shall suffer death. 5 G. II. c. 33.

Every justice of the peace by the statute, upon his own view, or on oath made to him by the surveyor, may make presentment of roads being out of repair; and thereupon like processes shall be issued as upon indictment.

HIGHWAYMEN, are robbers on the highway; for the apprehending and taking of whom a reward of 40*l.* is given by the statute of 4 and 5 Will. and Mar.

HILLIA, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking with those of which the order is doubtful. The calyx is hexaphyllous; the corolla cleft in six parts, and very long; the berry inferior, bilocular, and polyspermous. There are two species, shrubs of Jamaica.

HIP, or HAW, in the materia medica, is reputed attenuant and diuretic. There is a a very pleasant conserve of hips kept in the shops.

HIPPIA, a genus of the polygamia necessaria order, in the syngenesia class of plants. The receptacle is naked; there is no pappus; the seeds are naked, with very broad margins; the calyx is hemispheric, and subimbricated; the radius consists of 10 corollulæ, obscure, and rather cleft into three. There are three species, shrubs of the East Indies and the Cape.

HIPPOBOSCA, a genus of insects of the order diptera. The generic character is, mouth furnished with a bivalve, cylindric, obtuse, nutant snout; body depressed; feet furnished with several claws. This is not an extensive genus; the European hippoboscæ, so far as our present entomological information reaches, scarcely affording more than five or six distinct species. Of these the most familiar is the hippobosca equina (see Plate Nat. Hist. fig. 225), or horse-fly, so troublesome to those animals, as well as to cattle, during the decline of summer, by its irritating motion (which is performed in various directions with equal facility), and by the pungent pain which its proboscis excites while in the act of suction. In size it varies indifferent districts, and seems to be largest in the southern climates. It usually, however, measures something more than a quarter of an inch in length, and is of a flattened form, with a rounded abdomen, and moderately broad obtuse wings: its colour is a blackish chesnut, with the thorax speckled with white, and the abdomen marked with obscure variegations of a deeper cast: the skin is of a remarkably strong, or coriaceous nature, since the insect may be pressed strongly between the fingers without being apparently injured. The female of this insect deposits a single egg at distant intervals, and so very large is the egg, as at least to equal, if not in some degree to surpass, the size of the abdomen itself of the parent insect. In reality, however, this seeming egg may be rather considered as a pupa, since it undergoes no farther alteration of form. It continues perfectly inert, and gradually becomes of a brown, and at length of a polished, black colour; and thus commences a genuine or confirmed pupa, which, if opened after a certain period, exhibits the fly in its unadvanced state, and of a white colour. It often lies during the whole winter in this state, the fly emerging in the succeeding summer.

2. Hippobosca avicularia much resembles the preceding species, but is considerably smaller, and of a dull-green colour: it is often observed on the bodies of various birds, which it infests in a very troublesome degree.

3. Hippobosca hirundinis is equal in size to the H. avicularia, and is of a livid-greenish colour, with the abdomen deeply emarginated behind, so as to represent the usual figure of an inverted heart: the wings are of a sharpened or lanceolate form; and the feet, instead of being terminated by two claws only, as in the generality of insects, have six sharp curved divisions. This species is very often observed on the bodies of swallows, swifts, and martins; and may almost always be found in their nests. Its motion, like that of the two preceding kinds, is brisk, but irregular, moving in all directions with equal facility. The egg or pupa of this species is at least as large in proportion to the parent as that of the horse-fly: it gradually changes to a jet-black colour, and the complete fly is usually produced from it in the space of a month.

4. Hippobosca ovina is commonly known by the name of the sheep-tick, and is very frequently found imbedded in the wool of those animals. It is of a reddish-brown colour, and differs from the rest of the genus in being entirely destitute of wings. Its pupa is also of reddish-brown colour, exactly oval, and of a shining surface.

All the hippoboscæ are remarkably tenacious of life, and the H. ovina in particular, which may often be observed in wool that has long been packed into fleeces.

HIPPOCRAMPUS. See SYNGNETHUS.

HIPPOCRATIA, a genus of the monogynia order, in the triandria class of plants, and in the natural method ranking with those of which the order is doubtful. The calyx is quinquepartite; the petals five, the capsules three in number, and the latter of an obcordate shape. There are two species, scandent plants of the West Indies.

HIPPOCREPIS, *common horse-shoe-vetch*, a genus of the decandria order, in the diadelphia class of plants, and in the natural method ranking under the 32 order, papilionaceæ. The legumen is compressed and crooked, with many incisions on the interior suture. There are five species, two natives of the warm parts of Europe, and one of Britain. They are all low herbaceous trailing plants, with yellow flowers. They are propagated by seeds; but having no great beauty are seldom kept in gardens.

HIPPOMANE, the *manchineel-tree*, a genus of the monadelphia order, in the monœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ. The male has an amentum and bifid perianthium, without any corolla; the female perianthium is trifid; there is no corolla; the stigma is tripartite; and the plum or capsule tricoccous. See Plate. The species are,

1. The mancinella, with oval sawed leaves, is a native of all the West Indies islands. It has a smooth brownish bark. The flowers come out in short spikes at the end of the branches, but make no great appearance, and are succeeded by fruit of the same shape and size with a golden pippin. The tree grows to the size of a large oak.

2. The biglandulosa, with oblong bay leaves, is a native of South America; and grows to as large a size as the first, from which it differs mostly in the shape of its leaves.

3. The spinosa, with holly leaves, is a native of Campeachy, and seldom rises above 20 feet high; the leaves greatly resemble those of the common holly, and are set with sharp prickles at the end of each indenture. They are of a lucid green, and continue all the year.

These plants being natives of very warm climates cannot be preserved in this country without a stove; nor can they by any means be made to rise above five or six feet high even with that assistance. They are propagated by seeds; but must have very little moisture, or they will certainly be killed by it.

These trees have a very poisonous quality, abounding with an acrid milky juice of a highly caustic nature. Strangers are often tempted to eat the fruit of the first species; the consequences of which are, an inflammation of the mouth and throat, pains in the stomach, &c. which are very dangerous, unless remedies are speedily applied. The wood is much esteemed for making cabinets, book-cases, &c. being very durable, taking a fine polish, and not being liable to become worm-eaten: but as the trees abound with a milky caustic juice already mentioned, fires are made round their trunks to burn out this juice, otherwise those who fell the trees would be in danger of losing their sight by the juice flying in their eyes. This juice

raises blisters on the skin wherever it falls, turns linen black, and makes it fall out in holes. It is also dangerous to work the wood after it is sawn out; for if any of the sawdust happens to get into the eyes of the workmen it causes inflammation; to prevent which they generally cover their faces with fine lawn during the time of working the wood. It is with the juice of this tree that the Indians used to poison their arrows.

HIPPOPHAE, *sea-buckthorn*, a genus of of the tetrandria order, in the diœcia class of plants, and in the natural method ranking under the 16th order, calycifloræ. The male calyx is bipartite; there is no corolia; the female calyx is blind; there is no corolla; there is one style, and a monospermous berry. The species are,

1. The rhamnoides, with a shrubby stem, branching irregularly eight or ten feet high, having a dark-brown back.

2. The canadensis has a shrubby brown stem, branching eight or ten feet high, with oval leaves, and male and female flowers on different plants. Both these species are very hardy, and may be propagated in abundance by suckers from the roots, by layers, and by cuttings of their young shoots. They are retained in gardens on account of their two-coloured leaves in summer; and in winter on account of the appearance of the young shoots, which are covered with turgid, irregular, scaly buds. Goats, sheep, and horses, eat the first species; cows refuse it.

HIPPOPOTAMUS, a genus of quadrupeds of the order of belluæ. The generic character is, the front teeth of the upper jaw are four, and placed in pairs; those of the lower jaw are prominent, and the intermediate ones are protruded forward; the canine teeth are single, and obliquely truncated; the teats are only two, and placed near the groin. It is a native of the warmer regions of the globe, and is chiefly found in the middle parts of Africa, inhabiting large rivers, and especially such as run through countries overshadowed by large forests; walking about at the bottom, and raising itself at intervals to the surface, for the purpose of respiration. By night it quits its watery residence, to graze in the neighbouring plains, devouring great quantities of herbage, and with its vast teeth destroying the more tender kind of trees and other vegetables. It is sometimes seen even in the sea, at some distance from the mouths of rivers, but this is supposed to be merely for the purpose of exercise; for it will not even drink salt water, and does not prey on fish, or indeed live on any kind of animal food. The general size of the hippopotamus seems to be nearly equal to that of the rhinoceros, and it is sometimes even superior. Its form is highly uncouth; the body being extremely large, fat, and round; the legs very short and thick; the head very large; the mouth extremely wide, and the teeth of vast strength and size, more particularly the tusks or canine teeth of the lower jaw, which are of a curved form: they sometimes measure more than two feet in length, and weigh upwards of six pounds each. The whole animal is covered with short hair, which is much more thinly set on the under parts than on the upper. The hippopotamus when just emerged from the water appears of a palish-brown, or mouse colour, with a blueish or slate coloured cast on the upper parts; and the belly is flesh coloured, the skin appearing through the hair. When perfectly dry the colour is an obscure brown, without any of the blueish cast. The skin is most excessively tough and strong, except on the belly, where it is considerably softer. Its voice is a peculiar kind of interrupted roar, between that of a bull and the braying of an elephant. When on land it moves in a somewhat slow and awkward manner; but if pursued, can run with considerable speed, and directly plunging into the water sinks to the bottom, and pursues its progress beneath. It is observed to be extremely cautious of making its appearance by day, especially in such places as are much frequented by mankind, scarcely lifting its nose above the surface while breathing; but it is fearless in rivers which run through unfrequented regions, where it is occasionally seen to rush out of the water with sudden impetuosity, trampling down every thing in its way; and at such times is, of course, highly dangerous. It is, however, naturally of a harmless disposition; not attacking other animals, but merely committing havoc in plantations of maize, rice, sugar-canes, &c. and destroying the roots of trees, by loosening them with its vast teeth. It is capable, notwithstanding its great bulk, of swimming very swiftly. Sometimes hippopotami are seen going in herds, or companies, to the distance of some miles from the bank of a river in quest of food. If wounded in the water they become furious, and are said to attack the boats or canoes whence the injury proceeded, and either overturn or sink them, by biting out large pieces from the bottom. The hippopotamus sleeps in the small reedy islets which are found here and there in the rivers it frequents. In such spots it also brings forth its young; having only one at a birth, which it nurses with great care for a considerable time. The young is capable of being tamed, and we are assured by Belon that he saw one so gentle as to shew no inclination to escape, or to do any kind of mischief when let out of the stable in which it was kept.

These animals are said to be most successfully taken by preparing pitfals for them, of large size, near the rivers. They are also occasionally shot, or killed with harpoons. Their flesh is reckoned good by the Africans, and the fat is said to be a fine kind of lard. But it is chiefly on account of the teeth, and more particularly of the tusks, that this animal is killed; their hardness being superior to that of ivory, at the same time that they are not so subject to become yellow, for which reason they are much used by the dentists. The skin, from its great thickness and strength, when dried, is used by the African nations for bucklers or shields, and is said to be proof against the stroke of a bullet; and indeed the living animal, if shot at any where but on the head or the belly, is scarcely vulnerable, the tough skin causing a bullet to glance from its surface.

The largest female hippopotamus killed by colonel Gordon was about 11 feet long, and the largest male, which always exceeds the female in size, about 11 feet eight inches. Mr. Bruce, however, speaks of hippopotami in the lake Tzana of more than twenty feet long.

The hippopotamus has only a single stomach, and does not ruminate: the stomach, however, has certain cells and divisions, analogous, in some degree, to those of the camel.

M. Sonnini thinks it not improbable that there may in reality exist two species of hippopotamus; one of which confines itself entirely to rivers and fresh waters, and the other to the sea. See Plate Nat. Hist. fig. 226.

HIPPURIS, *mare's-tail*, a genus of the monogynia order, in the monandria class of plants, and in the natural method ranking under the 15th order, inundatæ. There is no calyx, nor any petals; the stigma is simple; and there is one seed. There are three species, one a native of Britain, and which grows in ditches and stagnant waters. The flower of this plant is found at the base of each leaf, and is as simple as can be conceived; there being neither empalement nor blossom; and only one chive, one pointal, and one seed. It is a very weak astringent. Goats eat it; cows, sheep, horses, and swine, refuse it.

HIRÆA, a genus of the trigynia order, in the decandria class of plants. The calyx is pentaphyllous; the petals roundish and unguiculated; there are three bilabiated seeds. There is one species, a tree of New Spain.

HIRCUS, a goat, in astronomy, a star of the first magnitude, the same with capella. See CAPELLA and ASTRONOMY.

HIRTELLA, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking with those of which the order is doubtful. There are five petals; the filaments are very long, persisting, and spiral; the berry is monospermous; the style lateral. There are three species, trees of the West Indies.

HIRUDO, the *leech*, a genus of insects belonging to the order of vermes intestina. The body moves either forward or backward. There are 17 species, principally distinguished by their colour. The most remarkable are the following:

1. The medicinalis, or medicinal leech, the form of which is well known, grows to the length of two or three inches. The body is of a blackish-brown colour, marked on the back with six yellow spots, and edged with a yellow line on each side; but both the spots and the lines grow faint, and almost disappear, at some seasons. The head is smaller than the tail, which fixes itself very firmly to any thing the creature pleases. It is viviparous, and produces but one young at a time, which is in the month of July. It is an inhabitant of clear running waters, and is well known for its use in bleeding.

2. The sanguisuga, or horse-leech, is larger than the former. Its skin is smooth and glossy; the body is depressed, the back is dusky; and the belly is of a yellowish-green, having a yellow lateral margin. It inhabits stagnant waters.

3. The geometra, or geometrical leech, grows to an inch and a half in length; and has a smooth and glossy skin of a dusky-brown colour, but in some seasons greenish spotted with white. When in motion its back is elevated into a kind of ridge; and it then appears as if measuring the space it passed over, like a compass, whence its name. Its tail is remarkably broad; and it holds as firmly by it as by the head. It is common on stones in shallow running waters; and is often

Glareola austriaca

214

Gryllus griseus

215

Gryllus stridulus

216

Guaiacum officinale

217

Gymnotus electricus
Electrical eel

218

Hæmatopus ostralegus
Sea-pie

219

Hedysarum gyrans

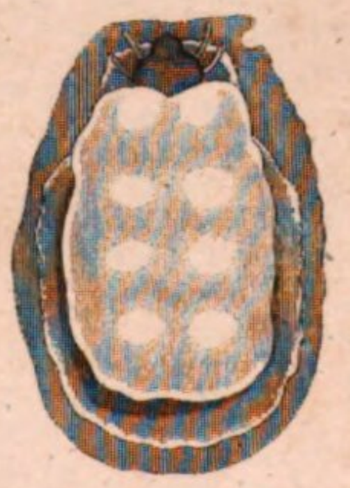
222

Helix sepium

223

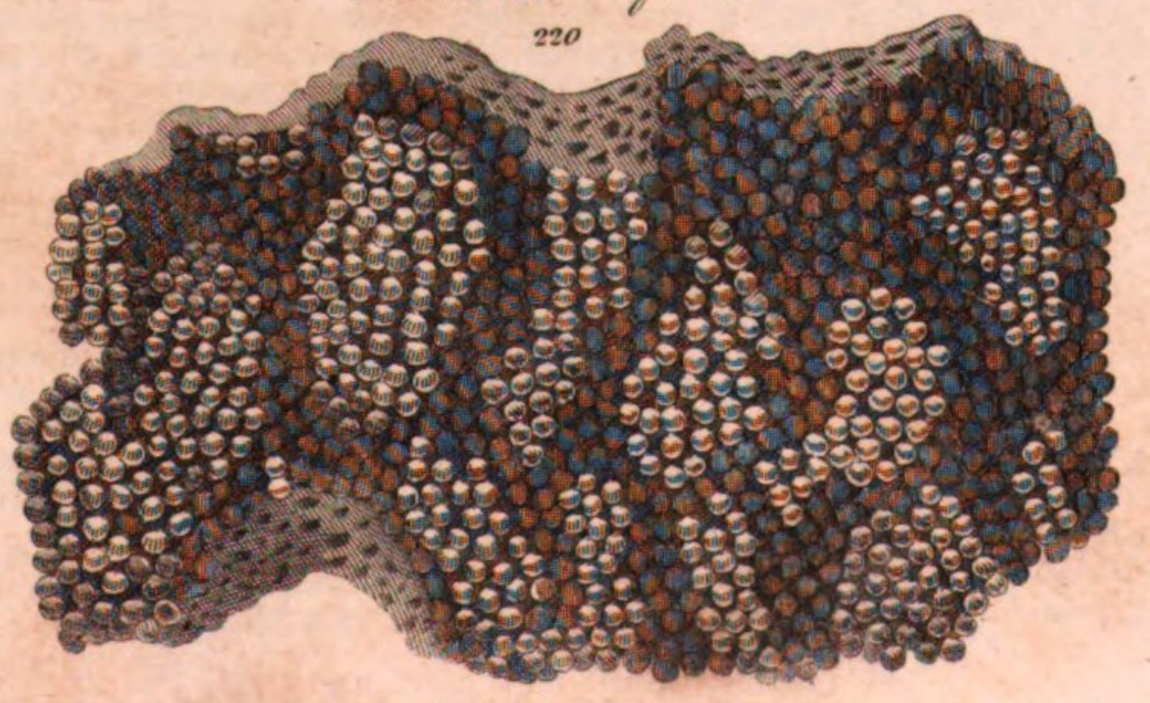
Haliotis tuberculata

227



Haematites uviformis

220



Hippobosca equina

225

Hemerobius perla

224

Heath Sc

found on trout and other fish after the spawning season.

4. The muricata, or muricated leech, has a taper body, rounded at the greater extremity, and furnished with two small tentacula, or horns, strongly annulated and rugged upon the rings, the tail dilated. It inhabits the Atlantic ocean, and is by the fishermen called the sea-leech. It adheres to fish, and generally leaves a black mark on the spot.

The mouth of the leech is armed with a sharp instrument that makes three wounds at once, and may be compared to the body of the pump, and the tongue or fleshy nipple to the sucker; by the working of this piece of mechanism the blood is made to rise up to the conduit which conveys it to the animal's stomach, which is a membranaceous skin divided into 24 cells. The blood which is sucked out is there preserved for several months, almost without coagulating, and proves a store of provision to the animal. The nutritious parts, pure and already digested by animals, have no call to be disengaged from the heterogeneous substances: nor indeed is there an anus discoverable in the leech; mere transpiration seems to be all that it performs, the matter fixing on the surface of its body, and afterwards coming off in small threads. Of this an experiment may be tried by putting a leech into oil, where it keeps alive for several days; upon being taken out and put into water, there appears to loosen from its body a kind of slough shaped like the creature's body. The organ of respiration, though unascertained, seems to be situated in the mouth; for if, like an insect, it drew its breath through vent-holes, it would not subsist in oil, as by it they would be stopped up.

It is only the first species that is used in medicine, being applied to the skin in order to draw off blood. With this view they are employed to phlebotomise young children. If the leech does not fasten, a drop of sugared milk is put on the spot it is wished to fix on, or a little blood is drawn by means of a slight puncture, after which it immediately settles. The leech when fixed should be watched, lest it should find its way into the anus when used for the hemorrhoids, or penetrate into the œsophagus if employed to draw the gums, as it would make great havoc in the stomach or intestines. In such a case, the best and quickest remedy is to swallow some salt; which is the method practised to make it loose its hold when it sucks longer than was intended. Salt of tartar, volatile alkali, pepper, and acids, make it also leave the part on which it was applied. Cows and horses have been known to receive them, in drinking, into the throat. The usual remedy is to force down some salt, which makes them fall off. The discharge occasioned by the puncture of a leech is usually of more service than the process itself. When too abundant it is easily stopped with brandy, vinegar, or other styptics, or with a compress of dry linen rag bound strongly on the bleeding orifice.

At Ceylon, travellers who walk bare-legged are molested by the great numbers of leeches concealed under the grass. All leeches vary in their colours at some seasons, but they are generally of a dusky greenish-brown or yellow, and often variegated. They are said to be very restless before a change of weather, if confined in glasses.

HIRUNDO, in ornithology, a genus of birds of the order of passeres. There are 37 species, chiefly distinguished by their colour. The most remarkable are,

1. The rustica, common or chimney-swallow, is distinguished from all the other species by the superior forkiness of its tail, and by the red spot on the forehead and under the chin. The crown of the head, the whole upper part of the body, and the coverts of the wings, are black, glossed with a rich purplish blue, most resplendent in the male: the breast and belly white, and in the male tinged with red. The food of this swallow is the same with the others of its kind, viz. insects. For the taking of these, in their swiftest flight, nature has admirably contrived their several parts: their mouths are very wide to take in flies, &c. in their quickest motions; their wings are long, and adapted for distant and continual flight; and their tails are forked, to enable them to turn the readier in pursuit of their prey. This species is the first comer of all the British hirundines; and appears in general on or about the 13th of April, though now and then a straggler is seen much earlier. This hirundo, though called the chimney-swallow, by no means builds altogether in chimneys, but often within barns and out-houses against the rafters; and so she did in Virgil's time. In Sweden she builds in barns, and is called *ladu swala*, the barn-swallow. Besides, in the warmer parts of Europe there are no chimneys to houses except they are English built: in these countries she constructs her nest in porches, and gateways, and galleries, and open halls. Here and there a bird may affect some odd and peculiar place; but in general with us this species breeds in chimneys, and loves to haunt those stacks where there is a constant fire, no doubt for the sake of warmth. Not that it can subsist in the immediate shaft where there is a fire, but prefers one adjoining to that of the kitchen, and disregards the perpetual smoke of that funnel. Her nest consists, like that of the house-martin, of a crust or shell composed of dirt or mud, mixed with short pieces of straw to render it tough and permanent; with this difference, the shell of the martin is nearly hemispheric, that of the swallow is open at the top, and like half a deep dish: this nest is lined with fine grasses, and feathers which are often collected as they float in the air.

This bird lays from four to six white eggs, dotted with red specks; and brings out her first brood about the last week in June, or the first week in July. The progressive method by which the young are introduced into life is very curious: first, they emerge from the shaft with difficulty enough, and often fall down into the rooms below; for a day or two they are fed on the chimney-top, and then are conducted to the dead leafless bough of some tree, where, sitting in a row, they are attended with great assiduity, and may be then called perchers. In a day or two more they become flyers, but are still unable to take their own food; therefore they play about near the place where the dams are hawking for flies; and when a mouthful is collected, at a certain signal given, the dam and the nestling advance, rising towards each other, and meeting at an angle; the young one all the while uttering such a little quick note of gratitude and complacency, that a person must have paid very little regard to the wonders of nature that has not often remarked this feat. The dam betakes herself immediately to the business of a second brood as soon as she is disengaged from her first; which she at once associates with the first broods of house-martins, and with them congregates, clustering on sunny roofs, towers, and trees. This hirundo brings out her second brood towards the middle and end of August.

Each species of hirundo drinks as it flies along, sipping the surface of the water; but the swallow alone, in general, washes on the wing, by dropping into a pool for many times together: in very hot weather house-martins and bank-martins dip and wash a little. The swallow is a delicate songster, and in soft sunny weather sings both perching and flying; on trees in a kind of concert, and on chimney-tops. Horsemen on wide downs are often closely attended by a little party of swallows for miles together, which plays before and behind them, sweeping around, and collecting all the sculking insects that are roused by the trampling of the horses' feet: when the wind blows hard, without this expedient, they are forced to settle to pick up their lurking prey.

This species feeds much on little coleoptera, as well as on gnats and flies; and often settles on dug-ground, or pats, for gravel to grind and digest its food. Mr. White informs us, that before they depart, for some weeks, to a bird, they forsake houses and chimneys, and roost in trees; and usually withdraw about the beginning of October; though some few stragglers may be seen at times till the first week in November. Mr. Pennant says, that for a few days previous to their departure, they assemble in vast flocks on house-tops, churches, and trees, whence they take their flight. They are supposed to take up their winter-quarters in Senegal and parts adjacent, and seem to possess in turn the whole of the old continent, being known from Norway to the Cape of Good Hope on the one hand, and from Kamtschatka to India and Japan on the other. They are also found in all parts of North America, migrating north and south, as with us.

2. The esculenta, or edible swallow, according to Buffon, is less than the wren, and only two inches and a quarter in length. The bill is black; the upper parts of the body are brown, the under whitish; the tail is forked, and each feather of it is tipped with white; the legs are brown. See Plate Nat. Hist. fig. 228.

The most curious part of the natural history of this bird consists in the nest, which is composed of such materials as render it not only edible, but one of the greatest dainties of the Asiatic epicures.

These nests are found in vast numbers in certain caverns, in various isles in the Soolo Archipelago, situated between longitude 117 and 120, latitude 5 and 7; particularly in three small isles, or rather rocks; in the caverns of which the nests are found fixed to the sides in astonishing numbers. Of these nests, it is said the Dutch alone export from Batavia 1000 pickles, upwards of 1300lb. English weight, every year, which are brought from the isles of Cochin China, and those lying to the east of them.

3. The urbica, or martin, is inferior in size to the chimney swallow, and its tail much less forked. The head and upper part of the body, except the rump, are black, glossed with blue; the breast, belly, and rump, are white; the feet are covered with a short white down. This is the second of the swallow kind that appears in our country. They begin to appear about the 16th of April. About the middle of May, if the weather is fine, the martin begins to think in earnest of providing a mansion for its family. As this bird often builds against a perpendicular wall without any projecting ledge under, it requires its utmost efforts to get the first foundation firmly fixed, so that it may safely carry the superstructure. That this work may not, while it is soft and green, pull itself down by its own weight, the provident architect has prudence and forbearance enough not to advance her work too fast; but by building only in the morning, and by dedicating the rest of the day to food and amusement, gives it sufficient time to dry and harden. By this method in about 10 or 12 days is formed an hemispheric nest, with a small aperture towards the top, strong, compact, and warm, and perfectly fitted for all the purposes for which it was intended. But then nothing is more common than for the house-sparrow, as soon as the shell is finished, to seize on it as its own, to eject the owner, and to line it after its own manner. At first, when the young are hatched, and are in a naked and helpless condition, the parent birds, with tender assiduity, carry out what comes away from their young. Was it not for this affectionate cleanliness the nestlings would soon be burnt up and destroyed in so deep and hollow a nest by their own caustic excrement. As soon as the young are able to shift for themselves, the dams immediately turn their thoughts to the business of a second brood: while the first flight, shaken off and rejected by their nurses, congregate in great flocks, and are the birds that are seen clustering and hovering on sunny mornings and evenings on round towers and steeples, and on the roofs of churches and houses. As the summer declines the congregating flocks increase in numbers daily, by the constant accession of the second broods, till at last they swarm in myriads upon myriads round the villages on the Thames, darkening the face of the sky as they frequent the aits of that river, where they roost. They retire in vast flocks together about the beginning of October. Unless these birds are very short-lived indeed, or unless they do not return to the district where they are bred, they must undergo vast devastations somehow, and somewhere; for the birds that return yearly bear no manner of proportion to the birds that retire.

4. The riparia, sand-martin, or shore-bird, is $4\frac{3}{4}$ inches in length, with the whole upper parts of the body of a mouse colour, the throat and under parts white, the bill and legs blackish. It is common about the banks of rivers and sand-pits, where it terebrates a round and regular hole in the sand or earth, which is serpentine, horizontal, and about two feet deep. At the inner end of this burrow the bird deposits her rude nest, consisting of fine grasses and feathers, usually goose-feathers, very inartificially laid together.

5. The apus, or swift, is a large species, being near eight inches long, with an extent of wing near 18 inches, though the weight of the bird is only one ounce. Their feet are so small, that the action of walking and rising from the ground is extremely difficult; but nature has made it full amends, by furnishing it with ample means for an easy and continual flight. It is more on the wing than any other swallow; its flight is more rapid, and that attended with a shrill scream. It rests by clinging against some wall, or other apt body; whence Klein styles this species hirundo muraria. It breeds under the eaves of houses, in steeples, and other lofty buildings; and makes its nest of grasses and feathers. The feet of this species are of a particular structure, all the toes standing forward: the least consists of only one bone; the others of an equal number, viz. two each, in which they differ from those of all other birds: a construction, however, nicely adapted to the purposes in which their feet are employed. See Plate Nat. Hist. fig. 227.

The swift is a summer inhabitant of these kingdoms. It comes the latest, and departs the soonest, of any of the tribe; not always staying to the middle of August, and often not arriving before the beginning of May.

6. The melba, or white bellied swift, is in length eight inches and a half, and weighs two ounces five drams.

7. The cayennensis, or white coloured swallow, is about the size of the martin: the head and bill are black; the chin and throat white, passing from the last in a narrow collar round the neck: between the bill and eye is a streak of white, which forks off into two, one passing a little above, and the other a little way beneath, the eye: the rest of the plumage is black, with a gloss of violet; but the greater coverts, nearest the body, are brown edged with white. This bird makes its nest in the houses at Cayenne. It is of a large size, in shape of a truncated cone; five inches one way by three the other, and nine inches in length. It is composed of the down of dog's-bane, well woven together; the cavity divided obliquely about the middle, lengthways, by a partition, which spreads itself over that part of the nest where the eggs lie, which is pretty near the base: a small parcel of the same soft down, forming a kind of plug, is placed over the top, serving to keep the young brood from the impression of the air, from which we may suppose them to be very tender.

By the myriads of insects which every single brood of swallows destroys in the course of a summer, they defend us in a great measure from the personal and domestic annoyance of flies and gnats; and, what is of infinitely more consequence, they keep down the numbers of our minute enemies, who, either in the grub or winged state, would otherwise render the labours of the husbandman fruitless. Since then swallows are guardians of our corn, they should every where be protected by the same popular veneration which in Egypt defends the ibis, and the stork in Holland. We more frequently hear of unproductive harvests on the Continent than in this country; and it is well known that swallows are caught and sold as food in the markets of Spain, France, and Italy. In England we are not driven to such resources to furnish our tables. But what apology can be made for those, and many there are, whose education and rank should have taught them more innocent amusements, who wantonly murder swallows, under the idle pretence of improving their skill in shooting game? Setting aside the cruelty of starving whole nests of young by killing the dam; those who follow this barbarous diversion would do well to reflect, that by every swallow they kill, they assist blasts, mildews, and vermin, in causing a scarcity of bread. Every lord of a manor should restrain his game-keeper from this execrable practice; nor should he permit any one on to sport on his lands who does not refrain from it.

HISPA, in zoology, a genus of insects belonging to the coleoptera order, the characters of which are these: the antennæ are fusiform, growing gradually larger from each extremity towards the middle, and are situated between the eyes; the thorax and elytra are covered with protuberances or spines. The larva of this insect seems to be yet wholly unknown. There are but two species of the perfect animal met with in Europe; one of which, the atra, is found in Britain, and is all over of a deep unpolished black, and has the upper part of its body entirely covered with long and strong spines, which render it bristly like the shell of a chesnut. There is even a spine at the case of the antennæ; the thorax has a row set transversely, which are forked; and the elytra are furnished with a very great number that are single. Its being thus covered with spines makes it resemble a hedge-hog in miniature. It is tather hard to catch, letting itself fall down to the ground as soon as approached. It bears its antennæ upright before it. See Plate Nat. Hist. fig. 229.

HISTER, a genus of insects of the coleoptera order. The generic character is, antennæ headed by a somewhat solid tip, lowest joint compressed and decurved; head retractile; mouth forcipated; wing-sheaths shorter than the body; fore-legs toothed.

The most common European species of this genus is the hister unicolor of Linnæus. It is entirely of a glossy coal-black colour, and of a slightly flattened shape, varying considerably in size, but usually measuring about the third of an inch in length, and is often seen in gardens, sandy fields, &c. Its larva seems to be unknown.

Hister quadrimaculatus, has much the appearance of a small beetle; its shape is strongly convex, and its colour black, with two dull-red bars on each wing-shell, viz. one at the base, and the other, smaller, at the tip. It is found about dunghills, &c.

HISTORY, *civil.* History, in its simplest definition, implies the mere narration of events and facts; but when placed in its true dignity, it is something more than this, it is philosophy "teaching by examples." The study of it is more or less the employment of all persons of reading and education; and the composition of it was the earliest use that was made of letters, since the first poems were historical: it is calculated for the use of all ranks and all professions in life, and places the reader of its events as a spectator out of all hazards, who may reap wisdom from the danger of others, and foretel, to a certain extent, the future by the past.

The general uses of history are exhibited by Dr. Priestley under three heads: 1. He says, history serves to amuse the imagination,

and interest the passions in general. 2. It improves the understanding: and, 3. It tends to strengthen the sentiments of virtue. In the first of these views we find history has a great advantage over every work of fiction: for we consider it as the voice of truth. The second has been aptly illustrated by Bolingbroke, who observes that "He who studies history as he would philosophy, will distinguish and collect certain general principles and rules of life and conduct, which always must be true, because they are conformable to the invariable nature of things; and by doing so he will soon form to himself a general system of ethics and politics on the surest foundations, on the trial of these principles and rules in all ages, and on the confirmation of them by universal experience." And the third is still more evident, from the very light in which characters and events are seen in it. Fame is found just to the dead, however partial to the living.

The sources of history form another topic of enquiry. The earliest of these was undoubtedly tradition; the next, perhaps, poetical narrations; which, though often mixed with the absurdities of fable, contain facts and characters of ancient life that illustrate the manners of the early ages. Coins, medals, and inscriptions, the works of artists of all kinds, and sometimes even rude heaps, are other monuments, whose collateral aids are equally necessary with the astronomical mediums employed by Newton, in the correction of chronology. In later times, as political society increased, the archives and laws of states perpetuated information in a more certain and extended form. The correct knowledge of events was easily obtained. Private experience could be joined to the information contained in public annals; and fair topics were presented to the pen of every man who proposed to himself the task of an historian.

In regard to what is necessary or useful to be known previous to the study of history, it it is proper to observe that it must be taken in very different degrees of extent, according to the views with which history is read; and these depend very much upon the age and situation of the person who applies to it. But whoever proposes to study history scientifically, must come to the reading of it furnished with the first principles of certain sciences. If not the knowledge, at least a general idea of the principles of human nature, will be an excellent guide to us in judging of the consistency of human characters, and of what is within and what is without the reach of human powers. Philosophical knowledge, in general, will be found of the most extensive use to all persons who would examine with accuracy the achievements of ancient nations in peace or war, or who would thoroughly weigh the accounts of any thing in which the powers of nature are employed. But those sciences which are of the most constant and general use are geography and chronology. A knowledge of the situation and relative magnitude of the several countries of the earth, assists and affords clear and distinct ideas of events; and a general comprehension of the current of time enables us distinctly to trace their dependence on each other.

Beside these, however, there are other helps. Obvious advantages will attend the use of a good compendium of general history, previous to the study of any particular portion. The earliest epitome was the Chronicon Carionis, printed at Wittenberg, 1532; but the most celebrated are, Turselin's, Bossuet's, and Baron Holberg's; the last of these was translated into English by Mr. Gregory Sharpe. Of chronological tables the best and most completely useful are Blair's: and of the charts of history, Dr. Priestley's. These shew at once the reference which the history of one country bears to that of another.

The misapplication to which history is liable, evinces the necessity of prosecuting the study of it according to a regular plan. To those who can reach its sources these directions may be serviceable: principally obtained from Dr. Priestley.

The sacred history may properly be said to stand alone: it is not only the most certain, but exhibits the continuation of the true religion uninterrupted from the creation of the world, and therefore ought to form the ground-work of our study.

The oldest history extant, next to the historical books of the Old Testament is that of Herodotus, who flourished about four hundred and fifty years before the christian era, a little after the invasion of Greece by Xerxes. His history comprises probably every thing he had an opportunity of learning concerning the history of the Lydians, Ionians, Lycians, Egyptians, Persians, Greeks, and Macedonians: computing from the earliest of his accounts to the latest, his history may be reckoned to commence about seven hundred and thirteen years before Christ, and to reach to about four hundred and seventy-nine before Christ; a period of about two hundred and thirty-four years.

Next to Herodotus, Thucydides is to be read; whose history reaches to the 21st year of the Peloponnesian war, the history of which is compleated in the first and second books of Xenophon's History of Greece. After this, the student may proceed to the expedition of Cyrus, and the return of the Greeks: and then go back to the remaining books of Xenophon's history. The fifteenth and sixteenth books of Diodorus Siculus contain the histories of Greece and Persia from the battle of Mantinæa to the beginning of the reign of Alexander the Great, in the year 336 before Christ. For the history of Alexander, Arrian, Quintus Curtius, and the tenth and eleventh books of Justin must be referred to. The eighteenth, nineteenth, and twentieth books of Diodorus Siculus contain the History of Greece from the year 323 before Christ, to the year 301: the thirteenth, fourteenth, and fifteenth books of Justin will complete the period; and those which follow to the twenty-ninth inclusive, carry on the history to about the year 195 A.C. Lastly, in the regular order of history read the thirteenth book of Justin, and all that follow to the two last, which completes the History of Greece till it mixes with that of the Romans.

The lives of illustrious men by Plutarch and Cornelius Nepos, form an excellent supplement to the regular historians.

Of the above works, which contain not only the History of Greece, but that of all the nations of the world known to the historians, Justin, Quintus Curtius, and Cornelius Nepos, only, are in Latin; the rest are in Greek.

The following course of Roman History comprehends all that is to be learnt now of the subsequent Antient History of all other nations. The writer who treats of the early part of the Roman history, in the fullest and most satisfactory manner, is Dionysius of Halicarnassus, a rhetorician as well as an historian: the remains of his works which originally brought the History of Rome to the beginning of the first Punic war, end at this time with the year 341 before Christ, the time when the consuls resumed the chief authority in the republic after the dissolution of the decemvirate: so that to compleat the period we must go to the three first books of Livy, whose history to the tenth book inclusive, brings that of Rome to the year 451, of the building of the city, or 292 before Christ. To supply the chasm between the tenth and twentieth books of Livy, read Polybius, the seventeenth, eighteenth, twenty-second, and twenty-third books of Justin, and Appian's Punic and Illyrian wars; and afterwards the remainder of Livy from the twenty-first book to the end, which brings the history to 166 years before Christ. Sallust's History of the War of Jugurtha and the Catalinarian conspiracy, are the next books to be proceeded to: they are all which remain to us of his works. The Commentaries of Cæsar, and Cicero's Epistles to Atticus, are the next works to be consulted, followed by the remains of Dio Cassius, and the Compendium of Vellerius Paterculus. Suetonius's Lives of the Cæsars, and the Works of Tacitus, close the list of Roman historians of the greatest eminence. Those who are called the writers of the brasen or iron age deserve a slighter mention. The principal of these are, Xiphilin, Herodian, The Historiæ Augustæ Scriptores, Zozimus, Ammianus Marcellinus, Paulus Deaconus, and Procopius; the last four, however, may be omitted; and Nicetas Acominatus and Nicephorus Gregoras, followed by Joannes Cantacuzenus, substituted in their room. Laonicus Chalcondiles brings up the conclusion of the Eastern Empire, in the year 1453, when Constantinople was taken by Mahomet II.

To enumerate all the modern compilations of ancient history which may be serviceable to those who cannot make their searches in the original authors would be endless. That of Rollin must not be passed over. The most complete body of history, however, ancient and modern, is the Universal: which has references to the original writers for almost every paragraph of information. Gillies and Mitford have written Histories of Greece, and Hooke is by far the most preferable among the compilers of the Roman history.

Having been thus particular on the subject of ancient history, we shall go on to the enumeration of those sources from which the last materials are derived for English history; and then proceeding to the other countries of modern Europe, make a slight mention of the best historians of each.

The earliest accounts of Britain are to be found among the Romans; and principally in the works of Julius Cæsar, Dio Cassius, and Tacitus. Livy and Fabius Rusticus were others who wrote expressly on its his-

tory; but their works have perished in the general wreck of ancient literature.

The most antient of our native historians, now extant, says bishop Nicholson, is Gildas, a monk of Bangor, who lived about the middle of the sixth century; a sorrowful spectator of the miseries and almost utter ruin of his countrymen, by a people under whose banners they hoped for peace. The title of his work was, "De Excidis Britanniæ." The next historian of note was Nennius, who is often confounded with Gildas: his work, which has gone by different names, was printed by Gale under that of "Historia Britonum." If we except a supplement to these writers, in the laws of Hoel Dha, we have nothing more of early British history. Geoffrey of Monmouth's work, which was written at a subsequent period, is nothing more than a romance.

For the history of the Saxon times we have better materials, the oldest of which, perhaps, that are now preserved, are in the Saxon Chronicle, printed from several manuscripts by bishop Gibson. Next to this Bede's Ecclesiastical History may be placed, and the Life of Alfred by Asser of St. David's.

Only two Danish historians, says bishop Nicholson, are necessary to the English antiquary's library; Saxo Grammaticus and Sweno Agonis.

The first English historian after the Norman Conquest, was Ingulph, abbot of Crozland, whose history extends from the year 626 to 1089. That portion of Marianus Scotus's history which relates to Britain never has been printed. Florence of Worcester's, who died 1119, is more full.

Eadmer's work, published by Mr. Selden, contains the history of the two Williams and Henry the First, from 1066 to 1122, and is a work of very good authority.

William of Malmsbury was the next historian, whose book "De Gestis Rebus Anglorum," is one of the most faithful of our numerous annals: it begins with the first arrival of the Saxons, and is continued to the death of Stephen. The other historians of the twelfth century were, Simeon Dunelmensis, Henry of Huntingdon, and William de Neuburg.

Gervase of Canterbury's history, of which a fragment only is left, is the earliest of the thirteenth century: his chief contemporary was Hoveden, who seems to have been chaplain to king Henry the Second. Ralph de Diceto, Walter of Coventry, and Matthew Paris, were others There were likewise a few meaner historians, whose names it is not necessary to repeat.

The principal writers of the fourteenth century were, Wikes, Trivet, John Brompton, Higden, John of Tinmouth, Matthew of Westminster, and Knighton: the last but one of whom is often called Florilegus.

The first and principal writer of the fifteenth century was Froissart, whose work has been so carefully translated by Mr. Johnes. It affords the best history of the English Nation during the reigns of Edward the Third and Richard the Second. Thomas de Walsingham is the next writer of credit, succeeded by John Harding, Caxton, and Rouse.

Fabian's Chronicle is the first work of consequence in the sixteenth century, and is said to have given great offence to Wolsey. Polydore Virgil's history is not believed to have been so faithful; though greater merit is attributed to the works of Hall and Hollinshead.

The industrious Stowe was the first writer among the historians of the seventeenth century: the next of eminence was Daniel Speed, sir Richard Baker, Sandford, Brady, Echard and Tyrrel, are others, whose names only it is quite sufficient to enumerate.

In the last century, bishop Burnet, Carte, Kennet, Tindal, Hume, Smollet, Macaulay, and Henry, are historians too well known to need either comment or commendation here.

In regard to the writers of particular histories of the kings with whom they were cotemporary, it may be sufficient to enumerate the following: William the Conqueror's life was written by William of Poictiers; king Stephen's memoirs, by Richard Prior of Hexham, printed among the decem-scriptores; Richard the First's Expedition into the Holy Land, was celebrated by Joseph of Exeter, or Iscanus; the Life of Edward the Second by sir Thomas de la More: Henry the Fifth's by some one under the name of Titus Livius: and that of Edward the Fifth, with a part of the History of Richard the Third, by sir Thomas More; Henry the Eighth's Reign, by lord Herbert of Cherbury; and Elizabeth's by Camden. Those of a later period, perhaps, are hardly entitled to so much credit for impartiality.

The historians of other particular countries may be mentioned in a briefer manner; enumerating such only as a reader may refer to when inquiring into facts. In regard to France, after mentioning the Chroniques de St. Denis, the Annales Francorum, with the works of Monstrelet, Mezeray, Daniel and Garnier, and Henault's Abridgment, we need only mention two of the most comprehensive bodies of French history, "Duchesne's Historiæ Francorum Scriptores;" and "Bouquet's Recueil des Historiens des Gaules et de la France," in thirteen volumes folio. For the general history of Italy, Guicciardini's work is undoubtedly the best, not only for its accuracy but its style; though Brusoni's and Capriata's works are much esteemed for their veracity. To those who make a deep search, the "Rerum Italiarum Scriptores," by Muratori, will be useful.

For the separate states of Italy, Giannoni's History of Naples, Machiavel's Historia Florentina, and the "Historia Veneziani." For Switzerland, the "Helvetic Confederacy" by Mr. Planta, may be referred to: for Holland, Le Clerc's "Provinces Unies," 1728. Among the writers of German history, the "Germani Scriptores" of Pistorius, Urstilius, Freher, and Reuber, may be mentioned; the writers on ancient Germany by Schard; the Scriptores Rerum Brunsvicensium; and Mascou's history of the Germans.

The most valuable history of Spain is Mariana's, first published in 1592; the best edition of which, continued to a late period, was published at Valencia 1783. Beside this, Curita's "Annales de Arragon" may be consulted with the "Annales de Cattaluna." The earliest materials for Portuguese history are to be found among the Scriptores Rerum Hispaniarum. The first historian whom Meusel mentions is Laimund de Ortega: but one of the most valuable and industrious was Bernard de Brito, who published the two first parts of the "Monarchia Lusitana," in 1597 and 1609; which was continued as far as an eighth part, in 1729. Others are, Meneze's Historia de Portugal, printed at Lisbon in two volumes, folio, 1679 and 1698; La Clede's Histoire de Portugal, Par. 1735; and the elaborate history of Gebauer, in German, Leipsig, 1759. On Sweden, Crusius's "Annales Suevicæ," 1596, and Puffendorf "de Rebus Suevicis," 1686, will be found works of considerable consequence. On Norway, Forfæus's "Historia Rerum Norvegicarum." On Denmark, Cragius's "Annales Danicæ;" Mallet's "Histoire de Dannemarc," and Langebek's "Scriptores Rerum Danicarum:" and on Russia, "Rerum Muscoviticarum Scriptores," 1600, folio, and Levesque's "Histoire de Russie," 1800. Those who would gain a more particular knowledge of the characters which the principal of these historians bear, may consult the works of Wheare and Rawlinson on History.

There are, however, some particular histories, which are so excellently written, that no person of a liberal education should neglect becoming acquainted with them. Under this character we may comprehend all the works of Tacitus, which now remain to us: in his writings every phrase is a maxim; the narrative goes on with rapidity; while all his characters are drawn with a more profound knowledge of human nature than those of any historian who went before him; his very brevity is pregnant. Thuanus's history of his own times is a work almost equal to any production of the classic ages. Guicciardini's History of Italy: Davila's of the Civil Wars of France; Bentivoglio's of those of the Netherlands; and Giannoni's History of Naples, deserve a similar character, as well as the elegant history of our own country by Hume. No writer whatever, says Dr. Priestley, can excel Vertot in the happy art of making history entertaining.

There are also periods of history more particularly deserving of a close attention. Among these the connection of sacred and profane history in the succession of the four great monarchies, stands foremost. Another period is that which comprises the history of the Grecian commonwealths, in which the peculiar evils and advantages of a popular government are exhibited with clearness. The rise and declension of the Roman empire is another object for extensive contemplation, as well as the foundation of the present European governments, and the restoration of learning.

We have now only to add a few words on the particular duty of the historian; the model for whom is preserved among the works of Cicero. It is the first law of history, he says that the writer should neither dare to advance what is false, nor to suppress what is true; that he should relate the facts with strict impartiality, free from ill-will or favour; that his narrative should distinguish the order of time, and when necessary, give the description of places; that he should unfold the statesman's motives, and in his account of the transactions and the events, interpose his own judgment; and should not only relate what was done, but how it was done; and

what share, chance, or rashness, or prudence, had in the issue; that he should give the characters of the leading men their weight and influence, their passions, their principles, and their conduct through life. In addition to these, Tacitus gives another rule: "Præcipuum munus annalium reor, ne virtutes sileantur, utque pravis dictis factisque ex posteritate et infamia metus sit:" that it is incumbent on the writer to rejudge the actions of men, to the end that the good and worthy may meet with the reward due to eminent virtue, and that pernicious citizens may be deterred by the condemnation that waits on evil deeds at the tribunal of posterity. In this consists the chief part of the historian's duty.

Let it be remembered that in this country, it is an indispensable duty of every man of liberal birth, to be acquainted in a certain degree with the science of politics. History is the school of politics: it unfolds to us the springs of human affairs; the causes of the rise, grandeur, revolutions, and fall of empires. It points out the reciprocal influence of government and of national manners: it dissipates prejudices, nourishes the love of our country, and directs to the best means of improvement. It illustrates equally the blessings of political union and the miseries of faction.

As to the events that stand recorded in history, says lord Bolingbroke, we see them all, we see them as they followed one another, or as they produced one another, causes or effects, immediate or remote. We are cast back, as it were, into former ages; we live with the men who lived before us, and we inhabit countries that we never saw. Place is enlarged, and time prolonged in this manner; so that the man who applies himself early to the study of history may acquire in a few years, and before he sets his foot abroad in the world, not only a more extended knowledge of mankind, but the experience of more centuries than any of the patriarchs saw. The events we are witnesses of in the course of the longest life, appear to us very often original, unprepared, simple, and unrelative; they appear such very often, are called accidents, and looked upon as the effects of chance: experience can carry us no farther, for experience can go a very little way back in discovering causes; and effects are not the objects of experience till they happen. Hence many errors in judgment, and by consequence in conduct, necessarily arise; and here too lies the difference we are speaking of between history and experience: the advantage on the side of the former is double. In ancient history the examples are complete, which are incomplete in the course of experience; experience is doubly defective; we are born too late to see the beginning, and we die too late to see the end of many things. History supplies both those defects. Modern history shews the causes when experience presents the effects alone; and antient history enables us to guess at the effects when experience presents the causes alone.

HITCH, in the sea-language, is to catch hold of any thing with a hook or rope, and by this means to hold it fast: thus when a boat is to be hoisted in, the sailors say, hitch the tackles into the ring-bolts of the boat; and when they are about to weigh anchor, hitch the fish-hook to the fluke of the anchor.

HIVE, in country affairs, a convenient receptacle for bees. See APIS.

HOARSENESS. See MEDICINE.

HODMAN, an appellation given to a young student admitted into Christ's College, Oxford, from Westminster-school.

HOE, a husbandman's tool, somewhat like a cooper's adze to cut up weeds in gardens, fields, &c. This instrument is of great use, and ought to be much more employed than it is in hacking and clearing the several corners and patches of land in spare times of the year, which would be no small advantage to it.

HOEING, in the new husbandry, is the breaking or dividing the soil by tillage while the corn or other plants are growing thereon. It differs from common tillage (which is always performed before the corn or plants are sown or planted) in the time of performing it; and it is much more beneficial to the crops than any other tillage. This sort of tillage is performed various ways, and by means of different instruments.

HOG. See SUS.

HOG, on board of a ship, is a sort of flat scrubbing broom, formed by inclosing a number of short twigs of birch or such wood between two pieces of plank fastened together, and cutting off the ends of the twigs. It is used to scrape the filth from a ship's bottom under water, particularly in the act of boot-topping. For this purpose they fit to this broom a long staff with two ropes; one of which is used to thrust the hog under the ship's bottom, and the other to guide and pull it up again close to the planks.

HOGSHEAD, in commerce, a measure of capacity, containing sixty-three gallons.

HOLCUS, Indian millet or corn; a genus of the monoœcia order, in the polygamia class of plants; and in the natural method ranking under the 4th order, gramina. The calyx of the hermaphrodite is an uniflorous or biflorous glume; the corolla is a glume with an awn; there are three stamina, two styles, and one seed. The male calyx is a bivalved glume; there is no corolla, but three stamina.

Of this genus there are fifteen species, two of which are natives of Britain. The most remarkable of these is the lanatus, or creeping soft-grass of Hudson. The most remarkable of the foreign species is the sorghum, or Guinea-corn. The stalks are large, compact, and full eight feet high. In Senegal the fields are entirely covered with it. The negroes, who call it guiarnot, cover the ears when ripe with its own leaves to shelter it from the sparrows, which are very mischievous in that country. The grain made into bread, or otherwise used, is esteemed very wholesome. With this the slaves in the West Indies are generally fed, each being allowed from a pint to a quart every day. The juice of the stalks is so agreeably luscious, that, if prepared as the sugar-canes, they would afford an excellent sugar.

HOLOCENTRUS. Holocentrus, a genus of the order thoracici; the generic character is, habit of the genus perca; gill-covers scaly, serrated, and aculeated; scales in most species, hard and rough. There are 35 species, the principal of which are:

1. Holocentrus sogo, a highly beautiful species: general length about a foot; habit somewhat resembling that of a carp, but of a squarer form, growing suddenly slender near the tail; eyes very large and gold-coloured; scales large and denticulated at the edges: tail very much forked. Native of the Mediterranean, Indian, and American seas, and considered as an excellent fish for the table.

2. Holocentrus schraetzer: length about ten inches; shape somewhat lengthened; head destitute of scales, for which reason this species is by Dr. Bloch arranged under a distinct genus by the name of gymnocephalus: scales rather small than large; tail slightly divided; lowest of the longitudinal lines composed of a row of spots; dorsal fin spotted with black; native of the Danube and its tributary streams; in considerable esteem as an article of food.

3. Holocentrus decussatus, decussated holocentrus: length about twelve inches; back dusky brown; sides marked by two longitudinal brown stripes from the gills to the tail, and by seven transverse ones, each continued to some little distance into the dorsal fin, which is white or pale; scales middle-sized; eyes blue; tail brown, and slightly lunated.

4. Holocentrus calcarifer, spur-gilled holocentrus: length about a foot; habit that of a carp, but rather more lengthened in proportion; body marked by dusky lines along each row of scales; anterior gill-covers furnished with four strong sharp spines, so placed as to bear some resemblance to the rowel of a spur; posterior gill-covers armed with a single spine: fins and tail marked across the rays by brown spotted streaks; native of Japan.

5. Holocentrus surinamensis, Surinam holocentrus: length twelve inches; habit of a carp; general colour brown, with several large, roundish, obscurely-yellow patches on each side; head and gill-covers red; mouth small; dorsal fin scaly at the base of the back-part; tail crossed near the base by a brown bar: native of Surinam, where it is highly esteemed for the table, being considered as one of the best fishes which the country produces.

6. Holocentrus afer, African holocentrus; length twelve inches; outline of the body, exclusive of the fins, somewhat resembling that of a sole; thickness considerable; scales very small, but those on the posterior gill-covers considerably larger than the rest; dorsal fin covered with small scales, and furnished on the fore-part with extremely thick or strong spines; back part and anal fin rounded, and reaching to within a little distance of the tail, which is remarkably small for the size of the fish, and of a round shape; pectoral fins, whitish; ventral, pale red; native of the coasts of Guinea, feeding on marine insects, &c. and in considerable estimation as a food.

HOLLY. See ILEX.

HOLLAND, in commerce, a fine and close kind of linen, so called from its being first manufactured in Holland.

HOLOSTEUM, a genus of the trigynia order, in the triandria class of plants, and in the natural method ranking under the 22d order, caryophyllei. The calyx is pentaphyllous; the petals five; the capsule, unilocular, and nearly cylindrical, opening at top. There are five species.

HOLOTHURIA, in zoology, a genus belonging to the order of vermes mollusca. The body, detached, naked, gibbous, terminated by the anus. Many tentacula at the other extremity surrounding the mouth. There are nine species, all inhabitants of the ocean. The following descriptions of three species are given by Mr. Barbut.

1. The tremula, or quivering holothuria, "commonly measures eight inches in length when dead; but alive it extends itself to more than a foot, or contracts its body into a ball. Its figure is cylindric, the diameter of which is every way equal to an inch and a few lines. The belly is of a pale brown, and set all over with cylindric tentacula, in such numbers that the head of a pin could scarcely find room between. By the help of these tentacula, the holothuria fixes its body at the bottom of the sea, so as not to be easily forced away by tempests, which would otherwise happen the more frequently, as this zoophite dwells near the shores where the water scarcely rises to a fathom's height.

2. The physalis, or bladder-shaped holothuria. The body of this species is oval, approaching to triangular, of a glossy transparency; the back sharp-edged, of a dark green colour, whence run out a number of sinews; anteriorly the body is of a reddish hue. The trunk spiral, reddish towards the thicker end. Many tentacula of unequal length under that thicker end; the shorter ones are taper and thicker, the middle ones capillary, the point clay-colour, and in shape like a ball; the rest, which are longer, are filiform, of which the middlemost is thicker and twice as long. Brown, in his Jamaica, calls it a diaphanous bladder with numerous tentacula representing a man's belly; above it is furnished with a comb full of cells; under the other extremity hang a number of branchy tentacula. It inhabits the seas.

3. The pentactes, or five-rowed holothuria, has the mouth encompassed with tentacula, the body bearing tentacula five different ways. The animal is of a red colour, nearly oval, or somewhat cylindrical, assuming various shapes. The mouth is set round with ten rays, bristly at the points; the body is longitudinally dotted with warts. It inhabits the sea of Norway.

HOLY-GHOST, *order of the*, the principal military order in the old government of France, instituted by Henry III. in 1569.

HOLLOW-SQUARE, in the military art, a body of foot drawn up, with an empty space in the middle for colours, drums, and baggage.

HOLLOW-TOWER, according to Harris, is a rounding made of the remainder of two brisures, to join the curtin to the orillon, where the small shot are played, that they may not be so much exposed to the view of the enemy.

HOMAGE. In the original grants of lands and tenements by way of fee, the lord did not only tie his tenants to certain services, but also took a submission, with promise and oath to be true and loyal to him as their lord and benefactor. This submission was and is called homage.

HOMAGE ANCESTREL, is where a man's ancestors, time out of mind, held their land of their lord and his ancestors, by homage; and if such lord has received homage, he is bound to acquit the tenant against all other lords above him of all service; and if the tenant has done homage to his lord, and is impleaded, and vouches the lord to warranty, the lord is bound to warrant him; and if the tenant loses, he shall recover in value against the lord so much of the lands as he had at the time of the voucher, or any time after.

HOMAGE JURY, a jury in a court baron, consisting of tenants that do homage to the lord of the fee, and there by the feudists are called pares curiæ; they inquire and make presentments of defaults and deaths of tenants, admittances, and surrenders in the lord's court, &c.

HOMALIUM, a genus of the class and order polyandria trigynia. The calyx is six or seven-parted: corolla, six or seven-petalled: stamina, 21 in three bodies: pericarpium, one-celled, many-seeded: There are two species, a tree of Jamaica and a shrub of Guiana.

HOMICIDE, properly so called, is the killing of a man by a man. Of this there are several species, as homicide by self-defence, homicide by misadventure, justifiable homicide, manslaughter, chance-medley, and murder.

Homicide by self-defence. Homicide se defendendo, or in a man's own defence, seems to be, where one has no other possible means of preserving his life from one who combats with him on a sudden quarrel, and kills the person by whom he is reduced to such inevitable necessity. 1 Haw. 75.

And not only he who on an assault retreats to a wall, or some such strait, beyond which he can go no farther before he kills the other, is judged by the law to act upon unavoidable necessity; but also he, who being assaulted in such a manner and in such a place, that he cannot go back without manifestly endangering his life, kills the other without retreating at all. Id.

And though a person who retreats from an assault to the wall should give the other wounds in his retreat, yet if he gives him no mortal wound till he gets thither, and then kills him, he is guilty of homicide se defendendo only. Id.

But if the mortal wound was given first, then it is manslaughter. Hale's Pl. 42.

Homicide by misadventure, is where a man in doing a lawful act without any intent of hurt, unfortunately chances to kill another, as where a labourer being at work with an hatchet, the head thereof flies off, and kills one who stands by. 1 Haw. 73.

It seems clear, that neither homicide by misadventure, nor homicide se defendendo are felonious, because they are not accompanied with a felonious intent, which is necessary in every felony. 1 Haw. 29.

Justifiable homicide. To make homicide justifiable, it must be owing to some unavoidable necessity, to which a person who kills another must be reduced, without any manner of fault in himself.

And there must be no malice coloured under pretence of necessity; for wherever a person who kills another, acts in truth upon malice, and takes occasion upon the appearance of necessity to execute his own private revenge, he is guilty of murder. 1 Haw. 69.

But if a woman kills him who assaults to ravish her, it is no felony; or if a man comes to burn my house, and I go out thereof and kill him, it is no felony. Id. 39.

If any evil-disposed person shall attempt feloniously to rob or murder any person in any dwelling-house, or highway, or feloniously attempt to break any dwelling-house in the night time, and shall happen to be slain in such felonious attempt, the slayer shall be discharged, and shall forfeit no lands, nor goods. 24 H. VIII. c. 5.

Justifiable homicide of a public nature, is such as is occasioned by the due execution or advancement of public justice, with regard to which it must be observed.

1. That the judgment, by virtue whereof any person is put to death, must be given by one who has legal jurisdiction in the cause; for otherwise both judge and officer may be guilty of felony.

2. The execution must be pursuant to, and warranted by the judgment, otherwise it is without authority; and consequently, if a sheriff shall behead a man, when it is no part of the sentence to cut off the head, he is guilty of felony. 1 Haw. 70.

Manslaughter. Homicide against the life of another, is either with or without malice; that which is without malice is called manslaughter, or sometimes chance medley, by which is understood such killing as happens either on a sudden quarrel, or in the commission of an unlawful act, without any deliberate intention of doing any mischief at all. 3 Inst. 56.

Hence it follows, that there can be no accessaries to this offence before the fact, because it must be done without premeditation; but there may be accessaries after the fact. Id.

The only difference between murder and manslaughter, is, that murder is upon malice aforethought, and manslaughter upon a sudden occasion, as if two meet together, and striving for the wall the one kills the other, this is manslaughter and felony. And so it is if they had, on that sudden occasion, gone into the field and fought, and the one had killed the other, this had been but manslaughter and no murder, because all that followed was but a continuance of the first sudden occasion, and the blood was never cooled till the blow was given. 3 Inst. 55.

Chance or chaunce-medley. Authors of the first authority disagree about the application of this word; by some it is applied to homicide by misadventure, by others to manslaughter. The original meaning of the word seems to favour the former opinion, as it signifies a sudden or casual meddling or contention; but homicide by misadventure supposes no previous meddling or falling out.

Murder is the highest crime against the law of nature that a man is capable of committing.

Murder is when a man of sound memory, and at the age of discretion, unlawfully kills another person under the king's peace with malice aforethought, either expressed by the party, or implied by the law, so as the party wounded or hurt die of the wound or hurt within a year and a day. 3 Inst. 47.

And the whole day on which the hurt was done, shall be reckoned the first. 1 Haw. 79.

By malice expressed, is meant a deliberate intention of doing any bodily harm to another, whereunto by law a person is not authorized.

And the evidences of such malice must arise from external circumstances discovering that inward intention; as lying in wait, menacings antecedent, former grudges, deliberate compassings and the like, which are various, according to the variety of circumstances. 1 H. H. 451.

Malice implied, is where a person voluntary kills another, without any provocation; for in this case the law presumes it to be malicious, and that he is a public enemy of mankind. 1 H. H. 455.

In general any formed design of doing mischief may be called malice; and therefore not such killing only as proceeds from premeditated hatred or revenge against the person killed, but also in many other cases, such as is accompanied with circumstances which shew the heart to be perversely wicked, is judged to be of malice prepense, or aforethought, and consequently murder. 2 Haw. 80.

If a man kills another, it shall be intended prima facie that he did it maliciously, unless he makes the contrary appear, by shewing that he did it on a sudden provocation or the like. 1 Haw. 82.

When the law makes use of the term malice aforethought, as descriptive of the crime of murder, it must not be understood in that narrow restrained sense, to which the modern use of the word malice is apt to lead one, a principle of malevolence to particulars; for the law by the term malice, in this instance, means, that the fact has been attended with such circumstances as are the ordinary symptoms of a wicked heart, regardless of social duty, and fatally bent upon mischief. Fost. 256.

The law so far abhors all duelling in cold blood, that not only the principal who actually kills the other, but also his seconds are guilty of murder, whether they fought or not; and it is holden that the seconds of the person killed are also equally guilty, in respect to that countenance which they give to their principals in the execution of their purpose, by accompanying them therein, and being ready to bear a part with them. 1 Haw. 82.

Also it seems agreed, that no breach of a man's word or promise, no trespass either to land or goods, no affront by bare words or gestures, however false or malicious it may be, and aggravated with the most provoking circumstances, will excuse him from being guilty of murder who is so far transported thereby, as immediately to attack the person who offends, in such a manner as manifestly endangers his life, without giving him time to put himself upon his guard, if he kills him in pursuance of such assault, whether the person slain did at all fight in his defence or not. Id.

HOMINE REPLEGIANDO, in law, is an antient writ that lies for bailing a person out of prison, where any one is confined without commandment of the king or his judges; or for any cause that is repleviable. This writ is directed to the sheriff, commanding him to replevy the prisoner. In case a person takes away secretly, or keeps in his custody any person against his will, on oath made thereof, and a petition to the lord chancellor, he will grant a writ of replegiari facias, upon which the sheriff returns an elongatus, and then there issues a capias in withernam, to take the party so offending.

HOMOGENEOUS SURDS, those which have the same radical character, or signs, as $\sqrt[2]{a}$ and $\sqrt[2]{b}$.

HOMOLOGOUS, in geometry, an appellation given to the corresponding sides and angles of similar figures, as being proportional to each other.

HOMOLOGOUS THINGS, in logic, those which agree in name, but are of different natures.

HONEY, a saccharine substance prepared by the bees (see APIS). It has a white or yellowish colour, a soft and grained consistence, a saccharine and aromatic smell. By distillation it affords an acid phlegm and an oil, and its coal is light and spongy like that of the mucilage of plants. Nitric acid extracts from it oxalic acid precisely as it does from sugar; it is very soluble in water, with which it forms a syrup, and like sugar passes to the vinous fermentation. Mr. Cavezzali has proved lately that honey is composed of sugar, mucilage, and an acid. The sugar may be separated by melting the honey, adding carbonat of lime in powder as long as any effervescence appears, and scumming the solution while hot. The liquid thus treated gradually deposits crystals of sugar when allowed to remain in a glass vessel. There are three distinctions of honey, according to its purity, fluidity, and the manner in which it has been procured from the honeycombs. The first and finest kind is virgin-honey, or the first produce of a swarm, obtained from the combs without pressing; these being only set to drain, in order to its running out. The second kind is that known by the name of white-honey, being thicker than the former, and often indeed almost solid; it is procured by pressing the combs, but without the assistance of heat. The third and worst kind is the common yellow honey, obtained from the combs first heated over the fire, and then pressed.

HONEY-COMB, a waxen structure, full of cells, framed by the bees, to deposit their honey and eggs in.

The construction of the honey-comb seems one of the most surprising of the works of insects, and the materials of which it is composed, which, though evidently collected from the flowers of plants, yet do not, that we know of, exist in them in that state, has given great cause of speculation to the curious. The regular structure of the comb is also equally wonderful. When the several cells in it are examined, it should seem that the nicest rules of geometry had been consulted for its composition, and all the advantages that could be wished, or desired, in a thing of that kind, are evidently found in it. Each cell consists of six plane sides, which are all trapeziums, but equal to each other; the bottom of the cell is contrived with three rhombuses, H K D I, D E F I, and F G H I, (plate Miscel. fig. 124) so disposed as to constitute a solid angle at I, under the three equal angles D I H, D I F, and H I F, each of which is double the maximum angle of $54^\circ\ 44' = D\,I\,K = D\,K\,I$. Hence it comes to pass, that a less quantity of surface is sufficient to contain a given quantity of honey, than if the bottom had been flat, in the proportion of 4658 to 5550, as has been found by calculation; that is, nearly a fifth of the whole, so far as the figure in the end of the cells extends, in each; which fifth part of wax and labour saved, amounts to a vast deal in the whole comb. The sides of the cells are all much thinner than the finest paper, and yet they are so strengthened by their disposition, that they are able to resist all the motions of the bee within them, as they are frequently obliged to be. The effect of their thrusting their bodies into the cells would be the bursting of those cells at the top, was not this well-guarded against. But to prevent this, the creatures extend a cord, or roll of wax, round the verge of every cell, in such a manner that it is scarcely possible they should split in that particular part. This cord or roll is at least three times as thick as the sides of the cell, and is even much thicker and stronger at the angles of the cells, than elsewhere, so that the aperture of each cell is not regularly hexagonal, though its inner cavity is perfectly so. See fig. 125.

The several combs are all placed parallel to one another (fig. 126) and there is such a space left between them, that the bees can easily pass; and often they place a part of the comb in a contrary direction to the rest, so that while the others are placed horizontally, these stand perpendicularly.

The celerity with which a swarm of bees received into a hive, where they find themselves lodged to their minds, bring their works of the combs to perfection is amazing. There are vast numbers at work all at once; and that they may not incommode one another, they do not work upon the first comb till it is finished, but when the foundation of that is laid, they go to work upon another, so that there are often the beginnings of three or four stories made at once, and so many parties allotted to the carrying on the work of each. In a very few days a new swarm will have completed several combs of the depth of four or five inches each.

HONEY-STONE. See MELLITE.

HONOUR, is used for a seignory or lordship, on which inferior lordships and manors depend; for as a manor consists of several lands, tenements, services, and customs, so an honour contains several manors, knights-fees, &c.

HONOUR-COURTS, are courts held within the honours or seignories.

HONOUR, *maids of*, are six young ladies in the houshold of the queen, and princess royal; the salary of those of a queen are 300*l*. each, and those of the princess dowager of Wales, 200*l*.

HONOUR-POINT, in heraldry, is that next above the centre of the escutcheon, dividing the upper part into two equal portions.

HOOF, the horny substance that covers the feet of divers animals, as oxen, horses, sheep, &c. See HORN.

HOOPING-COUGH. See MEDICINE.

HOP. See HUMULUS.

HOPEA, a genus of the polyandria order, in the polyadelphia class of plants. The calyx is quinquefid, superior; the corolla pentapetalous; the stamina are many, and coalited into five pencils; there is one style; the

fruit is a plum, with a trilocular kernel. There is only one species, the tinctoria, a native of Carolina.

HORARY, or HOUR-CIRCLE. See *Use of the* GLOBE.

HORARY CIRCLES, or LINES. See DIALLING.

HORARY MOTION *of the earth*, the arch it describes in the space of an hour, which is nearly 15 degrees, though not accurately so, as the earth moves with different velocities, according to its greater or lesser distance from the sun.

HORDEUM, *barley*, a genus of the triandria-trigynia class of plants, the corolla whereof consists of two valves; the inferior valve is angular, of an ovato-acuminated figure, bellied, and longer than the cup, and terminates in a very long arista; the anterior valve is lanceolated, plane and smaller; the corolla serves as a pericarpium, surrounding the seed, and not letting it out; the seed is oblong, ventricose, pointed at each end, and marked with a longitudinal furrow. See HUSBANDRY.

HORIA, in entomology, a genus of the coleoptera order. Antennæ moniliform; feelers four, thicker towards the tip; lip linear, rounded at the end. There are two species; the testacea, and the dermestoides.

HORIZON. See ASTRONOMY and GEOGRAPHY.

HORIZONTAL DIAL. See DIALLING.

HORIZONTAL LINE. See PERSPECTIVE.

HORIZONTAL PLANE, that which is parallel to the horizon of the place, or nothing inclined thereto. The business of levelling is to find whether two points are in the horizontal plane, or how much the deviation is.

HORIZONTAL RANGE *of a piece of ordnance*, is the distance at which it falls on or strikes the horizon, or on a horizontal plane, whatever is the angle of elevation or direction of the piece. When the piece is pointed parallel to the horizon, the range is then called the point-blank or point-blanc range.

The greatest horizontal range, in the parabolic theory, or in a vacuum, is that made with the piece elevated to 45 degrees, and is equal to double the height from which a heavy body must freely fall to acquire the velocity with which the shot is discharged. Thus, a shot being discharged with the velocity of v feet per second; because gravity generates the velocity $2g$ or $32\frac{1}{6}$ feet in the first second of time, by falling $16\frac{1}{12}$ or g feet, and because the spaces descended are as the squares of the velocities, therefore as $4g^2 : v^2 :: g : \frac{v^2}{4g}$, the space a body must descend to acquire the velocity v of the shot or the space due to the velocity v; consequently the double of this, or $\frac{x^2}{2g} = \frac{v^2}{32\frac{1}{6}}$ is the greatest horizontal range with the velocity v, or at an elevation of 45 degrees; which is nearly half the square of a quarter of the velocity.

In other elevations, the horizontal range is as the sine of double the angle of elevation; so that, any other elevation being e, it will be, as radius $1 :$ sin. $2e :: \frac{v^2}{32\frac{1}{6}} : \frac{v^2}{32\frac{1}{6}} \times$ sin. $2e$, the range at the elevation e, with the velocity v.

But in a resisting medium, like the atmosphere, the actual ranges fall far short of the above theorems, insomuch that with the great velocities the actual or real ranges may be less than the tenth part of the potential ranges; so that some balls, which actually range but a mile or two, would in vacuo range 20 or 30 miles. And hence also it happens that the elevation of the piece, to shoot farthest in the resisting medium, is always below 45°, and gradually the more below it as the velocity is greater; so that the greater velocities with which balls are discharged from cannon with gunpowder, require an elevation of the gun equal to but about 30°, or even less. And the less the size of the balls is too, the less must this angle of elevation be to shoot the farthest with a given velocity. See PROJECTILE and GUNNERY.

HORN, *cornu*, in physiology, a hard substance growing on the heads of animals, particularly the cloven-footed quadrupeds; and serving them both as weapons of offence and defence.

Horns are not very hard, as they may be easily cut with a knife or rasped with a file; but they are so tough as not to be capable of being pounded in a mortar. When in thin plates, they have a degree of transparency, and have been sometimes substituted for glass in windows. When heated sufficiently, they become very soft and flexible, so that their shape may be altered considerably. Hence they may be gradually squeezed into a mould, and wrought into various forms, as is well known.

The quantity of earthy matter which they contain is exceedingly small. Mr. Hatchett burnt 500 grains of ox-horn. The residuum was only 1.5 grain, and not the half of this was phosphat of lime. Seventy-eight grains of the horn of the chamois left only 0.5 of residue, of which less than the half was phosphat of lime. They consist chiefly of a membranous substance, which possesses the properties of coagulated albumen; and probably they contain also a little gelatine. Hence we see the reason of the products that are obtained when these substances are subjected to distillation.

The horns of the hart and buck must, however, be excepted. From the experiments of Scheele and Rouelle, together with those of Hatchett, we know that these substances possess exactly the properties of bone, and are composed of the same constituents, excepting only that the proportion of cartilage is greater. They are intermediate, then, between bone and horn.

The nails, which cover the extremities of the fingers, are attached to the epidermis, and come off along with it. Mr. Hatchett has ascertained that they are composed chiefly of a membranous substance, which possesses the power of coagulated albumen. They seem to contain also a little phosphat of lime. Water softens, but does not dissolve them. But they are readily dissolved and decomposed by concentrated acids and alkalies. Hence it appears that nails agree with horns in their nature and composition. Under the head of nails must be comprehended the talons and claws of the inferior animals, and likewise their hoofs, which differ in no respect from horn.

The substance called tortoise-shell is very different from shells in its composition, and approaches much nearer to the nature of nail: for that reason we have placed it here. When long macerated in nitric acid, it softens, and appears to be composed of membranes laid over each other, and possessing the properties of coagulated albumen. When burnt, 500 grains of it yield three of earthy matter, consisting of phosphat of lime and soda, with a little iron.

The scales of animals are of two kinds: some, as those of serpents and other amphibious animals, have a striking resemblance to horn; while those of fish bear a greater resemblance to mother-of-pearl. The composition of these two kinds of shells is very different.

The scales of fish, as has been observed by Lewenhoeck, are composed of different membranous laminæ. When immersed for four or five hours in nitric acid, they become transparent, and perfectly membranaceous. The acid, when saturated with ammonia, gives a copious precipitate of phosphate of lime. Hence they are composed of alternate layers of membrane and phosphat of lime. To this structure they owe their brilliancy. Mr. Hatchett found the spicula of the shark's skin to be similar in its composition, but the skin itself yielded no phosphat of lime.

The horny scales of serpents, on the other hand, are composed alone of a horny membrane, and are destitute of phosphat of lime. They yield, when boiled, but slight traces of gelatine: the horn-like crusts which cover certain insects and other animals appear from Mr. Hatchett's experiments to be nearly similar in their composition and nature.

The casting of the horns of deer is a singular phænomenon, the true reason of which seems to be a stoppage of the circulation; so that being deprived of the nourishing juice, they fall off much in the same manner as the leaves of trees in autumn. About ten days after the horns are cast, the new ones begin to appear: these at first are soft and hairy, but they afterwards grow hard, and the creature rubs off the hair.

Horns make a considerable article in the arts and manufactures. Bullocks' horns, softened by the fire, serve to make lanthorns, combs, knives, ink-horns, tobacco-boxes, &c.

Dyeing of horns. Black is performed by steeping brass in aqua-fortis till it is turned green: with this the horn is to be washed once or twice, and then put into a warmed decoction of logwood and water. Green is begun by boiling it, &c. in alum-water, then with verdigris, ammoniac, and white-wine vinegar, keeping it hot therein till sufficiently green. Red is begun by boiling it in alum-water, and finished by decoction in a liquor compounded of quicklime steeped in rain-water, strained, and to every pint an ounce of Brazil wood added. In this decoction the bone, &c. is to be boiled till sufficiently red.

Dr. Lewis informs us, that horns receive a deep black stain from solution of silver. It ought to be diluted to such a degree as not sensibly to corrode the subject, and applied two or three times, if necessary, at considerable intervals, the matter being exposed as much as possible to the sun, to hasten the appearance and deepening of the colour.

Dyeing or staining horn to imitate tortoise-shell. The horn to be dyed must be first pressed into proper plates, scales, or other flat form, and the following mixture prepared: Take of quick-lime two parts, and

of litharge one part; temper them together to the consistence of a soft-paste with soapley. Put this paste over all the parts of the horn, except such as are proper to be left transparent, in order to give it a near resemblance of the tortoise-shell. The horn must remain in this manner covered with the paste till it is thoroughly dry; when, the paste being brushed off, the horn will be found partly opaque and partly transparent, in the manner of tortoise-shell, and when put over a foil of the kind of latten called assidue, will be scarcely distinguishable from it. It requires some degree of fancy and judgment to dispose of the paste in such a manner as to form a variety of transparent parts, of different magnitudes and figures, to look like the effect of nature: and it will be an improvement to add semitransparent parts, which may be done by mixing whiting with some of the paste to weaken its operation in particular places, by which spots of a reddish brown will be produced, which if properly interspersed, especially on the edges of the dark parts, will greatly increase both the beauty of the work and its similitude to real tortoise-shell.

HORN is also a musical instrument of the wind kind, chiefly used in hunting, to animate the hunters and the dogs, and to call the latter together. The French horn is bent into a circle, and goes two or three times round, growing gradually larger and wider towards the end, which in some horns is nine or ten inches over.

HORNS *of insects*, the slender oblong bodies projected from the heads of those animals, and otherwise called antennæ or feelers. See ENTOMOLOGY.

HORNBLENDE. This mineral enters into the composition of many mountains. It is also amorphous, but frequently also crystallized. The primitive form of its crystals is a rhomboidal prism, the faces of which are inclined at angles of 124° 34′ and 55° 26′, and whose bases are angles of 122° 56′ and 57° 4′. The most common variety is a six-sided prism, terminated by trihedral or tetrahedral summits.

HORNBLENDE, *common*. Its texture is very conspicuously foliated; fracture conchoidal; fragments often rhomboidal; opaque; tough; specific gravity 2.922 to 3.41; colour black, blackish-green, olive-green, or leek-green; streak greenish. It neither becomes electric by friction nor heat. Before the blow-pipe it melts into a black glass. A specimen of black hornblende, analysed by Mr. Hermann, was composed of

37 silica
27 alumina
25 iron
5 lime
3 magnesia

97

HORNBLENDE, *basaltic*. This stone is found commonly in basaltic rocks; hence the name *basaltine*, which was imposed by Mr. Kirwan. It is crystallized either in rhomboidal prisms, or six or eight-sided prisms, terminated by three-sided pyramids. Its texture is foliated; its fracture uneven; specific gravity 3.333; colour black, dark-green, or yellowish-green; streak white; transmits a reddish-yellow light. Before the blow-pipe it melts into a greyish-coloured enamel, with a tint of yellow. A specimen, seemingly of this stone, analysed by Bergman, contained

58 silica
27 alumina
9 iron
4 lime
1 magnesia

99

HORNBLENDE, *shistose*. Colour greenish-black or deep green; forms strata; structure shistose; texture radiated or fibrous; opaque; brittle; streak greenish grey; moderately heavy; gives an argillaceous smell when breathed upon. This mineral is often confounded with slate. In Sweden it is employed for covering houses.

HORNERS, those artificers whose business it is to prepare various utensils of the horns of cattle. The horners were a very antient and considerable fraternity in the city of London some hundred years ago. In the reign of Edward II. they complained to parliament, that by foreigners buying up the horns in England, they were in danger of being ruined, and this business lost to the nation. For this reason was made the statute 6 Edw. IV. by which the sale of horns to foreigners (except such as the said horners refused) was prohibited; and the wardens had power granted them to search all the markets in London and 24 miles round, and to inspect Stourbridge and Ely fairs, to prevent such practices, and to purchase horns at stated prices. But on plausible pretences this law was repealed in the reign of James I. and thereupon the old evil revived. The horners again applied to parliament, and king Edward's statute was renewed (excepting as to the inspection of the fairs), and still remains in force. The importation of unwrought horns into this country is also prohibited. The present company of horners were incorporated January 12, 1638.

HORN-FISH, a species of esox, otherwise called gar-fish. See ESOX.

HORN-WORK, in fortification, an out-work composed of two demi-bastions, joined by a curtin. See FORTIFICATION.

HORNET, in zoology, a species of vespa with a black thorax, and double black spots on the segments of the body. See VESPA.

HORNSTONE, in mineralogy. This stone is usually amorphous, occurring sometimes in mass, and sometimes in round balls. Fracture splintery, and sometimes conchoidal; specific gravity 2.7; colour greyish-blue, but sometimes grey, red, blue, green, and brown, of different shades. According to Kirwan, it is composed of

72 silica
22 alumina
6 carbonat of lime

100

HORSE. See EQUUS.

HORSE-DEALERS. Every person exercising the trade or business of a horse-dealer, must take out a licence from the stamp-office, for which he shall pay annually, if within London, Westminster, the bills of mortality, the parish of St. Pancras, or the borough of Southwark, 20*l*.; elsewhere, 10*l*.

The commissioners are to grant licences to horse-dealers for not exceeding one year; and every licence shall cease on September 29, then in the year for which the same shall be issued, and commence from the date; and every licence taken out for any year subsequent to the year in which the same shall be issued, shall commence from September 29, then next ensuing, and continue till September 29 following; and a fresh licence is to be taken out ten days at least before the expiration of the year.

One licence is sufficient for partners, and the licence is confined to the place mentioned therein. But no licences to be granted to horse-dealers, unless they declare they seek their living by buying and selling horses, and add the name of the place where the said business is carried on. 29 Geo. III. c. 49.

Horse-dealers so licenced, shall cause the words *licenced to deal in horses* to be painted or written in large and legible characters either on a sign hung out or on some visible place in the front of their house, gate-way, or stables; and if they shall sell any horse without fixing such token, they shall forfeit 10*l*. to be recovered by action, half to the king, and half to the informer. 36 Geo. III. c. 17.

Horse-dealers who shall, after January 1, 1796, carry on the said business without having obtained a licence under this act, shall be liable to be assessed the duties on riding-horses, and shall deliver lists thereof as other persons.

HORSE-SHOE, in fortification, is a small work, sometimes of a round and sometimes of an oval figure, inclosed with a parapet, sometimes raised in the moat or ditch, or in low grounds, and sometimes to cover a gate, or to serve as a lodgment for soldiers. See FORTIFICATION.

HORSE-SHOES. See FARRIERY.

HORSE, in a ship, is a rope made fast to each yard arm, and on which the men stand to furl the sails. It is also a wooden frame with a rowel fixed in it, made use of by the riggers to woold ships-masts.

HORSES. It shall be lawful for any person, native or foreigner, at any time to ship, lade, and transport by way of merchandize, horses into any parts beyond the seas in amity with his majesty, paying for each horse, mare, or gelding, 5*s*. and no more.

No person convicted for feloniously stealing a horse, gelding, or mare, shall have the privilege of clergy. 1 Edw VI. c. 12. And not only all accessaries before such felony done, but also all accessaries after such felony, shall be deprived and put from all benefit of their clergy, as the principal, by statute heretofore made, is or ought to be.

If a horse be stolen out of the stable, or other curtilage of a dwelling-house, in the night time, it falls under the denomination of burglary; if in the day-time, it falls under the denomination of larceny from the house; and in either case there is a reward of 40*l*. for convicting an offender, and the prosecutor is entitled to a certificate which will exempt him from all parish and ward offices in the parish and ward where the burglary or larceny is committed, and which may be once assigned over, and will give the same exemption to the assignee as to the original proprietor. Burn's Just. 621.

If an unsound horse is sold at the price of a sound horse, though not absolutely war-

ranted to be sound, the seller sins against the law of morality and the law of the land; but if he acknowledges him not to be sound, and sells him greatly under the value of a sound horse, as if he disposes of him for 25*l.* when he would have been worth 50*l.* if sound, such sale may be considered as fair and legal.

If a horse which is warranted sound at the time of sale is proved to have been at that time unsound, it is not necessary that he should be returned to the seller. No lapse of time elapsed after the sale will alter the nature of a contract originally false. Neither is notice necessary to be given; though the not giving notice will be a strong presumption against the buyer, that the horse at the time of sale had not the defect complained of, and will make the proof on his part much more difficult. The bargain is compleat; and if it is fraudulent on the part of the seller, he will be liable to the buyer in damages, without either a return or notice.

If on account of a horse warranted sound, the buyer shall sell him again at a loss, an action might *perhaps* be maintained against the original seller, to recover the difference of the price. 1 Hen. Black. 17.

Slaughtering horses. Great abuses having arisen, and many horses having been stolen, from the facility and safety of disposing of them to those who kept slaughter-houses for horses, some regulations and restrictions seemed absolutely necessary. It was no uncommon thing for horses of great value to be sold for the purpose of making food for dogs; the thief rather choosing to receive 20*s.* for a stolen horse, without fear or danger of detection, than venture to dispose of him publicly, though he might possibly have found a purchaser who would have given as many pounds for him. These considerations induced the legislature to pass the act of 26 Geo. III. c. 71, for regulating these slaughter-houses.

Killing or maiming horses. Where any person shall in the night-time maliciously, unlawfully, and willingly kill or destroy any horses, sheep, or other cattle, of any person, every such offence shall be adjudged felony, and the offender shall suffer as in the case of felony. 22 and 23 Car. II. c. 7.

Offenders may be transported for seven years, either at the assizes or at the sessions, by three justices of the peace, one to be of the quorum.

By the 9th Geo. I. c. 22. commonly called the black-act, it is enacted, that if any person shall unlawfully and maliciously kill, maim, or wound any cattle, every person so offending, being thereof lawfully convicted in any county of England, shall be adjudged guilty of felony, and shall suffer death, as in cases of felony, without benefit of clergy. But not to work corruption of blood, loss of dower, nor forfeiture of lands or goods.

Prosecution upon this statute shall or may be commenced within three years from the time of the offence committed, but not after.

If an horse or other goods are delivered to an inn-keeper or his servants, he is bound to keep them safely, and restore them when his guest leaves the house. 2 Black. 451.

If an horse is delivered to an agisting farmer, for the purpose of depasturing in his meadows, he is answerable for the loss of the horse, if it is occasioned by the ordinary neglect of himself or his servants. Jones on Bailm. 91.

If a man rides to an inn, where his horse has eaten, the host may detain the horse till he is satisfied for the eating, and without making any demand. 14 Vin. Abr. 437. But an horse committed to an inn-keeper can only be detained for his own meat, and not for that of his guest or any other horse; for the chattels in such case are only in the custody of the law for the debt which arises from the thing itself, and not for any other debt due from the same party. 2 Rol. Abr. 85.

By the custom of London and Exeter, if a man commits an horse to an inn-keeper, if he eats out his price, the inn-keeper may take him as his own, upon the reasonable appraisement of four of his neighbours; which was it seems a custom arising from the abundance of traffic with strangers, that could not be known so as to be charged with an action. But it has been holden, though an inn-keeper in London may, after long keeping, have the horse appraised and sell him, yet, when he has in such case had him appraised, he cannot justify the taking him to himself at the price he was appraised at. Vin. Abr. 233.

HORTUS SICCUS, a *dry garden*, an appellation given to a collection of specimens of plants, carefully dried and preserved. The value of such a collection is very evident, since a thousand minutiæ may be preserved in the well-dried specimens of plants, which the most accurate engraver would have omitted.

Among the different methods adopted by botanists for obtaining a hortus siccus, the following appear to be the most practicable:

1. Lay the plants flat between papers; then place them between two smooth plates of iron screwed together at the corners: in this state they are to be committed to a baker's oven for two hours. After being taken out, they must be rubbed over with a mixture consisting of equal parts of brandy and vinegar, then pasted down on paper with a solution of gum-tragacanth in water, after which they are to be laid in a book, where they will adhere, and retain their original freshness. The following method is however more simple:

2. Flatten the plant by passing a common smoothing-iron over the papers between which it is placed, and dry it slowly in a sand-heat. For this purpose the cold sand ought to be spread evenly, the smoothened plant laid gently on it, and sand sifted over so as to form a thick bed; the fire is then to be kindled, and the whole process carefully watched, till the plant is gradually and perfectly dried. Thus the colour of the tenderest herb may be preserved, and the most delicate flowers retain all their pristine beauty.

3. Another and far more complete method was suggested by the ingenious Mr. Whately. He directs those who intend to follow his plan, previously to procure—1. A strong oak-box of the same size and shape as those employed for packing up tin plates; 2. a quantity of fine sifted sand, sufficient to fill the box; 3. a considerable number of pieces of pliant paper, from one to four inches square; and 4. some small flat leaden weights, and a few small bound books.

The plant is first to be cleared from the soil as well as the decayed leaves, and then laid on the inside of one of the leaves of a sheet of common cap-paper. The upper leaves and flowers are next to be covered, when expanded, by pieces of the prepared paper, and one or two of the leaden weights placed on them. The remainder of the plant is now to be treated in a similar manner.

The weights ought next to be gently removed, and the other leaf of the sheet of paper folded over the opposite one, so as to contain the loose pieces of paper and plants between them. A book or two is now to be applied to the outside of the paper till the intended number of plants is thus prepared; when a box is to be filled with sand to the depth of an inch, one of the plants put in, and covered with sand sufficient to prevent the form of the plant from varying. The other plants may then be placed in succession, and likewise covered with a layer of sand, one inch thick between each; after which the whole is to be gently pressed down in a greater or less degree, according to the tenderness or firmness of the plants.

The box is next to be carefully placed before a fire, one side being occasionally a little raised, as may be most convenient; the sides being alternately presented to the fire two or three times in the day, or the whole may be put into an oven gently heated. In the course of two or three days the plants will be perfectly dry, when the sand ought to be taken out and put into another box: the plants should likewise be removed to a sheet of writing paper.

HOSPITALERS, an order of religious knights, now known by the title of knights of Malta.

HOT-BEDS, in gardening, beds made with fresh horse-dung, or tanner's bark, and covered with glasses to defend them from cold winds.

According to the quantity and quality of the materials put together for hot-beds, the heat will be proportioned as to strength and duration; and by a judicious use in making, and the management afterwards, many advantages may be obtained from them. The great point is, to suit the degree of heat to the nature of the different plants to be cultivated, that they may have neither more nor less than is necessary to promote a regular vegetation.

Two errors are common in the use of hot-beds, sowing or placing in the same bed things of a very different nature, as to the climate they grow best in, and forcing with too much heat even the tenderest. Though it may not answer our often too hasty views, the heat of a bed had better be slack than otherwise. A strong hot-bed that ought at least to be made a fortnight before it is used, is sometimes furnished by impatience in a few days, and various ill consequences follow, which naturally frustrate expectation.

The place where hot-beds are worked should be open to the full sun, catching it as early as possible in the morning, and having it as long as can be in the evening; and if not naturally sheltered, it should be screened from the north and north-east winds by a boarded fence or rather one of reeds, as from a solid fence the wind reverberates; but straw or flake-hurdles set endwise may do. A screen of some sort (and a close-clipt hedge is as good as any) not only protects the inclosure from the harsher winds, and confines the warm air, but keeps a rather un-

sightly work from view, and straws from blowing about, the litter of which is so disagreeable.

Working of the dung is necessary previous to the making of a hot-bed, *i. e.* it should be thrown together on an heap, in a conical form; and when it has taken a thorough heat, and has been smoking or sweating for two or three days, it should be turned over, moving the outside in, or mixing the colder parts with the hot. When it has taken heat again for two or three days, give it a second turn as before, and having lain the same time, it will be in proper order for making a good lasting bed with a steady heat. If in haste, it may be made into a bed after the first heating; but it will be better for shifting again, or even a third time. When dung is ready before wanted, keep turning it over, lest it should be too much spent. It will be proper to begin to work fresh dung a week or ten days before it is to be used; but if the dung is not fresh, it is only necessary to throw it together for once heating.

The size of a hot-bed, as to length and breadth, is of course to be according to the frame; and the height of it according to the season and the degree of heat requisite to the nature of the plant to be cultivated. In a dry soil, a bed may be sunk in the ground from six inches to a foot, to make it more convenient to get at and manage. But beds made forward in the season should rather be on the surface, for the sake of being able to add stronger linings, &c.

In case of an insufficient quantity of good horse-dung, that of cows, oxen, or pigs, if it is strawy, and not too wet, may be mixed with it, in the proportion of one-fourth or more, especially in an advanced part of the season, or to cultivate things that are only forcing, and do not naturally require heat.

When the season is pretty much advanced, hot-beds may be made of grass mowings (as from an orchard) and weeds, which is a common practice in the cyder countries. These heats, however, are often too violent, and last not long; yet they may be lined with the same materials if done in time, otherwise if a green hot-bed gets greatly cool, it will not be recovered. A grass bed may be used as soon as warm, but let it not be overweighted by putting on heavy frames, or more mould than necessary. It should rather be worked with hand-glasses or oiled paper covers.

Hot-beds are sometimes made of the refuse bark of a tanner's yard, and also of oak-leaves; but these must have walled pits for them of a large size, and are seldom used but in hot-houses. A bark-bed properly made, and managed by forking up at two or three month's end, &c. will hold a fair, moderate, and steady heat four, five, or six months.

To decrease the heat of a bed, several holes may be made in it, by thrusting an iron bar, or a thick smooth sharp-pointed stake, up to the middle, which holes are to be close stopt again with dung or hay when the heat is sufficiently abated.

The uses to which hot-beds may be applied are various, but chiefly for the cultivation of cucumbers and melons. At the spring of the year, hot-beds are commonly made use of for forcing crops of several vegetables, as radishes, carrots, cauliflowers, lettuces, potatoes, turneps, kidney-beans, purslane, tarragon, small sallading, &c. Fruits of several sorts, as cherries, strawberries, raspberries, &c. are sometimes brought forward by dung heat; as also various shrubs and flowers, by means of forcing-frames. Tender annuals, as balsams and other flowers that necessarily require heat to bring them up, and the less tender, and some even of the hardy sorts, are also cultivated on hot-beds, or by other assistance from dung, to produce an earlier blow than could otherwise be had.

HOT-HOUSE, in salt-making, the place where they dry the salt, when taken out of the boiling-pan. It is situated near the furnace, which, by means of funnels or tubes, conveys the heat into it.

HOT-HOUSE, in gardening, an erection intended for the culture of the tender exotics of tropical climates. It is usually built lower than a greenhouse, with double flues, and a pit in the middle for tanner's bark, in which, as in a kind of hot-bed, the pots containing the plants are to be plunged. A hot-house should be kept at a regular heat, seldom less than 70°; and when the weather becomes about 10° below that extremity, the fires may be left off. The tan should be renewed twice a year, in spring and autumn; and care must be taken not to plunge the plants in it till the heat is risen to a proper degree.

The ingenious Dr. Anderson, so well known for his labours in agriculture, has lately constructed a hot-house to be kept warm by air chiefly warmed by the heat of the sun. It is entirely of glass, and the upper part is a close chamber to contain the heated air, which is let into the house by a valve. In the winter the chamber is heated by a lamp, and the warm air is admitted in the same manner as that which is warmed by the sun. The house is also moveable; but for further details we must refer to the doctor's Agricultural Recreations.

HOTCH-POT, in law, is used for mixing of lands given in marriage with other lands in fee which fall by descent; as where a man possessed of thirty acres of land has issue only two daughters, and after his having given with one of them ten acres in marriage, he dies possessed of the other twenty. Here she that is thus married, in order to gain her share of the rest of the land, must put her part given in marriage in hotch-pot; that is, she must refuse to take the sole profits of her lands, and cause it to be mingled with the other, so that an equal division may be made of the whole between her and her sister; by which means, instead of only her ten acres, she has fifteen.

HOVENIA, a genus of the class and order pentandria monogynia. The petals are five, convoluted; stigma trifid; capsule three-celled, three-valved. There is one species, a shrub of Japan.

HOVERING. Ships of 50 tons, laden with customable or prohibited goods, hovering on the coasts of this kingdom, within the limits of any port (and not proceeding from foreign parts), may be entered by officers of the customs, who are to take an account of the lading, and to demand and take a security from the master, by his bond to his majesty, in such sum of money as shall be treble the value of such foreign goods then on board; that such ship shall proceed (as soon as wind and weather and the condition of the ship will permit) on her voyage to foreign parts, and shall land the goods in some foreign port; the master refusing to enter into such bond on demand, or who having given bond, shall not proceed on such voyage (unless otherwise suffered to make a longer stay by the collector or other principal officer of such port where the vessel shall be, not exceeding 20 days); in either of the said cases, all the foreign goods on board may be taken out by the customhouse-officers, by direction of the collector, and properly secured; and if they are customable, the duties shall be paid; and if prohibited, they shall be forfeited.

The officers of the customs may prosecute the same, as also the ship, if liable to condemnation. 3 Geo. III. c. 21.

Commanders of men of war, and customhouse-officers, may compel ships of 50 tons, or under, hovering within two leagues of shore, to come into port. 6 Geo. I. c. 21.

If any ship or vessel shall be found at anchor, or hovering within eight leagues of the coast (except between the North Foreland and Beachy Head), unless by distress of weather, having on board foreign spirits, in any vessel or cask which shall not contain 60 gallons at least, or any wine in casks (provided such vessel have wine on board), shall not exceed 60 tons burthen, or six pounds weight of tea, or 20 pounds weight of coffee, or any goods whatever liable to forfeiture upon importation, that such goods, with the ship and furniture, shall be forfeited; spirits for the use of seamen, not exceeding two gallons per man, excepted. 42 Geo. III. c. 82.

HOUND. See CANIS.

HOUR, *hora*, in chronology, an aliquot part of a natural day, usually a 24th, sometimes a 12th. See ASTRONOMY, GEOGRAPHY, &c.

There are different hours used by chronologers, astronomers, dialists, &c. Sometimes hours are divided into equal and unequal. Equal hours are the 24th part of a day and night precisely, that is, the time wherein 15 degrees of the equator mount above the horizon. These are also called equinoctial hours, because they are measured on the equinoctial; and astronomical, because used by astronomers. They are also differently denominated according to the manner of accounting them in different countries. Astronomical hours are equal hours, reckoned from noon or mid-day, in a continued series of twenty-four. Babylonish hours are equal hours reckoned in the same manner from sun-rise. The Italian hours are also equal hours, reckoned in the same manner too, from sun-setting. European hours are also equal hours, reckoned from midnight; 12 from thence to noon, and 12 more from noon to midnight. Jewish, or planetary, or antient hours, are the twelfth part of the artificial day and night, each being divided into 12 equal parts. Hence, as it is only in the time of the equinoxes that the artificial day is equal to the night, it is then only that the hours of the day are equal to those of the night. At other times they will be always either increasing or decreasing: and they will be the more or less unequal according to the obliquity of the sphere.

HOUSE. Every man's house is as his castle, as well to defend him against injuries, as for his repose.

Upon recovery in any real action or ejectment, the sheriff may break the house and

deliver seisin, &c. to the plaintiff, the writ being habere facias seisinam, or possessionem; and after judgment it is not the house of the defendant in right and judgment of the law.

In all cases where the king is party, the sheriff, if no door is open, may break the party's house to take him, or to execute other process of the king, if he cannot otherwise enter; but he ought first to signify the cause of his coming, and request the door to be opened: and this appears by the statute Westm. 1, 17, which is only in affirmance of the common law; and without default in the owner, the law will not suffer an house to be broken.

In all cases where the door is open, the sheriff may enter and make execution at the suit of any subject, either of body or goods; but otherwise where the door is shut, there he cannot break it to execute process at the suit of a subject.

Though an house is a castle for the owner himself and his family, and his own goods, &c. yet it is no protection for a stranger flying thither, or the goods of such a one, to prevent lawful execution; and therefore in such case, after request to enter, and denial, the sheriff may break the house. 5 Rep. 91.

If a person authorized to arrest another who is sheltered in an house, is denied quietly to enter into it, in order to take him, it seems generally to be agreed, that he may justify the breaking open of the doors upon a capias from the king's bench or chancery, to compel a man to find sureties for the peace or good behaviour, or even upon a warrant from a justice of the peace for such person.

So where one known to have committed treason, is pursued either with or without a warrant, by a constable or private person.

So where an affray is made in an house in the view or hearing of a constable; or where those who have made an affray in his presence fly to an house, and are immediately pursued by him, and he is not suffered to enter in order to suppress the affray in the first case, or to apprehend the affrayers in either case. 2 Haw. 86, 87.

A man ought so to use his house as not to damnify his neighbour: and a man may compel another to repair his house in several cases by the writ de domo reparandâ. 1 Salk. 360.

If a man builds his house so close to mine, that his roof overhangs my roof, and throws the water of his roof upon mine, this is a nuisance for which an action will lie.

But depriving one of a mere matter of pleasure, as of a fine prospect, by building a wall or the like; this, as it abridges nothing really convenient or necessary, is no injury to the sufferer, and is therefore not an actionable nuisance. 3 Black. 217.

HOUSEHOLD, the whole of a family considered collectively, including the mistress, children, and servants: but the household of a sovereign prince includes only the officers and domestics belonging to his palace.

The principal officers of his majesty's household are, the lord steward, lord chamberlain of the household, the groom of the stole, the master of the great wradrobe, and the master of the horse. The civil government of the king's house is under the care of the lord steward of the king's household, who, as he is the chief officer, all his commands are observed and obeyed. His authority extends over all the other officers and servants, except those of his majesty's chapel, chamber, and stable; and he is the judge of all crimes committed either within the court or the verge. Under him are the treasurer of the household, the comptroller, cofferer, the master of the household, the clerks of the green-cloth, and the officers and servants belonging to the accounting-house, the marshalsea, the verge, the king's kitchen, the household kitchen, the acatery, bakehouse, pantry, buttery, cellar, pastry, &c. Next to the lord steward is the lord chamberlain of the household, who has under him the vice-chamberlain, the treasurer, and comptroller of the chamber; 48 gentlemen of the privy chamber, 12 of whom wait quarterly, and two of them lie every night in the privy chamber; the gentleman usher, the grooms of the great chamber, the pages of the presence chamber; the mace-bearers, cup-bearers, carvers, musicians, &c.

The groom of the stole has under him the eleven other lords of the bed chamber, who wait weekly in the bed chamber, and by turns lie there a-nights on a pallat-bed; and also the grooms of the bed-chamber, the pages of the bed chamber and back stairs, &c.

The master or keeper of the great wardrobe has under him a deputy, comptroller, clerk of the robes, brusher, &c. and a number of tradesmen and artificers, who are all sworn servants to the king.

The master of the horse has under his command the equerries, pages, footmen, grooms, coachmen, farriers, sadlers, and all the other officers and tradesmen employed in his majesty's stables.

Next to the civil list of the king's court is the military, consisting of the band of gentlemen pensioners, the yeomen of the guard, and the troops of the household; of which the two first guard the king above stairs.

When the king dines in public, he is waited upon at table by his majesty's cup-bearers, carvers, and gentlemen sewers, the musicians playing all the time. The dinner is brought up by the yeomen of the guard, and the gentlemen sewers set the dishes in order. The carvers cut for the king, and the cup-bearers serve him the drink with one knee on the ground, after he has first tasted it in the cover.

HOUSTONIA, a genus of the monogynia order, in the tetrandria class of plants, and in the natural method ranking under the 47th order, stellatæ. The corolla is monopetalous and funnel-shaped; the capsule biocular, dispermous, superior. There are two species, shrubs of America.

HOUTTYNIA, a genus of the class and order polyandria polygynia. The calyx is four-leaved; corolla none; stamina mixed with the pistils, seven about each gem. There is one species, an herb of the East Indies, having the habit of a polygonum.

HUDSONIA, a genus of the monogynia order, in the dodecandria class of plants. There is no corolla; the calyx is pentaphyllous and tubular; there are 15 stamina; the capsule is unilocular, trivalvular, and trispermous. There is one species, a shrub of Virginia.

HUE AND CRY, is the antient common law process after felons, and such as have dangerously wounded any person, or assaulted any one with intent to rob him; and it has received great countenance and authority by several acts of parliament. In any of which cases, the party grieved, or any other, may resort to the constable of the vill; and, 1, give him such reasonable assurances thereof as the nature of the case will bear: 2. if he knows the name of him that did it, he must tell the constable the same: 3. if he knows it not, but can describe him, he must describe him, his person, or his habit, or his house, or such circumstances as he knows, which may conduce to the discovery: 4. if the thing is done in the night, so that he knows none of these circumstances, he must mention the number of persons, or the way they took: 5. if none of all these can be discovered, as where a robbery, or burglary, or other felony, is committed in the night, yet they are to acquaint the constable with the fact, and desire him to search his town for suspected persons, and to make hue and cry after such as may probably be suspected, as being persons vagrant in the same night; for many circumstances may happen to be useful for discovering a malefactor, which cannot at first be found out.

For the levying of hue and cry, although it is a good course to have a justice's warrant, where time will permit, in order to prevent causeless hue and cry; yet it is not necessary nor always convenient, for the felon may escape before the warrant is obtained. And upon hue and cry levied against any person, or where any hue and cry comes to a constable, whether the person is certain or uncertain, the constable may search suspected places within his vill, for the apprehending of the felon. And if the person against whom the hue and cry is raised, is not found in the constablewick, then the constable, and also every officer to whom the hue and cry shall afterwards come, ought to give notice to every town round about him, and to one next town only; and so from one constable to another, until the offender is found, or till they come to the sea-side. And this was the law before the conquest.

And in such cases it is needful to give notice in writing to the pursuers of the thing stolen, and of the colour and marks thereof, as also to describe the person of the felon, his apparel, horse, or the like, and which way he is gone, if it may be: but if the person that did the fact is neither known nor describable by his person, cloaths, or the like, yet such an hue and cry is good, and must be pursued, though no person certain can be named or described. 2 H. H. 100. 103.

HUER, a name given to certain fountains in Iceland, of a most extraordinary nature, forming at times jets d'eaux of scalding water 94 feet high and 30 in diameter. They arise out of cylindrical tubes of unknown depths. Near the surface they expand into apertures of a funnel shape, and the mouths spread into a large extent of stalactical matter, formed of successive scaly concentric undulations. The playing of these stupendous spouts is foretold by noises roaring like the cataract of Niagara. The cylinder begins to fill: it rises gradually to the surface, and as gradually increases its height, smoking amazingly, and flinging up great stones. After attaining its greatest height, is gradually sinks till it totally disap-

pears. Boiling jets d'eaux and boiling springs are frequent in most parts of the island; and in many parts they are commonly applied to the culinary uses of the natives. The most capital is that which is called geyer or geyser, in a plain rising into small hills, and in the midst of an amphitheatre, bounded by the most magnificent and various-shaped icy mountains, among which the three-headed Hecla soars pre-eminent. These huers are not confined to the land; they rise in the very sea, and form scalding fountains amidst the waves. Their distance from the land is unknown; but the new volcanic isle, twelve miles off the point of Reickness, emitting fire and smoke, proves that the subterraneous fires and waters extend to that space; for those awful effects arise from the united fury of these two elements.

HUGONIA, a genus of the decandria order, in the monadelphia class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is pentapetalous; the fruit is a plum with a striated kernel. There is one species, a tree of the East Indies.

HUGUENOTS, a name given by way of contempt to the protestants of France. The name had its rise in the year 1560; but authors are not agreed as to its origin. The most plausible opinion, however, is that of Pasquier, who observes, that at Tours, the place where they were first thus denominated, the people had a notion that an apparition or hobgoblin, called king Hugon, strolled about the streets in the night-time; whence as those of the reformed religion met chiefly in the night to pray, &c. they called them Huguenots, that is, the disciples of king Hugon.

HULL, in the sea language, is the main body of a ship, without either masts, yards, sails, or rigging. Thus to strike a hull in a storm is to take in her sails, and to lash the helm on the lee-side of the ship; and to hull or lie a hull, is said of a ship whose sails are thus taken in, and helm lashed a-lee.

HUMERUS. See ANATOMY.

HUMERUS, *luxation of the.* See SURGERY.

HUMMING-BIRD. See TROCHILUS.

HUMULUS, *the hop*, a genus of the pentandria order, in the dioecia class of plants, and in the natural method ranking under the 53d order, scabridæ. The male calyx is pentaphyllous; there is no corolla: the female calyx is monophyllous, patent obliquely, and entire; there is no corolla, but two styles, and one seed within the calyx, the latter consisting of one large leaf. There is only one species, viz. the lupulus, which is sometimes found wild in hedges near houses and gardens, but probably is not indigenous. The stalk is weak and climbing; it creeps up the support in a spiral, ascending always from the right hand to the left.

Hops are said to have been first brought into England from the Netherlands in the year 1524. They are first mentioned in the English statute-book in the year 1552, viz. in the 5th and 6th Edw. VI. cap. 5.: and by an act of parliament of the first year of king James I. anno 1603, cap. 18. it appears that hops were then produced in abundance in England. The hop being a plant of great importance in this country, we shall consider what relates to the culture and management of it under distinct heads.

Of soil. As for the choice of soil, the hop-planters esteem the richest and strongest ground the most proper; and if it is rocky within two or three feet of the surface, the hops will prosper well; but they will by no means thrive on a stiff clay or spongy wet land.

The Kentish planters account new land best for hops; they plant their hop gardens with apple-trees at a large distance, and with cherry-trees between; and when the land has done its best for hops, which they reckon it will in about ten years, the trees may begin to bear.

To plant hops. In the winter time provide your soil and manure for the hop-ground against the following spring. If the dung is rotten, mix it with two or three parts of common earth, and let it incorporate together till you have occasion to make use of it in making your hop-hills; but if it is new dung, then let it be mixed as before till the spring in the next year, for new dung is very injurious to hops.

Hops require to be planted in a situation so open as that the air may freely pass round and between them, to dry up and dissipate the moisture, whereby they will not be so subject to fire-blasts, which often destroy the middles of large plantations, while the outsides remain unhurt.

The hills should be eight or nine feet asunder, that the air may freely pass between them. If the ground is intended to be ploughed with horses between the hills, it will be best to plant them in squares checquerwise; but if the ground is so small that it may be done with the breast-plough or spade, the holes should be ranged in a quincunx form. Which way soever you make use of, a stake should be stuck down at all the places where the hills are to be made.

Persons ought to be very curious in the choice of the plants as to the kind of hop; for if the hop-garden is planted with a mixture of several sorts of hops that ripen at several times, it will cause a great deal of trouble, and be a great detriment to the owner. The two best sorts are the white and the grey bind; the latter is a large square hop, more hardy, and is the more plentiful bearer, and ripens later than the former. There is another sort of the white bind, which ripens a week or ten days before the common; but this is tenderer, and a less plentiful bearer; but it has this advantage, that it comes first to market.

If there is a sort of hop you value, and would increase plants and sets from, the superfluous binds may be laid down when the hops are tied, cutting off the tops, and burying them in the hill; or when the hops are dressed, all the cuttings may be saved; for almost every part will grow, and become a good set the next spring.

As to the seasons of planting hops, the Kentish planters approve the months of October and March. The most usual time, however, of procuring them is in March, when the hops are cut and dressed.

As to the manner of planting the sets, there should be five good sets planted in every hill, one in the middle, and the rest round about sloping. Let them be pressed close with the hand, and covered with fine earth, and a stick should be placed on each side the hill to secure it.

Dressing. As to the dressing of the hops, when the hop-ground is dug in January or February, the earth about the hills, and very near them, ought to be taken away with a spade, that you may come the more conveniently at the stock to cut it. About the end of February, if the hops were planted the spring before, or if the ground is weak, they ought to be dressed in dry weather; but else, if the ground is strong and in perfection, the middle of March will be a good time; and the latter end of March, if it is apt to produce over-rank binds, or the beginning of April may be soon enough. Then having with an iron picker cleared away all the earth out of the hills, so as to clear the stock to the principal roots, with a sharp knife you must cut off all the shoots which grew up with the binds the last year; and also all the young suckers, that none be left to run in the alley, and weaken the hill. It will be proper to cut one part of the stock lower than the other, and also to cut that part low that was left highest the preceding year. In dressing those hops that have been planted the year before, you ought to cut off both the dead tops and the young suckers which have sprung up from the sets, and also to cover the stocks with fine earth a finger's length in thickness.

The poling. About the middle of April the hops are to be poled, when the shoots begin to sprout up; the poles must be set to the hills deep into the ground, with a square iron picker or crow, that they may the better endure the winds; three poles are sufficient for one hill. These should be placed as near the hill as may be, with their bending tops turned outwards from the hill to prevent the binds from entangling; and a space between two poles ought to be left open to the south to admit the sun-beams.

The tying. As to the tying of hops, the buds that do not clasp of themselves to the nearest pole when they are grown to three or four feet high, must be guided to it by the hand, turning them to the sun, whose course they will always follow. They must be bound with withered rushes, but not so close as to hinder them from climbing up the pole. This you must continue to do till all the poles are furnished with binds, of which two or three are enough for a pole; and all the sprouts and binds that you have no occasion for, are to be plucked up; but if the ground is young, then none of these useless binds should be plucked up, but should be wrapped up together in the middle of the hill.

Gathering. About the beginning of July hops begin to blow, and will be ready to gather about Bartholomew-tide. A judgment may be made of their ripeness by their strong scent, their hardness, and the brownish colour of their seed. When by these tokens they appear to be ripe, they must be picked with all the expedition possible; for if at this time a storm of wind should come, it would do them great damage by breaking the branches, and bruising and discolouring the hops; and it is very well known that hops, being picked green and bright, will sell for a third more than those which are discoloured and brown.

The most convenient way of picking them is into a long square frame of wood, called a

bin, with a cloth hanging on tenter-hooks within it, to receive the hops as they are picked.

The hops must be picked very clean, *i. e.* free from leaves and stalks; and, as there shall be occasion, two or three times in a day the bin must be emptied into a hop-bag made of coarse linen cloth, and carried immediately to the oast or kiln in order to be dried; for if they should be long in the bin or bag, they will be apt to heat and be discoloured. If the weather is hot, there should no more poles be drawn than can be picked in an hour, and they should be gathered in fair weather, if it can be, and when the hops are dry; this will save some expence in firing, and preserve their colour better when they are dried.

Drying. The best method of drying hops is with charcoal on an oast or kiln, covered with hair-cloth, of the same form and fashion that is used for drying malt. There is no need to give any particular directions for making these, since every carpenter or bricklayer in those countries where hops grow, or malt is made, knows how to build them. The kiln ought to be square, and may be of ten, twelve, fourteen, or sixteen feet over at the top, where the hops are laid, as your plantation requires, and your room will allow. There ought to be a due proportion between the height and breadth of the kiln and the beguels of the steddle where the fire is kept, viz. if the kiln is twelve feet square on the top, it ought to be nine feet high from the fire, and the steddle ought to be six feet and a half square, and so proportionable in other dimensions.

The hops must be spread even upon the oast a foot thick or more, if the depth of the curb will allow it; but care is to be taken not to overload the oast if the hops are green or wet. The oast ought to be first warmed with a fire before the hops are laid on, and then an even steady fire must be kept under them; it must not be too fierce at first, lest it scorch the hops, nor must it be suffered to sink or slacken, but rather be increased till the hops are nearly dried, lest the moisture or sweat which the fire has raised fall back or discolour them. When they have lain about nine hours they must be turned, and in two or three hours more they may be taken off the oast. It may be known when they are well dried by the brittleness of the stalks and the easy falling off of the hop-leaves.

Bagging. As soon as the hops are taken off the kiln, lay them in a room for three weeks or a month to cool, give, and toughen; for if they are bagged immediately they will powder, but if they lie a while (and the longer they lie the better, provided they are covered close with blankets to secure them from the air) they may be bagged with more safety, as not being liable to be broken to powder in treading; and this will make them bear treading the better, and the harder they are trodden the better they will keep.

Laws relating to hops. By 9 Anne, cap. 12, an additional duty of 3*d.* a pound is laid on all hops imported, over and above all other duties; and hops landed before entry and payment of duty, or without warrant for landing, shall be forfeited and burnt; the ship also shall be forfeited, and the person concerned in importing or landing shall forfeit 5*l.* a hundred weight, 7 Geo. II. cap. 19. By 9 Anne, cap. 12, there shall be paid a duty of 1*d.* for every pound of hops grown in Great Britain, and made fit for use, within six months after they are cured and bagged; and hop-grounds are required to be entered on pain of 40*s.* an acre. Places of curing and keeping are also to be entered on pain of 50*l.* which may be visited by an officer at any time without obstruction, under the penalty of 20*l.* All hops shall, within six weeks after gathering, be brought to such places to be cured and bagged, on pain of 5*s.* a pound. The re-bagging of foreign hops in British bagging for sale or exportation, incurs a forfeiture of 10*l.* a hundred weight; and defrauding the king of his duty by using twice or oftener the same bag, with the officer's mark upon it, is liable to a penalty of 40*l.* The removal of hops before they have been bagged and weighed, incurs a penalty of 50*l.* Concealment of hops subjects to the forfeiture of 20*l.* and the concealed hops; and any person who shall privately convey away any hops with intent to defraud the king and owner, shall forfeit 5*s.* a pound. And the duties are required to be paid within six months after curing, bagging, and weighing, on pain of double duty, two-thirds to the king, and one third to the informer. No common brewer shall use any bitter ingredient instead of hops, on pain of 20*l.* Hops which have paid the duty may be exported to Ireland; but by 6 Geo. II. cap. 11, there shall be no drawback; and by 7 Geo. II. cap. 19. no foreign hops shall be landed in Ireland. Notice of bagging and weighing shall be sent in writing to the officer, on pain of 50*l.* 6 Geo. cap. 21. And by 14 Geo. III. cap. 68. the officer shall, on pain of 5*l.* weigh the bags or pockets, and mark on them the true weight or tare, the planter's name and place of abode, and the date of the year in which such hops were grown; and the altering or forging, or obliterating such mark, incurs a forfeiture of 10*l.* The owners of hops shall keep at their oasts, &c. just weights and scales, and permit the officer to use them, on pain of 20*l.* 6 Geo. cap. 21. And by 10 Geo. III. cap. 44. a penalty of 100*l.* is inflicted for false scales and weights. The owners are allowed to use casks instead of bags, under the same regulations, 6 Geo. II. cap. 21. If any person shall mix with hops any drug to alter the colour or scent, he shall forfeit 5*l.* a hundred weight. If any person shall unlawfully and maliciously cut hop-binds growing on poles in any plantation he shall be guilty of felony without benefit of clergy. 6 Geo. II. cap. 37. By a late act, five per cent. is added to the duties on hops.

HUNDRED. In the time of king Alfred the kingdom was in gross, and then divided into counties and hundreds, and all persons came within one hundred or other.

By stat. 2 Ed. III. c. 12. it was enacted, that all hundreds and wapentakes granted by the king, shall be annexed to the king, and not severed. And by 14 Ed. III. c. 9. that all should be annexed, and the sheriff should have power to put in bailiffs, for which he will answer, and no more shall be granted for the future.

Hundreds are not answerable to persons who are robbed travelling on a Sunday. 29 Car. II. c. 7.

Hundreds are liable to penalty on exportation of wool. 7 and 8 W. III. c. 28.

Hundreds are liable to damages sustained by pulling down buildings. 1 Geo. I. c. 5.

Hundreds are liable for damages by killing cattle, cutting down trees, burning houses, &c. 9 Geo. I. c. 22, and 29 Geo. II. c. 36.

Hundreds are liable for damages incurred by destroying turnpikes or works on navigable rivers. 8 Geo. II. c. 20.

By cutting hop-binds, 10 Geo. II. c. 32. By destroying corn to prevent exportation, 11 Geo. II. c. 22. By wounding officers of the customs, 19 Geo. II. c. 34; or by destroying wood, &c. 29 Geo. II. c. 36.

All monies recovered against the hundred to be levied by a rate. 22 Geo. II. c. 46.

HUNGARY-WATER, a distilled water, so denominated from a queen of Hungary, for whose use it was first prepared.

Quincey gives the following directions for making it: Take of fresh gathered flowers of rosemary two pounds, rectified spirits of wine two quarts; put them together, and distil them immediately in balneo.

HURA, a genus of the monadelphia order, in the monœcia class of plants, and in the natural method ranking under the 38th order, tricoccæ. The amentum of the male is imbricated, the perianthium truncated: there is no corolla; the filaments are cylindrical, peltated on top, and surrounded with numerous or double antheræ. The female has neither calyx nor corolla; the style is funnel-shaped; the stigma cleft in twelve parts; the capsule is twelve-celled, with a single seed in each cell. There is but one species, viz. the crepitans, a native of the West Indies. It rises with a soft ligneous stem to the height of 24 feet, dividing into many branches. After the flower, the germen swells, and becomes a round compressed ligneous capsule, having 12 deep furrows, each being a distinct cell, containing one large round compressed seed. When the pods are ripe, they burst with violence, and throw out their seeds to a considerable distance. It is propagated by seeds raised on a hot-bed; and the plants must be constantly kept in a stove. The kernels are said to be purgative, and sometimes emetic.

HURDLES, in fortification, twigs of willows or osiers interwoven close together, sustained by long stakes, and usually laden with earth. See FORTIFICATION.

HURRICANE, a furious storm owing to a contrariety of winds. See WIND.

Hurricanes are frequent in the West Indies, where they make terrible ravages, by rooting up trees, destroying houses and shipping, and even whole plantations.

These dreadful convulsions of nature, Dr. Perkins, of Boston, in America, supposes to be caused by some occasional obstruction in the usual and natural progress of the equatorial trade winds. The reason he assigns for this conjecture is, the more than usual calm which commonly precedes them. In the natural course of the trade winds, the air rises up in the line, and passes off towards the poles, and, in the more contracted degrees of the higher latitudes, takes the course of the west trade-winds, so that could their ascent be prevented through the whole circle of the zone, there would be no more west winds in those latitudes than in any other. Very vio-

lent rains and cold, however, tend to check the ascent of air out of this circle, rather causing it to descend. Great clouds of vapour generate cold and wet, while rain beats down the air; and as these prevent the rising of the air out of the line, so they hinder its usual progress from the tropics on both sides: hence the calms which usually precede hurricanes. Calms, in these tropical regions, are caused by the ascent of the air into the higher part of the atmosphere, instead of its remaining near the line: the accumulation of air above then becomes heavier by the cold which it meets in those regions, and descends into the more rarefied region below. These heavy gales, therefore, will continue to descend till the upper regions are entirely exonerated.

HUSBAND AND WIFE, usually called baron and feme, are one person in law: that is, the very being or legal existence of the woman is suspended during the marriage, or at least is incorporated and consolidated into that of the husband, under whose wing, protection and cover she performs every thing. She is therefore called in our law French, a *feme covert*, that is, under the protection and influence of her husband, her baron, or lord; and her condition during her marriage is called her coverture.

A man cannot grant lands to his wife during her coverture, nor any estate or interest to her, nor enter into covenant with her. But he may by his deed covenant with others for her use, as for her jointure, or the like; and he may give to her by devise or will, because the devise or will does not take effect till after his death. 1 Inst. 112.

All deeds executed by the wife, and acts done by her during her coverture, are void, except a fine, or the like matter of record, in which case she must be solely and secretly examined, that it may be known whether or no her act is voluntary. 1 Black. 444.

A wife is so much favoured in respect of that power and authority which her husband has over her, that she shall not suffer any punishment for committing a bare theft in company with, or by coercion of her husband. But if she commits a theft of her own voluntary act, or by the bare command of her husband, or is guilty of treason, murder, or robbery, in company with or by coercion of her husband, she is punishable as much as if she was sole; because of the odiousness and dangerous consequences of these crimes. 1 Haw. 2.

By marriage the husband has power over his wife's person; and the courts of law still permit an husband to restrain a wife of her liberty, in case of any gross misbehaviour. But if he threatens to kill her, &c. she may make him find surety of the peace, by suing a writ of supplicavit out of chancery, or by preferring articles of the peace against him in the court of king's bench, or she may apply to the spiritual court for a divorce propter sævitatem.

The husband by marriage obtains a freehold in right of his wife, if he takes a woman to wife that is seized of a freehold; and he may make a lease thereof for 21 years, or three lives, if it is made according to the statute. 32 Hen. VIII. c. 28.

The husband also gains a chattel real, as a term for years, to dispose of if he pleases by grant or lease in her life-time, or by surviving her: otherwise it remains with the wife. And upon execution for the husband's debt, the sheriff may sell the term during the life of the wife. 1 Inst. 351.

The husband also by the marriage has an abso'ute gift of all chattels personal in possession of the wife in her own right, whether he survives her or not. But if these chattels personal are choses in action, that is, things to be sued for by action, as debts by obligation, contract, or the like, the husband shall not have them, unless he and his wife recover them. 1 Inst. 351.

By custom in London, a wife may carry on a separate trade; and as such, is liable to the statutes of bankruptcy with respect to the goods in such separate trade, with which the husband cannot intermeddle. Burr. 1776.

If the wife is indebted before marriage, the husband is bound afterwards to pay the debt, living with the wife; for he has adopted her and her circumstances together. 1 Black. 143. But if the wife dies, the husband shall not be charged for the debt of his wife after her death, if the creditor of the wife does not get judgment during the coverture. 9 Co. 72.

The husband is bound to provide his wife necessaries; and if she contracts for them, he is obliged to pay for the same; but for any thing besides necessaries, he is not chargeable.

And also if a wife elopes, and lives with another man, the husband is not chargeable even for necessaries; at least if the person who furfurnishes them is sufficiently apprized of her elopement. 1 Black. 442.

A man having issue by his wife born alive, shall be tenant by the courtesy of all the lands in fee simple, or fee tail general, of which she shall die seized. Litt. 52.

And after her death he shall have all chattels real: as the term of the wife, or a lease for years of the wife, and all other chattels in possession; and also, all such as are of a mixed nature (partly in possession and partly in action), as rents in arrear, incurred before the marriage or after: but things merely in action, as of a bond or obligation to the wife, he can only claim them as administrator to his wife, if he survives her. Wood. b. 1. c. 6.

If the wife survives the husband, she shall have for her dower the third part of all his freehold lands: so she shall have her term for years again, if he has not altered the property during his life: so also she shall have again all other chattels real and mixed: and so things in action, as debts, shall remain to her, if they were not received during the marriage. Id.

But if she elopes from her husband, and goes away with her adulterer, she shall lose her dower, unless her husband had willingly, without coercion ecclesiastical, been reconciled to her, and permitted her to cohabit with him. 1 Inst. 32.

HUSBAND LAND, a term used in Scotland for a portion of land containing six acres of sock and scythe land; that is, of land that may be tilled with a plough and mown with a scythe.

HUSBANDRY, in the general sense of the word, comprehends the whole practice of agriculture; in which we have to consider the nature of the soils we meet with, on and near the surface of the earth. The methods of correcting those which are unfavourable to the production of useful vegetables; the improvement of such as are deteriorated by over-cropping; such implements as are fittest for facilitating the operations of agriculture; the means and powers best adapted for such purposes; the cattle and live stock most profitable to man, whether for labour or more immediate use as food; the grass, grain, roots, and pulse, most beneficial to him; and the minor subjects connected with this important science.

The culture of the earth is coeval with man; his beneficent Creator placed him in a well-stored garden, enjoining him "to dress and to keep it;" and after a fatal lapse of obedience, he was driven from his paradisical situation, a new injunction was laid on him, "to till" the ground, "that thorns and thistles" may not choak the better productions of it. Adam, "by the sweat of his brow," so cultivated the soil, that it produced a sufficiency for himself and family: his sons he instructed in the art, and they communicated the same to their descendants: and thus the knowledge and practice of agriculture were promulgated through the early ages of mankind.

When the deluge had swept away from the face of the earth every vestige of human art, the ark excepted, Noah and his descendants found themselves under the necessity of reviving the practice of husbandry, as one of the surest means of procuring the necessaries and comforts of life. The methods pursued by the early generations are unknown to us, as are most of the implements which they employed; perhaps the mattock and coulter were their principal tools.

It seems probable that the inhabitants of the ages which immediately succeeded the flood, knew not the proper methods of restoring fertility to an exhausted soil; for we find them frequently changing their place of residence, as their flocks and herds required fresh pasturage, or their tillage land became unproductive. When the descendants of Abraham settled themselves in Palestine, agriculture began to raise itself into importance, and was considered not only as an useful but honourable employment. The Chaldeans, who inhabited the country where agriculture had its birth, cultivated the land with great assiduity, and seemed to have found out the means of restoring fertility to an exhausted soil, having plentiful harvests in succession, so that they were not obliged, as their predecessors had been, to be frequently changing their situation, in order to obtain a sufficiency for themselves and their numerous flocks and herds. The Phœnicians were also remarkable for their skill in agriculture. The Athenians taught the rest of the Greeks the use of corn, and how to cultivate the land that it might produce so wholesome a food. As the arts of agriculture encreased, and the blessings they afforded became more generally known, these savage Greeks forsook their acorns, and the wild roots of the field, and applied themselves assiduously to the cultivation of the earth; their kings encouraging such laudable pursuit. The old Ro-

mans esteemed agriculture so honourable an employment, that one of the highest praises which could be given to a man, was that of saying he had well cultivated his spot of ground. The most illustrious senators, in the intervals of public concerns, applied themselves to this profession.

But to bring the subject home to our own country, we find that the art of husbandry was at a low ebb until the fourteenth century; at which time it began to be practised in the midland and south-western parts of England; yet it seems not to have been cultivated as a science, until the latter end of the sixteenth century; when Fitzherbert, a judge of the common pleas, studied the nature of soils and the laws of vegetation with philosophical attention; and in 1534 published his first work entitled, "The Book of Husbandry." Beyond which, small advances only were made in the theory until the time of the commonwealth; when sir Hugh Platt, one of the compleatest husbandmen of the age, discovered and brought into use a multitude of manures, little thought of by others, for meliorating and fertilizing exhausted soils. At the time of the Restoration, agriculture appears to have suffered considerable neglect, until Evelyn and Tull, by their literary labours, mightily promoted the study. Since their days, many valuable improvements have been made in the practice, and many are the writers who have rendered essential services, by enlightening the minds of their countrymen, and exciting them to emulation. In our own days, with pleasure we behold many respectable agricultural societies established in different parts of the kingdom, greatly contributing to the advancement of the practice as well as theory of agriculture; among which we must particularly notice that of high national concernment, instituted a few years since, under the title of the "Board of Agriculture."

About the year 1790, sir John Sinclair, a gentleman of genuine patriotic philanthropy, conceived an idea that such a board, properly constituted, would be of vast importance to the agricultural interests of the kingdom. Having, with much attention to the subject, matured his plan, and communicated the same to some of his parliamentary friends, in May 1793, "An address from the honourable house of commons was presented to his majesty, entreating that his majesty would be graciously pleased to take into his royal consideration the advantages which might be derived by the public from the establishment of a board of agriculture and internal improvement."

After surmounting the difficulties naturally attending the formation of such an institution, the charter for the same was drawn up, and sanctioned by the authority of the great seal, in August of the same year, and the founder elected president. To this society we are indebted for 80 volumes of the most useful agricultural knowledge, which could be procured from literary men, resident in, or intimately acquainted with the respective counties, under the title of a "General View of the Agriculture thereof, with observations on the means of Internal Improvement." The grand outlines of the plan of these views are, the geographical state of each county, the state of property, farm buildings, mode of occupation, implements, fences, arable land, grass, orchards, plantations, draining and other improvements, live-stock, rural economy, means of improvement, &c.

A work comprising so many important objects in the science of agriculture, cannot fail of producing national benefits, greater perhaps than have been derived from any other political institution of modern times.

Besides the county reports of agricultural views, the board have published sundry volumes of communications on various topics of husbandry, which have been transmitted to them by writers fully conversant with the subjects of their respective communications. By pursuing such plan for a few years, and publishing to the world such communications, under some systematic arrangement, we may expect that agriculture will become the best understood, and the most accessible of any art in the whole circle of human acquirement.

Soils. A land considered as the basis of vegetation is called soil. The particles of the various solid, as well as less compact bodies, that are met with in nature, and which have been rubbed down and reduced by the successive operations of the atmosphere, and the agency of other natural causes, being mixed and blended together in different ways and proportions, constitute the earthy compounds, which, from their being capable of absorbing, and in some measure retaining, moisture, as well as giving stability, afford the means of support to various products of the vegetable kind, and form the bases of soils in general; while the materials proceeding from the decomposition and decay of numerous organized animal and vegetable substances, uniting with such compounds, compose the superficial layers of rich mould, from which plants chiefly draw or derive their nourishment and support.

Soils being formed in this manner, it is evident they must vary much, both in the qualities and proportions of the ingredients of which they are composed. In one situation or district one sort of material is abundant, and consequently enters largely into the soil; in others it is deficient, while those of other kinds are plentiful, and constitute the principal parts of the soils where they are found. Some situations too abound much more with animal and vegetable matters than others, which produce great diversity in regard to the soils. The harder and more firm substances of nature, being, on account of their structure, reduced more slowly, and with greater difficulty, into the state of earth, generally enter in much smaller proportions into the composition of soils, than those which are of a soft and pliable disposition, and which approach nearer to the quality of earth. Thus argillaceous, loamy, and vegetable matters are found to predominate very much in soils in their primitive state, and, according to their particular qualities and proportions, to constitute very material differences in their properties. Calcareous and siliceous earthy matters are distributed over some districts in great abundance, while in others they enter into the composition of the soils in much smaller proportions, and thus contribute to vary their textures and qualities.

One of the means of deciding in respect to soils, which, in many cases, when properly limited and exercised, by a person of sound judgment and duly experienced, is certainly not a bad one, though in some respects also defective, is that of determining from the nature of the plants that are naturally produced, and the degrees of their growth and luxuriance. Thus, where plants that are only accustomed to grow in good or peculiar sorts of soil, are met with in their natural and flourishing states in other places, the soils may be concluded to be of this or that kind, according to the circumstances in which they are found. The growth of certain sorts of timber trees and hedges, may also in various instances serve to direct the judgment, and likewise the appearances or colours of the mould in particular instances; the smell and the touch will also help to inform us of the quality of a soil: The best emits a fresh pleasant scent, when fresh dug up; and if due proportions of clay and sand are intimately blended, it will not much stick to the fingers in handling. But, however, that our readers may be informed of some of the leading principles which chemistry employs, in analysing soils, we give him the following, which may be depended on.

1. To ascertain the quantity of water in any soil, take a pound of the soil, spread it very thin before the fire, or in the sun-shine in a warm day, let it lie till it is thoroughly dry; the evaporation of the water will be known by the weight lost.

2. To know if there are any metallic or earthy salts, take a pound of soil, pour upon it a pound of boiling distilled water, stir them thoroughly together, and let them stand for ten minutes, filter off the water through filtering paper, pour into what comes through a solution of the fixt vegetable alkali; if there is any earthy or metallic salt, a precipitation will take place.

3. To know if the salt contained has calcareous earths for one of its elements, take the filtrated solution, pour into it half an ounce of caustic volatile alkali, or continue to drop in this alkali till no further precipitation takes place; afterwards filtrate it, and pour to what filtrates through a little solution of fixt vegetable alkali; if there is any further precipitation, it shews that there is an earthy salt consisting of calcareous earth for one of its elements; if a precipitation took place upon the application of the caustic volatile alkali, it shews that there certainly are earthy or metallic salts.

4. To know if the salt contained is metallic or aluminous, add to the filtrated solution an infusion of galls; if there is any metallic or aluminous salt, a precipitation will take place; if iron, a purplish black; if copper, or allum, a grey: copper may also be distinguished from iron by falling in a blue precipitate upon the application of an alkali, while iron forms a greenish, and allum a white one.

5. To know if magnesia is an element of the salts found, take the filtrated solution, apply to it a solution of galls; if no precipitation takes place, apply caustic volatile alkali, which will precipitate the magnesia if it is an element of the salt contained.

6. To know if a neutral salt is contained, evaporate the filtrated solution with a boiling heat, till the whole water is nearly gone off, and let it stand to cool: if there is any neutral sat, it will crystallize.

7, To know if there is any mucilage, and what quantity, take 30 or 40 lbs. of the soil, boil it in 10 gallons of water for an hour, let the earth subside, pour off the clean solution, afterwards add four or five gallons of water to the earth, stir them thoroughly, let them stand to subside, pour off the water clear, mix it with the former, and evaporate the whole to dryness, putting it into a water bath towards the end of the evaporation; what remains is the mucilage, making allowance for that part of the decoction which was not washed out from the earth, and deducting the saline substances, which will crystalize if there is a considerable quantity, but will be destroyed in the operation, if in small proportion, as they generally are.

8. To know if there is any calcareous earth in the soil, and what quantity, take 2¼ oz. of the dry soil, apply to it ½ oz. of muriatic acid, and 4 oz. of water in a glass vessel sufficiently large; let them stand together till no more effervescence takes place; and if it was very considerable, pour in ½ oz. more of the acid, let this stand also till the effervescence ceases, if any arises upon pouring it in, continue to add more acid in the same manner, until what was poured in last produces little effervescence, which is often at the first, and generally at the second or third half ounce. After the effervescence has ceased, put the whole in a filter, let the solution filtrate through; pour half a pint of water upon what remains in the filter, let that filtrate also in the same vessel; add to the solution thus filtrated 1½ oz. of caustic volatile alkali for every ounce of acid used; if any precipitation takes place there is magnesia, earth of allum, or the calx of a metal (generally iron or copper) contained in the soil; after adding the volatile alkali, the whole is to be thrown into a filter again; after the filtration has taken place, pour into the liquor a solution of mild fixt vegetable alkali in water; if there is any calcareous earth in the soil, a precipitation will take place; continue to add the solution of the alkali till no fresh precipitation ensues, throw the whole into a filter, let the liquor filtrate off, pour on by degrees a pint of water, let that filtrate off also, dry what remains in the filter, it is the calcareous earth.

9. To know the proportion of sand and clay, take what remains in the filter after the first solution in the foregoing operation, and by the elutriation separate the sand from the clay, dry and weigh them; if there is any pyrites it will appear in the sand.

In the above processes the principal things to be attended to are, whether there are any metallic or aluminous salts, as these are absolute poisons, and therefore are to be decomposed by quick lime; whether there is such a proportion of neutral or earthy as to be hurtful, in which case the solution in process 2. will taste salt, a soil containing them in so large a proportion will hardly ever admit of culture for grain: whether there is calcareous earth, and in what proportion, as that ascertains the propriety of applying any manure containing it, and the quantity of that manure: what the proportion of sand and clay is which ascertains the propriety of adding clay or sand: whether there are pyrites, as that shows why, and when a soil will be long in being brought into cultivation; pyrites are best destroyed by fallowing, and afterwards applying lime.

The soils of this country have been described under numerous heads, and distinguished by a variety of vague local terms. They seem, however, to be capable of being considered and characterised, as far at least as is necessary for practical purposes, under the distinctions of

Clayey,	Gravelly,
Loamy,	Peaty or Mossy, and
Calcareous,	Vegetable Earthy soils.
Sandy,	

Each of these divisions must of course comprehend several varieties, according to the nature and preponderancy of the different sorts of materials of which they are constituted or composed. By different combinations of these substances all the intermediate kinds of soils are formed; and upon a proper mixture of them, in certain proportions, depends the success of the farmer's industry. Sand, clay, and water, are the grand component parts, whatever colour or texture the soil may happen to have.

Clayey or argillaceous soils. Soils of this kind differ very materially, according to the nature and quantity of the clay that enters into their compositions, and the adulteration which has been produced in it by the intermixture of different earthy matters, as well as various mineral, vegetable, and animal substances. For clays are, in general, far from being pure in the states in which they are found in the earth. They are in many instances united with large proportions of siliceous or sandy matter. On these accounts it is that the clayey soils of some districts are so abundantly fruitful and productive, while those of others are insuperably sterile and refractory.

These facts not only shew that there is a prodigious variety in respect to the qualities of these substances, but that they must afford equal variety to the soils into which they enter, and therefore require to be more closely examined, and more nicely ascertained than they appear yet to have been, before all the varieties of soil usually classed under the denomination of clayey can be well ascertained and understood.

But these substances do not differ only in their properties and qualities, but likewise in their colours, and the closeness with which their particles are united. They are found in their natural states of various colours, such as red, white, blue, and yellow, and of different degrees of density, so as, in some instances, readily to admit of being united with the different materials that are applied, in order to meliorate their conditions; in others they can scarcely be made to join with them by any means in the power of the agriculturist. In soils of the first kind, the quantity of siliceous or sandy matter, in general, bears a much larger proportion to that of the argillaceous or clayey, than in those of the latter, and in many cases too the mixture of other substances is proportionably larger. The nature of the clayey stratum, in respect to its thickness or thinness, as well as its contiguity, or remoteness from springs of water underneath it, is too commonly overlooked in considering these sorts of soils; but all these circumstances demand particular attention, and ought to have considerable influence in directing the means of cultivating and improving clayey soils.

It is obvious, from what has been already advanced, that, notwithstanding the differences that take place from the accidental mixture of different materials, in different degrees and proportions, all the descriptions of this sort of soils must possess more or less of the heavy and adhesive stiff qualities; and that according as these are more or less predominant, due respect being at the same time had to the various other circumstances that have been stated, the business of cultivation and improvement must be varied and applied.

Loamy soils. Loam denotes any soil which is moderately cohesive, that is, less so than clay, and more so than loose chalk. Soils, therefore, of this description admit of considerable variety. The substances that are most commonly found to contribute to the formation of loamy soils, are clay, sand, gravel, and chalk: and as either ingredient predominates, so is the soil denominated, as clayey loam, sandy loam, &c. Clayey loam is moderately cohesive, in which the argillaceous ingredient predominates; so that its coherence is greater than that of any other loam, but less than that of pure clay. Besides the argil silex enters largely into the composition. Sometimes an oxide or calx of iron in small proportion is found blended with the clay and sand. In proportion as the argillaceous or clayey principle diminishes, they recede from the nature of the clayey soils; consequently the nearer the quantity of that substance approaches to that of the others, the stronger and more heavy will the loamy soil be. The differences in the lightness and friability of the soils of this class, in a great measure, depend on the relative proportions of the other ingredients. Where the calcareous ingredient greatly exceeds those of the sandy or gravelly kinds, they are neither so light nor so pulverizable as where they are nearly equal, or where the sandy or gravelly matters considerably predominate over it.

In situations where this sort of soil has been but little disturbed, and consequently little changed by the artificial additions of either animal or vegetable substances, and those which it naturally contained not having advanced to the stage of perfect solution and decay, it is generally found of a light brown or hazel colour; but where much culture has been employed for a length of time, and large applications of animal and vegetable matters frequently made, the natural and artificial materials of these kinds having proceeded more nearly to the state of perfect resolution and destruction, it has an appearnce that approaches to black. From these various circumstances the properties of the soils are likewise considerably altered and affected, as well as their colours changed.

From the soils of the loamy class being more friable and brittle, as well as more dry, than most of the clayey ones, they are capable of being tilled with much greater ease and facility, as well as much less strength of team, and at almost every season of the year. And, on account of their property of receiving and transmitting moisture more freely, they are less apt to be indurated by too much dry, or chilled by too much wet weather. Besides, they are more influenced on exposure to the agency of the atmosphere and other external causes, and thereby more

adapted for the promotion and support of vegetation. And as they are found in most cases to be less disposed to the production of weeds, particularly those of the more injurious kinds, they can of course be kept clean with less labour, and without the expensive system of management which is requisite on many other kinds of soil.

Chalky or calcareous soils. Soils of the calcareous kind, which are composed of clay, sand, and chalk, occupy very extensive tracts of land in different parts of the kingdom, and are marked with considerable diversity, as proceeding from the nature, properties, and proportions of the calcareous matter as it exists in them; the substances that are mixed and combined with it; the depth and qualities of the earthy stratum which is placed upon it, and the disposition of the sub-soil or basis on which this is formed and deposited.

Calcareous matter is contained in many different stony substances, besides that of chalk, as marble, lime-stone, coral, and shells of different kinds; and in states of union with other materials, such as sand, the different simple earthy bodies, in different proportions, and in some instances with iron and magnesia. Its capability or powers of imbibing and retaining moisture is considerable, though not so great as that of clay. It burns to lime by proper degrees of heat, and absorbs carbonic acid gas, or fixed air in different proportions from the atmosphere, and returns again to the state of chalk or mild calcareous matter. It is found of very different degrees of hardness and friability, as well as of different states of fineness or pulverization, in different soils of the class to which it belongs. It varies also greatly in its effects in respect to vegetation; from the different matters that may happen to be combined with it in its primitive or original state. It has long been known to the practical agriculturist, that some sorts of lime may be employed in large proportions, while others cannot be used, except in very small quantities, without doing very considerable injury to the soil with which they are incorporated.

Calcareous matter, whether it is in the state of carbonat, or in the more active one of causticity, as quick-lime, seems ultimately to promote the resolution and destruction of vegetable and animal substances; in the latter state, however, it acts with much greater violence on these materials, destroying their organization, and dissipating their principles more quickly, as well as robbing them more completely of the carbonic acid gas, or fixed air, which is so essential, while in the former it operates with great mildness, and only aids the resolution of those substances by gently promoting the process of putrefaction.

The proportions of clayey, loamy, and gravelly ingredients, which are conjoined with the calcareous matters of these soils, are various in different districts; where the argillaceous and loamy materials are comparatively in large quantities, soils of the heavier chalky kinds are formed, and where the sandy or gravelly are predominant, we have the lighter ones. There are also material differences proceeding from the earthy matter with which the calcareous ingredient is mixed in the state of soil. Where the quantity of this is small, and not reduced into any very perfect state of mould, the soil, as it is evident, must be poor and thin; but where the depth of this superficial stratum is considerable, and the animal, vegetable, and other substances, of which it is composed, is advanced to a more complete stage of decomposition and decay, the soils are more rich and heavy. Some variety is likewise caused by the state of the under-stratum or sub-soil. If it is compact, and much intermixed with siliceous or flinty matter, or have a mortary hardness, it is less favourable than where it is of a more open, brittle, or powdery texture.

Whatever appearances of lightness there may be in chalky soils, they require considerable strength in the team, where the staple or earthy stratum of the lands will admit of their being wrought to a tolerable depth; but where there is a thinner surface of earthy materials, less force of draught will be requisite. In the latter cases, the soil is, however, far more precarious and uncertain, as well as much less productive in respect to the crops that are cultivated upon it, than in the former. As chalky soils are not so liable to be injured by water as others, the business of tillage is much less impeded from that cause; but a dry season sometimes renders them so hard as to be totally incapable of being broken up, until they have been moistened by the falling of a considerable quantity of rain.

Sandy or siliceous soils. Sands seem to have been gradually formed by the attrition and rubbing down of the various solid substances that are found in nature, especially such as are of the siliceous, calcareous, and stony kinds, and are of different degrees of fineness as they approach the size of gravel. They are also met with of various colours and appearances in different regions or tracts of country, such as white, dusky brown, yellow, and red. These differences, as well as those which respect their weight, tenacity, and other properties, depend on the nature and proportions in which many other materials enter into combination with them.

Where the proportions of clayey, loamy, or other earthy substances with which they are mixed, approach nearly to that of the sand, the heavier sorts of sandy soils are formed; but where these enter only in very small quantities, we have the light sandy soils; and where they are hardly met with at all, the soil is a loose blowing sand, most commonly of a white or brownish appearance. The portions of vegetable matters that are intermixed with different soils of the sandy kind are not less various than those of the clayey and loamy, from which considerable differences of quality are produced. These differences in their textures and compositions also introduce others which respect their powers of admitting and retaining heat and moisture. The openness and want of adherence in such soils, while they allow of the admission of heat and water more readily, permit them to be carried off with greater ease and expedition, they are therefore less permanently benefited by their influence than the closer and more adhesive soils.

The light, open, and porous texture of sandy soils renders them much more easily cultivated and kept in order than those of the strong and close kinds; consequently the farms where they prevail are generally large; and when properly prepared, they are better adapted for the growth of many sorts of crops, such as those of the bulbous and tap rooted sorts. They have also another advantage, which is that of pushing forward the crops with more expedition. Whatever inconveniences attend them are mostly such as proceed from the want of a sufficient degree of cohesion among their constituent particles and solidity of texture. On these accounts they often counteract the best and most judicious management. The roots of the crops are liable to become naked and exposed from storms and various other causes; and if grain, to fall down and be lodged so early in the season as to render them of little value.

Gravelly soils. In the state of gravels which contribute to the formation of this class of soils, there is a variation of size in the pieces or particles of which they are composed, from that of a very small pea to the largest cockle. Where they become of still larger dimensions they are termed stones or rocks, according as they are in small portions or large masses; and the soils are then said to be stony or rocky, as the circumstances of the different cases may happen to be.

The beds of gravel, whether they are of the larger or smaller kinds, are mostly either of the siliceous or flinty kind, or of the calcareous or chalky; but the stones and rocks are of very different kinds. With these dissimilar substances, some others in different states of reduction and pulverization are blended and united in various proportions, so as to constitute gravelly soils that differ considerably in their textures and other properties. The chief of these are loams, and the mould or earthy matter formed by the destruction and decay of numerous animal and vegetable substances.

The gravelly mixture is sometimes also found to approach nearly to the surface, while at others it recedes considerably from it. In some instances springs rise immediately underneath; in others they are at a great depth. The bottom, or sub-soil, is likewise various; in some cases it is stony and rocky, in others it is clayey, or a rocky gravel, and sometimes sand, &c.

The open porous nature of gravelly soils disposes them to admit moisture very readily, as well as to part with it with equal facility; from the latter of which circumstances they are subject to burn, as it is termed, in dry seasons, which is not the case in the heavier or more retentive sort of soils.

Gravelly soils, from the lightness of their texture, and their not affording great resistance, except where the stones are large, or there are rocks, are not expensive or difficult in the means of cultivation. All the necessary business of this sort is capable of being carried forward with much ease and expedition, and the lands are in general soon brought into the proper states for the reception of crops.

Peaty or mossy soils. These soils consist chiefly of the roots of decayed vegetables, mixed with earth, mostly argillaceous, and sand, and a coaly substance derived also from decayed vegetables. They differ, like all the other kinds of soils, according to the nature of the ingredients of which they are constituted or composed, and the proportions in which these are found to prevail in them.

Where the vegetable or peaty material predominates but little over the other substances with which it is mixed and incorporated, the lighter sorts of peaty, moory, or heathy soils, are formed; but where the other matters bear only a slight proportion to it, the deep and heavy, peaty or mossy, soils present themselves. In different districts the peaty matter is found of different depths, and of various degrees of density or closeness of texture, probably proceeding from some original differences in the vegetable substances from which it was formed, or the greater advances which it has made to the state of perfect decomposition or decay. The sub-soil in most of the deep mossy districts is of the clayey kind, more or less stiff and heavy, over which the peaty or mossy material is deposited, generally in a sort of stratified order; the first layer of which being commonly not more than ten or twelve inches in thickness, exhibits the appearance of a rich brown earth, in all probability from the incorporation of the loamy or clayey matters, with the peat or vegetable earth, lying immediately upon them, and constituting originally, perhaps, the surface of the ground. The layer that succeeds to this is mostly of a dark colour, and considerable thickness, apparently formed of a great variety of vegetable materials in the more perfect stages of resolution and decay, united together by time and other circumstances with more or less compactness and solidity. The uppermost stratum, or that which is placed upon this dense, peaty matter, is, in general, of very pale colour, and very light spongy texture, arising possibly from the grasses, leaves, and other vegetable substances, of which it is formed, not having attained that state of decay which constitutes the darker sorts of peaty earth.

But in the more superficial peaty soils, little or nothing of this stratified appearance is met with. A coat of peaty earth, differing greatly in thickness according to the peculiarity of the situations, and other circumstances, is formed by a great length of time from the destruction and decay of successive crops of grasses, leaves and substances of the heathy or other kinds, and deposited upon, and intermixed with, the various harder materials of the soils which happened to be underneath them. By these means much variety is produced in the soils. Where the under-strata of earthy matter are tolerably good, and the crops of vegetables large and luxuriant, the better sorts of light peaty soils seem to be predominant; but where the quality of the under-strata are indifferent, and the vegetable products scanty, as well as feeble in their growth, and principally of the heathy tribe, the poor peaty and heathy, or moory soils, are met with.

All peaty soils seem to be thus gradually formed by the deposition of vegetable matter, supplied by the dissolution and decay of aquatic and other plants that grow in low moist situations, as well as substances of other kinds brought down by water, from the high grounds in their neighbourhood, in the states of solution and diffusion, and gradually deposited from it on its becoming in a state of stagnation, by means of obstruction and stoppages proceeding from different causes.

From the nature of the composition of these soils, it is obvious that they must be very retentive of water, especially where they are of any great depth. Hence they seldom or ever become free from the excessive quantities of moisture, with which they are loaded in the rainy seasons.

Vegetable earth or soil. This kind of earthy material constitutes the superficial bed or stratum, in which plants for the most part vegetate in every sort of soil, and differs very much in different places, from the variations that take place in its depth, and the greater or less progress that has been made in the several substances of which it is composed, to the stage of perfect decomposition or decay.

Some variety may likewise be caused by its being more intimately or more loosely mixed and blended with the other bodies that are found in soils. It seems probable too, that the earthy matter which is formed from the destruction of some sorts of vegetable substances may be better suited for the purposes of vegetation than that which proceeds from others.

Vegetables, from their containing a considerable portion of mucilaginous matter in a state of mixture with their other substances, become, in some measure, capable of solution in water, though the external surfaces of living plants, on account of the resinous and animalized materials that enter into their composition, are protected from its operation. From the former circumstance, and that of earthy matters being contained in them, which had been taken up in the state of solution with their fresh juices while growing, it is evident that large quantities of vegetable mould must be continually formed and deposited on lands by the natural decay of such substances.

But the formation of vegetable mould or earth is farther effected by means of the putrefaction or dissolution of such vegetables as are cut down, or otherwise destroyed, on the surface of the ground, and the application of various kinds of dung and composts. Where these have been in great abundance for a long time, there is mostly a deep rich surface soil of this earth; but where few vegetable products, and those of the less luxuriant kind, have been left to undergo the above process, or little assistance given by means of manures, the crust of surface mould is generally thin and poor. The resolution of vegetable matters is greatly promoted by a proper degree of moisture and heat, as well as a suitable state of the air.

From the preceding account of soils, we may perceive that those are the best which contain the greatest store of those principles which constitute the pabula of vegetation. Such are calcareous soils, in which carbon must exist in large quantities, from the natural attraction of lime for carbon, and where there will be a constant supply by means of this attraction. Soils formed from the decomposition of animal and vegetable matters, are in their natures eminently favourable to vegetation; for they contain hydrogen and carbon combined, together with the remains of animals and vegetables, as yet only tending to decomposition, with various salts resulting from the decomposition of animal bodies, water, earth, and gaseous principles.

Improvement of soils. From various causes, we perceive that some sorts of soil are less adapted to a vigorous production of vegetables than others. To improve the less fertile is a main branch of husbandry. According to circumstances, various methods must be employed; such as commixing one kind with another; draining such as are too retentive of moisture; irrgiating such as are by nature too dry; and refreshing those with manures whose fertility has been exhausted.

Of commixing various soils. Chemical analysis has shewn that substances of the calcareous kinds are the most beneficial in bettering the condition of clayey soils. Where the deficiency is in the want of calcareous matter, lime-stone, gravel, and calcareous marls are the most proper. If, however, these substances cannot be conveniently procured, a mixture of the coarser sands with lime and dung may be employed; or even coal ashes, sea sand, or chalk in the state of coarse powder may be advantageously used.

Loamy soils stand not in need of so much commixture with other substances as clayey soils; the soil of ponds, ditches, or even a small proportion of clayey soil may however be applied to advantage, and especially dung.

Chalky or calcareous soils of the heavier sorts may be benefited by the application of sandy loams; the lighter sort, by clay, dung, and argillaceous marl.

Sandy soils may be improved by applying calcareous marl, argillaceous and loamy ingredients, and by the use of the fold.

Gravelly soils of the calcareous kind may be improved by clay, clayey loam, or chalk.

Peaty soils, after being properly drained of their superfluous moisture, may be improved by the application of gravel, common sand, coarse earth, chalk, calcareous marl, dung, or sea sand. See DRAINING.

Irrigation or watering land. The systematic manner of watering meadow land, as now practised, is of modern invention, but of material importance to that farmer who possesses land of proper quality, and commands a stream of water suitable to the purpose; as he will be enabled to procure an earlier and fuller crop of grass than he could by other means.

Water, independent of any substances it may hold in suspension, is of univeral utility in vegetation; being composed of two chemical elements (hydrogen and oxygen) which are highly favourable to vegetation, and directly and powerfully nutritive to plants. It enters, even undecomposed, as an aliment into the organization of vegetables. It is the only vehicle by which nourishment can be conveyed from solid bodies to plants. And whatever gaseous food the roots of vegetables receive, it is presented to them by the intermediation of water. Although thus beneficial when administered in season and due proportion, yet an excessive affusion of water tends to the destruction of many of the better grasses, and to the nourishment of rushes, mosses, sedge, and other aquatic weeds. A gentle affusion of this fluid, dispersing itself in all directions, never stagnant, never running with great impetuosity of current, more copiously applied in the light and under the heat of the sun than in the dark, operates with the best efficacy, as a promoter of vegetation.

The idea of watering meadows, so far as it relates to bringing the water upon the land, was undoubtedly taken from nature. It must have been always observed that winter floods produced fertility, provided the water did not

remain too long on the land. The idea of taking the water off the land at will, and bringing it on again at will, is the effect of art; and the knowledge of the proper seasons to do this, is the effect of observation.

Suitable soils for water meadows are such as are of a sandy or gravelly nature, especially in the nearest sub-soil. A bed of flints, or loose gravel, is the most desirable. It is also observable, that whatever may be the most abundant grasses in a meadow before irrigation, those kinds will always predominate which best agree with the soil and the water, provided the supply of water is regular and constant every winter.

There are two distinct methods of watering land, according as a less or greater quantity of water can be commanded. If the water is taken from a streamlet, near to the spring head, and the quantity small, only a small portion of land can be irrigated at a time, the water carriages and floating sluices are laid out, and cut in a form which (provincially) is by some called catch-work, by others frame-work. But where a river or large stream can be commanded, the work assumes another appearance, and being of greater power than the foregoing, is called flowing-work.

It is necessary, before entering upon works of this kind, to consider whether the stream of water to be employed will admit of a temporary weir or dam to be made across it, so as to keep the water up to a proper level for covering the land, without flooding or injuring other adjoining grounds; or if the water is in its natural state sufficiently high without a weir or dam, or to be made so by taking it from the stream higher up more towards its source, and by the conductor keeping it up nearly to its level till it comes upon the meadow or other ground. Further, if the water can be drawn off the meadow or other ground as rapidly as it is brought on.

This is to be done by the use of a spirit level, beginning from the highest part of the land that the stream can be commanded from, where the grounds on the different sides are the property of the same person, and weirs, or other works, as has been just observed, can be carried across the streams for the purpose of forcing the water, either wholly or in a partial manner, into a different course. After it has been raised as high as possible in this way, the level is to be formed from the surface of the water, carrying it on what is termed the dead level, allowing some small degree of depression for the flow of the current.

After this has been done, the land on the different sides of the stream, below the lines set out by the level should be minutely examined and inspected, as the whole may be irrigated if the command of water is sufficient. The extent that can be properly performed must however depend much on the degree of fall or descent from the entrance of the water and its out-fall, as well as on the declination of the more elevated parts of the ground.

The next circumstance of importance is that of deciding where to commence the business. This must depend on various points, which can only be settled by the judgment of the operator. If there is a full supply of water, the whole should be covered; but in the contrary case, the expense of cutting the mains or carriers on such levels in a sufficient manner should be considered; and where one side of the stream is better adapted to the purpose than the other, that on such side should be the first executed. And if the land most adapted to the purpose of watering is at much distance from the place whence the water is first taken, and there is not a supply for the whole of the land below the line of level on one of the sides, the expense of forming the carrier should be put in comparison with the greater advantage of irrigating the most suitable grounds, in preference to others that are nearer, without possessing equal advantages. It mostly happens that the beneficial consequences of irrigating at command are such as to overbalance that of forming the mains or carriers. Besides, though the supply of water may be insufficient in such seasons as are very dry, as it may be abundant in the winter time, the simply covering the land at that period may be more than adequate to the expense of the business, which is a circumstance that may render it more beneficial to lengthen the carriers, than by having them shorter to be confined to the watering of such lands as are less proper for the purpose. It is probable also, that in particular cases the winter irrigation may extend through the whole of the level that has been set out.

Where it can be done, it is best to begin with such parts as are contiguous to, or approach the nearest the mains or carriers; and after having passed the water over them, to mark the lowest places, where it can be carried off to the best advantage; and from such parts it should then be seen to which other lands the water can be conducted with the greatest facility and benefit. Where the natural shelving of the ground is considerable, less care is necessary; but where this is not much, it may often be requisite to convey the water in a slanting direction for a considerable way, before lands sufficiently low for being covered by it are met with; as in this sort of business it is invariably necessary, in order to prevent the waste of water, to proceed with that which is first made use of to its final outlet into the river before the works on other divisions are commenced.

When the piece of ground to be floated is so much upon the level that the descent cannot easily be determined by the eye, it will be necessary to take an accurate level, and compare the highest part with the stream intended to be used, by which the degree of fall from the surface of the water to the highest point of the land will be ascertained; and in order to convey the water to this point, should it be distant from the stream, the sides of the ditch or canal should be sufficiently raised for the purpose not to keep the water in a dead level, but with such degree of descent as the two points will admit of. In the operation of cutting this canal or main feeder, it will be easy to preserve the proper degree of fall, having previously ascertained the length, for instance, in cutting 50 yards with a fall of five inches, it will be obvious that in every ten yards a descent of one inch should take place, this is necessary to keep the water in a constant lively motion. In some cases it may be necessary to have two main feeders, in order to effect a more equal distribution of the water; the depth and width of which feeders must be regulated by the supply requisite for the smaller gutters. Near to the mouth of the canal or feeder it will be proper to have a flood-hatch or clow, by which the water may be admitted or excluded at pleasure.

In forming the floating gutters, it is perhaps the best method to cut them at right angles, or nearly so, to the feeders; however, where the surface is uneven, in order to preserve a regular descent, a different direction must be given to them, the distance from each other being about ten yards, and the gutters becoming, as has been observed, gradually narrower as they recede from the main canal or feeder. The object in view being to throw the water as evenly over the surface as possible, these gutters should be so constructed that the water which has been introduced may overflow their little banks rather than run rapidly along the bed. Obstructions may sometimes occur, such as low parts, or deep ditches, over which a pipe or spout may easily be made to continue the progress of the water; and such as proceed from ridges, roads, or small eminences, by trunks or other contrivances made to convey the water underneath them.

It has been observed, that there are two distinct methods of watering lands, catch-work and flowing. The methods of making such works may be thus described. From the spring at A, Plate Husbandry, fig. 13, take the level towards C, to include as much of the meadow BCDE as possible. Cut the trench or main drain AC of a width and depth sufficient to take all the water issuing from the spring, and convey it to the proposed meadow. Cut also the carriage gutter of a sufficient depth to take off all waste water which may fall into it; and also float sluices, &c. laid out by a level, placing sods taken from the sluices on the lower side. Was the meadow small, of a smooth surface, and regular declivity, the water might be let out of the main drain at different places, and so water the whole at once; but as these favourable circumstances seldom occur, recourse must be had to the floating sluices above mentioned, which must be cut at proper distances, such as 10 or 12 yards, according to the declivity of the land; the catches or frames may be about 30 yards apart.

If the meadow is large, it must be divided into catches or frames, by several carriage gutters, as in fig. 14, and a frame or two watered at a time, according to the body of water which can be commanded; and when the water is withdrawn thence, it may be conveyed to other frames.

In meadows thus watered from springs or small streams, it is of material consequence that the works should be kept as dry as possible between the intervals of watering; and as such situations are not affected by floods, and generally have but little water, they must be rewatered the more frequently; and as the top works of each frame will be in the way of getting more of the water than those lower down, care must be taken to give the latter a longer time, so as to make them as equal as possible.

Flowing meadows described. The other kind of water meadows, viz. those usually called "flowing meadows," require much more labour, and system, in their formation

than the foregoing. The land applicable to this purpose being frequently a flat morass, the first object to be considered is, how the water is to be got off when once brought on; and in such situations this can seldom be done without throwing up the land in high ridges, with deep drains between them, as *a*, *b*, *c*, *d*, fig. 15. plate 6. A main carriage AB being then taken out of the river at a higher level, so as to command the tops of these ridges, the water is carried by small trenches or carriages along the top of each ridge, and by means of moveable stops of earth is thrown over on each side, and received in the drains below, from whence it is collected into a main drain CD, and carried on to water other meadows, or other parts of the same meadow below. One tier of these ridges being usually watered at once, is generally called "a pitch of work," and it is usual to make the ridges 30 or 40 feet wide; or, if water is abundant, perhaps 60 feet, and 9 or 10 poles in length, or longer, according to the strength and plenty of the water.

It is obvious, from this description, that as the water in this kind of meadow is not used again and again, in one pitch, as in the catch meadows, that this method is only applicable to large streams or to vallies subject to floods; and as these ridges must be formed by manual labour, the expence of this kind of meadow must necessarily exceed the more simple method first described; and the hatches that are necessary to manage and temper the water or rivers, must be much more expensive than those in small brooks.

Management of water meadows. As soon as the after-grass is eaten off as bare as can be, the manager of the mead, (provincially "the drowner") begins cleaning out the main drain, then the main carriage, and then proceeds to "right up the works," that is, to make good all the water carriages that the cattle have trodden down, and open all the drains they may have trodden in, so as to have one tier or pitch of work ready for "drowning," and which is then put under water (if water be plenty enough) during the time the drowner is righting up the next pitch. In the flowing meadows this work is, or ought to be, done early enough in the autumn, to have the whole mead ready to catch, if possible, "the first floods after Michaelmas," the water being then "thick and good," being the first washing of the arable land on the sides of the chalk hills, as well as dirt from the roads, &c.

The length of this autumn watering cannot always be determined, as it depends on situations and circumstances; but if water can be commanded in plenty, the rule is to give it a good soaking at first; perhaps a fortnight or more, with a dry interval of a day or two, always taking the water off at the first appearance of white scum; after which, the works are made as dry as possible, to encourage the growth of grass, and to allow the land to pitch or sink close together.

Whilst the grass grows freely, a fresh watering is not wanted, but as soon as it flags, watering for a few days is necessary. In the months of October, November, or December, some meadows will bear the water for three weeks, which in February or March will not bear it one week, and in April or May not three days.

In all cases where the watering system is undertaken, except in the time of floods, it may be highly useful to disturb the mud and dirt in the bottom of the main carriers, or drains, before watering; a practice frequently adopted on the continent. Lime has also been thrown into these cuts by some irrigating farmers, and raked with a heavy harrow, or other implement at the bottom, which is a process that will be found to add considerably to the manuring quality of the water. It is probable that many other substances might be employed in the same way, and be thus spread over the surface of grass lands in a minute state of division, with vast advantage in promoting vegetation.

The great degree of verdure and luxuriance which almost immediately succeeds the occasional covering of grass lands with water, sufficiently demonstrate the power which it possesses in promoting vegetation. It is a means of fertility that has been employed for ages in more warm climates, with the most beneficial consequences in increasing the quantity of vegetable produce. But though it has been long in use in other countries, and of late more particularly attended to in this, the principle on which it produces its effects does not seem to be fully understood. In speaking of manure as the food of plants, we have already noticed some of the properties of this fluid that may be useful in the vegetable economy when taken up by the fibrous roots of plants; and there are still other ways in which it would seem to be advantageous in forwarding the growth of grass crops.

Winter and spring are the two seasons when meadows are usually watered, as from the month of November till the beginning of March; the experience of the operator can alone regulate this proceeding as to the length of time they should remain under water. In some districts the water is allowed to flow over the fields for several weeks together, with only the interval of a day or two occasionally; in others, the practice is to flood them the alternate weeks. When frosts set in, floating is usually suspended; but it has been remarked, that in such cases the succeeding crop of grass has been abundant. As the spring advances, much less floating is found to be necessary. However, in all cases, when floating is performed to advantage, the meadows should be laid dry between every watering.

Manures. An encreased population requires more abundant stores of food for man, and the beasts immediately under his command, than were before necessary: to this end, where the extension of land cannot be obtained, recourse must be had to the enriching of that which is already in possession, whenever it becomes deteriorated by constant and heavy cropping, with such plants as exhaust the pabulum of vegetables; and also to improve such soils as are by nature less adapted than others to the production of advantageous crops.

Besides the methods we have already spoken of for the improving of lands, mankind have discovered various substances, which, when judiciously applied, possess the power of encreasing the fertility of soil in a wonderful degree. These substances are numerous, and always near at hand. They arise from the decomposition of animal and vegetable matter, and from the agency of fossil and saline substances.

From the changes that are constantly taking place among bodies in nature, and the new combinations which are formed in consequence of those changes, a great variety of matters are unfolded, elaborated, and prepared for the nourishment and support of vegetable life.

Some of the substances which contribute in this way possess considerable fluidity and volatility, such as water, and various gaseous materials, as oxygen, hydrogen, azote, and carbonic acid, in different states of combination. While others are more gross and heavy, and require to be applied and incorporated with soils, or spread out upon their surfaces, in order that they may produce their effects in promoting vegetation. It is principally to these, as being the means of sustaining different sort of plants as crops, that the term manure has been given by practical writers on agriculture; though it is extremely obvious that they must undergo different changes, and be resolved into their more elementary principles, before they can be taken up, and contribute to the increase and support of vegetables. In the various materials which the art and industry of mankind have rendered capable of being beneficially employed in this manner, there is great diversity; some are found to yield the matters which are necessary for the support of plants much more readily and more abundantly than others, as animal, vegetable, and all such substances as are rich in mucilage, saccharine matters, and calcareous earth, and readily afford carbon, phosphorus, and some aerial fluids; while others that are greatly deficient in all or many of these principles, or do not readily part with them, are found to be of much less utility, when employed in the way of manures. This is probably a principal reason why some sorts of manures, or substances, when put upon grounds, are so greatly superior to others, used at the same time, and in the same manner and proportion.

There are, however, many other ways in which substances, when applied to soils, may render them more fertile and productive, and contribute to the aid of vegetation. Some, besides furnishing such matters as are suitable for the purpose of promoting the growth of plants, are known to add considerably to the quantity of vegetable and other matters contained in the soils on which they are placed, and thereby provide a more suitable and convenient bed for the reception of the roots of plants; others contribute little in this way, but operate chiefly upon such materials as are contained in them, breaking down their organization or texture, and thus setting at liberty different volatile and other ingredients, by which new compounds are formed, and brought to such states as are the most adapted to the support of vegetable life; others again act principally by producing certain changes and alterations in the constitution or texture of soils, such as rendering them more open and porous, or more stiff and compact, and by such means bringing them into the most proper conditions for the bearing of different vegetable productions; and there are still others that contribute in all or several of these ways at the same time.

Substances of the animal kind, when reduced by the process of putrefaction, or other means, into a soft, pulpy, or mucilaginous state, are found by experience to afford those matters which are suited to the nutrition and support of plants with greater readiness, and in more abundance, than most other bodies that can be employed. By chemical analysis it has been seen that the component materials of these substances, so far as agriculture is concerned, are principally water, jelly, or mucilage, and saccharine oleaginous matters, with small portions of saline and calcareous earthy substances. Hence animal matters, though they agree in some circumstances with vegetable productions, each having, in common water, saccharine, and calcareous matters, are far more compounded; and in animal substances, some of these materials are in large proportion, while in vegetables they only exist in a very small degree; and the jelly, which in some measure resembles the gum and mucilage of plants, differs likewise from them, in its having much less tendency to become dry, as well as in its property of attracting humidity from the atmosphere, and of running with great rapidity into a state of putrefaction and decay.

All these principles of animal substances are resolved by their ultimate decomposition into other matters, such as the different gaseous fluids that have been mentioned above, carbon, phosphorus, lime, &c.

Animal substances of every kind, on being deprived of their vital principle, have a quick tendency to take on or run into the state of putrefaction; a process which is considerably affected and influenced by the circumstances under which it is produced. But in the horny and more compact animal matters, this tendency to putrefaction and decomposition is, under similar circumstances, much less rapid than in such as are of a less firm and dense texture.

Hard animal substances. In the matters of this sort that are employed as manures, there is considerable differences in respect to their texture and firmness, some being quite firm and solid, such as bones, horns, hoofs, shavings of horn, and some other similar substances, while others are more soft and pliable. The bones of all animals are capable of affording much nutritious matter to plants, but those which are procured from cattle that have been killed when fat, are the best for the purposes of manure. Those which have been boiled are far inferior, in this view, to those which have not undergone that process, as by such means they are principally robbed of their oily and mucilaginous properties, and consequently must yield much less nourishment to the immediate crop, whether it be grain or grass. All these sorts of substances require to be ground down in mills constructed for the purpose, or otherwise reduced into small pieces, before they are laid on and mixed with the soil. They are excellent for potatoes.

These substances are constituted of a considerable proportion of mucilaginous or gelatinous matter, a slight portion of fat, and an earthy salt composed of the phosphoric acid and calcareous earth. If great heat be applied, they afford a large quantity of hydrogen gas, carbonic acid gas, and a volatile alkaline liquor. From the nature of these different principles, it is evident that some sorts of substances may be blended and united with the reduced particles of bony matters, so as to promote their effects, as manures, in a considerable degree, such as lime, chalk, peat, earth, and good vegetable mould, in suitable proportions, as by such means new combinations may be formed highly favourable to the process of vegetation.

Soft animal substances. There are various matters of this nature that may be of use for the purpose of improving land as manures, some of which have yet been but little attended to by the farmer. Of this sort are greaves, or the residuum which is left after the making of candles, and the scum which is collected in the boiling or refining of sugar.

Different trials with the former have fully convinced us that it is a substance that possesses great powers when employed as a manure. And although it is a substance which is generally procured at a high price, from its going a great way, and being a lasting manure, it may probably be more frequently had recourse to than has hitherto been the case. It is mostly procured in the state of hard compressed square cakes, though sometimes in a soft condition, without having undergone any pressure. When in the former state, the cakes must be broken down and reduced into as great a state of division as possible, which may be rather a troublesome and expensive process, except a mill, or some proper machine for the purpose, be employed. But when it has been even reduced to the finest state possible, it will still be improper for application as a manure, until it has been mixed and incorporated with a pretty large proportion of some rich earthy substance with which it may combine. Excellent for turnips.

A combination of lime and greaves, mixed with mould from the headlands, in the proportion of about 50 bushels of lime to a ton of greaves. This composition resembles sugar scum, which consists of lime and bullocks' blood.

Lime might thus be combined with bones or woollen rags, or with a compost of earth and night-soil; and would certainly greatly facilitate their conversion into manure, as well as render them more active in producing their effects in the support of vegetable crops. And by some of their properties being absorbed by the lime, during the time of their decomposition, and afterwards parted with more slowly in the soil, they may also by such means be, probably, rendered more durable and lasting, as manures.

There are still more substances of the animal class, such as the blood, serum, wool, hair of animals, refuse of glue-makers, the cuttings of felt-mongers, the clippings of furriers, the scrapings of oiled-leather, and the chips or waste of shoe-makers, which may be made use of as manures, when they can be collected in sufficient quantities. These animal materials, from their abounding in mucilage and oil, their great attraction for moisture, and their being readily soluble in water, contribute quickly to the support of vegetation, but are not probably so durable in their effects upon land as many other substances. Hence they should only be made use of with a view to the immediate crop, which, we believe, is pretty much the case in those places where they can be obtained in such quantities as to be employed for the purposes of agriculture.

Various animal substances of the fish kind, as the blubber remaining after the preparation of oil from the whale, and other large fishes, and different sorts of small fish, both of the shell and other kinds, may be employed as manures; and also the offals of such animals, where they can be procured in a large quantity, as in large towns, sea districts, and where they are cured or prepared in great numbers for the market.

These substances may be readily reduced to that state which is proper for manure, by mixing with them a small portion of the carbonat of lime, and afterwards, according to circumstances, a quantity, two or three times more than the whole, of good vegetable mould.

The refuse of slaughter-houses and butchers' shops may likewise be prepared and made use of in a similar manner to that of fish. For as the manures that are formed from these animal materials are capable of affording much elastic volatile matters during their decomposition, they of course require to be well mixed and blended with such earthy substances as they can combine with, and render soluble, and in proportions suited to their powers, in order to produce the most beneficial effects on vegetation.

Animal dungs. The animalized substances that are, however, most generally made use of as manures, are the excrements of various kinds of animals, which are found in very different conditions, or states of preparation and richness, proceeding in some measure from the kind of food on which the animal has been fed, the matters with which they are incorporated, and the texture of the substances themselves.

The dung of fat animals is unquestionably more rich, and consequently possesses greater powers of fertilization than the dung of lean ones; and that the quality of the dung of every sort of animal will in a great measure be proportioned to the goodness or poverty of its food. Thus, when the animal is fed on oily seeds, such as lint, rape, and others of a similar nature, it will be the most rich; when kept on oil-cake, or those seeds which have been deprived of part of their oily matter, the next so; on turnips, carrots, and such-like vegetable roots, the next; on the best hay, next; on ordinary hay, next; and on straw, perhaps, the poorest of all.

The urine of animals appears to be a more perfect extract from the animal system than the other; it is therefore surprising that this valuable substance is not more attended to by agricultors. Let it be mixed with the dung-hill, or else carted to the field after it has passed through the putrefactive fermentation. Its effect on land is immediate.

Some manures of this kind, such as the soil of privies, is sometimes met with in a state fit to be applied to the ground, when not much mixed with fluid matters, such as urine. It most frequently happens, however, that it is in such a liquid state as to require other more solid substances to be blended with it, before it can be conveniently applied to the soil. In doing this, too little regard seems to have in common been paid to the choice of the most proper materials; but it

is obvious, that such as can be the most fully acted upon, and the most readily converted into the states suitable for affording the nutrition of vegetables, by the principles of the matters thus employed as manures, must be the most adapted for the purpose, as well as the most beneficial. When, therefore, the manure made use of in this way is either wholly or principally constituted of such animalized matters, as from their fluidity are in an improper state or condition to be set on land without having other substances previously mixed with them, such peaty, boggy, or black vegetable earths should be chosen as contain large proportions of matter, which the ammonia or volatile alkali so abundantly provided by the decomposition of such substances may exert itself upon, and reduce into that state of solubility which is suitable for promoting the growth of plants.

The results of experiments attentively made in this way, indeed, clearly demonstrate that an inconceivable loss is incurred by the inconsiderate practice of exficcating human excrement, as well as the negligent custom of permitting the gaseous or liquid parts of dung heaps to evaporate or run away. The trials which we have been enabled to make also lead us to suspect that it is a much more wasteful practice to apply these liquors to ground in their uncombined state, than in conjunction with such earthy materials as have been mentioned above. Besides, much of them must be imperceptibly carried off by the process of evaporation, even when they are carried out in the most favourable seasons of the year; and they cannot in this way always be made use of on those soils that contain a sufficient quantity of those earthy materials or principles with which they can readily form combinations, and exert their most beneficial and fullest effects. It may be demonstrated, by experiment, that yard and stable dung should be applied to the land in its half decomposed state, and not be suffered to remain in heaps until the putrefactive fermentation has reduced it to over putridity.

We are decidedly of opinion, that the soil of privies is a manure of the most enriching kind, but that its effects are not so lasting as those of many other substances. In some trials which have been lately made with it, it has produced such astonishing fertility, as induces us to conclude that it exceeds all other sorts of manure that can be put in competition with it for the first year after its application. The second is of some service, but in the third its effects nearly, if not quite, disappear. The circumstances which render this sort of manure so immediately active in promoting vegetation, and so quickly deprived of its beneficial influence, would seem to be from the great quantity of elastic principles which it contains in a loose state of combination, and the small quantity of earthy matter which it is capable of supplying to the soil, by the last stages of decomposition or decay.

This view of the nature of the manures afforded by different animals, should lead the practical agricultor to be more attentive to the subject, in order that he may render them more abundant, and be capable of employing them under the most favourable circumstances, which cannot be the case while they are, as at present, indiscriminately mixed and blended in the common dung-heap.

It is, however, from the larger animals that the farmer derives the principal part of the dung that is made use of as manure, in the cultivation and improvement of land. The dung of such horses as are highly fed being found, as has been already seen, to be much more valuable for the general purposes of agriculture, and some uses in horticulture, than that which is made by horses when fed with hay or grass only. Where the animals are kept in the latter way, it is probably not so good as that of well-fed cows and neat cattle in general, as in these it may, perhaps, become more animalized from the circumstance of their food being more intimately blended with the saliva, or other juices, during the ruminant state of feeding in such animals. The dung of horses is, however, in common much more disposed to the process of putrefaction, and cause more heat, than that of cows and other neat cattle; and indeed these are the chief distinguishing circumstances between them as manures. The dung of neat cattle may also, on account of its less disposition to run into the state of putrefaction, contribute more of the earthy material to the land on which it is applied. Hence, probably, its superior utility on the leaner and poorer or thinner sorts of soil. The dung and urine of animals when newly voided are not, except when the animals are morbid, in a putrescent condition, the length of time in which they remain in their bodies being too short for its fully taking place; but some degree of, or tendency to, putridity is constantly necessary to their discharge.

From the experiments that have been made with the dung of sheep, it is evident that it is equally valuable with that of many other animals that feed in the same way, but agriculturists have not yet turned their attention sufficiently to the means of collecting and preserving it, so that it may be used alone as a manure. The method by which it is at present applied to land is by folding the animals upon it, under which method of management, on many soils, a great part of the advantage must be derived from the operation or action of the ammonia of their urine upon the vegetable matters contained in them, as well as from the consolidation produced by their treading. It is well known that the urine and dung of sheep want no fermentation previous to its being applied to the land; the sooner therefore the seed is sown after folding, the greater is the effect.

Vegetable, as well as animal substances, when deprived of their vital principle or life, are soon rendered fit, by the separation, reduction, and ultimate decomposition, of their constituent principles, for the nourishment and support of new plants. This process is greatly promoted, in all kinds of substances, by the materials being exposed to the free influence or agency of atmospheric air, moisture, and a middling degree of heat; various matters are set at liberty, by which different new combinations take place, that are capable of promoting vegetation in different degrees, and upon which their utility as manures, perhaps, chiefly depends. The stages of this decomposition have generally been supposed to regularly succeed one another, from that which is productive of sweetness, through the vinous and acetous, to that which is the ultimate result of putrefaction. Different sorts and parts of organised matters, when dead, undergo many different sorts of chemical changes, which are different according to the degrees of heat, the quantity of water, and of air, to which they are exposed.

In the vinous fermentation or process which commences after the saccharine, carbon becomes united with pure air in a large proportion; and it is probable that, at the moment of their combination, while they are in the form of a liquid, and before they assume the gaseous state, they may be taken up by the roots of vegetables.

The substances of the vegetable kind that may be advantageously converted into manure are so extremely numerous, that it is impossible within our limits to describe them. All kinds of green vegetable productions may be employed in this way; such as the luxuriant weeds of rivers, lakes, ponds, and ditches; fern, and the refuse of different kinds of garden vegetables. Where green materials of this nature are made use of, they should always be cut down while in their juicy state, just before their flowers begin to appear, in order that they may be in the most suitable condition for becoming quickly putrid, and to prevent the injury that might otherwise be sustained from the vegetation of their seeds. They are afterwards to be collected into heaps of a moderate size, and their putrefaction promoted by their being thrown together as lightly as possible, and the occasional sprinkling of them with water, if the season be hot and dry; and as lime is found, when applied to vegetables in their green moist state, to disengage from them both hydrogen and azote, by the combination of which volatile alkali is produced, it may be advantageous to blend a portion of lime at first with the heaps, and afterwards add a suitable quantity of peat earth, or good vegetable mould, for the alkali thus formed to act upon. By this method, the quantity of manure from such substances may be greatly augmented, and rendered more valuable. But when dry materials, such as hay, straw of different kinds, fern, and rushes, such additions cannot be had recourse to with equal success, unless where much of the dung and urine of animals have been incorporated with them; but their resolution and decay may be greatly promoted by their being kept in a state of moisture, without the water being suffered to stagnate upon them, and by their not being permitted to be trodden down too much by cattle, or other means, in the farm yards.

Another beneficial means of vegetable manure, which is yet far from being sufficiently practised, is that of providing full crops of succulent green vegetables, such as clover, buck-wheat, tares, vetches, spurry, pease, beans, turnips, and many other similar plants, to be turned down by the plough, in order that they may undergo the putrefactive process under the ground, and by that means be converted into manure, and supply the nutrition of plants.

Sea-weed is another vegetable production which is capable of being employed as a manure with great advantage, and should never be neglected where it is within the reach of the farmer. In some places it is the practice to spread it upon the lands as soon as possible after being cut from the verges of the rocks on the different sea coasts, or collected after

being left by the tides, and to plough it in: where this method is adopted, as little time as possible should be suffered to elapse after the cutting or collecting of the weed, before it is ploughed down; for as the plant in its green or succulent state readily decays and becomes putrid, if there be any considerable delay in the performance of the business, especially when the weather is hot, much of its valuable properties as a manure is dissipated, and carried away by means of evaporation.

Bark, which has been made use of for the purpose of tanning leather, may likewise be employed as a manure: when used in this way it should be collected into moderate sized heaps, before it has become dry by too much exposure to the heat of the sun and wind; and then by having a quantity of lime mingled with it, and being kept slightly moistened with water, its putrefaction and decay may be greatly promoted.

The mud taken from the bottom of rivers, ponds, and other places where water has stagnated for some length of time, fresh or maiden earth, and the scourings of old ditches, are substances that may frequently be employed with advantage as manures, being principally composed of the recrements of decayed vegetable matters. They should not, however, be put upon grounds, especially those under grass, until they have been reduced into a considerable degree of fineness, by means of frequent turning over, and the mixing of a portion of lime, rotten dung, or other materials of the same kind, with them, in order to promote and render the decay of the more solid parts more full and complete.

Substances of the calcareous kind, which are to be considered under this head, produce effects more or less powerful in promoting the growth of vegetable crops, in some measure, according to the state and quantity in which they are applied, the nature of the soils on which they are employed, and the properties of the matters with which they are combined.

Substances that contain much saline matter in combination with their earthy and other ingredients, are found, in many instances, when properly employed as manures, to contribute greatly to the support of vegetation. The materials principally made use of in this way are the refuse of different manufactures, such as bleaching and soap-boiling, where they can be procured in sufficient quantities, as in the vicinity of large towns, and where such manufactures are carried on in an extensive manner; the ashes remaining after the combustion or burning of various green vegetable matters, wood, pit-coal, peat, &c. and some other substances, such as soot and sea-salt.

It is most probably to the different alkaline principles contained in these substances, from the great facility and power which they possess of acting upon and dissolving the parts of animal and vegetable matters, especially such of the latter kind as have been rendered insoluble by the absorption of the oxygen, or pure air of the atmosphere, from long or frequent exposure to it, that their benencial effects as manures are chiefly to be ascribed.

But these substances, besides their forming in the soils, or the earthy materials with which they are mixed, such compounds as are beneficial in promoting the growth of vegetables may be useful in many cases when properly applied, and used in sufficient quantity, in correcting acidity, in altering the state or condition of the lands, as by the taking away of moisture from the surface where it prevails in an over-proportion in meadows and pastures, and thereby supports crops of coarse vegetables, and by rendering the texture of such grounds as are under the plough more open and friable, consequently more suitable for the reception of the roots of corn crops.

It is evident, from what has been already observed on the nature of the different substances that are capable of being made use of as manures, that they may frequently be mixed and blended with each other, or with substances of other kinds, and by such means be not only considerably increased in quantity, but in many cases rendered more effectual and more suitable for application than in their simple states; but at the same time, that some of them may be mixed and incorporated in this way with much more advantage than others; for though the general experience of farmers has fully shewn the great importance and utility of employing compound manures, or composts, little attention has till lately been paid to the compounding or mixing together of such substances as are, from the principles which they originally contain, or which are formed from them in the changes which they undergo in the different stages of their decomposition, adapted to act in the most suitable manner for producing such combinations or alterations in the materials as are capable of being beneficial in the promotion of vegetation when they are employed as manures.

Farm-yard manure, which is the most general application of any, from its being formed by the decay of various kinds of vegetable matters, such as hay, straw, fern, and many other materials of a similar nature, with which the dung and urine of animals is incorporated and combined, must be considered as a compound substance. And from the large proportion in which such vegetable productions enter into its composition, and the quantity of earthy materials that is in most cases, especially where the management is upon a judicious plan, added by the laying of suitable bottoms, it is not so frequently necessary to be blended with other substances that are usually employed in forming composts. But from most of the vegetable materials that constitute the chief part of this sort of manure, being made use of in a dry and hard state, they do not so quickly ferment or run into the state of decay, notwithstanding the proportion of animalized matters that may be mixed with them; it therefore becomes an useful practice to turn them over, by which their complete putrefaction may not only be promoted, but the different materials be more minutely blended together, on both which accounts they may become more useful when applied as manure upon land. In the forming of this manure, care should also be constantly taken that the heaps be so situated as that they may not become too dry, or too much soaked in water, as in either case they must be greatly injured. Whenever it may be requisite to incorporate any earthy material with this sort of manure, the agricultor should always carefully attend to the state or richness in which it may exist in the yard, and proportion such additions accordingly. It will, however, never demand nearly so large a proportion, as such manures as consist almost wholly of animal matters.

Where animal matters are collected and thrown together in any quantity, there can be little doubt but that a great increase of good manure may be provided by mixing with them, as has been already observed, rich surface-mould, peat-earth, or the scrapings of old ditches and roads; as by such a practice the ammonia formed during the decomposition of the animal substances is prevented from escaping, as would otherwise be the case, which, by combining with and acting upon the earthy materials, quickly renders them proper for the purposes of manure. As substances of the animal kind have been shewn to run very rapidly into the state of putrefaction, they may frequently be incorporated with such vegetable materials as are little disposed, or with difficulty made, to rot or become putrid, and by such means useful composts be more expeditiously formed. In making use of such earthy substances as have been mentioned, it may be of much advantage to have them exposed to the influence of the atmosphere for a considerable length of time, frequently turning them over, before they are mixed with the manures, as by such means they become in a more pulverized state, and are capable of being more intimately blended with such materials, and afterwards spread over the land with much greater equality, a circumstance upon which their effects very much depend. If, in performing this business, the earthy substances be formed into a sort of ridge, about five or six feet in height, and nearly the same breadth in the bottom, they will be in the most proper situation for being united with dung, or other matters that may be employed.

In the application of manure to land, several circumstances are necessary to be considered, such as the state or condition of the substances which are to be made use of, the nature of the soils on which they are to be laid, the kind of crop that is to be promoted by them, and the season in which they are put into or upon the ground.

As we have already seen that changes are continually taking place from the moment the materials of the dung-heap are thrown together, to the period in which they are reduced into a black carbonic earthy matter; and that in most of the different stages through which they pass in this process of decomposition, such substances are formed as are capable of contributing to the nutrition and support of vegetable crops; it seems probable, that in cases where manures are to be turned into the ground, and such crops cultivated as require a supply of nourishment for a considerable length of time, they should be employed in their long or more imperfectly reduced states, as by the heat which is evolved in the commencement of their dissolution, the process of early vegetation may be greatly promoted, and their gradual decomposition and decay afterwards, under the ground, afford a more durable and regular supply of nutrient materials, and thereby contribute more effectually to the growth of the crops; but that where they are to be buried in, or applied to, the surface of the soil, and intended merely for the benefit and support of such crops as are of short duration, or quickly arrive at their full growth, they may be more advantageously made use of after they have

seen more fully and completely reduced, as in this state the manure is, in the case of grass lands, not only capable of being spread out in a more regular and uniform manner, by which it becomes more evenly as well as more generally carried down to the roots of the plants by rains, but it is in the most suitable condition for allowing the young plants the means of springing up with facility, and at the same time, whether used under or upon the soil, of affording the crops that abundant supply of nourishment which is necessary to their speedy growth and great luxuriance, and by these means to contribute the most perfectly to the promotion of their increase.

And as in the slow and gradual decomposition of the materials which are made use of for manures, when slightly deposited beneath the soil, there is much less waste of heat and those elastic matters which contribute so greatly to the support of vegetation, than where they are made to undergo the various processes of dissolution in large masses, as in dung heaps, they may probably sometimes on that account be most advantageously employed in this state.

On this principle too the ploughing down of fresh vegetable crops, in many cases, in their most succulent states, may be a more economical as well as more beneficial practice; especially in such light and dry kinds of soil as will more readily admit of their gradual putrefaction and decay, than to cut and take them off for the purpose of being by other means converted into manure. It seems likewise probable, on the same grounds, that for the production of crops of bulbous-rooted vegetables on the more stiff and tenacious soils, the matters made use of as manures may be employed with the greatest advantage, when put into the earth before they have undergone any great degree of decay by means of putrefaction, as in this way there is no waste, the whole being ultimately converted and applied, though more slowly, to the support of the crops.

As to the season in which manures may be put into the soil, or spread out upon its surface, with the greatest benefit and advantage, though in practice it must, in some measure, depend on the state of the land and the convenience of the farmer, it should, in cases where they are buried in the ground, be as nearly as possible to the periods in which the seeds or roots which they are designed to support, are sown or placed in the earth; and in the latter case, or where they are to be laid upon the surface of the land, it ought to be just before the crops of grass, or other vegetables, begin naturally to spring or shoot forth.

And by the application of such manures as are employed in the way of top-dressings in the beginning of the spring, they are laid on in the most favourable period for affording their nutritious principles, and for their being drank up by the roots of plants, consequently become useful at the time they are most wanted for the promotion of the crops, and the great waste which must otherwise be caused, either by the excessive falls of rains and floods in the winter season, washing down much of the valuable properties into the adjoining rivers and ditches, or the evaporation of their more volatile or elastic matters by means of the summer heats, is most effectually guarded against and prevented.

On all these accounts, therefore, farmers should contrive as much as possible to apply the manures, intended as top-dressings to grass lands, as early in the spring as it can be conveniently done, which may be easily managed on those that are dry, and on such as are inclined to be wet and poachy, it may probably be greatly facilitated by having small light carts constructed for the purpose, and placed on broad cylinders as wheels.

In the application of manures to lands under tillage, as well as those in the state of grass there are a few other circumstances that require the attention of cultivators; such as the depth they may be deposited in the soil, the modes of putting them upon the ground, and the most economical methods of employing them.

In respect to the advantage of using one sort of manure in preference to another, it may be observed, that as animal matters are found in general to undergo more speedily the process of putrefaction or decomposition, than those of the vegetable kind, and as in most instances they afford those mucilaginous and elastic principles that contribute so largely to the support of vegetable life in greater proportions; such manures as are either wholly or in a great measure composed of them, must be the most beneficially employed, where quick and abundant supplies of nourishment are required, as in the growth of all the more gross and luxuriant crops, whether of grain, plants, or grasses; and that as those vegetable substances which contain saccharine, farinaceous, oily, saline, or mucilaginous principles in the largest quantities are ascertained from experience to proceed the most readily into the state of dissolution or decay, and consequently to afford more fully and more expeditiously the nutrient food of new plants, where manures are principally formed from them, they should be preferred to such as have been made from the harder and more ligneous vegetable substances; that contain such properties in scarcely any, or much smaller degrees, for all the purposes of agriculture.

Of the natural spontaneous grasses. Having thus stated the nature and principles of the various soils which are met with on the surface of the earth, and shewn the different modes of improving the same, it becomes us, in the next place, to speak of the best natural productions thereof, especially of the gramina kind; that from thence the agricultor may make his selection of such land as may be most profitable.

In our meadow and pasture lands we find a great variety of grasses, of which some are far more valuable than others; to know the good from those which are indifferent becomes the interest of the farmer; we therefore give him the characters (accompanied with figures. See plates I. and II.) of the most valuable, so classed in our catalogue as they stand in precedence of quality one to another.

1. Great smooth stalked meadow grass—Poa pratensensis.
2. Hard fescue grass—Festuca duriusculo.
3. Meadow fesc. grass—Festuca pratensio.
4. Ray grass—Lolium perenne.
5. Meadow fox-tail grass—Alopecurus pratensis.
6. Sheeps' fescue grass—Festuca ovina.
7. Rough stalked meadow grass—Poa trivialis.
8. Marsh meadow grass—Poa palustris.
9. Compressed meadow grass—Poa compressa.
10. Crested dogs' tail grass—Cynosurus cristatus.
11. Knotty cats' tail grass—Phleum nodosum.
12. Sweet scented spring grass—Anthoxanthum odoratum.

Great or smooth-stalked meadow grass. This grass is considered as the best of all we have; it is early in its foliage, makes the best hay, affords the richest pasture, all sorts of cattle are fond of it, it is in all our meadows, and will continue in the same land much longer than any other grass.

Hard fescue. This is an early and productive grass, with fine foliage, which grows well on downs and rich meadows. It is well adapted for being combined with other grasses in forming sheep pastures, and stands high in esteem as a very good hay grass.

Meadow fescue grass. This is a grass that comes near in its appearance to ray grass, but to which it seems greatly superior, as being larger, and more productive of foliage. It is strictly perennial and hardy, thriving well in most soils, growing in all situations; and it abounds in the best meadows, in the best hay districts; is sweet, luxuriant, and quick of growth, affording rich pasture, and making good hay. In short, it seems well calculated to supply the defects of ray grass. Besides, it has the quality of producing more seeds than most of the other sorts of grasses, which are easily gathered, and grow readily.

Ray or rye grass. This is a sort of grass that has been much in cultivation, but is deficient in some of the properties necessary for meadow or pasture lands. In rich moist meadows its foliage is abundant; and it seems probable that it is highly acceptable and nutritious in feeding cattle; its foliage is of rapid growth, and flowering stems continually shooting forth. It is best adapted to the loamy and sandy descriptions of soils; but it will succeed on any except stiff clay, and even on that it may be grown.

On converting ray grass into hay, it is necessary to cut it at a period previous to its being so ripe as to have perfected its seed, and changed to a yellow colour; for in this case a great part of the juices of the plant, which constitute a principal part of the nutriment it is to afford, will be converted into a species of straw, and its nutritive properties be proportionably diminished.

Meadow fox-tail grass. It is in some measure distinguished by the largeness of its foliage, which is rather coarse, and by its producing a soft spike on a long stalk, early in May. If it be mown early, just as it comes into bloom, the hay will not be coarse. It shoots very rapidly after mowing, and produces a plentiful aftermath.

Sheeps' fescue. This grass is praise-worthy both for the purposes of pasture and hay; sheep and other sorts of stock are fond of it, and are soon rendered fat in pastures where it prevails, giving to mutton a sweet delicious flavour.

Rough-stalked meadow grass. It delights in moisture, and situations that are sheltered; on which account, though there are few more productive, or better adapted for the purpose of hay or pasturage, it is tender, and liable to be injured by severe cold or drought;

and in moist rich ground it has been observed to grow tall, while in poor land it has been found equally diminutive. It is a grass well adapted to good, sound, moist loams. The produce is admirable for the feeding of all sorts of cattle.

Marsh meadow grass. This is a fine exuberant grass, and one of the best dairy grasses we have. It grows in all our rich marshes, which are subject to be flooded in the winter; generally four feet high. Its panick, when full-blown, is wonderfully fine and flowing.

Compressed meadow grass. This is an excellent grass for parks and sheep walks, deer and sheep being fond of it; and as it is a dwarf grass, the blades seldom exceeding two inches, it makes a fine turf, and renders the flesh of the animals short, and sweet flavoured.

Crested dog's tail grass. This is a grass that is a favourite and wholesome food for sheep. It grows best in dry pastural lands, and will not thrive in meadows that are very moist. It abounds greatly in the best pastures, and is a blade grass that shoots up the first after the land has been mown; its thickest tufts afford much food for sheep in the time of snow and severe weather in the winter season. From the rapidity of its growth it may be apt to get coarse, if not cut down more quickly than is often the case.

Knotty cat's tail grass. It is a fine exuberant grass, very fit for dairy pastures and for cow-hay. It produces much rich milk, and kine are fond of it.

Sweet-scented vernal grass. This is a sort of grass that comes early into blossom; and is also valuable for its readiness to grow in most kinds of soil and situation, but in point of crop it is not so productive as some others; and it it well known to be the only grass of this climate which is odoriferous; the agreeable scent of new-made hay being produced almost entirely by it; and the green leaves, when bruised, readily impart this odour to the fingers, by which means the foliage may constantly be known.

Cultivation of grass lands. Lands in the state of grass must obviously be applied to different purposes, according to their nature, situation, and other circumstances. Those which are of the more moist kinds, whether from the nature of the soil or the peculiarity of situation, are for the most part kept under the scythe; while those of the contrary description, that are situated at a greater height, and of course, in most cases, possess a greater degree of firmness, are in general appropriated to the purpose of pasturage: though, in particular situations, where grass land is scarce, and consequently of great value, it is good management to convert them occasionally to the purpose of hay.

Meadow lands, from their being situated in the hollows and sloping sides of the valleys, where the staple and depth of soil of the lands have for a long time been continually increasing by the deposition of various sorts of vegetable and other matters brought down from the higher grounds, are, however, in general, in a considerably greater state of fertility, and evidently better fitted for the permanent production of grass than those from which they have derived their richness.

Management of meadow lands. From the greater retention of moisture in the vale land, in consequence of their situation, and the depth of vegetable matter, they are liable to throw up coarse herbage in many cases, more drainage, as well as other management, is necessary to bring them into the proper condition for the growth of good herbage, than is requisite in the hay grounds in the more elevated places. And by a more particular attention in these respects they would, in many instances, be rendered a vast deal more productive than they are at present, and at the same time afford a much better herbage. They would also admit stock upon them a much greater length of time, both in the autumn and spring seasons.

The most proper season for surface-draining grass lands is in the autumn, when they are somewhat firm and dry, as in the early spring months such lands are too full of moisture. The grips, or small open drains, should be cut obliquely, in the most suitable directions for conveying off the superficial stagnant water, the materials taken out being wholly removed. Much of this sort of draining may be performed at a small expense, and the beneficial effects be very considerable.

Meadow lands also demand much more attention in their management than those which are fed by cattle. In all cases stock should be turned upon the lands, and manures applied with much care, and only when the land is in such a state of dryness as not to be injured by the poaching in or breaking of the sward.

It must be evident, that the breaking of the surface, texture, or sward of grass lands must in all cases be prejudicial, not only by the destruction of plants, which is thereby immediately produced, but also by the retention and stagnation of water upon them in the holes and depressions from small portions of the turf being forced in.

The most proper periods of shutting up such grass lands as are designed for hay must, like those of eating them down in the autumn by stock, depend on various circumstances that can only suit the particular cases. In general, however, it is the best practice not to delay it too long. When the lands are not eaten at all in the spring by cattle, after the sheep have been removed, about the middle of February, nothing further should be allowed to enter the meadows; by which means a quick vegetation is secured, as well as a more plentiful crop and a more early hay harvest. And in other cases it should seldom much exceed the middle of March, as when eaten much later, there is not time for the grass to produce a full crop before the commencement of the hay season; of course the farmer sustains more loss than can be repaid by any advantage in the additional feeding he may obtain. This is, therefore, the best practice where the view of the farmer is hay; and it should be particularly adopted and attended to in cow farms, where it is of much importance to cut early, to secure hay of a fine, grassy quality, for the purpose of producing large supplies of milk.

After the meadows or other grass lands have had the cattle and other sorts of live stock removed from them in the early spring months, and been shut up for hay, they should be prepared for the scythe, by having all sorts of obstructions picked up and removed. This work should always be executed as soon as possible, before the grass begins to spring up too much and conceal them, as it is difficult to perform the business effectually afterwards.

It is an excellent practice to have all sorts of coarse plants of the aquatic and other kinds, such as rushes, fern, docks, thistles, and various others, effectually drawn up and eradicated both from the hedge-rows and other parts of the fields, in order to prevent their running up to seed and disseminating themselves over the lands.

Mowing of hay lands. In the cutting of grass crops for the purpose of being converted into hay, it is necessary that they be in the most suitable states of growth and maturity for affording the best and most nutritious fodder. With this view, it would seem that they should neither be cut at too early a period, nor suffered to stand too long; as in the former case there will be considerable loss in the drying, from the produce being in so soft and green a condition, and in the latter from a large proportion of the nourishing properties being expended. It is probable, therefore, that grass, when mown before it becomes in full flower, while the rich saccharine juice is in part retained at the joints of the flower-stems, is in the most proper condition for being cut down, as at that period it must contain the largest proportion of nutritious material, but which then begins to be absorbed and taken up in proportion as the flowers expand and the seeds ripen.

But there are other circumstances besides those of ripeness to be attended to in determining the period of cutting crops of grass; as in some cases, where they are thick upon the ground, the bottom parts become of a yellow colour before the flowering fully takes place: under such circumstances, it will always be the most advisable practice to mow as soon as the weather will possibly admit; for if this is neglected there will be great danger of its rotting, or at any rate of its acquiring a disagreeable flavour, and of becoming of but little value. Where grass is very tall, as is often the case in moist meadows, it is liable to fall down and lodge, by which the same effects are produced. In this case also the mowing should be performed as soon as possible.

In the operation of mowing, the chief art consists in cutting the crop as close to the surface of the ground as possible, and perfectly level, pointing the swaths well out, so as to leave scarcely any ridges under them.

Hay-making. The great art in converting grass into hay consists in rendering it sufficiently dry to prevent its fermentation taking on too great a degree of heat in the stack or mow, and at the same time preserving a large proportion of the natural juice of the plants. Where this medium can be attained with the most exactness, the best and most nutritious hay will be produced.

In the making of hay, some attention should be paid to the quality of the soil and the kind of herbage growing upon it. The hard benty hay of a poor soil is in little or no danger of heating too much in the stack; it should, therefore, be put very early together, in order to promote a considerable sweating, as the only means of imparting a flavour to it, which will make it agreeable to horses and lean cattle, as it will be nearly unfit for every other sort of stock. It is the succulent herbage of rich land, or land highly manured,

GRASSES.

1

Poa pratensis
Smooth stalkd meadow Grass

2

Festuca duriuscula
Hard fescue Grass

3

Festuca pratensis
Meadow fescue Grass

4

Lolium perenne
Common Ray Grass

5

Alopecurous pratensis
Meadow foxtail Grass

6

Festuca ovina

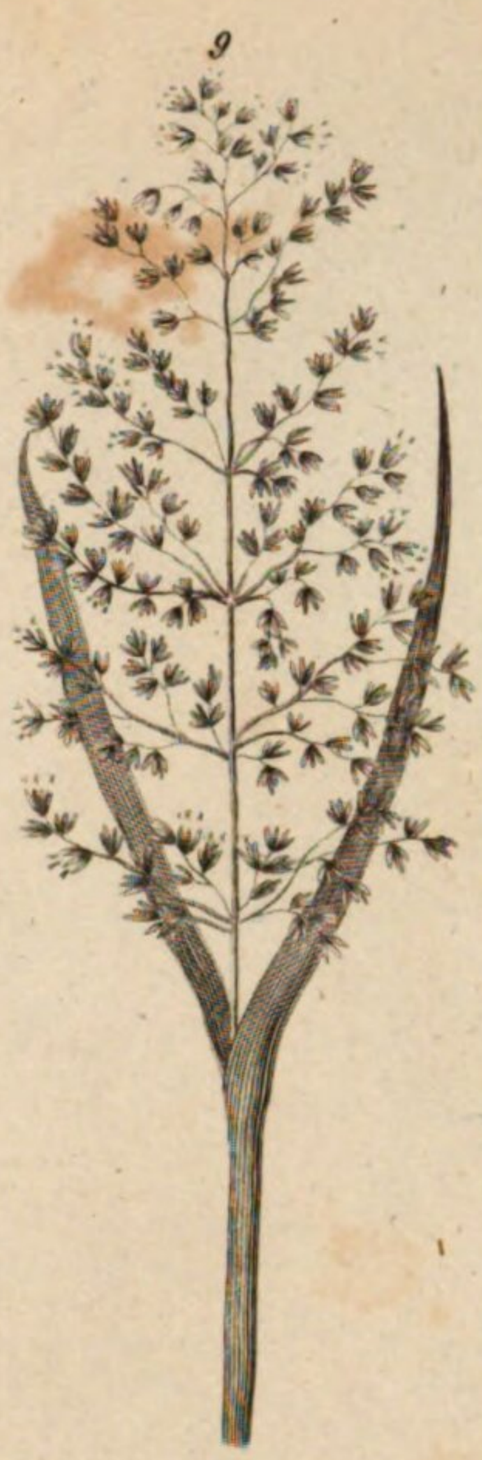
7

GRASSES, &c.

8

Poa trivialis
Rough stalk'd meadow Grass

9



Poa palustris
Marsh meadow Grass

10

Cynosurus cristatus
Crested dogs tail Grass

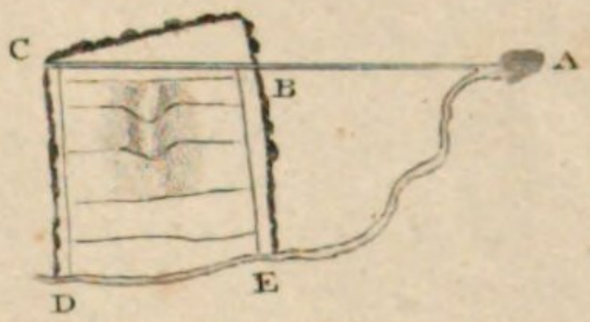
11

Phleum nodosum
Knotty stalk'd Cat's tail Grass

12

Anthrox odoratum
Sweet scented spring Grass

13



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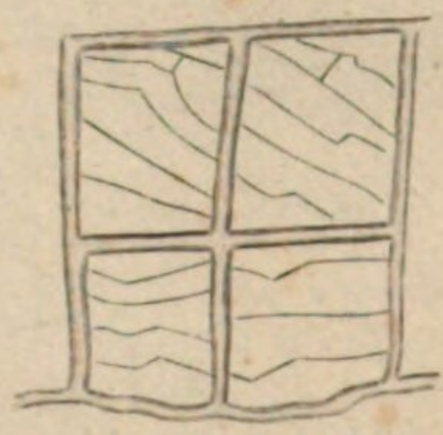
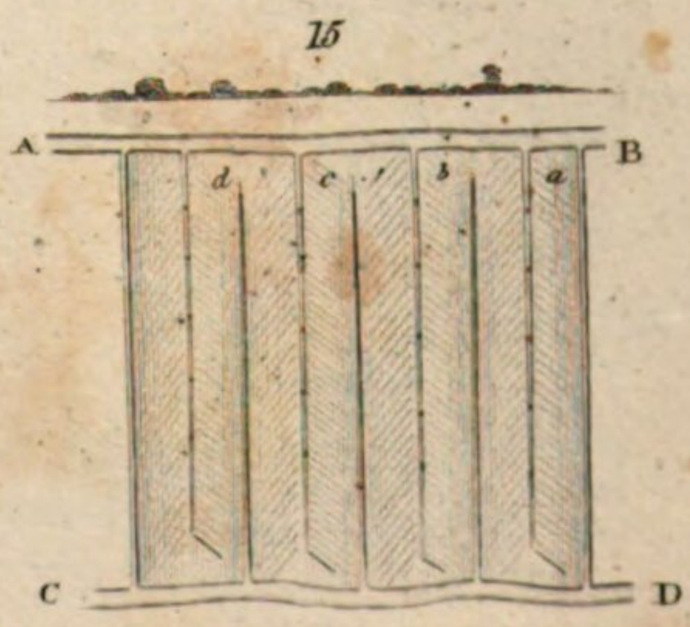


Irrigation

15



that is most likely to generate too great a degree of heat; of course grass from such land should have more time allowed in making it into hay. In moderately hot seasons the proper point of drying may be easily judged of; but when they are very hot and scorching it is easy to be mistaken; as in such weather the grass becomes crisp, rustles, and handles like hay, before the moisture or sap is sufficiently dissipated for it to be in a state fit to be laid up in large stacks. If that, however, be done when it is thus insufficiently made, it mostly heats too much, becoming mow-burnt in some cases.

The art of hay-making much depends in the due observance of the following rules, as nearly as circumstances will admit.

In the first day's process all the grass mown before nine o.clock in the morning must be tedded or spread out, great care being taken to shake it so as to leave it free from lumps, and to strew it evenly over the whole surface of the ground. It is soon afterwards turned, with an equal degree of care and attention; and if the number of hands be sufficient, they turn the whole again, or at least as much of it as they can before one o'clock. It is then raked into what are termed single windrows, or so as that each person may form a row at about three feet distance; and the last operation of the day is to put it up into grass cocks. The business of the succeeding day commences with the process of tedding all the grass that was mown the first day after nine o'clock, and all that was mown the second day before the same hour. The grass-cocks are then well shaken out into separate plats of five or six yards in breadth. The plats are next turned, and after that, the grass that was tedded in the first part of the morning once or twice, in the same manner as described in the first day. This business should all be performed before one o'clock, that the whole may lie to dry while the people are at dinner. After this the first thing is to rake the plats into double windrows, which is done by every two persons raking the hay in opposite directions or towards each other, forming a row between them of double the size of the single windrows, each being about six or eight feet distant from the other. They afterwards rake the grass tedded thus into single windrows; then put the double windrows into bastard cocks; and conclude by putting the single windrows into grass-cocks. The labour of the third day is begun by first tedding and spreading out the grass mown and not spread the preceding day, as well as that mown in the early part of the day, and then the grass-cocks are thrown out into plats as before, and the bastard cocks into plats of less extent. These narrow plats, though last spread out, are first turned, then those which were in grass-cocks; and lastly the grass is turned once or twice before one o'clock. When the weather has been sunny and fine, the hay which was last night in bastard cocks will this afternoon be in a proper state to be carried, as in fine seasons it may mostly be performed on the third day; but when the weather has been cool and cloudy, no part of it probably will be fit to carry. In that case, the first business after dinner is to rake that which was in grass-cocks last night into double windrows; then the grass which was this morning spread from the swaths into single windrows. After this the hay which was last night in bastard cocks is made up into full sized cocks, and care taken to rake the hay up clean, and also to put the rakings upon the top of each cock. And lastly, the double windrows are put up into bastard cocks and the single ones into grass-cocks, as in the preceding days. On the fourth day the great cocks just described are mostly carried before dinner. The other operations are similar to those of the former days, and proceed in the same order, continuing them daily until the whole is finished.

During the whole course of hay-making the grass should, as much as possible, be protected both in the day and night against rain and dew, by cocking.

The preserving hay of a proper green colour is a circumstance of some importance. In order to effect it, the bastard cocks, previous to their being carried, should be put up in the heat of the day, and remain in that condition till the following morning, when they must be turned and opened so as to dispel any damp that might induce it to heat in the stack, and in that way spoil the colour. The acquisition of a lightish brown colour in the stack is not found injurious to hay, but where it becomes of a dark brown from too much heat, it is said to weaken and relax horses that are fed upon it by its powerful diuretic quality. It is of course of inferior value for that purpose, but not the worse for fattening cattle with.

For the purpose of facilitating the business of getting the hay together in bad showery seasons, hay-sweeps have been constructed.

A contrivance of the first sort has been invented, and described in vol. xiv. of the Transactions of the Society for the Encouragement of Arts, Manufactures, &c. It is so constructed as to be drawn by four horses in pairs, but smaller ones might be made to be drawn by two, and is managed by two boys, one of whom drives each pair of horses, being mounted on one of them. Where the ground is level, little more will be necessary in order to assist the machine, than merely to break and turn up the rows of hay in different places. In catching or showery weather, such a machine may be particularly useful, in getting a field of hay, nearly dry, into large heaps in different parts of the field, whence it may be made into large cocks of half a ton or more each, with the utmost facility.

Stacking and thatching hay. The form of the hay stack is not a matter of much consequence, the long square, or oblong shapes are the most safe and convenient, especially when not too broad, as they admit the air the most fully. But the circular form for farm use, where straw is scarce, may be the most advantageous in the economy of straw in thatching.

The size of the staddle or stack bottom should be proportioned to the quantity of hay, but it is better not to have the stacks too large; 24 feet by 14 or 15 is for most occasions a good size.

The business of stacking hay is best performed, if possible, while there is a full sun, as by such means it is much improved. It is necessary to have a person that understands the art of setting up stacks, and a sufficient number of helpers to assist in spreading the hay and treading it well down. In building, the middle of the stack should always be well kept up, something higher than the sides. In this district, where work of this sort is well executed; at leisure times, during the whole period the stack is building, the men are employed in pulling the sides and ends into proper form.

After the work of stacking has been completed, and the stack is pulled and topped up, it is left till it has sweated, and is perfectly settled, which is mostly the case in a week or ten days: the roof should then be well covered by a good coat of thatch. The roof should be dry when the thatch is put on, to prevent the hay from becoming mouldy. It is of great consequence that this sort of work be well performed.

It is a point not perfectly decided among agricultors, whether hay keeps better in stacks in the open air or in barns for the purpose. It is the opinion of most farmers that the first mode has the advantage in so far as respects the quality of the hay.

After-grass. Where after-grass is fed off by stock, there is much difference of opinion in regard to the most proper periods of turning in the animals. Some have contended that it is the best practice to let them into the field before the young grass has attained any very great head; while others maintain the opposite doctrine, and think it the best method to allow the grass to get up to a full bite before the stock is turned upon the land. Both endeavour to support their opinions by experience. But as they cannot be both of them true, it is probable that the extremes of each are to be avoided; and that, as in many other matters, the truth may lie in the middle. This is indeed equally supported by fact and the observation of the most intelligent managers; as when the cattle are turned in too early there is not a sufficient bite to keep up the condition of the animals; while in the contrary extreme, the stock so soon fill themselves, that much of it is trodden down and wasted afterwards in their roaming about the fields to pick the sweetest morsels.

Where much stock is turned upon after grass in a full state of growth, there cannot be any doubt but that much loss must, as has been just observed, be sustained by the treading down and rendering the grass unfit for being eaten off. It is therefore perhaps only by beginning the pasturage of after-grass when in the middle state of growth that it can be consumed to the best advantage, and without loss in either of the ways that have been just noticed.

In the stocking of after-grass, some attention is necessary not to have too great a number of animals on a given proportion of land. One cow to the acre on well-grown after-grass is an ample stock. Good grass-land may, however, admit something more.

Management of pasture lands. Having explained the different methods of management that seem necessary to the cultivation of those sorts of grass lands that are chiefly applied to the purpose of producing hay, we shall now describe the modes of practice which appear requisite in such as are almost wholly appropriated to the support and fattening of live stock.

The grounds that are the most perfectly adapted to this use are, all those which have a considerable depth of good mould, and at the same time that they afford a good herbage, are so dry in their nature as to admit the animals to feed upon them at almost all seasons without injury by poaching. Coarse rushy lands may, however, in many cases be converted into good pastures, by proper at-

tention in draining, and cutting over the rushes in the early part of the spring, and about Midsummer, as by these means the plants decay, the young shoots being afterwards eaten by young stock, and the good grass plants allowed to flourish.

Pasture lands should likewise, as much as possible, possess properties in the nature of their grasses that are the most advantageous for the particular method of management under which they are to be conducted. In this view, some may be more adapted to the producing of milk or butter, others of cheese, and others again of feeding or fattening animals. It is in some measure on this account, as well as that of local convenience, that different modes of management are employed on grass lands.

The difference of situation in pasture lands has likewise much influence in directing the uses to which they may be applied with the greatest benefit. The higher or more elevated grounds being in general more proper for sheep, while those of the lower and more inclosed kinds are mostly better suited for the purpose of neat cattle or other animals under the fattening system.

Pastures, when not well attended to, are frequently prevented from being properly fed, by various kinds of low shrubby plants, such as those of the alder, brier, broom, furze, and other sorts that shoot out upon the surface; these which should always be extirpated as soon as the business can be conveniently done; as by their remaining upon and shading the ground they render the herbage sour, and improper for the food of cattle. This sort of work may be performed by cutting them closely down as they rise in the early spring months; but a better practice is to dig them completely out.

Where pastures are productive in grasses of the more sharp coarse bladed kinds which rise into tufts or tussocks, and which are known to agricultors under the titles of pink or carnation grasses, it is a certain indication that the soil is too retentive of moisture, and stands in need of draining.

The improvement of the fertility of pasture grounds may be effected in different ways, as either by the direct application of manure in its natural state, such as that of rotten dung, lime, marl, or in that of earthy compost, occasionally, over their surfaces in a thin even manner; or indirectly by the folding or confining of sheep upon the land during the time they consume other sorts of green food, such as turnips, &c. The latter mode is unquestionably the most advantageous and convenient, as it is in but very few situations that the former can be practised without robbing the arable or hay lands of their property.

In explaining the methods of management that are necessary in the cultivation of arable lands, in order to afford a suitable state of soil and nourishment for the growth of grain or other crops, it will be proper to consider them as relating to grounds that have not yet been brought under the plough, and such as have been already in the state of tillage.

Removing obstructions to tillage. In the first place, the removing of stones, the eradicating of wood, the destruction of different sorts of plants, and the removal of such degrees of wetness as may be injurious, before the business of ploughing or loosening the mould of the soil can be properly carried on. The stones that oppose obstruction, in this view, are principally either such as are met with in a loose state in the ground on its being ploughed, or such as are fixed in the soil, and incapable of being removed without much labour and difficulty. Some of these last are often of such a size as to present themselves upon the surface, and cause much land to be lost, by their not permitting the plough to come near them. Those which are concealed below the surface are, however, the most detrimental, as the implements are frequently destroyed, and much inconvenience experienced from them, before they can be perceived by the ploughman, though he may be perfectly attentive to the circumstance.

In all cases, land should be as much as possible cleared from such stones as retard or prevent the operation of the plough before the business of tillage be undertaken; as without due attention in this respect considerable loss may be sustained by the breaking of implements, and the great delay that must take place in the work.

In the clearing of lands from wood, different methods must be pursued, according to the nature of the wood with which they are covered. Where there are large trees of the timber kind, they should be completely grubbed up at a proper season of the year, care being taken that the roots be as much as possible removed.

In cases where broom, furze, brambles, or thorn shrubs, have become of considerable size, the general method of proceeding is to cut them down as close as possible to the surface of the ground, and afterwards to dig round, and grub up the roots in the manner that the larger trees are cleared. With furze it is sometimes customary to set fire to them, in order to uncover their stems before any attempt is made to grub them up; but this is a practice that ought to be as much as possible avoided, from the danger that may attend it, and the loss of the furze, as well as a large portion of the valuable vegetable matter accumulated in many cases beneath them.

As it has been found from experience, that such lands as have been attempted to be cleared from brushy plants of this kind, especially those of broom and furze, are extremely liable, from the roots and seeds that may be left in the soil, to have them coming up again in great abundance after they have been laid down to grass; it should be a practice to keep lands that are much disposed to their production in the state of tillage for such a length of time as may be fully sufficient, by the various means of cultivation, and the application and blending of lime and other suitable manures with them, to have them as completely removed as possible; and that when they are restored to the state of grass, to have them pastured, as much as can be conveniently done, with sheep.

Heathy lands should be cut as close to the surface of the ground as it can be conveniently done; and lime, in its caustic state, should be applied in large proportions.

When this sort of ground has been broken down and pulverised as much as possible by the operations of ploughing and harrowing, it should always, where not too stiff, be sown with some sort of close, luxuriant, green crop, such as turnips, peas, and tares, that may be fed off by sheep; but where it has a sour quality, and is more stiff, clayey, and adhesive, those plants that strike more deeply into the soil, as beans, rye, and oats of the grey kind. In many cases too, rape, peas, clover, and vetches, will succeed in a very beneficial manner. But as the principal intention in most cases of breaking up this sort of land, is that of bringing it in a cheap and expeditious manner to a suitable condition after a grain crop or two for growing grass, the green crops, of whatever description they may be, should be consumed by animals upon the ground.

And in whatever method such lands may be brought into the state of cultivation, the processes of tillage should not be carried further than the destruction of the heathy or other coarse plants, and the removal of the sour and unfriendly disposition of such soils for the growth of useful vegetable productions. They should be then restored as soon as possible to the state of grass or pasture.

There is another description of land that is frequently to be brought into the state of tillage; this is that of the boggy kind. In these the first thing, after having them well drained by the cutting of proper ditches, which, where they are large, may serve for their inclosure, and by giving the ridges a suitable form in order to aid this, is to pare off and level the surface by means of the spade or plough; such matters as are of little value being deposited in the hollows, while those that are of a good quality may be mixed into a compost with good dung, where it can be procured, or with lime; together with the spare earth taken from the ditches, which should be immediately spread equally over the land, and incorporated, as much as possible with it, by ploughing it up with a very slight or ebb furrow, in order that the uniting materials may not sink too deep for affording due support to the crop, that it may be cultivated. Indeed, though deep ploughing may sometimes be of utility in first opening up these soft soils, it should never be had recourse to when the application of manure is to be made; and on this account also the ploughings after the taking of different green crops should only be slight. It is seldom proper to continue soils of this description for any great length of time in the state of tillage, as from their great moisture, on account of the general flatness of their situation, and their being liable from continued ploughing to become very loose and open, so as not to afford proper nourishment and stability to the roots of the crops, this sort of land will in general be the most advantageous in the state of grass.

The most beneficial sorts of crops for these soils will in general be turnips, rape, or potatoes. The light and drier parts will be the most adapted to potatoes, as their bulbous roots will be there the most able to spread and extend themselves, and consequently produce large crops. These crops will, in the stiffer sorts of these soils, leave the land in a suitable condition for wheat or oats, and in the lighter for barley or rye.

Moss lands, from their being much disposed to the throwing up of grass, are not so proper for the growing of grain crops, but a crop or two may frequently be taken after potatoes or turnips, especially where liming has been performed some length of time. Oats and barley are mostly good crops, but

such land is often too light for wheat. Where barley is employed, grass seeds are frequently sown with it, but it is probably a better practice to put them in separately. On those soils, rye-grass, as well as white and yellow clover, have been found to thrive extremely well, especially where they were in a proper state of preparation for them, as by the growth of potatoe or turnip crops. And though red clover has not always succeeded, it is probable, that in such mosses as are not of the deep kind, it will be found an useful plant. In some districts it has been found that clover may be sown with great advantage immediately after the potatoe crop, when it has been taken off early.

It is evident, from what has been advanced, that as there is much variety in soils of this kind, they will of course require different modes of tillage. Where they are very thin, and deposited upon a loamy or clayey substratum, it may be a good practice to plough so as to bring up a portion of them, by which, and the use of lime, the land may be rendered highly productive.

Ploughing. This, or some other method of loosening and turning up the superior parts of soils, is constantly requisite in order to render them suitable for the reception of the seed or crop that is to be cultivated. It is by means of this kind that a convenient bed for the roots of the young plants, and a proper condition of the land for supplying them with due nourishment, is in a great measure provided, as well as a proper state of dryness in many cases afforded.

There are certain circumstances that constantly demand notice in the practice of ploughing land. In all the stiff, heavy, and more adhesive kinds of soils, that are much disposed to the retention of moisture, whether they be perfectly clayey, or have more of a loamy quality, it should be a common rule never to plough or turn them up when wet in any great degree, except where the nature of the crop requires it. And further, great injury is produced by the treading of the team, as well as a much greater power necessary in performing the operation. But at the same time they should not be permitted to become so dry and hard as to afford too great resistance in that way, before the operation is proceeded upon.

But in the dry, sandy, and probably in some of the more mellow and friable kinds of loamy soils, the business of ploughing, especially for the putting in of the seed, may be performed when they are in a state of considerable moisture, not only without their suffering any inconvenience, or the seed being injured, but often with advantage, as they are liable to part with the watery particles that they contain too readily. On this last account the very dry sorts of sandy land should, whenever the weather is hot and dry, merely be stirred in such way as may be necessary to prevent the growth of weeds, otherwise the great exhalation of moisture in such seasons may render them too dry for the healthy vegetation of the seed or plants that may be sown or set upon them.

In regard to the depth and frequency of ploughing lands, they most constantly depend, in a great measure, upon the qualities and the sorts of crops that are to be grown. But in general the different preparatory ploughings should be deeper than those of the seed furrow, which ought mostly to be light, and the slice not too much laid over, that the seed, especially where the broad-cast method of sowing is adopted, may be the more perfectly covered.

Upon all light soils it is necessary to preserve, at six or eight inches below the surface, what farmers call a pan; that is, the staple, at that depth, should be kept unbroken; by which means manure will be kept longer on the top: and in dry seasons the less depth the pan has, the less liable the corn will be to burn, provided the pan consists of earth, and not of rock; because the roots of the corn will find more moisture by striking against a body of close earth than they will in a greater depth of hollow earth; as it is evident the former preserves more moisture in dry seasons.

In regard to the frequency of ploughing or turning over ground, in order to prepare and render it suitable for the production of good crops, it is obvious there must be much difference according to the nature and condition of the soil, as well as the kind of crop that is to be grown. The stiff, clayey, loamy, and even chalky soils will, in general, stand in need of more frequent stirring, either by means of the plough, drag, or harrow, in order to separate and break down their tenacious particles, than those of the sandy or gravelly, and more light kinds, in which there is much less adhesion. Besides, where lands, have been in a course of tillage for some length of time, whether they are of a clayey, loamy, or even sandy quality, they may require less frequent stirring than where the contrary is the case. And where the method of putting the seed into the ground by means of drill machines is to be had recourse to, a fine state of tilth will, in general, be indispensably necessary.

The nature of the crop that is to be cultivated must, however, in most cases, direct the number of ploughings that may be necessary, as some demand a much finer state of tillage than others; though in most cases a well-reduced earth is favourable.

In the choice of implements for the performance of this business, the agricultor should be careful that they are well suited to the nature and quality of the land, as it is not possible that any particular sort of plough can be employed with equal facility and advantage on soils of every description. The more stiff and heavy kinds of land will require ploughs of more strength than those of the thin chalky, and a light, sandy, or gravelly nature. The former may mostly be managed in a proper manner by any of the well-constructed kinds of strong ploughs; as the Somerset single-wheel plough, the Hampshire two-wheel plough, and the latter by those of the light sort, as the Rotheram plough, the Norfolk light two-wheeled plough, or the double-furrowed plough. See Plate, Ploughs, &c. But whatever description of plough may be had recourse to, it is a matter of the greatest consequence that it be properly formed and attached to the draught, as where these points are not minutely attended to, there must constantly be a considerable loss in the economy of labour and time, as well as in the compleatness of the work.

HUSK, the same with what botanists call the calyx, or cup of a flower. See CALYX.

HYACINTH, in natural history, a genus of pellucid gems, whose colour is red with an admixture of yellow. See ZIRCON.

HYACINTHUS, a genus of the monogynia order, in the hexandria class of plants, and in the natural method ranking under the 10th order, coronariæ. The corolla is campanulated, and there are three melliferous pores at the top of the germen. There are 17 species, of which the most remarkable is the orientalis, or eastern hyacinth. Of this there are a great number of varieties, amounting to some hundreds, each of which differs from the rest in some respect or other.

These plants are cultivated with the greatest success in Holland, whence great numbers are annually imported into Britain. Each variety is by the florists distinguished either by the name of the place where first raised, or the person who raised them, or the names of illustrious personages, as of kings, generals, poets, and celebrated antient historians, gods, goddesses, &c. They are sold by all the seed-dealers. The prices are from 3*d*. per root to 5*l*. or 10*l*. or more; and some varieties are in such high esteem among the florists, that 20*l*. or 30*l*. will be given for a single bulb. They are hardy, and will prosper any where, though the fine kinds require a little shelter during the winter. They may be propagated either by seeds or off-sets from the roots.

HYADES, in astronomy, seven stars in the bull's head, famous among the poets for the bringing of rain. The principal of them is in the left eye, called by the Arabs Aldebaran.

HYALITE, in mineralogy, a stone frequently found in trap rocks. It occurs in grains, filaments, and rhomboidal masses. Texture foliate. Fracture uneven, inclining to conchoidal; sometimes opaque; specific gravity 2.11; colour pure white. Infusible 150° Wedgewood, but it yields to soda. According to Mr. Link it is composed of

57 silica
18 alumina
15 lime

90 and a little iron.

HYDATIDES, in medicine, little transparent vesicles or bladders, full of water, sometimes found solitary, and sometimes in clusters, upon the liver, and various other parts, especially in hydropical constitutions. See MEDICINE.

HYDNUM, a genus of the natural order of fungi, in the cryptogamia class of plants. The fungus is echinated or prickly on the under side. There are six species. One of them, named the imbricatum, is a native of Britain, and is found in the woods. It has a convex hat, tiled, standing on a smooth pillar, of a pale flesh-colour, with white prickles. It is eaten in Italy, and is said to be of a very delicate taste.

HYDRA, in astronomy, a southern constellation imagined to represent a water-serpent. The number of stars in this constellation in Ptolemy's catalogue is 25, and in the Britannic catalogue 68.

HYDRA, a genus of vermes zoophyta. The generic character is, animal fixing itself by the base, linear, gelatinous, naked, contractile, and furnished with setaceous tentacula, inhabiting fresh waters, and producing

its deciduous offspring, or eggs, from the sides. The hydra viridis inhabits the stagnant waters and slowly running streams of Europe, generally on the surface of plants, and appears like a little transparent green jelly, when contracted and transparent: when expanded it is a linear body, fixed at one end, and surrounded at the other by tentacula, or arms placed in a circle round the mouth, and gradually producing its young from the sides, which at first seem small papillæ, increasing in length, till they assume the form of the parent, and then dropping off. Like all its tribe, it has the power of reproducing parts which have been destroyed, and if cut or divided in any direction, each separate part becomes a perfect polype. See Adams on the Microscope. There are five species.

HYDRACHNA, a genus of insects of the order aptera: the generic character is, head, thorax, and abdomen united or connate; feelers two, jointed; eyes two, four, or six; legs eight, formed for swimming. The genus hydrachna, allied in the closest manner to that of acarus, under which the only species known to Linnæus were arranged, was first instituted by the ingenious Muller, by whose industrious researches many new and curious kinds have been discovered.

Among the larger insects of this genus is the hydrachna flaccida, so called, in order the more clearly to distinguish it from one or two others with which it may sometimes be confounded. Its size is that of a small pea, and its colour a very bright red: its shape is nearly globular, but the skin is of such a nature as to yield to every inclination of the body, so that the whole, when taken out of the water, has an irregularly flaccid appearance. This is most remarkable in the full-grown animal, which is also of a much more torpid nature than the rest of the genus, which are animals of great celerity of motion; and indeed the young or unadvanced individuals of the present species are of a more compact appearance, and swim with a greater degree of swiftness than the larger ones. The hydrachna flaccida is not very uncommon in stagnant waters.

Of all the hydrachnæ yet discovered by far the most elegant is the hydrachna geographica, so named from the fancied map-like distribution of its variegations. It is one of the largest of the genus, equalling the size of the former: it is occasionally seen in clear ponds and other stagnant waters, but is one of the rarer kinds: its shape is globular, and its colour a polished black, decorated with carmine-coloured spots and patches, which, in a certain light, are accompanied by a kind of gilded lustre.

Hydrachna roeseliana is named after Roesel, by whom it is figured in his well-known work on insects. It is of equal, or even superior size to that immediately preceding, which in many points it seems greatly to resemble; the ground-colour however in this is red, with black variegations, disposed in a different manner from those of the former. It is found, though not very frequently, in stagnant waters.

Among the smaller, or middle-sized hydrachna, one of the most common is the hydrachnæ extendens, which is of the size of a very small hemp-seed, and of a bright red colour, without any variegations; it is extremely nimble in its motions, and always carries the hinder pair of legs, which exceed the rest in length, in an extended posture.

Hydrachna araneoides is a small species, of a brown colour, clouded with red, and marked on the back by a very large oval patch of the same colour. It is found, like the rest, in stagnant waters, and has the habits of a young spider.

Some of the genus are distinguished by a kind of cylindric process at the end of the abdomen; of this kind is the hydrachna buccinator. It is a very small species, of a dark-brown colour, with a large rufous patch at the upper part of the body, the cylindric process being of a dull yellow. It is a native of stagnant waters.

The eggs of the hydrachnæ, which are small and round, are deposited in flat clusters, sometimes on the bodies of the napæ, and other water insects. The young, when first excluded, are furnished with six legs only, but after the first and second change of their skins, become eight legged insects.

HYDRARGYRUM, a name given in the pharmacopeia to mercury or quicksilver.

HYDRANGEA, a genus of the digunia order, in the decandria class of plants, and in the natural method ranking under the 13th order, succulentæ. The capsule is bilocular, birostrated, and cut round, or parting horizontally. There are three species, of which the hortensis is a very handsome and now a popular greenhouse plant.

HYDRASTIS, a genus of the polygamia order, in the polyandria class of plants, and in the natural method ranking with those of which the order is doubtful. There is neither calyx nor nectarium; there are three petals, and the berry is composed of monospermous acini. There is one species an herb of Canada.

HYDRAULICS. The science which has for its object the motion of fluids is called hydraulics; and its immediate application is to furnish us with the means of conducting water from one situation to another, by canals or aqueducts, and to elevate it by pumps, jets-d'eaux, and other hydraulic engines, either for the purposes of ornament or use.

In treating of this subject we shall commence with the simplest principles, and shall first speak of the discharge of fluids through small apertures.

When water flows from a vessel which has a hole or aperture in the bottom, small in comparison to the width of the vessel, the water descends vertically, and the surface appears smooth, but at three or four inches from the bottom the particles turn from this direction, and proceed on all sides with a motion more or less oblique towards the aperture. The same effect takes place when water flows through an aperture laterally. The tendency of the particles towards the aperture is a necessary consequence of their perfect mobility; for they will certainly be directed towards the point where there is the least resistance, and that point is the aperture.

It is also to be observed, that in this case, at a small distance from the bottom, a kind of funnel is formed in the water, the point of which corresponds to the center of the aperture; when, however, the water flows through a lateral orifice or aperture, there is formed only a kind of half funnel, which does not appear to commence till the surface is near touching the upper side of the hole. It is probable that the funnel begins to form itself from the first moment of the flow; but it does not become perceptible till the surface is only at a small distance from the bottom.

It appears also, that the funnel commences higher or lower, according to the width of the bottom; and that the formation of it is less prompt or less perceptible, according to the proportion of the aperture to the extent of the bottom. The funnel is also augmented by any roughness which may exist at the sides or bottom of the vessel.

Water flows out of a small hole in the bottom of a vessel with a velocity equal to that which a ponderous body acquires in falling from a height equal to the vertical height of the surface of the fluid above the aperture.

The same law takes place in a lateral orifice; for the pressure of the fluid is equal (at the same depth) in all directions, and consequently produces the same degree of velocity. See HYDROSTATICS.

A fluid, in running out of an aperture, acquires a velocity sufficient to make it remount to a vertical height equal to that of the fluid above the aperture, in the same manner as a falling body acquires a velocity capable of making it ascend to the height from which it descended.

It is evident, from the theory of falling bodies, that if the velocity of the fluid in running through the aperture was uniformly continued, the fluid would move through a space double the height of the fluid above the aperture, in the same time that a falling body would employ in descending from that height.

The height being the same, the velocity of the fluid in running out of the orifice will always be the same, whatever the species of the fluid may be, and whatever its density. It is true, that when the fluid has more density it presses more forcibly, but then the mass is more considerable; and it is evident, that when the moving powers are proportioned to the masses which they put in motion, the velocities are equal.

The quantities of a fluid discharged in the same space of time through different orifices, supposing the vessels equally full during the whole of the experiment, are to each other as the products of the areas of the apertures by the square roots of the heights. For instance, it has been proved by experiment, that a circular orifice of an inch diameter, made in a thin vessel or partition, and under a surface of fluid four feet in height, will furnish, in one minute of time, 5436 cubic inches French.

If, therefore, it was an object to ascertain how much a circular orifice of two inches diameter, under nine feet of height from the surface of the water, would furnish in the same, the following proportion must be employed (it must be observed, that the orifice of two inches is four times as great as an orifice of one inch, because the areas of circles are as the squares of their diameters):

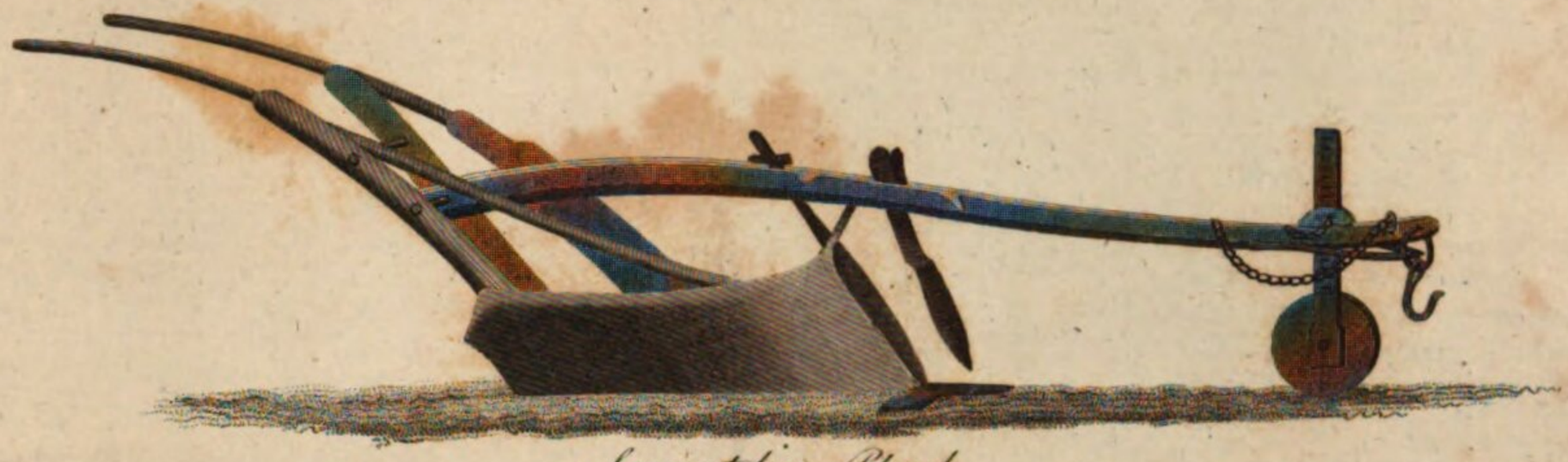
$$1 \times \sqrt{4} : 4 \times \sqrt{9} :: 5436 : x$$

Or at length

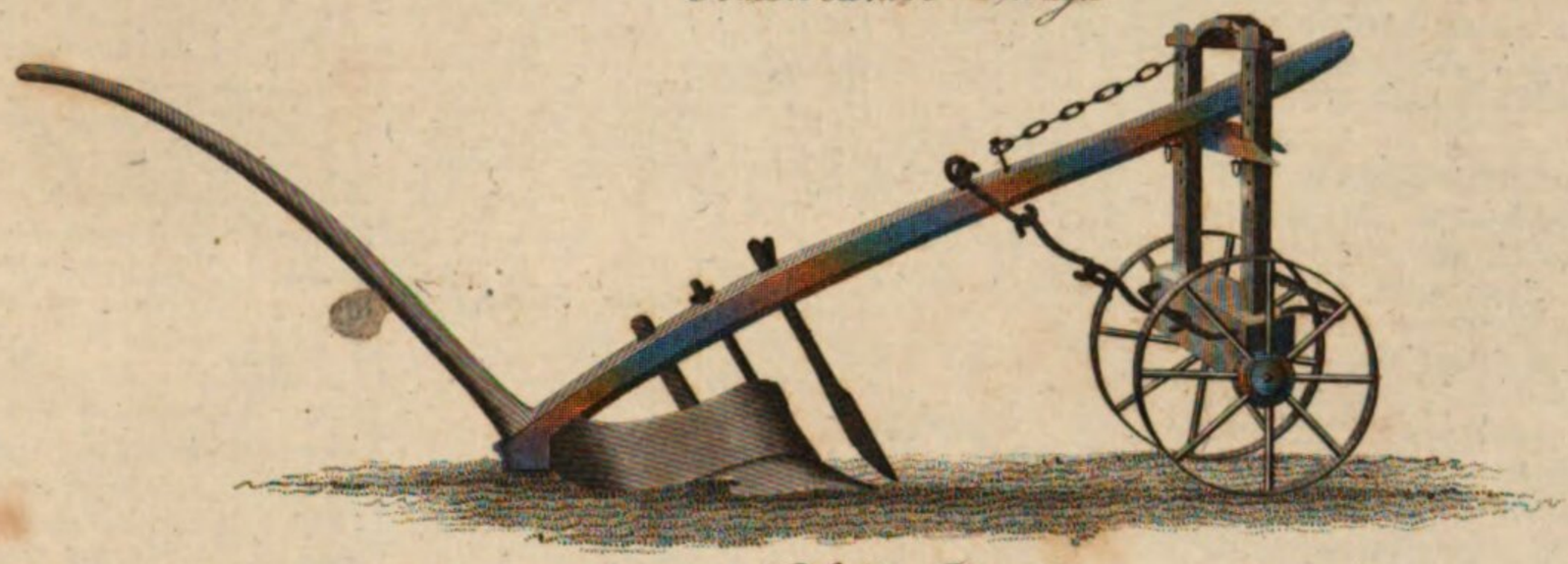
$$2 : 12 :: 5436 : 32616$$

12

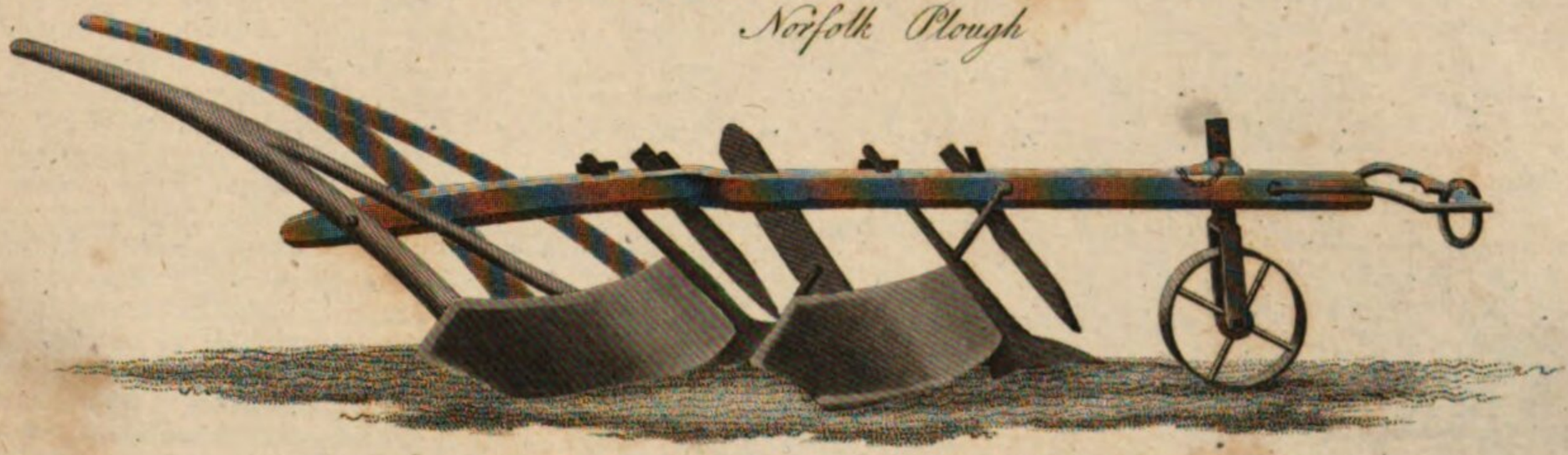
2)653232



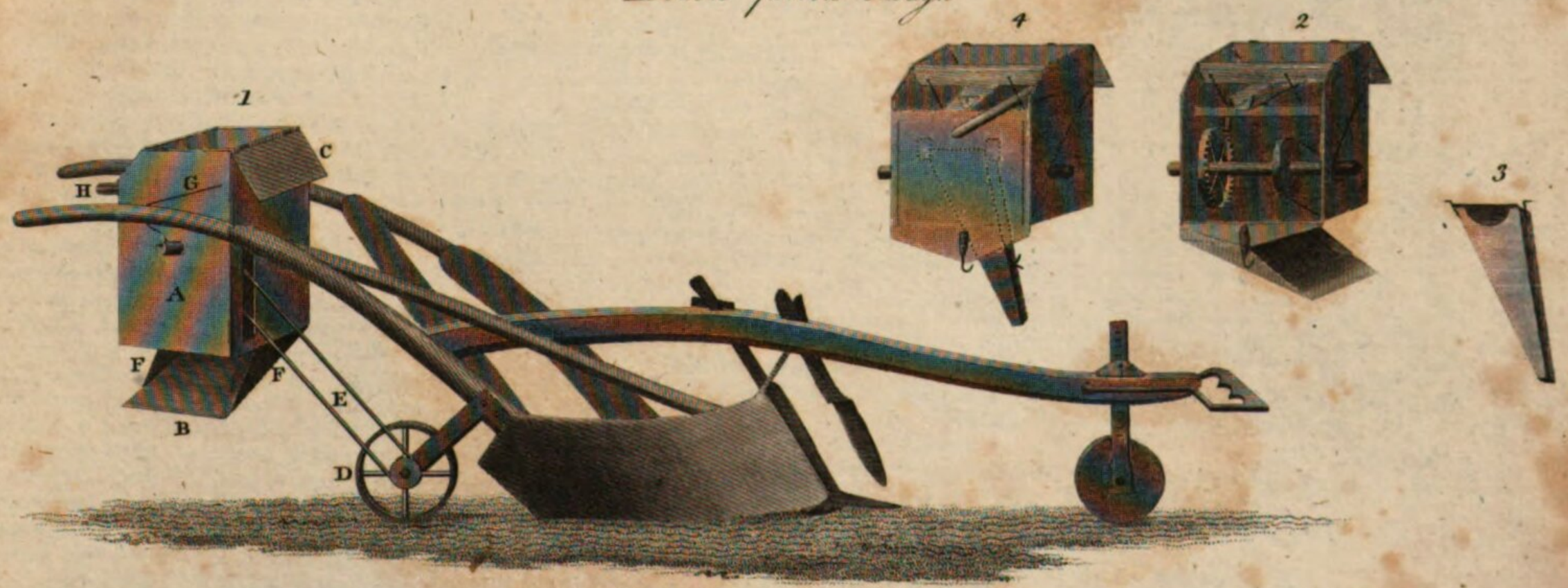
Somersetshire Plough



Norfolk Plough



Double furrow Plough



Horne's sowing Machine

Therefore 32616 cubic inches of water will flow from an aperture of two inches in diameter in one minute, the orifice being made nine inches from the surface, which is supposed to be kept at that height the whole time.

If a vessel of a prismatic form is filled with water, and permitted to empty itself entirely through an orifice at the bottom, and the time that it consumes in emptying itself is observed; and if afterwards, having replenished the vessel, the water is made to flow through the same aperture, the vessel being kept full the whole time, there will run out in this second instance, during the same time that the vessel took to empty itself at first, a quantity of water, double that which runs out in the first case, in which the abstraction of the water diminishes the height, and consequently the velocity.

We often perceive water flow through lateral apertures, which, though small in comparison to the width of the reservoirs, cannot be regarded as having all their points at an equal distance from the surface of the fluid; such, for example, as the apertures through which water sometimes flows in mills. The common method of determining the quantity discharged is as follows: suppose, in the first place, the aperture to be stopped up by a plate of metal, which is perforated with a number of holes; if each of these holes is regarded as particular and insulated, the rapidity of the flow through each will be according to the correspondent height of the fluid; then if the number of holes are multiplied ad infinitum, or, which will amount to the same thing, if the plate is supposed to be entirely taken away, the velocity at each point of the supposed orifice will be according to the correspondent height of the fluid; and in estimating the quantity of water discharged, some attention must be paid to the inequality of the motion; yet it must not be asserted that this reasoning is entirely conclusive. In proportion as the sum of the small holes made in the plate is small in comparison with the size of the reservoir, the portions of water which flow through each hole are forced out by the absolute weight of the column above; but the moment that the number of apertures augment ad infinitum, and the streams of water which run through them become contiguous, it cannot be clearly said that the liquid flows in the same manner as through small insulated holes; yet as this hypothesis gives a result sufficiently conformable to experiments, it may be useful to preserve it, and the more so, as it leads to very simple calculations, and in all common questions this simplicity may be preferable to the minuteness of fractional operations.

The quantity of water which issues from these apertures in a given time is not so great as their size might at first suggest, because the stream is contracted by running out of each orifice, and that contraction extends to a distance nearly equal to half the diameter of the aperture; and the diameter of the contracted stream is to the diameter of the aperture a little more than as three to four, or as three and one-sixth to four, or nineteen to twenty-four; so that its area is to that of the aperture as ten to sixteen. It is nearly the same when water flows through lateral apertures. The contraction of the stream is a proof of what has been before stated, viz. that withinside a vessel the lateral particles direct themselves towards the orifice with a motion more or less oblique; and this oblique motion may be decomposed into two forces, the one parallel to the plane of the orifice, and which contracts the stream; the other perpendicular to the same plane, and the only one which produces the efflux.

This contraction occurs also when water is made to flow through pipes, and that at the entrance of the water into the pipe, and not at its exit, where the stream preserves a cylindrical form. We shall prove that this contraction diminishes, in a sensible manner, the quantity of water which would naturally flow.

In order to ascertain these facts by experiments, many have been made. In all the following instances, the orifices through which the water flowed were pierced perpendicularly through plates of copper of about one-twenty-fourth of an inch thick, and the time of each experiment is reduced to one minute.

The constant height of the water above the centre of each orifice was 11 feet 8 inches 10 lines.

		No. of cubic inches furnished in 1 min.
Expt.	1. Through an horizontal circular orifice of $\frac{1}{2}$ inch (6 lines) diameter -	2,311
	2. Through ditto of 1 inch diameter - -	9,281
	3. Through ditto of 2 inches diameter - -	37,203
	4. Through an horizontal rectangular orifice of 1 inch long and $\frac{3}{12}$ inch wide	2,933
	5. Through an horizonal square orifice of 1 inch the side - - -	11,817
	6. Through ditto of 2 inches each side of the orifice	47,361
Constant height = 9 feet.		
	7. Through a lateral circular orifice of $\frac{1}{2}$ inch diameter	2,018
	8. Through ditto of 1 inch diameter - -	8,135
Constant height = 4 feet.		
	9. Through a lateral circular orifice of $\frac{1}{2}$ inch diameter	1,353
	10. Through ditto, of 1 inch diameter - -	5,436
Constant height = $\frac{7}{12}$ inch.		
	11. Through a lateral circular orifice of 1 inch diameter	628

It follows from the preceding table,

1. That the quantities of water discharged in the same time, by different apertures, under the same height of surface in the reservoir, are to each other nearly as the areas of the apertures. Compare together the results of the second and third experiments of which the areas of the orifices are in the proportion of one to four, and it will be found that the quantities of water afforded, viz. 9281 cubic inches, 37203, inches, are very nearly in the same proportion.

2. That the quantities of water discharged in the same time through the same aperture, under different heights of surface in the reservoirs, are to each other nearly as the square roots of the corresponding heights of the water in the reservoir above the centre of the aperture. Compare together the results of the 8th and 10th experiments, where the heights of the reservoirs are nine and four feet, the square roots of which are three and two, and it will be found that the two quantities of water, 8135 cubic inches, 5436 cubic inches, which run through the same orifice of one inch diameter under the different heights of nine feet and four feet, are to each other nearly in the proportion of three to two.

3. That in general the quantities of water discharged in the same time through different apertures, under different heights of surface in the reservoirs, are to each other as the areas of the apertures are to the square roots of the heights of water in the reservoirs.

4. That in consequence of the friction, the small apertures furnish a less quantity of water in proportion than the great ones, under the same height of water in the reservoir; because, comparatively to the extent of the area of each orifice, there are more points of friction against the sides of the orifice in the small than there are in the great ones; for the circumferences do not diminish so much as the areas.

5. That of many apertures of equal areas, that of which the circumference is the least, will, on account of the friction, furnish more water than the others, under the same height of the reservoir; circular apertures are, for this reason, the most advantageous of all; for the circumference of a circle is the shortest line that can be made use of to inclose a given space, therefore there is less surface of friction relatively to the size of the area.

It is easy to perceive, that the quantity of water discharged in the table of experiments is not near so great as might be expected from the extent of the areas and the heights of the reservoirs. The quantity is in fact diminished by the friction, and still more by the contraction of the stream; for the velocity which is in proportion to the entire altitude of the fluid is not sensibly changed. Supposing, first, that the area of the stream is the same as that of the orifice; and supposing, secondly, that the stream is contracted, then the difference of the quantities afforded is as sixteen to ten; that is, supposing the area of the aperture to be diminished in the proportion of sixteen to ten, the discharge of the fluid out of vessels kept equally full may be determined with sufficient exactness. By the expression, an inch of water, is understood the quantity which flows out of a circular and lateral orifice of one inch diameter, the surface of the water being constantly kept seven-twelfths of an inch above the centre of the orifice. This is the case with the eleventh experiment in the preceding table, where it appears that the quantity of water furnished is 628 cubic-inches. Mr. Mariotte, who made the same experiment, found the quantity to be a little more; but it is probable that he might commit a small error, because the experiment just cited was made, M. Brisson informs us, with the utmost care and attention. A (French) pint of water, he adds, instead of weighing two pounds, as is commonly believed, is proved to fall short of that weight considerably, as will be evident by strictly examining that experiment.

When additional pipes are employed, it appears,

First, That the quantity of water discharged by different additional pipes, under the same height of water in the reservoir, is pro-

portional to the areas of the apertures, or to the squares of their diameters.

Secondly, That the quantities of water discharged through additional pipes of the same diameter, under different altitudes of water in the reservoir, are proportional to the square root of the altitude.

Thirdly, That in general the quantities of water discharged in the same space of time through different additional pipes, under different heights of water in the reservoir, are to each other nearly as the product of the square of the diameters of the pipes by the square root of the altitude of the reservoirs.

The efflux of water, therefore, through additional pipes, follows the same laws as water when discharged through apertures made in thin substances.

If the vessel AB (Plate Hydrostatics, &c. fig. 1.) is full of water, and the horizontal pipe D in the middle of its side, and the semicircle NEC described upon D, as a centre, with the radius, or semidiameter DC, or DN, the perpendicular DE to the diameter CDN, is the longest that can be drawn from any part of the diameter to the circumference: and if the vessel be kept full, the jet will spout from the pipe D to the horizontal distance MN, which is double the length of the perpendicular DE. If two other pipes, as F and G, be fixed into the side of the vessel, at equal distances above and below the pipe D, the perpendiculars FH and GI, from these pipes to the semicircle will be equal; and the jets spouting from them, will each go to the horizontal distance NK, which is double the length of either of the perpendiculars FH or GI.

Fluids, by their pressure, may be conveyed over hills and valleys, in bended pipes, to any height not greater than the level of the springs whence they flow. This the antients were ignorant of; and therefore they usually built aqueducts (vast rows of arches, one above another, between two hills, at an immense expence of money, time, and labour) in order to convey water over them, across the valley.

This is now done to equal advantage, and at much less expence, by a range of pipes laid down one hill and up the other. If water is poured into one of the legs of the bended pipe ACB (fig. 2.) it will rise exactly to the same level in the other. The reason is obvious: in the leg A there are, suppose, two ounces of water, endeavouring by the force of gravity to descend with the force of two; this will thrust forward, buoy up and support an equal quantity of a like fluid in B; and the bottom of the machine C, against which both sides equally bear, will of consequence sustain a double pressure, or that of four ounces; and in the present case, will pretty well represent the prop, or fixed point, of a balance-beam; as the equal fluid columns AC and BC, may be admitted to denote equal weights, suspended on the balance-arms, counterpoising each other: so that the rise of fluids to their first level, thus considered, is a case truly statical; and all their other motions proceed only from weight added.

We have seen, that water will rise through bended pipes to the same level as the reservoir from which it proceeds. Upon the same principle, jets, or fountains, are formed; for if near the bottom of the vessel AB (fig. 1.) you fasten a small pipe *m*, bending upwards, the water will spout out through the pipe, and rise nearly as high as the surface of the water in the vessel. It will not rise quite so high, because it is somewhat impeded by the resistance of the air, and the friction against the opening of the pipe, or adjutage.

It is always found necessary to increase the bore of the adjutage, or spouting-pipe, with the height of the reservoir; for if it is too small, the rising stream will want sufficient weight and power to divide the air, which being densest near the earth, a small stream of water, endeavouring to mount to a great height, will be dashed against it with so much violence, as to fall away in a mist, and be wholly lost.

There is a certain and fit proportion to be observed between the adjutage by which the jet is delivered, and the pipe conducting it from the head. In general, about five times the diameter of the adjutage, for jets under half an inch, and six or seven times for all above, will give the size of pipes of conduct pretty well; though it will always be an error on the right side, to have them rather larger than in strictness they ought to be, that the jet may always be freely supplied with water, and in due time.

For a like reason, if there is occasion for a cock to be placed in any part of the pipe of conduct, particular care must be taken that it should be there bigger in proportion, that the water may not be pinched, but that the cavity be left at least equal to the bore of the rest of the pipe.

The bore of an adjutage cannot be too smooth, or true. Those that are cylindrical are best; those that are bored conical, worst; because of the reflections of the water from the inclined sides of the machine, which, in the hurry of the issuing stream, will in them unavoidably be made.

Archimedes' screw (fig. 7.) deserves consideration, not only for its antiquity, but its usefulness in raising water. It consists of a long cylinder, with a hollow pipe-tube, or groove, coiled about it, as represented in the figure. It is placed in a position oblique to the horizon, with the lower end in the water, the other being supported on the lower part of the winch I, by which the screw and cylinder are turned round. As soon as the screw is immersed in water, it immediately rises in the machine by the orifice C, to the level of the surface of the water E; and if the point of the helix, or spiral, which in the beginning of the motion is coincident with the surface of the water, happens not to be on the lower side of the cylinder, the water will, upon the motion of the screw, move on in the helix, until it comes to the point which is on the under side, and coincident with the watery surface: when it is arrived at that point, it cannot afterwards possess any other part of the spiral, than that which is upon the lowest part of the cylinder, for it cannot move towards H, because H is situated higher; and since this will ever be the case, after the surface of the water in the helix has attained the point E, it is plain that it must always be on the under side of the cylinder. But since the cylinder is in motion, every part of the spiral screw from EF, will by degrees succeed to the under part of the cylinder; the water therefore in the helix must succeed to every part from E to F, as it comes to the lower side; that is, it must ascend on the lower part of the cylinder through all the length of the pipe, until it comes to the orifice at top, where it will run out.

Of all the machines the antients invented to raise water, it appears that though Archimedes' screw was the most curious, the tympanum, mentioned by Vitruvius, elevated the greatest quantity at once; a brief description of this may suffice, as preparatory to the account of machines made in imitation of it, but more ingenious and more perfect.

The tympanum is a great hollow wheel, forming a kind of barrel or drum (as its name imports) composed of several planks joined together, well calked and pitched, and having a horizontal axle on which it turns: the interior of this drum is divided into eight equal spaces by as many partitions placed in the directions of the radii; each space or cell has an orifice of about half a foot in the rim of the drum or wheel, so shaped as to facilitate the admission of the water; moreover, there are eight hollow channels running contiguous to each other, and parallel to the axle of the wheel, each corresponding to one of the eight large cells; into these channels the water passes out of the cells just mentioned, and after running along the channels to a convenient distance, it escapes through orifices into a reservoir placed just under the axle. Thus the water is elevated through a vertical space equal to the radius of the hollow wheel. When the tympanum is used to raise water from a running stream, it is moved by means of float boards which are impelled by the stream; but when it is employed to raise stagnant water, there is commonly a smaller wheel on the same shaft, which is turned by men walking in it, as in the old walking crane. The chief defect of this machine is that it raises the water in the most disadvantageous situation possible; for the load being found always towards the extremity of a radius of the wheel, the arm of the effective lever which answers to its increases through the whole quadrant the water describes in passing from the bottom of the wheel to the altitude of its centre; so that the power must act as if it was applied at a winch handle, and cannot therefore act uniformly.

Mr. H. Sarjeant, of Whitehaven, contrived a very cheap engine for raising water, for which the Society for the Encouragement of Arts awarded him a silver medal in the year 1801. A sketch of this simple invention is given in fig. 8.

This engine was erected at Irton-hall, which is situated on an ascent of 60 or 61 feet perpendicular height: at the foot of this elevation, about 140 yards distant from the offices, there runs a small stream of water, and in order to procure a constant supply of that necessary fluid, the object was to raise such stream to the house for culinary and domestic uses. With this view, a dam was formed at a short distance above the current, so as to cause a fall of about four feet: the water was then conducted through a wooden trough, into which a piece of leaden pipe, two inches in diameter, was inserted, and part of which is delineated at A.

The stream of this pipe is directed in such a manner as to run into the bucket B, when the latter is elevated; but as soon as it begins to descend, the stream passes over it, and flows progressively to supply the wooden trough or well, at the foot of which stands the

forcing-pump C, being three inches in diameter.

D is an iron cylinder attached to the pump-rod, which passes through it: such cylinder is filled with lead, and weighs about 240 lbs. This power works the pump, and forces the water to ascend to the house through a pipe one inch in diameter, and which is 420 feet in length.

At E is fixed a cord, which, when the bucket approaches to within four or five inches of its lowest projection, extends, and opens a valve in the bottom of the vessel through which the water is discharged.

An engine in a great degree similar to this was erected some years ago by the late James Spedding, esq. for a lead mine near Keswick, with the addition of a smaller bucket which emptied itself into the larger near the beginning of its descent, without which addition it was found that the beam only acquired a libraratory motion, without making a full and effective stroke.

To answer this purpose in a more simple way, Mr. Sarjeant constructed the small engine in such manner as to finish its stroke (speaking of the bucket end) when the beam comes into an horizontal position, or a little below it. By this means the lever is virtually lengthened in its descent in the proportion of the radius to the cosine, of about 30 degrees, or as seven to six nearly, and consequently its power is increased in an equal proportion.

It is evident, that the opening of the valve might have been effected, perhaps better, by a projecting pin at the bottom, but Mr. S. chose to give an exact description of the engine as it stands. It has now been some years in use, and completely answers the purpose intended.

The only artificers employed, except the plumber, were a country blacksmith and carpenter; and the whole cost, exclusive of the pump and pipes, did not amount to 5*l*. Pumps are engines depending also on the principles of hydraulics. See PUMP.

HYDRO-CARBONATES, combinations of carbon with hydrogen. A gas of this name is obtained from moistened charcoal by distillation.

HYDROCELE. See SURGERY.

HYDROCHARIS, the *little water-lily*, a genus of the enneandria order, in the dicœcia class of plants, and in the natural method ranking under the first order, palmæ. The spatha of the male is diphyllous; the calyx trifid; the corolla tripetalous; the three interior filaments styliferous. The female calyx trifid; the corolla tripetalous; the styles six; the capsule has six cells, and is polyspermous inferior. There is only one species, a native of Britain, growing in slow streams and wet ditches. It has kidney-shaped leaves, thick, smooth, and of a brownish-green colour, with white blossoms. There is a variety with double flowers, of a very sweet smell.

HYDROCOTYLE, *water-navel wort*, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking under the 45th order, umbellatæ. The umbel is simple; the involucrum tetraphyllous; the petals entire; the seeds are half round and compressed. There are 15 species, none of which are ever cultivated in gardens. One of them, a native of Britain, growing in marshy grounds, is supposed by the farmers to occasion the rot in sheep. The leaves have central leaf-stalks, with about five flowers in a rundle; the petals are of a reddish white.

HYDROGEN, in chemistry, one of the simple combustibles, the base of hydrogen gas, formerly called inflammable air.

HYDROGEN-GAS. To obtain this, put one part of iron-filings into a retort, attached to the pneumatic cistern, and pour thereon two parts of sulphuric acid previously diluted with four times its bulk of water. Immediately the mixture begins to boil or effervesce with violence, and air-bubbles rush abundantly from the beak of the retort. Allow them to escape for a little, till you suppose that the common air which previously filled the retort has been displaced by the newly generated air. Then place an inverted jar over the beak of the retort. The bubbles rush in abundantly and soon fill the jar.

It was obtained by Dr. Mayow and by Dr. Hales from various substances, and had been known long before in mines under the name of the fire-damp. But Mr. Cavendish ought to be considered as its real discoverer; since it was he who first examined it, and pointed out the difference between it and atmospheric air, and who ascertained the greatest number of its properties.

Hydrogen gas, like air, is invisible and elastic, and capable of indefinite compression and dilatation. Its specific gravity differs according to its purity. Kirwan found it 0.00010; Lavoisier 0.000094, or about 12 times lighter than common air. All burning substances are immediately extinguished by being plunged into this gas. It is incapable therefore of supporting combustion. Small animals, when they are obliged to breathe it, die; but large animals resist its action longer. Scheele found that he could breathe it for some time without much inconvenience; but Fontana, who repeated the experiment, affirmed that this was owing to the quantity of common air contained in the lungs when he began to breathe; for on expiring as strongly as possible before drawing in the hydrogen gas, he could only make three respirations, and even these three produced extreme feebleness and oppression about the breast.

The ingenious Mr. Davy, professor of chemistry in the Royal institution, to whom we are indebted for many curious and important; but rather hazardous experiments on respiration, made chiefly upon himself, after a complete exhaustion of his lungs, found great difficulty in breathing this gas for so long as half a minute. It produced uneasy feelings in the chest, momentary loss of muscular power, and sometimes a transient giddiness.

Pilatre de Rozier publicly verified the assertions of Scheele. He breathed hydrogen gas six or seven times from a bladder without inconvenience. To demonstrate that it was really hydrogen gas which he was breathing, he made a strong inspiration, and expired the air slowly through a long tube. On bringing a lighted taper to the end of the tube, the gas took fire, and continued to burn for some time. It was objected to him, that the gas which he breathed was diluted with common air. To shew that this was not the case, he mixed together one part of common air and nine parts of hydrogen gas, and having drawn the mixture into his lungs, he threw it out the same way. On applying a taper to the tube, the whole of the gas exploded in his mouth, and almost stunned him. At first he thought that the whole of his teeth had been driven out, but fortunately he received no injury whatever.

If a phial is filled with hydrogen gas, and a lighted candle brought to its mouth, the gas will take fire, and burn gradually till it is all consumed. If the hydrogen gas is pure, the flame is of a white colour; but if the gas holds any substance in solution, which is often the case, the flame is tinged of different colours, according to the substance. It is most usually reddish, because the gas holds in solution a little charcoal. A redhot iron likewise sets fire to hydrogen gas. From my experiments it follows, that the temperature at which the gas takes fire is about 1000°.

If pure oxygen and hydrogen gas be mixed together, they remain unaltered; but if a lighted taper be brought into contact with them, or an electric spark be made to pass through them, they burn with astonishing rapidity, and produce a violent explosion. If these two gases be mixed in the proportion of one part in bulk of oxygen gas and 2.527 parts of hydrogen gass, or, more accurately, 85 parts by weight of oxygen gas and 15 of hydrogen gas, they explode over water without leaving any visible residuum; the vessel in which they were contained (provided the gases were pure) being completely filled with water. But if the explosion be made in a close vessel, there is always found instead of them a quantity of water exactly equal to them in weight. This water must be composed of these two gases; for it did not previously exist in the vessel, and no other substance besides the gases were introduced. Water then is composed of oxygen and hydrogen; and the combustion of hydrogen is nothing else but the act of its combination with oxygen.

When two parts (in bulk) of hydrogen gas are mixed with six parts of common air, the mixture explodes with equal violence; and after the explosion, the bulk of the mixture is reduced to five parts. The whole of the hydrogen gas is consumed, and likewise all that part of the common air which consists of oxygen gas, and there is formed a quantity of water equal in weight to these two bodies. This experiment is often employed to ascertain the purity of hydrogen gas. Common air and the hydrogen gas to be examined are mixed in certain proportions in a glass tube, graduated and closed at one end; they are then fired by an electric spark. The purity of the gas is proportional to the diminution of bulk. Thus, when the bulk of a mixture of two parts of hydrogen gas and six parts of air is diminished after the explosion to five parts, the hydrogen gas may be considered as pure; if only to six, it contains some foreign ingredients, and so on. This method of detecting the purity of hydrogen gas was first employed by Berthollet. Volta, indeed, had employed it before him; but for a different purpose.

Hydrogen gas is not sensibly absorbed by water, though left for some time in contact with it. But by artificial pressure water may be made to absorb about the third part of its bulk of that gas. The taste of the water is not sensibly altered. Mr. Paul, who first formed this compound, informs us, that it is

useful in inflammatory fevers and in nervous complaints, but it is injurious in dropsy.

Hydrogen gas dissolves sulphur, phosphorus, and carbon. The compounds are called sulphureted, phosphureted, and carbureted hydrogen gas. See AIR, CHEMISTRY, &c.

HYDROGENIZED *sulphurets*, certain bases combined with sulphureted hydrogen.

HYDROGRAPHY, the art of measuring and describing the sea, rivers, lakes, and canals.

With regard to the sea, it gives an account of the tides, counter-tides, soundings, bays, gulphs, creeks, &c. as also of the rocks, shelves, sands, shallows, promontories, harbours, the distance and bearing of one port from another, with every thing that is remarkable, whether out at sea or on the coast.

HYDROLEA, a genus of the digynia order, in the pentandria class of plants, and in the natural method ranking with those of which the order is doubtful. The calyx is pentaphyllous; the corolla rotaceous; the filaments at the base are cordate; the capsule is bilocular and bivalved. There are four species, herbs of the East and West Indies.

HYDROMETER, an instrument much used for determining the specific gravities of liquids. It usually consists of a hollow sphere of glass or metal B, and balanced by another *b* below, containing quicksilver, or a metallic weight. Fig. 19. The larger ball has a shorter neck at C, into which is screwed the graduated stem AC, which by a small weight at A causes the instrument to descend in the fluid with part of the stem. When this instrument is swimming in the jar ILMK, the part of the fluid displaced by it will be equal in bulk to the part of the instrument under water, and equal in weight to the whole instrument. This instrument, therefore, marks the differences in the density of fluids by the place at which the surface cuts the stem as it floats, or by the proportionate addition or diminution of weight which is required to make it float at the same level in each.

Beaumé's areometer is often referred to in the works of French chemists. The inventor seems to have been led to a method of making instruments of this kind, which should agree with each other by reflecting on the way in which thermometers are graduated, that is, by means of an interval between two stationary points of temperature. Thus M. Beaumé adopted two determinate densities, in order to mark an interval in the stem of his hydrometer. These were that of pure water, and that of water containing $\frac{1}{8}\frac{5}{5}$ parts of its weight of pure common salt at 10° Reaumur or 57° Fahrenheit. The instrument (represented by fig. 20.) was so balanced as to sink in the water to 0 near the top of the stem. In the saline solution the latter emerged more, and a certain additional portion appeared above, which was assumed to contain 15 degrees. By means of a scale and compasses, a scale of equal degrees was thus formed, adapted to the length of the stem, and being fixed within it, at a proper height, the latter was sealed at the blow-pipe without altering the weight. It is usually constructed in two pieces, to avoid an inconvenient length; one of which serves for the lower, the other for the higher, degrees of density. The glasses may be procured from the makers of thermometers, and it is convenient to have a passage from the top quite down to the lower bulb for introducing the quicksilver, which being adjusted, may be secured there by a small morsel of cork. It is obvious that persons of ingenuity may adapt such instruments to their own purposes, by fixing on two liquids of known specific gravities to serve as the extremes of their scale, and may thus apply them to the trial of all liquids, from ether to sulphuric acid, in respect to gross differences, or for the purpose of having them of uniform strength. But the instrument is not to be depended on for those accurate reports on the specific gravity of liquids which are expected in detailing chemical experiments.

Fahrenheit contrived a more accurate metallic hydrometer, having a very slender stem, terminating in a small dish. The middle, or half-length of the stem, is distinguished by a fine line across. In this instrument every division of the stem is rejected, and it is always immersed to the line by means of weights put into the dish. Thus, as the part immersed is constantly of the same magnitude, and the whole weight of the hydrometer is known; this last weight, added to the weight in the dish, will be equal to that of the fluid, displaced by the instrument. Consequently, as the whole weight of the hydrometer and its load, when adjusted in distilled water, is to 1.000, so is the whole weight when adjusted in any other fluid, to the number expressing the specific gravity of that fluid.

Were the instrument constructed so that it should displace exactly 1.000 grains of distilled water at a mean temperature, the grains to be added or taken away for any other fluid would express the difference of the specific gravity at once. But as this would require much nicety, the weight of the instrument and its load adjusted in distilled water may be ascertained, and a set of decimal weights provided, each of which should bear the same proportion to its nominal value in grains that the whole adjusted in distilled water did to 1.000. By this, or by the former expedient, the trouble of calculation may be avoided; but those who use the instrument often will find it expedient to construct a set of tables adopted to the same purpose. See SPIRITS.

HYDRO-OXIDES, metallic oxides combined with water.

HYDROPHOBIA. See MEDICINE.

HYDROPHILUS, a genus of insects of the coleoptera order. The generic character is, antennæ clavate-perfoliate; hind legs villose, formed for swimming. The principal European species of this genus, which is not an uncommon insect in our own country, is the hydrophilus piceus, perhaps the largest of the British coleoptera, if we except the lucanus cervus; measuring nearly an inch and half in length. It is entirely black, and of a smooth surface, and is particularly distinguished by the form of its thorax, which is produced beneath into a very long and sharp-pointed spine, stretching to a considerable distance down the abdomen; the hind legs are furnished on each side with strong, but very fine, hairs. It is a native of stagnant waters, where its larva is principally observed to prey on the smaller kind of water snails, and is distinguished by a particularity in the highest degree remarkable; this consists in the apparently anomalous situation of the legs, which seem, unless very accurately considered, to be placed, not beneath the thorax, as in other insects, but on the upper part, and thence to be deflected towards the sides. This uncommon appearance, however, is not owing to a real dorsal insertion of the legs, but principally to the peculiar shape and position of the head; and the deception is so much heightened by the inverted posture in which the insect generally swims and rests, that it is by no means easy, even for the most scientific observer, to divest himself of the erroneous idea beforementioned.

The larvæ of the hydrophils are supposed to remain about two years before they change into pupæ or chrysalides. When the larva is arrived at its full growth, it secretes itself in the bank of the water it inhabits, and having formed a convenient cavity or cell, lies dormant for some time, after which it divests itself of its skin, and appears in the form of a chrysalis, in which state having continued for some time longer, it again delivers itself from its exuviæ, and appears in its complete or beetle form. When first disengaged from the skin of the chrysalis, it is of a pale colour, and very tender; but in the space of a few hours the elytra, or wing-cases, acquire a degree of strength and colour, which gradually grows more and more intense, till the animal, finding itself sufficiently strong, comes forth from its retreat, and commits itself in its new form to the waters.

The male is distinguished from the female by the structure of the fore legs, which are furnished, near the setting on of the feet, with a sort of horny, concave flap or shield; the legs of the females being destitute of this part.

The female of the hydrophilus piceus affords an example of a faculty which seems to be exercised by no other coleopterous insect, viz. that of spinning a kind of web or flattish circular case of silk, which it leaves floating on the water, and in which it deposits its eggs. This case is terminated on its upper surface by a lengthened conical process resembling a horn, of a brown colour, and of a much stronger or denser nature than the case itself, which is white. The young larvæ, as soon as hatched, make their escape from the envelopement of the case, and commit themselves to the water.

The hydrophilus caraboides is a species measuring about three quarters of an inch in length, and is of a polished black colour, and of an oval shape.

The genus hydrophilus has been greatly increased by the persevering researches of modern entomologists. Mr. Marsham enumerates 28 British species.

HYDROPHYLLAX, a genus of the monogynia order, in the tetrandria class of plants. The calyx is tetrapartite; the corolla funnel-shaped; the fruit two-edged and one-seeded. There is one species, an aquatic of the East Indies.

HYDROPHYLLUM, *water-leaf*, a genus of the monogynia order, in the pentandria class of plants, and in the natural method ranking with those of which the order is doubtful. The corolla is campanulated, with five melliferous longitudinal stria on the inside; the stigma is bifid; the capsule globose and bivalved. There are two species, the virginianum, or water-leaf of Morinus, grows naturally in Canada and many other parts of America on moist spongy ground. The root

is composed of many strong fleshy fibres, from which arise many leaves with footstalks five or six inches long, jagged into three, five, or seven lobes, almost to the mid-rib, indented on their edges. The flowers are produced in loose clusters hanging downward, are bell-shaped, and of a dirty white colour.

HYDROSCOPE, an instrument antiently used for the measuring of time. The hydroscope was a kind of water-clock, consisting of a cylindrical tube, conical at bottom: the cylinder was graduated, or marked out with divisions, to which the top of the water becoming successively contiguous, as it trickled out, the vertex of the cone pointed out the hour.

HYDROSTATICAL BALANCE, a kind of balance contrived for the easy and exact finding the specific gravities of bodies, both liquid and solid. See HYDROSTATICS.

HYDROSTATICS have for their object the weight and pressure of fluids; and in this branch of science the art of determining the specific gravities of bodies is usually included, but this we have already been under a necessity of anticipating. Archimedes, among the antients, accomplished the most remarkable discoveries in this science. He is honoured even at this day, as the inventor of the ingenious hydrostatic process, by which the purity or baseness of a crown of gold was ascertained. Among the moderns we are indebted to Galileo, Torricelli, Descartes, Pascal, Guglielmini, and Mariotte, for the best information on this subject; and by their experiments (which are as curious as they are decisive) we are instructed in what we may expect or fear from the power of fluids violently acted upon by the principle of gravity, and in what manner and upon what principles we may employ, for the use of man, the hydraulic machines.

It has been observed in another place (See GRAVITATION), that the propensity which bodies have of approaching towards the earth, or perhaps towards its centre, is the only cause of what we term weight or gravity, and that it is by the continual efforts which they make to obey that law, that they press upon every obstacle which impedes their progress. As fluids, like solid bodies, are impelled by their gravity, so in this case they press upon every object which opposes their fall; but from their nature they press in a different manner from solid bodies; hence arise the peculiar phenomena concerning which we are now to inquire.

Fluids are substances, the component parts of which are moveable among themselves, having scarcely any cohesion one with another, and moving independently of each other. Some philosophers have included in this definition what they term the grosser fluids, as, for example, a heap of corn, a heap of shot, of sand, &c. as well as the rarer and more elastic fluids, as common air, and all other aeriform substances. The proper objects, however, of the hydrostatic science, are those fluids which, in common language, are termed liquids, or those which always present to us a plane surface, level or parallel to the horizon.

All liquid substances are not equally so; hence it follows, that the laws of hydrostatics apply with less exactness in proportion as those substances depart from perfect fluidity. Water and oil both flow when the vessels, which contain them, are either overturned or broken; but the effusion of oil is slower than that of water, because the particles of oil have more cohesion among themselves. The most singular effects in hydrostatics principally depend, perhaps, upon the extreme minuteness of the particles of fluids, but at least upon their great mobility.

To preserve a lucid order in the consideration of this subject, it will be necessary to divide the objects of our inquiry into three branches. In the first place, therefore, we shall consider in what manner the principle of gravity acts on the particles of fluids, and the phenomena which it produces in the fluids themselves; as well as their action against the sides, the bottoms, and tops of the vessels in which they are contained. Secondly, in what manner fluids of different densities act upon each other; and thirdly, the action of fluids on bodies immersed in them.

I. In pursuing the first object of this inquiry, it may be established as an axiom:

1. That the parts of the same fluid act with respect to their weight or pressure, independently o each other.

This property arises from their having scarcely any cohesion among themselves. It is otherwise with solid bodies; their several parts adhering together, they press in one common mass; hence the falling of solid bodies is productive of a different effect from that of liquids: We dread the falling of a pound of ice upon our heads, while we are much more indifferent concerning that of a pound of water. The latter, in its descent, is divided by the resistance of the air, by which some of its parts are retarded more than others; and the swiftness of the whole mass is still more retarded by this division than it otherwise would be; for by being thus divided it requires a larger surface, which abates its effect. On the contrary, a solid body falls upon a small space, which receives its whole force. Hence it follows, that angular bodies falling upon any part of the human frame are more dangerous than flat or plane ones of the same weight, and descending from the same height.

It follows from this principle, that if an aperture is made at the bottom of a vessel full of any fluid, in order to prevent the flowing out of the liquor, it is only necessary to counteract the weight of that column of fluid which has the aperture for its base, and that to counteract that weight it is the same whether the vessel is full of liquor, or whether it contains only a column, the base of which shall be equal to the aperture at the bottom.

Let the cylindrical vessel of glass A B (Plate Hydrostatics, fig. 9.) have a hole in the bottom at C, furnished with a cylindrical ferule of copper of an inch diameter D, which is to be stopped with a piston G, or the sucker of a pump well fitted to the ferule, and oiled, that it may yield to a moderate pressure. Let the piston be supported by a small rod G H, fastened at H to the silk which unites with the portion of the pulley M, with which the extremity of the lever M N is furnished, and which has for its center of motion the point L. The other portion of the pulley N, which terminates the other extremity of the lever, is also furnished with lines of silk, which support the small bason or scale I. Upon the copper ferule D then fit a cylindrical tube of glass F E, the interior diameter of which is equal to that of the ferule, and its height equal to that of the vessel A B. When the apparatus is disposed in this manner, fill the tube E F with water, and continue to put small weights into the scale I, until the piston begins to rise. Afterwards take away the glass tube E F, and place the piston G in the copper ferule D, and pour water into the large vessel A B, and it will appear that the same weights as before in the bason I, will raise up the piston when the larger vessel A B is entirely full. Hence it follows that there is the same power to be counteracted, whether there rests upon the piston only a column of water of its own size, or whether the vessel A B is entirely full. Such a column, therefore, presses upon its base independently of the rest of the water contained in the vessel.

To account for this, let us suppose all the water in a vessel to be divided into several columns, 1, 2, 3, 4, 5, (fig. 10.) each composed of an equal number of parts. If the bottom of the vessel, which serves for the base and support of all the columns, is opened in *a*, the column 3, being no longer supported, will descend through the aperture, sliding between the two columns 2 and 4, which are supported by the parts of the bottom of the vessel *b* and *c*, all the moveable parts of which become (if we may use the expression) small rollers, which retard the fall only in a very slight degree. This effect is the result of the small degree of cohesion between the parts of the fluid. If the columns 1 and 2 on the one part, and 4 and 5 on the other, were composed of parts adhering together, they would retard each other in their descent during their whole length, in the same manner as a wax candle would do; and by the fall of the column 3, a void would be made between them. But as all the particles are extremely minute, moving easily upon each other, they descend when the summit of the column 3 begins to descend, having no longer any support from that side; and the superficies of the whole mass descends in the same manner, though only one of the columns caused the flow from its fall. When the parts have a degree of viscosity, as those of oily fluids, or when the mass of the flowing liquor has much more of breadth than of height, the void which the descending column leaves above it is easily perceived, for then the surface, instead of being plane and even, is hollow in the middle, and assumes a funnel-like form, because the adjacent parts do not arrive with sufficient swiftness to replace those which descend through the aperture; besides the pressure of the air above, the aperture is stronger than its resistance below.

From what has been now stated, it is easy to perceive how fluids differ from solids in the phenomena of gravitation. If the vessel A B (fig. 9.) being full of water, and the tube E F being removed, it was required to raise up the piston G; all that is necessary in this case is, to support the weight of the column of water directly above the piston, because this column can move independently of the remainder; but if the whole mass of water was converted into ice, then the mass ceasing to be a liquid, and all its parts adhering together, to raise up the piston it would be necessary to support the weight of the whole mass.

2. Fluids press equally in all directions.

In other words, they not only press from

the top to the bottom like other bodies, but they also press, according to their weight, upon all bodies that oppose them in a lateral direction, and even from the bottom to the top. Hence, if a cask is filled with liquid oil, the oil will run out if an aperture is made in the side, but when it is congealed it will not run out on account of its having become a solid body, for solid bodies press only from their vertex to their base, and not laterally.

To understand properly this lateral pressure of fluids, and also that which they exert from their base towards their vertex, it is necessary to consider them as a mass of small globules deposited in a vessel; and to remember that these minute globules are not arranged regularly as upon a cord, but that very frequently one column exercises its pressure between two others, and has a propensity to displace them, as may be seen in fig. 11. where the perpendicular pressure which is made opposite to the point *d*, is directed by the lateral columns towards the sides, *e f*, of the vessel, in such a manner, that if the vessel was open in those places the liquid would flow out, on account of the great mobility of its parts. It is by the same mode of reasoning, that the pressure of fluids, from their base towards their vertex, is accounted for.

It is upon this principle that the water, elevated by the New River water-works, after having descended from a bason in a vertical pipe, and then after having flowed horizontally in a succession of pipes under the pavement, is raised up again, through another pipe, as high as the fountain at the Temple Garden. It is also upon this principle that a vessel may be filled either at the mouth or at the bottom indifferently, provided that it is done through a pipe, the top of which is as high as the top of the vessel to be filled. Hence it follows, that when piers, aqueducts, reservoirs, or other hydraulic works for the retention of water are to be constructed, it becomes necessary to proportion their strength to the lateral pressure which they are likely to sustain, which becomes greater as the height of the water is more considerable. Nearly the same precautions are necessary to be taken with respect to what some philosophers call the grosser fluids, which also have a propensity to expand, as well on account of the smallness of their parts as from the small degree of cohesion which exists between them. Walls designed to support terraces ought to be sufficiently strong to resist the lateral pressure of the earth and rubbish which they are to sustain, since this pressure will be greater as the particles of earth, and of the other materials of which the terraces are composed, are less bound together, and in proportion as the terraces are more elevated.

3. All the parts of the same fluid are in equilibrium with each other, whether they are contained in one vessel or many, provided they communicate with each other; and their surfaces also are always in a plane parallel to the horizon.

This is a consequence of the principle which has been before established: for, since the particle *k* (fig. 11.) would be raised from the base towards the top, unless a column equal to the column *i k*, pressed upon it to retain it in its place; it follows that to be in equilibrium, the upper extremities of the two columns should be in the same horizontal plane, or in points equally distant from the centre of the earth; which points, however, cannot be found by a right line; for in the distance of a thousand fathoms there is about one foot difference in the perpendicular height. From this property of fluids it follows, that water conducted by pipes placed in the earth, will remount as high as the place whence it flowed, whatever the depth under ground through which it may have been conducted by the pipes. It is customary to allow half an inch of inclination in the length of six feet, to counteract the resistance produced by friction; but it is clear from what has been said, that this is not absolutely necessary, for however long the passage might be the water would still ascend as high as the place whence it came, but it would require a little longer time to accomplish the ascent. We are enabled, upon this principle, to account for the springs which are sometimes found on the tops of mountains. Such waters flow from mountains still more elevated (whether they are far or near), by subterraneous canals. It follows from this principle, that if there are many reservoirs which communicate together, it is necessary only to see one of them to know the height of the water in the others; for it must necessarily be of the same height there as in all the rest.

From what has been observed, viz. that when all the parts of the same fluid are in equilibrium, their surfaces will also be in a plane parallel to the horizon, or, in other words, every part of the surface at an equal distance from the centre of the earth, it follows, that when the surface of water is very large, it becomes necessarily and sensibly convex. This is easily perceived at sea, where the masts of ships are observed at a distance before any other part of the ship can be distinguished.

It follows from the equal pressure of fluids in all directions, that the horizontal bottom of a vessel sustains just the pressure of a column of the fluid, whose base is the area of the bottom of the vessel, and whose perpendicular height is equal to the depth of the fluid. Thus in the vessel A B C fig. 12. the bottom B C does not sustain a pressure equal to the whole quantity of fluid contained in the vessel, but only of a column whose base is C B, and height C E. Also in the vessel F G H, the bottom G H, fig. 13, sustains a pressure equal to what it would be if the vessel were as wide at the top as bottom.

This leads us to notice what is called the hydrostatical paradox, which is thus expressed, "that a quantity of fluid, however small, may be made to counterpoise a quantitity however large." Thus if to the wide vessel A B, fig. 14, the tube C D is attached, communicating with A B, and then water be poured into either of them, it will stand at the same height in both, consequently there is an equilibrium between them.

It may be thus illustrated: Let A B D G, fig. 15, represent any cylindrical vessel, to the inside of which is fitted a cover C, which will slide up and down without suffering any water to pass between the edges. In the cover is inserted a small tube, C F, which is open at top, and communicates with the inside of the cylinder beneath the cover at C. The cylinder is filled with water, and the cover put on. Then if the cover is loaded with a weight, as a pound, it will be depressed, and the water rise in the tube to E, and the weight will be sustained. If another weight be added, the water will rise to F, and the weight sustained, and so on, according to the weight added, and the length of the tube. Now the weight of the water in the tube is but a few grains, yet its lateral pressure serves to sustain as much as the weight of a column of water whose base is equal to that in the tube. Thus the column E d produces a pressure in the water contained in the cylinder, equal to what would have been produced by the column A a d D; and as this pressure is exerted equally every way, the cover will be pressed upwards with a force equal to the weight of A a d D; consequently if A a d D weigh a pound, E C will sustain a pound: and the like of any other heights and weights.

One of the most useful machines to shew that a small quantity of water is capable of great pressure, is the hydrostatic bellows. This machine (fig. 16.) consists of two thick circular or oval boards, united to each other by leather, like a pair of common bellows, or a barber's puff. Into the lower board a pipe B, several feet high is fixed. Now, in shewing experiments with this simple machine, which the reader might easily make, let water be poured into the pipe at its top, which will run into the bellows, and separate the boards a little: then, to shew how much a small quantity of water will be able to effect by pressure, let weights be laid upon the upper board. If we pour more water into the pipe, it will as before run into the bellows, and raise up the board with all the weights upon it. And though the water in the tube should weigh in all but a single pound, yet the pressure of this small force upon the water below in the bellows, will support the weights, which are perhaps a hundred pounds; nor will they have weight enough to make them descend, and conquer the weight of the water, by forcing it out of the mouth of the pipe.

Upon the principle of the upward pressure of fluids, a piece of lead may be made to swim in water, by immersing it to a proper depth, and keeping the water from getting above it. Let C D, fig. 17, be a glass tube open throughout, and G a flat piece of lead half an inch thick, fitted exactly to the lower end of the tube, but not to go within it. By means of the packthread L, the lead is held close to the bottom of the tube, and in this situation it is immersed in the water of the vessel K to somewhat more than eleven times its own thickness, because lead is more than eleven times heavier than water; then the thread L may be let go, but the lead will not fall, but be sustained by the upward pressure of the water below it. If some water be poured upon the lead, or if the tube be raised a little, the lead will fall by its own weight, which will then be too heavy for the pressure of the water round the tube, upon the column of water below it.

It is clear, from the foregoing principles, that a tun filled with water, may be burst by pressing it with some pounds additional weight of the fluid, through a tube, which may be supposed to be from twenty-five to thirty feet in height; for from what has been said, it necessarily follows, that the small quantity of water which the tube contains, presses upon the bottom of the tun as much as if a column of water had been added as wide as the tun itself, and as long as the

tube, which would evidently be an enormous weight.

II. The effects of gravity on fluids of different densities will, from what has preceded, not be very difficult to comprehend.

It has been observed, that fluids are masses of small bodies moveable with great facility among themselves independently of each other, pressing separately, and in proportion to their masses.

It is proved also by chemical analysis, that even these minute particles are composed of particles still smaller. Now whether it results from the interposition of caloric in greater or less quantities, which we know is the cause of all fluidity, and also of the difference that exists between the incompressible and elastic fluids; or whether it may depend upon the shape or size of the particles, which, as in solid bodies, may increase or diminish the porosity, it is certain, that there is a considerable difference with respect to density in different fluids.

From this difference in point of density, a separation may be observed generally to take place, soon after mixing two heterogeneous fluids together, unless this effect is counteracted by some more powerful cause. It has been observed, that the particles, according to their weight, press independently of each other. Those therefore which have the most density, having more power to gain possession of the lower part of the vessel which contains them, oblige the others to yield and resign their situation; and hence a separation is effected. When oil and water, for instance, have been well shaken together, and afterwards the whole is left in a state of rest, the water, having more density than the oil, takes the lower position, and the oil rises to the surface. If this effect does not take place, it is owing to the intervention of one of the following causes: First, a kind of elective attraction, which may exist between the particles of different fluids, as when water and wine are mixed together, the water, though heavier than the wine, does not separate itself. Secondly, the viscosity of one of the substances, as when the whites of eggs are beaten together, and by that means a considerable quantity of air mixes with them; the air, though much lighter, has not power to disengage itself from the matter in which it is enveloped, in order to effect its escape.

If two fluids of different densities are placed in a state of equipoise with each other, and have the same base, their perpendicular heights above the horizon will be in a reciprocal ratio to their densities or specific gravities.

If, for example, mercury is put into an inverted siphon, and water is poured into one of the branches, in order to elevate the mercury in the other branch one inch above its level, it is necessary that the water should be about thirteen inches and an half high. The height of the water then will be thirteen times and a half that of the mercury; because the specific gravity of mercury is about thirteen times and a half as great as that of water.

This observation will also apply to the reciprocal action of air and water, or air and mercury upon each other. Many of the phenomena of hydrostatics and hydraulics are to be referred to the pressure of the atmosphere, for which we must refer to PNEUMATICS.

It is, however, proper on the present occasion, to call the reader's attention to some of the properties of this fluid, and he will easily remember, that as a fluid, air is possessed of gravity, and consequently presses upon all bodies which oppose it; and it is necessary to add, that like water, it presses in all directions. If, therefore, a small hole is made with a gimblet, either in the side or bottom of a cask or vessel which is quite full of liquor, it will not run out, because the external air which presses against the hole, sustains the liquor, which has not a sufficient height to overcome its pressure. Hence the necessity of a vent peg, to enable liquor to be drawn out of a full cask. The elasticity of the small quantity of air which is introduced at the vent presses the fluid, and overcomes the pressure of the air at the cock. There is an instrument in common use, called a valencia, for extracting small quantities of liquor out of the bung-holes of casks. It is a tube with a small aperture at the bottom and the top. When full, if the hole at the top is stopped with the thumb or finger, so as to prevent the pressure of the air at the top, the liquor will not run out of the hole at the bottom, being kept in by the force of the external air.

It is proper to observe, that all the effects which depend upon the pressure of air, take place in a room where the column of air is terminated by the ceiling, as well as without doors where the column of air has the whole height of the atmosphere; and the reason is, because the air in the room has a communication with that on the outside, supposing it to be only by means of the key-hole. Thus a barometer placed in a hall, will have its mercury as high as if it was placed in an open field.

The curious effects produced by siphons, all depend upon the pressure of the air.

A siphon is a bent tube, A B C, (fig. 3) made of glass, metal, &c. One branch of which A B, is shorter than the other B C. In order to make use of this instrument, place the extremity of the short branch in the vessel A, which may be supposed to contain any fluid matter, as water for instance. If the air then is drawn out of the siphon (fig. 4.), by means of the long branch x, the liquor will begin to flow, and will not cease while the short branch A B remains immersed in the fluid. It is easy to see that the pressure of the air upon the surface of the fluid in the vessel, is the cause of its discharge through the siphon. For suppose G F the confines of the atmosphere, all the points of the surface A of the liquor will be equally pressed by the column of air A F; if, therefore, at some point of this surface, the pressure is suspended, the liquor must flow at that point, because it finds less resistance there than in any other part; this is therefore the obvious reason why the siphon becomes full immediately after the air is drawn out at the extremity C.

If the two branches of the siphon were of equal lengths, as B A, B D, the flow through the bent tube would not take place; because the column of air D G which would resist in D, being of an equal height with that which presses at A, would also be in equilibrium with it, in the same manner as the two columns of the fluid B A, B D. But since B C, one of the legs, is longer than the other, though the column of the air G C, which answers to it, is really longer than that which presses in A; yet it is not capable of preventing the passage of the fluid. To understand this more perfectly, let us consider the column of air G C to be divided into two parts, one of which G D, would form an equipoise with the column of air F A, and would be capable of stopping the flow from the tube if the branch B C ended in D. The portion of fluid which fills the part D C of the siphon, will find no other resistance in C than one column of air D C of the same length with it, which is evidently very inferior to it in weight. This portion of fluid then flows out, because it greatly exceeds in weight the column of air which is opposed to it. But while it continues to flow, nothing sustains that which is above it, which flows necessarily, while the pressure of the air at A furnishes a new supply of fluid to replace that which runs out. It is by these means, that the water in the siphon continues to flow without intermission; because the resistance of the air in C is as much exceeded, as the length of the branch B C of the siphon exceeds that of the branch A B. In order to prove this, suppose there is added at C a tube to lengthen that branch, then it will plainly appear that in a given time more water will flow than would have been discharged without that augmentation to the branch B C.

Since it is the pressure of the air which elevates the fluid in the short branch B A, it follows, that the height of this branch is limited to thirty-two feet when the fluid is water, because the pressure of the atmosphere cannot elevate water higher; but when the liquor is mercury, the height of the short branch should not exceed thirty inches, because the atmosphere cannot sustain mercury at a greater height.

A siphon may be disguised in a cup, fig. 5, from which no liquor will flow, until it be raised above the bend of the siphon; but when the efflux once begins, it will continue to flow till the vessel be emptied. This has been called Tantalus's cup, because it is usual to place a hollow figure over the inner tube of such a length, that when the fluid has got nearly up to the lips of the figure, the siphon may begin to act, and empty the cup.

Intermitting springs, which puzzled philosophers formerly, are found to be natural siphons, which may be thus explained: Let A fig. 6, be part of a hill, within which there is a cavity B B, and from this cavity a vein, or channel running in the direction B C D. The rain that falls upon the side of the hill will sink and strain through the small pores and crevices in the hill, and fill the cavity B B with water. When the water rises to the level of C, the vein B C D will be full, and the water will run through it as a siphon, and will empty the cavity B B. It must then stop, and when the cavity is again filled, it will begin to run again.

III. The action of fluids on solid bodies immersed in them, has been treated of in SPECIFIC GRAVITY, which see.

To finish the subject of hydrostatics, however, we may add that it is evident that when a solid body is plunged into a fluid, it occupies a space in that fluid exactly equal to its own magnitude. The quantity of fluid then so displaced, either equals in density, and consequently in weight, the solid which displaced it; or, on the contrary, one of the two must

weigh more than the other. In the last case, which is most common, the quantity by which the heavier body surpasses the lighter, is called the specific weight or gravity.

If a body is heavier than the fluid in which it is immersed, it is evident that it will sink to the bottom by its specific gravity. If a body is lighter than the same bulk of the fluid into which it is plunged, a part of it will swim, and the remaining part which is immersed displaces a quantity of fluid which weighs exactly as much as the whole of the solid body.

The instrument used for finding the specific gravities of bodies, is called the hydrostatic balance (fig. 18.) See SPECIFIC GRAVITY.

It differs very little from a common balance that is nicely made; only it has a hook at the bottom of one of the scales, on which different substances that are to be examined may be hung by horse-hairs, or silk threads, so as to be immersed in a vessel of water, without wetting the scale.

If a body thus suspended under the scale, at one end of the balance, be first counterpoised in air by weights in the opposite scale, and then immersed in water, the equilibrium will be immediately destroyed; then, if as much weight be put into the scale from which the body hangs, as will restore the equilibrium, without altering the weights in the opposite scale; that weight which restores the equilibrium, will be equal to the weight of a quantity of water as large as the immersed body; and if the weight of the body in air be divided by what it loses in water, the quotient will shew how much that body is heavier than its bulk of water. Thus, if a guinea suspended in air, be counterbalanced by 129 grains in the opposite scale of the balance, and then, upon its being immersed in water, it becomes so much lighter as to require $7\frac{1}{4}$ grains put into the scale over it, to restore the equilibrium, it shews that a quantity of water of equal bulk with the guinea, weighs $7\frac{1}{4}$ grains, or 7.25; by which divide 129 (the weight of the guinea in air), and the quotient will be 17.793; which shews that the guinea is 17.793 times as heavy as its bulk of water. And thus, any piece of gold may be tried, by weighing it first in air, and then in water; and if upon dividing the weight in air by the loss in water, the quotient comes out to be 17.793, the gold is good; if the quotient be 18, or between 18 and 19, the gold is very fine; but if it be less than 17, the gold is too much alloyed with other metal.

By this method, the specific gravities of all bodies that will sink in water, may be found; first weighing the body in air, then in water, and dividing the weight in air by the loss in water.

But as to those which are lighter than water, as most sorts of wood are, the following method must be taken: A sort of pincers, or tongs, must be provided, to retain the substance to be examined under water. First weigh the body in air; then having balanced the tongs in water, fix to it the body to be weighed, which being lighter than water, will raise the tongs, and cause the other scale to preponderate. Observe the loss of weight of the body in water, and proceed as before.

There are some things that cannot be weighed in this manner, as quicksilver, fragments of diamonds, &c. which must be put into a glass bucket hanging to the scale.

HYDROSULPHURETS, in chemistry. Sulphureted, or sulphurated hydrogen gas possesses the properties of an acid. It is absorbed by water, in considerable quantities, and the solution reddens vegetable blues; it combines also with alkalies and earths, and with several metallic oxides. The combinations which sulphureted hydrogen forms with bases have been called hydrosulphurets.

Sulphureted hydrogen combines with alkalies and earths, and forms with them compounds which may be distinguished by the following properties:

1. They are all soluble in water, and the solution is colourless.

2. When the solution is exposed to the air, it becomes green or greenish yellow, and deposits sulphur on the sides of the vessel in the state of a fine black crust.

3. After long exposure to the air, the solution becomes limpid and colourless; and on examination is found to contain only the sulphat of the base of the original hydrosulphuret.

4. The solution of the hydrosulphurets precipitate all metallic solutions; iron and lead, black; antimony, orange; arsenic, yellow.

The hydrosulphurets may be formed by dissolving or mixing the bases respectively with water, and causing sulphureted hydrogen gas to pass through them till they refuse to absorb any more. The excess of the gas is driven off by heating the solution. It is proper to cause the sulphureted hydrogen gas to pass through a small vessel of water before it reaches the base with which it is to combine, in order to separate any impurities with which it might be mixed. By this method solutions of the different hydrosulphurets in water may be obtained.

If these compounds be decomposed while they are colourless, by pouring upon them sulphuric acid, muriatic acid, or any other acid which does not act upon hydrogen, the sulphureted hydrogen gas exhales without the deposition of a single particle of sulphur; but if the hydrosulphuret has become yellow, some sulphur is always deposited during its decomposition, and the quantity of sulphur is proportioned to the deepness of the colour.

The yellow colour, therefore, which hydrosulphurets acquire by exposure to the atmosphere is owing to a commencement of decomposition. Part of the hydrogen of the sulphureted hydrogen abandons the sulphur, combines with the oxygen of the atmosphere, and forms water. By degrees, however, a portion of the sulphur is also converted into an acid; and when the proportion of sulphureted hydrogen is diminished, and that of the sulphur increased to a certain point, the sulphur and the hydrogen combine equally with oxygen.

If sulphuric or muriatic acids be poured upon a hydrosulphuret after it has been for some time exposed to the air, a quantity of sulphureted hydrogen gas exhales, sulphur is deposited, and after an interval of time sulphureous acid is disengaged. It is therefore sulphurous, and not sulphuric acid, which is formed while the hydrosulphuret spontaneously absorbs oxygen. This acid, however, is not perceptible till after a certain interval of time, when separated from the hydrosulphuret by means of another acid; because as long as it meets with sulphureted hydrogen a reciprocal decomposition takes place. The oxygen of the acid combines with the hydrogen of the gas, and the sulphur of both is precipitated.

The affinities of the alkalies and earths for sulphureted hydrogen appear from the experiments of Berthollet to be as follows:

Barytes,	Ammonia,
Potass,	Magnesia,
Soda,	Zirconia.
Lime,	

HYGROMETER, a machine, or instrument whereby to measure the degrees of dryness, or moisture of the atmosphere.

There are divers sorts of hygrometers; for whatever body either swells or shrinks, by dryness or moisture, is capable of being formed into an hygrometer. Such are woods of most kinds, particularly ash, deal, poplar, &c. Such also is catgut, the beard of a wild oat, &c. Stretch an hempen cord or lutestring, as A B, (plate Hydrostatics, fig. 21.), along a wall, bringing it over a pulley, B; and to the other end D, fix a weight E; into which fit an index F. On the same wall fit a plate of metal H I, divided into any number of equal parts, and the hygrometer is compleat. For it is known from experience that moisture sensibly shortens the length of cords or fiddle-strings; and that as the moisture evaporates, they return to their former length. The weight, therefore, in the present case, upon an increase of the moisture of the air, will ascend; and upon a diminution of the same, it will descend.

Hence, as the index F will shew the spaces of ascent and descent; and those spaces are equal to the increments and decrements of the length of cord, or gut, A B D; the instrument will discover whether the air is more or less humid now, than it was at another given time.

But if a more sensible and accurate hygrometer is required, strain a whipcord or fiddlestring over several pullies, C, D, E, F, and G, fig. 22, and proceed as in the former example. Nor does it matter whether the several parts of the cord are parallel to the horizon, as expressed in the figure or perpendicular to the same.

The advantage of this above the former hygrometer, is, that we have a greater length of cord in the same compass; and consequently greater contraction or dilatation.

The following is much more lasting: Take a nice balance and place in it a sponge, or other body, which easily imbibes moisture; and let it be in equilibrio, with a weight hung at the other end of the beam. Now if the air become moist, the sponge becoming heavier, will preponderate; if dry, the sponge will be raised up. This balance may be contrived two ways; by either having the pin in the middle of the beam, with a slender tongue a foot and a half long, pointing to the divisions on an arched plate fitted to it; or, the other extremity of the beam may be made so long as to describe a large arch on a board placed for the purpose, as is represented in the figure.

To prepare the sponge, it may be necessary to wash it in water; and when dry again, in water or vinegar, in which sal ammoniac, or salt of tartar, has been dissolved, and let it dry again, then it is fit to be used.

A, fig. 23, represents a thin piece of sponge, so cut as to contain as large a superficies as possible. This hangs by a fine thread of silk, upon the beam B, and is exactly balanced from another thread of silk at D, strung with the smallest lead shot, at equal distances, and so adjusted as to cause the index to point at G, in the middle of the graduated arch F G H, when the air is in a middle state between the greatest moisture and the greatest dryness. I, shews a little table or shelf for that part of the silk and shot which is not suspended to rest upon.

Both Dr. Hales and Dr. Desaguliers contrived another form of sponge hygrometer, on this principle. They made an horizontal axis, having a small part of its length cylindrical, and the remainder tapering conically with a spiral thread cut in it, after the manner of the fuzee of a watch. See fig. 24. The sponge is suspended by a fine silk thread to the cylindrical part of the axis upon which it winds. This is balanced by a small weight W, suspended also by a thread, which winds upon the spiral fuzee. Then when the sponge grows heavier, in moist weather, it descends and turns the axis, and so draws up the weight; which coming to a thicker part of the axis it becomes a balance to the sponge, and its motion is shewn by an attached scale: and vice versa when the air becomes drier. Salt of tartar, or any other salt, or pot-ashes, may be put into the scale of a balance, and used instead of the sponge.

HYMEN. See ANATOMY.

HYMENÆA, the bastard locust tree; a genus of the monogynia order, in the decandria class of plants; and in the natural method ranking under the 33d order, lomentaceæ. The calyx is quinquepartite; there are five petals, nearly equal; the style is intorted; the legumen full of mealy pulp. There is but one species, the courbaril, which is a large tree growing naturally in the Spanish West Indies. The trunk is covered with a light ash-coloured bark, is often more than sixty feet high, and three in diameter. The seeds are covered with a light brown sugary substance, which the Indians scrape off and eat with great avidity, and which is very agreeable. At the principal roots under ground, is found collected in large lumps a yellowish red transparent gum, which dissolved in rectified spirit of wine affords a most excellent varnish, and is the gum anime of the shops.

HYMENOPTERA, derived from ὑμὴν membrane and πτερον wing, in the Linnæan system of natural history, is an order of insects having four membranaceous wings, and the tails of the females are furnished with stings, which in some are used for instilling poison, and in others for merely piercing the bark and leaves of trees, and the bodies of other animals, in which they deposit their eggs.

HYOBANCHE, a genus of the angiospermia order, in the didynamia class of plants. The calyx is heptaphyllous; the corolla ringent, with no under lip. The capsule bilocular, and polyspermous. There is one species a parasitical plant of the Cape.

HYOIDES. See ANATOMY.

HYOSCYAMUS, henbane, in botany, a genus of the monogynia order, in the pentandria class of plants; and in the natural method ranking under the 28th order, luridæ. The corolla is funnel-shaped and obtuse; the stamina inclining to one side; the capsule covered and bilocular. There are eight species, one of which, viz. the niger, or common henbane, is a native of Britain. It grows on road-sides, and among rubbish. It is a biennial plant, with long fleshy roots which strike deep into the ground, sending out several large soft leaves, deeply flashed on their edges: the following spring the stalks come up, which are about two feet high, with yellow flowers standing on one side in a double row, sitting close to the stalks alternately. The seeds, leaves, and roots of this plant, as well as of all other species of this genus, are poisonous: and many well-attested instances of their bad effects are recorded; madness, convulsions, and death, being the common consequence. In a smaller dose they occasion giddiness and stupor. It is said that the leaves scattered about a house will drive away mice. The juice of the plant evaporated to an extract is prescribed in some cases as a narcotic; in which respect undoubtedly it may be a powerful medicine if properly managed. The dose is from half a scruple to half a dram. The roots are used for anodyne necklaces. Goats are not fond of the plant; horses, cows, sheep, and swine refuse it.

HYOSERIS, a genus of the polygamia æqualis order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is naked, the calyx nearly equal; the pappus hairy, or scarce perceptible. There are ten species, resembling dandelion.

HYOTHYROIDES. See ANATOMY.

HYPALLAGE, among grammarians, a species of hyperbaton, consisting in a mutual permutation of one case for another. Thus, Virgil says, "dare classibus austros," for "dare classes austris;" and again, "necdum illis labra admovi," for "necdum illa labris admovi."

HYPECOUM, wild cummin; a genus of the digynia order, in the tetrandria class of plants; and in the natural method ranking under the 24th order, corydales. The calyx is diphyllous; the petals four; the exterior two larger and trifid; the fruit a pod. There are three species, all of them low herbaceous plants with yellow flowers. The juice of these plants is of a yellow colour, resembling that of celandine, and is affirmed by some eminent physicians to be as narcotic as opium. From the nectarium of the blossom the bees collect great quantities of honey.

HYPERBATON, in grammar, a figurative construction inverting the natural and proper order of words and sentences. The several species of the hyperbaton are the anastrophe, the hysteron-proteron, the hypallage, synchysis, tmesis, parenthesis, and the hyperbaton, strictly so called.

HYPERBATON, strictly so called, is a long retention of the verb, which completes the sentence, as in the following example from Virgil:

Interea *reges:* ingenti mole Latinus
Quadrijugo vehitur curru, cui tempora circum
Aurati bis sex radii fulgentia cingunt
Solis avi specimen: bigis it Turnus in albis,
Bina manu lato crispans hastilia ferro:
Hinc pater Æneas Romanæ stirpis origo,
Sidereo flagrans clypeo & cœlestibus armis;
Et juxta Ascanius magnæ spes altera Romæ
Procedunt castris.

HYPERBOLA, in geometry, the section of a cone made by a plane, so that the axis of the section inclines to the opposite leg of the cone, which in the parabola is parallel to it, and in the ellipsis intersects it. The axis of the hyperbolical section will meet also with the opposite side of the cone, when produced above the vertex. See CONIC SECTIONS.

HYPERBOLE, in rhetoric, a figure, whereby the truth and reality of things are excessively either enlarged or diminished.

HYPERBOLIC CYLINDROID, is a solid figure, whose generation is given by Sir Christopher Wren, in the Philosophical Transactions. Thus, two opposite hyperbolas being joined by the transverse axis, and through the centre a right line being drawn at right angles to that axis; and about that, as an axis, the hyperbolas being supposed to revolve; by such revolution, a body will be generated, which is called the hyperbolic cylindroid, whose bases, and all sections parallel to them, will be circles. In a subsequent transaction, the same author applies it to grinding of hyperbolical glasses; affirming, that they must be formed this way, or not at all. Hyperbolic leg of a curve, is that which approaches infinitely near to some asymptote. Sir Isaac Newton reduces all curves, both of the first and higher kinds, into those with hyperbolic legs, and those with parabolic ones.

HYPERBOLIC line is used by some authors for what we call the hyperbola itself. In this sense, the plane surface, terminated by the curve line, is called the hyperbola, or hyperbolic space; and the curve line that terminates it the hyperbolic line.

HYPERBOLOIDES, are hyperbolas of the higher kind, the nature of which is expressed by this equation: $ay^{m \times n} = bx^m (a + x^n)$: especially if $m > 1$, or $n > 1$, e. g. $ay^3 = bx^2 (a + x)$.

HYPERICUM, St. John's wort; a genus of the polyndria order, in the polydelphia class of plants; and in the natural method ranking under the 20th order, rotaceæ. The calyx is quinquepartite; the petals five; the filaments many, and coalited at the base into five pencils; the seed-vessel is a pencil. Of this genus there are 57 species, most of them hardy deciduous shrubs. The most remarkable are, 1. The hircinum, or stinking St. John's wort. Of this there are three varieties; one with strong stalks, six or eight feet high, broad leaves and large flowers; the other with strong stalks, broad leaves, and without any disagreeable odour; the third has variegated leaves. All these varieties are shrubby, and flower in June and July in such numerous clusters, that the shrubs appear covered with them; and produce abundance of seed in autumn. 2. The canariensis has shrubby stalks, and at the ends of the branches, clusters of yellow flowers appearing in June and July. 3. The ascyron, or dwarf American St. John's wort, has spreading roots, sending up numerous slender square stalks, a foot long, and at the end of the stalks large yellow flowers. 4. The androsæmum, commonly called tutsan, or park-leaves, has clusters of small yellow flowers appearing in July and August, and succeeded by roundish berry-like black capsules. This grows naturally

in many parts of Britain. 5. The balearicum, or water-leaved St. John's wort, is a native of Majorca, and has a shrubby stalk, with reddish scarified branches, small oval leaves warted underneath, and large yellow flowers appearing great part of the year. 6. The monogynum, or one-styled China hypericum, has a shrubby purplish stalk, about two feet high, and clusters of small yellow flowers, with coloured cups, and only one style, flowering the greatest part of the year.

The tutsan long held a place in the medicinal catalogues; but its uses are very little thought of at present. The leaves given in substance are said to destroy worms. By distillation they yield an essential oil. The flowers tinge spirits and oils of a fine purple colour. Cows, goats, and sheep eat the plant; horses and swine refuse it. The dried plant boiled in water with alum dyes yarn of a yellow colour; and the Swedes give a fine purple tinge to their spirits with the flowers.

HYPHYDRA, a genus of the class and order monoecia gynandria; the male cal. is one-leafed; cor. none; stam. six. The female no cal. or cor.; caps. one-celled. There is one species, a little aquatic plant of Guiana, of no note.

HYPNUM, feather-moss; a genus of the natural order of musci, belonging to the cryptogamia class of plants. The anthera is operculated, or covered with a lid; the calyptra smooth; the filament lateral, and rising out of a perichætium, or tuft of leaflets different from the other leaves of the plant. There are fifty species, many of them natives of Great Britain; none of them, however, have any remarkable property, except the proliferum and parietinum. The first is of a very singular structure, one shoot growing out from the centre of another; the veil is yellow and shining; the lid with a kind of long bill; the leaves not shining; sometimes of a yellowish, and sometimes of a deep green. This moss covers the surface of the earth in the thickest shades, through which the sun never shines, and where no other plant can grow. The second has shoots nearly flat and winged, undivided for a considerable length, and the leaves shining; but the old shoots do not branch into new ones as in the preceding species. It grows in woods and shady places; and, as well as the former, is used for filling up the chinks in wooden houses.

HYPOCAUSTUM, among the Greeks and Romans, a subterraneous place, wherein was a furnace, to heat the baths.

HYPOCHÆRIS, hawk's-eye; a genus of the polygamia æqualis order, in the syngenesia class of plants; and in the natural method ranking under the 49th order, compositæ. The receptacle is paleaceous; the calyx a little imbricated; the pappus glumy. There are five species; none of which have any remarkable property, except the maculata, or spotted hawk's-eye. It is a native of Britain, and grows on high grounds. The leaves are boiled and eaten like cabbage. Horses are fond of this plant when green, but not when dry. Cows, goats, and swine eat it; sheep are not fond of it.

HYPOCHONDRIA. See ANATOMY and MEDICINE.

HYPOTHENUSE, in geometry, the longest side of a right-angled triangle; or it is that side which subtends the right angle.

Euclid, lib. 1. proposition XLVII. demonstrates, that, in every rectilinear right-angled triangle, the square of the hypothenuse is equal to the squares of both the other sides.

This celebrated problem was discovered by Pythagoras, who is said to have sacrificed a hecatomb to the Muses, in gratitude for the discovery.

HYPOXIS, a genus of the monogynia order, in the hexandria class of plants; and in the natural method ranking under the 10th order, coronariæ. The corolla is divided into six parts, and persisting, superior; the capsule narrowing at the base; the calyx a bivalved glume. There are fourteen species, bulbs of America and the Cape.

HYRAX. Hyrax, a genus of quadrupeds of the glires order. The generic character is, front teeth in the upper jaw two, broad, somewhat distant; in the lower jaw four, broad, flat, twice crenated; grinders large, four on each side in both jaws; fore-feet with four toes; hind-feet with three toes; tail none; clavicles none. This genus is distinguished from all the rest of the glires by the remarkable circumstance of having four teeth in the lower jaw instead of two: these lower teeth are also of a different structure from the upper, being broad, short, and crenated or denticulated at the top: the upper teeth in this genus are also less sharp or pointed than in the rest of the glires. In other particulars the genus hyrax seems most nearly allied to that of cavia. The most remarkable species are:

1. Hyrax Capensis is a native of mountainous situations about the Cape of Good Hope; residing in the hollows of rocks, and leaping with great agility about the prominences of the irregular regions it frequents, though its general or walking pace is not remarkably quick. Its size is nearly that of a rabbit, and in colour it much resembles that animal, but is whitish beneath. It is said to be known at the Cape by the name of rock badger, but Mr. Allamand observes, that this is an improper name, since the structure of its feet evidently shews that it has no power of digging or burrowing. It is a diurnal animal, and by night retires into the cavities of rocks, &c.

This animal appears to be easily tamed, and in that state is observed to be remarkably cleanly, and of a lively and active disposition; leaping almost as readily and with as much security as a cat.

2. Hyrax Syriacus, or Syrian hyrax, seems to have been first clearly described by Mr. Bruce, in the appendix to his celebrated Abyssinian Travels. It is found in Ethiopia, in the caverns of the rocks, or under the great stones in the Mountain of the Sun, behind the queen's palace at Koscam. It is also frequent in the deep caverns in the rock in many other parts of Abyssinia. It does not burrow or make holes, as the rat and rabbit.

In the place of holes, it seems to delight in less close, or more airy places, in the mouths of caves, or clefts in the rock. They do not stand upright upon their feet, but seem to steal along as in fear, their belly being nearly close to the ground, advancing a few steps at a time, and then pausing. They have something very mild, feeble, and timid, in their deportment; are gentle and easily tamed, though, when roughly handled at the first, they bite very severely. The hyrax is supposed to be the animal erroneously called by our translators of the bible cuniculus, the rabbit or coney. See Plate Nat. Hist. fig. 230.

3. Hyrax Hudsonius. Its colour is a cinereous brown, with the ends of the hairs white. It is a native of Hudson's Bay. Its size is nearly that of a common marmot; the feet are tetradactylous; of a similar form to those of the cape hyrax, but have rounded claws on all the toes.

HYSSOPUS, hyssop, a genus of the gymnospermia order, in the didynamia class of plants; the cor. has the lower lip with a small crenate segment; stam. straight, distant. There are three species; but only one of them, viz. the officinalis, or common hyssop, is cultivated for use. Besides possessing the general virtues of aromatics, they have been supposed useful in humoral asthmas, coughs, and other disorders of the lungs; and are said to promote expectoration.

HYSTERICS. See MEDICINE.

HYSTRIX. Porcupine, a genus of quadrupeds, of the order glires. The generic character is front-teeth two, both in the upper and under jaw, obliquely cut; grinders eight; body covered with spines intermixed with hairs; four toes on the fore-feet; five on the hind.

1. Common porcupine. From their obvious external characters alone, without reference to the form and disposition of the teeth, the porcupine and the hedgehog might be placed together; but such is the dissimilarity of these organs, that the one must of necessity belong to the Linnæan order feræ, and the other to that of glires.

The singular appearance of the porcupine, so different from that of the generality of quadrupeds, must in the earliest ages have attracted the attention even of the most incurious; the variegated spines or quills with which it is covered, naturally suggesting the idea of a fierce and formidable animal: it is, however, of a harmless nature, and the quills are merely defensive weapons, which, when disturbed or attacked, the animal erects, and thus endeavours to repel his adversary.

The general length of the porcupine *is* about two feet from head to tail, and *that of* the tail about four inches. The upper parts of the animal are covered with long, hard, and sharp quills; those towards the middle and hind part of the body being longer than the rest, and measuring from nine or ten to twelve or fifteen inches in length: they are very sharp-pointed, and are variegated with several alternate black and white rings: the root, or point of attachment, is small: the head, belly, and legs, are covered with strong dusky bristles, intermixed with softer hairs: on the top of the head the hairs are very long, and curved backwards in the manner of a ruff or crest: the ears are short and rounded: the nose blunt; the upper lip divided by a strongly-marked furrow; the two fore-teeth, both above and below, extremely large and strong: the fore feet have four toes; the hind feet five; all armed with strong crooked claws: the tail is covered with short and rather flattish quills, which are often abrupt or truncated, rather than pointed at the extremities. This animal is a native of Africa, India, and the Indian islands: it is also found in some of the warmer parts of Europe, and is said to be not very uncommon in Italy and

HYDROSTATICS &c.

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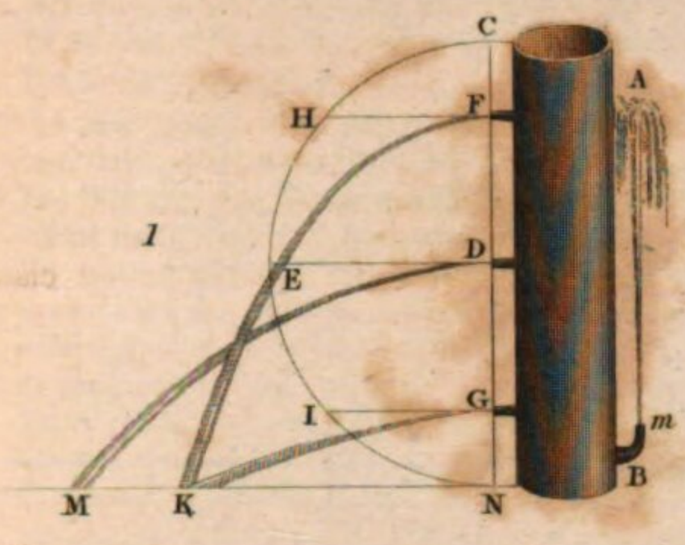

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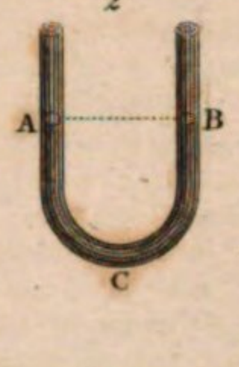

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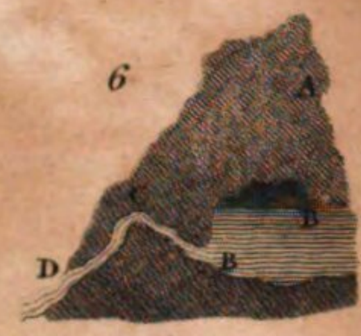

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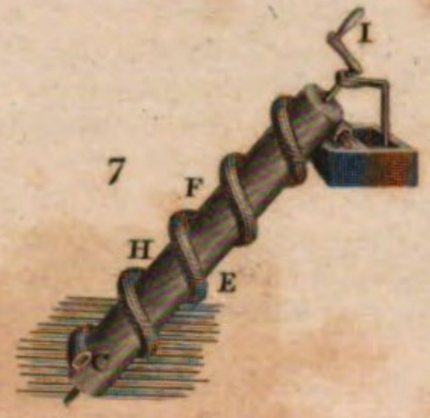

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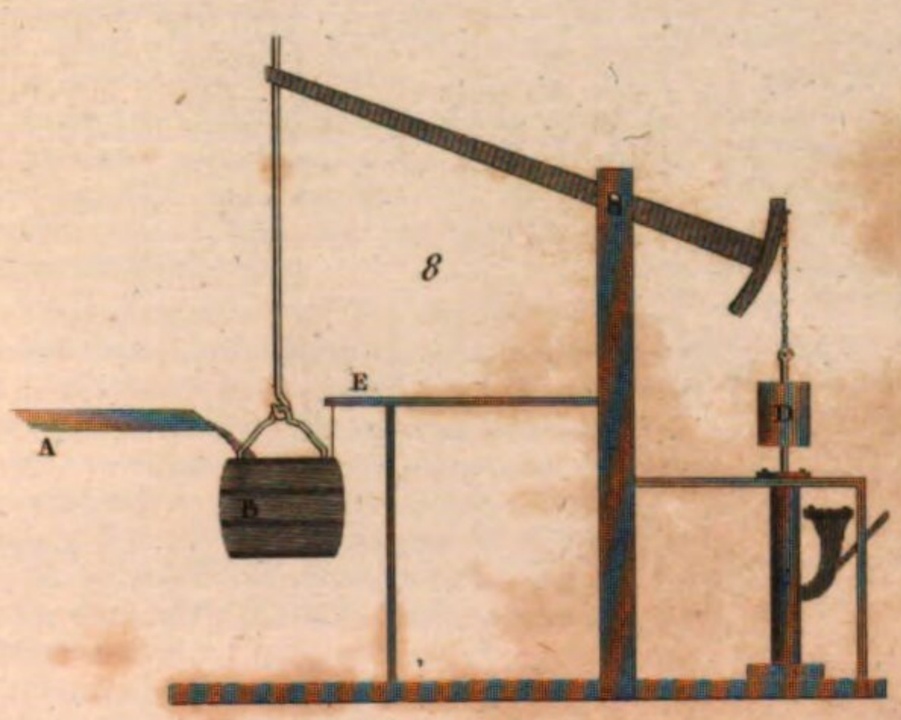

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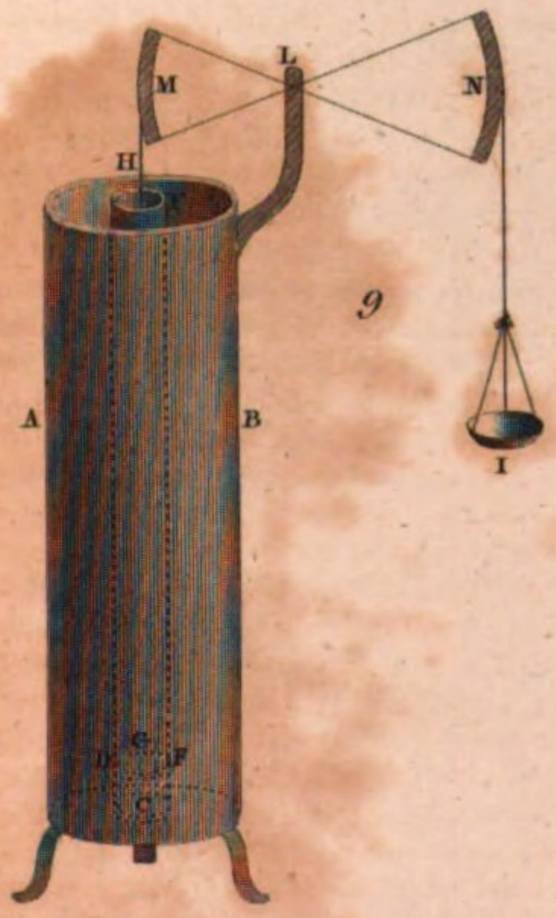

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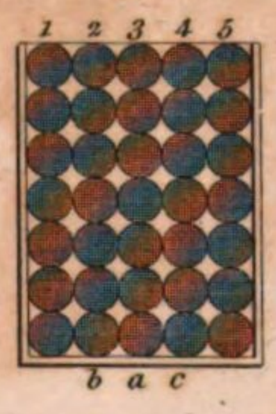

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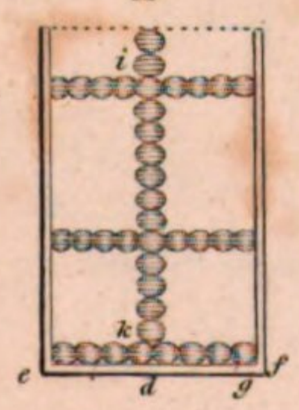

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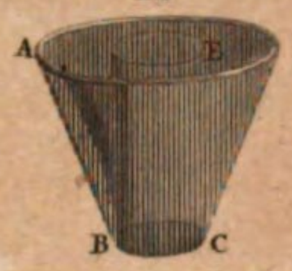

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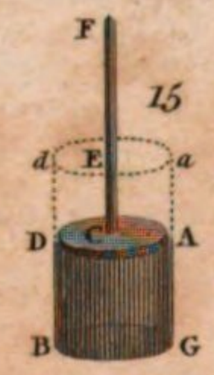

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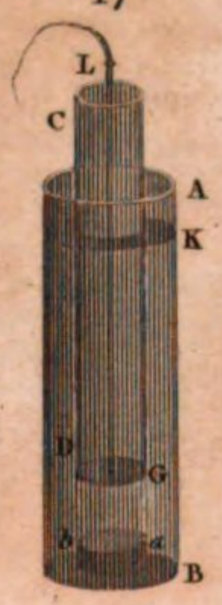

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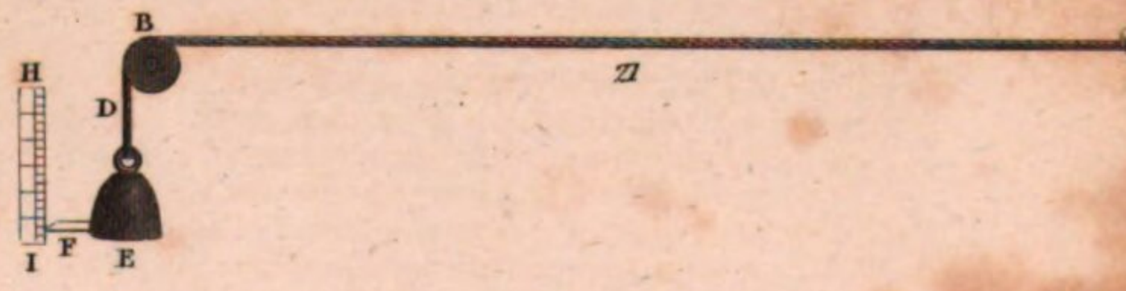

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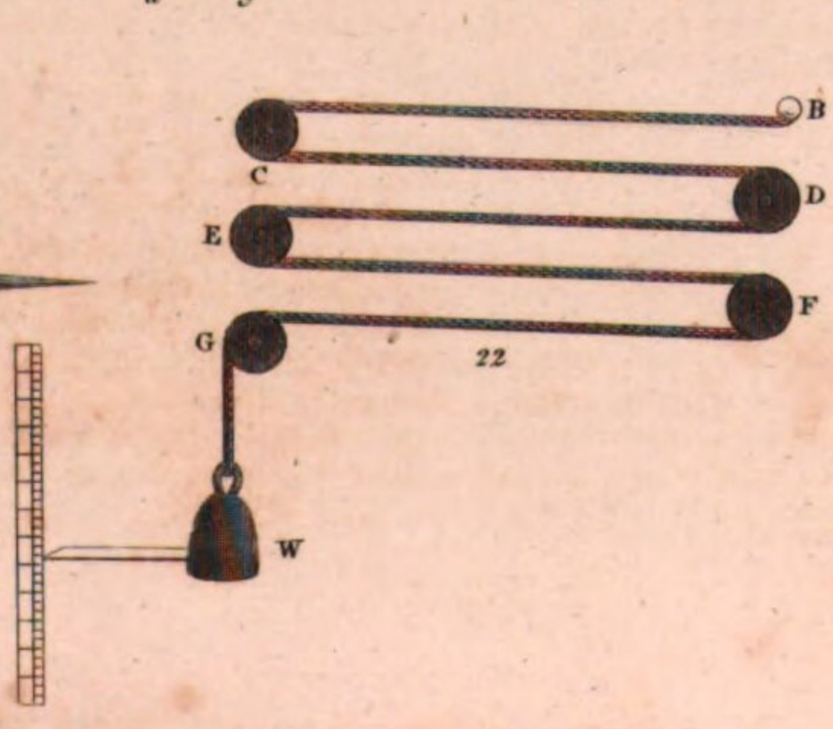

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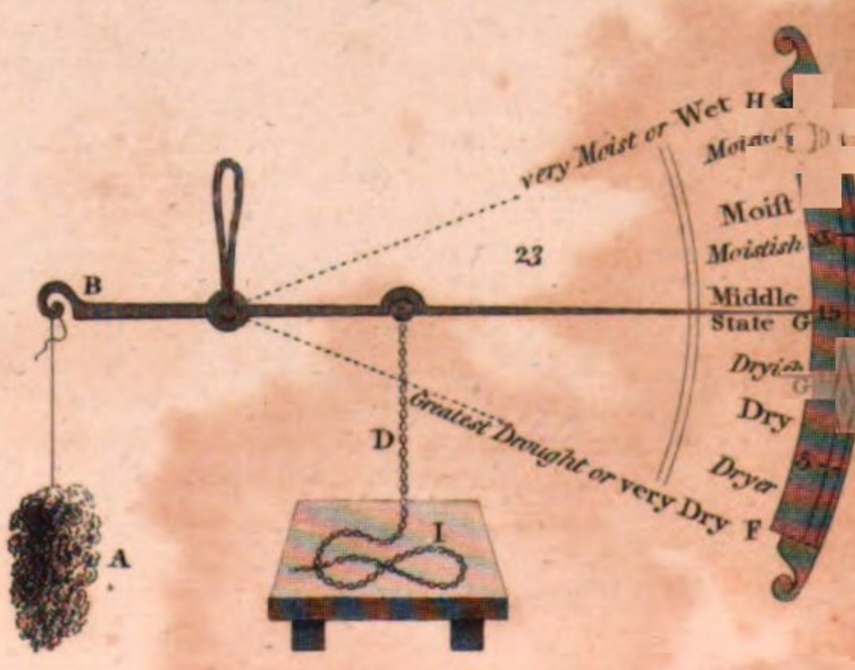

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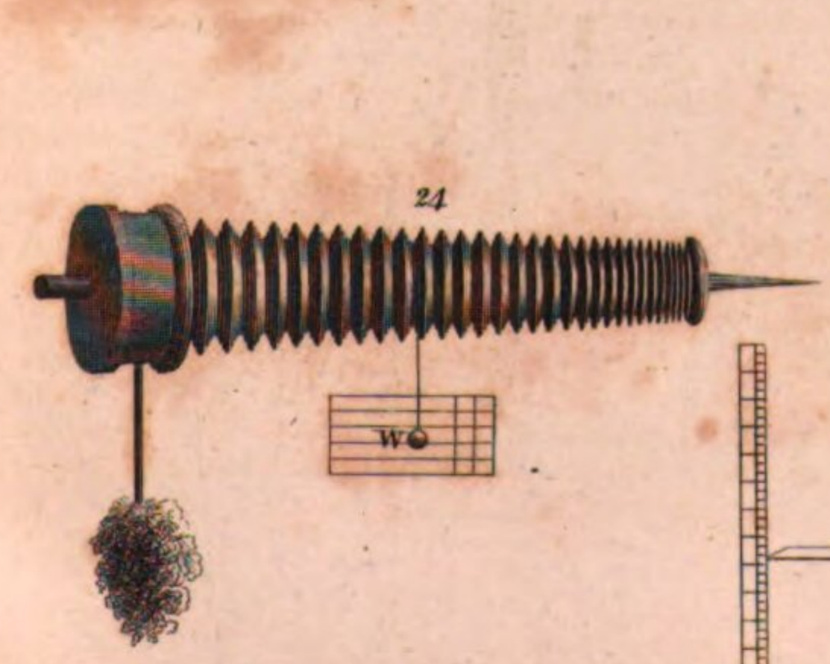

Sicily; but is supposed to have been originally imported into those parts of Europe from other regions.

The power of darting its quills with great violence, and to a considerable distance, so confidently ascribed to the porcupine, has been doubted; but it is surely not improbable that the porcupine possessing, like other quadrupeds, the power of corrugating or shaking the general skin of its body, may sometimes by this motion cast off a few of its loose quills to some distance, and thus slightly wound any animal that may happen to stand in its way; and this may have given rise to the popular idea of its darting them at pleasure against its enemies. That it really does cast them off occasionally with some degree of violence there is no reason to doubt. The strongest and shortest of the quills are most easily detached, and are those which the animals dart against the hunters, by shaking their skin as dogs do when they come out of the water.

The porcupine feeds principally on roots, fruits, barks, and other vegetable substances: it inhabits holes or subterraneous retreats, which it is said to form into several compartments or divisions, leaving only a single hole or entrance. It sleeps much by day, and makes its excursions for food during the night. The female produces two young at a birth, and these, if taken early, are said to be easily tamed.

The porcupine admits of considerable variety as to the length and proportion of the quills in different specimens and from different countries: the long crested bristles on the back of the head, in particular, are much more conspicuous in some than in others. See Plate, Nat. Hist. fig. 231.

2. Hystrix prehensilis, is an American species, and is found in many of the hotter parts of that continent; particularly in Brasil, where it inhabits woods, and climbs trees; clinging occasionally to the branches by its tail, in the manner of some of the opossums and monkies. It is said to feed not only on fruits of various kinds, but also on birds. It sleeps during the greater part of the day, concealing itself in the hollows of trees, or beneath their roots. Its voice, according to Marcgrave, resembles the grunting of a pig. Its general length is about a foot, and the tail about eighteen inches. The whole animal, except on the belly and insides of the limbs, is covered with short, strong, and very sharp spines, of which the longest measure three inches, and are white, barred towards the points with black. The colour of the hair with which the under parts are covered is a dusky brown. The head is small; the nose extremely blunt; and the teeth very large and strong: the ears short, moderately large, and rounded; the feet have four toes each, with strong claws, and a tubercle in place of a fifth toe; the tail is covered with spines for about a third part of its length; the remainder being nearly naked, and strongly prehensile.

3. Hystrix Mexicana. The Mexican porcupine, which is placed as a variety of the hystrix prehensilis in the Gmelinian edition of the Systema Naturæ, seems to be justly considered by Mr. Pennant as a distinct species. It is as large, according to Hernandes, as a middle-sized dog, and is of a dusky brown colour, with very long bristles intermixed with the fur. This animal inhabits the hilly parts of Mexico, residing in woods, and feeding, like the former, on fruits, &c. It is said to be easily tamed.

4. Hystrix macroura. The iridescent porcupine is an animal of a very extraordinary appearance. It is of a very thick form, and is coated with short, stiff, needle-like bristles, or small spines, which, according to the different directions of the light, exhibit changeable colours, appearing either of a gilded green, or of a reddish tinge. If we except the gilded, or cape mole, it seems to be almost the only quadruped yet known with changeable-coloured hair.

5. Hystrix fasciculata is a native of Malacca. It differs from the common porcupine in several particulars, and especially in the form and length of its tail, which is naked, scaly, about a third of the length of the body, and terminated by a tuft of long flat hairs, or rather small white laminæ, resembling strips of parchment. The body measures fifteen or sixteen inches, and is consequently less than that of the European porcupine.

This species, like others of its genus (which nature seems to have provided with defensive weapons only), possesses a kind of instinctive fierceness: when approached, it stamps with its feet, and appears to inflate itself, raising and shaking its quills. It sleeps much by day, and is active only by night. It eats in a sitting posture, holding apples and other fruits between its paws, peeling them with its teeth.

6. Hystrix dorsata is a native of the northern parts of America, and is not uncommon in Canada. It is a short thick-bodied animal, approaching somewhat to the form of a beaver, and is remarkable for the length and fulness of its fur, which is soft, of a dusky brown colour, and intermixed with longer and coarser hairs with whitish tips. Edwards compares the size to that of a fox, though the shape is widely different. The spines are nearly hid in the fur, and are only visible on a close inspection: they are situated on the head and upper parts, as well as on the tail: the longest are those on the back, which measure about three inches, while those on the other parts are proportionally shorter: they are strong and sharp-pointed, and so formed as to appear, when examined with a magnifier, as if barbed at the tips with numerous, small, reversed points or prickles, and are so slightly attached to the skin as to be loosened with great ease: and the animal will sometimes purposely brush against the legs of those who disturb it, leaving several of the spines sticking in the skin.

It is said to feed principally on the bark of the juniper tree. It drinks by lapping, in the manner of a dog. It resides in holes under the roots of trees, on which, like some others of this genus, it often climbs, and is thus killed by the American Indians, who consider it as a useful article of food: they also use the quills by way of fringes, and for the purpose of ornamenting their boxes, &c.

END OF THE FIRST VOLUME.

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EXPLANATION OF THE ARTERIES, VEINS, AND ABSORBENTS, IN THE ANATOMICAL PLATES,

OMITTED TO BE INSERTED IN ITS PROPER PLACE.

FIG. I. ARTERIES.

1. Aorta
2. Trunk of the coronal artery
3. Ligamentum arteriosum
4. Subclavian artery
5–5. Carotid arteries
6–6. Vertebral arteries
7–7. Arteries of the lower part of the face, &c.
8–8. Temporal arteries
10–10. Trunks to the foramina-narium
11–11. Occipital arteries
12–12. Arteries to the fauces
13–13. Contorsions of the carotids
14–14. Carotid arteries
15. Contorsions of the vertebrals
16. Vertebrals on the medulla-oblongata
18. Arteries within the skull
19. Arteries of the larynx
20–20. Arteries to the muscles of the neck and scapula
21–21. Mammary arteries
22. Arteries to the muscles of the os-humeri
23. } Divisions of the arteries of the arm.
24. }
25–25. Branch of artery not always found
26–26. External artery of the cubitus
27–27. Arteries of the hand and fingers
29. Bronchial artery
30. Descending aorta
31. Intercostal arteries
32. Cæliac artery
33. Hepatic arteries
34. Gall-bladder, on which the arteria-cystica ramifies
35. Lower coronary artery
36. Pyloric artery
37. Epiploic artery
38. Ramifications of the coronary artery
39. Upper coronary artery
40–40. Phrenic arteries
41. Splenic artery
43. Upper mesenteric artery
44. Superior branches of the mesenteric
45. Lower mesenteric artery
49–49. Emulgent arteries
50. Vertebral arteries of the loins
51. Spermatic arteries
52. Arteria Sacra
53–53. Iliac arteries
54–54. Iliacus externus
55–55. Iliacus internus
56–56. Umbilical arteries
57–57. Epigastric arteries
60. Arteries to the penis
61. Artery of the urinary bladder
62. Arteries of the pudendum
63. Penis
64. Glans-penis
65. Upper part of the dorsum-penis
66. Corpora cavernosa-penis
67. Arteries of the penis
68. Septum of the corpora-cavernosa
69. Crural artery
70. Arteries to the muscles of the thighs and tibiæ
71. Part of the crural artery
72. Three trunks of the arteries of the leg
73. Arteries of the foot.
A. Semilunar valves
B. B. Small portions of the basis of the skull
C. Pituitary gland
D. D. Opthalmic arteries
E. E. Arteries of the cerebellum.

FIG. II. VEINS.

a. *a*. Vena-cava
b. Descending trunk of a cava
c. Ascending trunk
d. *d*. Subclavians
e. Vena-azygas
f. Intercostal veins
g. Mammary veins
i. *i*. Internal jugulars
l. *l*. External jugulars
m. Right axillary vein
n. Cephalic
o. Basilic
q. Phrenic
s. *s*. Emulgents
w. Internal iliacs
1. Vena sacra
2. Spermatic veins
3. Epigastric
4. Saphena.

FIG. III. ABSORBENTS.

1. The neck
2–2. Jugular veins
3. Vena-cava. Superior
4–4. Subclavian veins
5. Beginning of aorta, pulled on one side to shew the thoracic duct
6. Branches
7. Carotid artery
9. Trachea
10. Spine
11. Vena azygos
12. Descending aorta
13. Cæliac artery, dividing into 3 branches
14. Superior mesenteric artery
15. Right crus diaphragmatis
16–16. Two kidneys
17. Right emulgent artery
18. External iliac arteries
19. Internal iliac artery
20. Cavity of the pelvis
21–21. Spine of the os ilium
22–22. Groins
23. A lymphatic gland in the groin, receiving lymphatics from the lower extremity
24–24. Lymphatics of the lower extremities
25. A plexus of lymphatics on the side of the pelvis
26–29. Musculi psoæ
27. A plexus of lymphatics, which having passed over the brim of the pelvis at (25), and having entered the cavity of the pelvis, next ascends and passes behind the iliac artery to (29).
28. Lymphatics of the left side passing over the upper part of the os sacrum, to meet those of the right side.
29. Right psoas, with a plexus of lymphatics on its side
31. Spaces occupied by lymphatic glands
32. Trunk of the lacteals
33. The same dividing into two branches
34. Thoracic duct
35. Duct passing under the crus diaphragmatis, and under the right emulgent artery
38. Thoracic duct, passing under the curvature of the aorta, to be inserted into the left subclavian vein
39. A plexus of lymphatics passing upon the trachea from the thyroid-gland to the thoracic duct.

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